Title: PRODRUGS OF IMIDAZOLE DERIVATIVES, FOR USE AS PROTON PUMP INHIBITORS IN THE TREATMENT OF E.G. PEPTIC ULCERS

Abstract: An imidazole compound represented by the formula (I), a salt thereof and a compound of the formula (V), which is one of the intermediates thereof, wherein each symbol is as defined in the present specification. The compound of the present invention shows a superior anti-ulcer activity, a gastric acid secretion inhibitory action, a mucosa-protecting action, an anti-Helicobacter pylori action and the like. Since it shows low toxicity, the compound is useful as a pharmaceutical product.
DESCRIPTION
IMIDAZOLE COMPOUND, PRODUCTION METHOD THEREOF AND USE THEREOF

Technical Field

The present invention relates to an imidazole compound, which is converted to a proton pump inhibitor in living organisms and shows an anti-ulcer activity and the like, a production method thereof and use thereof.

Background Art

There are known variously substituted 2-(pyridylmethyl)sulfinyl)-1H-benzimidazole derivatives and structurally related sulfoxides, that inhibit the proton pump and show anti-ulcer activity and the like. For example, a compound having a general name lansoprazole, 2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole, and a salt thereof are reported in JP-A-61-50978 and the like. In addition, a compound having a general name, omeprazole (5-methoxy-2-[[4-methoxy-3,5-dimethyl-2-pyridyl]-methyl]sulfinyl]-1H-benzimidazole) and a salt thereof are described in JP-A-54-141783 and the like, a compound having a general name, pantoprazole (5-difluoromethoxy-2-[[3,4-dimethoxy-2-pyridyl]-methyl]sulfinyl]-1H-benzimidazole) and a salt thereof are described in JP-A-61-22079 and the like, a compound having a general name, rabeprazole (2-[[4-(3-methoxypropoxy)-3-methyl-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole) and a salt thereof are described in JP-A-1-6270 and the like, and a compound having a general name, tenatoprazole (5-methoxy-2-[[4-methoxy-3,5-dimethyl-2-pyridyl]methyl]sulfinyl]imidazo[4,5-b]pyridine) and a salt thereof are described in JP-A-63-146882 and the like.

However, since the above-mentioned compounds are unstable to acids, for oral administration, they are formulated into an enteric-coated preparation, filled in a capsule and administered, or filled in an enteric capsule and administered,
or formulated into an enteric tablet and administered, thereby to prevent decomposition by gastric acid.

Therefore, the development of a prodrug of the above-mentioned compound, which is stable to acid and which resists decomposition by gastric acid, has been desired, and such prodrug has been reported in US Patent No. 6,093,734. In addition, prodrugs of proton pump inhibitors other than the above-mentioned prodrug have been disclosed in US Patent Nos. 4,045,563, 4,686,230, 4,873,337, 4,965,269, 5,021,433, 5,039,806 and the like.

In view of the above situation, the development of a prodrug of a proton pump inhibitor having superior stability to acid has been desired.

It is therefore an object of the present invention to provide a compound having superior stability to acid, which is converted to a proton pump inhibitor in living organisms and shows an anti-ulcer activity and the like, an intermediate therefor, a production method thereof and use thereof.

**Disclosure of the Invention**

The present inventors have first synthesized a compound represented by the following formula (I) and first found that this compound has unexpectedly superior stability to acid, gradually eliminates the substituent on the nitrogen atom of benzimidazole ring and affords a sustained acid secretion-suppressive action. Further studies based on these findings have resulted in the completion of the present invention.

According to the present invention, variously substituted 2-[(pyridylmethylsulfinyl)-1H-benzimidazole derivatives and structurally related sulfoxides are modified to give a prodrug (the compound of the formula (I)) stable to acid, which enables oral administration of the compound as a conventional tablet and the like without formulating an enteric-coated preparation. This has a consequence that the cost for
formulating an enteric-coated preparation can be eliminated and the preparation of tablet and the like can be made smaller. A smaller preparation is advantageous in that it is easily swallowed by patients having difficulty in swallowing, particularly the elderly and children. In addition, absorption is rapid due to the absence of a sustained release effect afforded by enteric-coated preparations, expression of a gastric acid secretion-suppressive action is rapid, and alleviation of symptoms such as pain and the like is rapid. Furthermore, because the compound is gradually converted to a proton pump inhibitor in living organisms, a sustainable anti-ulcer agent and the like can be provided.

Accordingly, the present invention provides the following.

[1] An imidazole compound represented by the formula (I):

![Chemical Structure](image)

wherein

ring A is a pyridine ring optionally having substituents,
ring B is a benzene ring optionally having substituents or a monocyclic aromatic heterocycle optionally having substituents,

$X_1$ and $X_2$

are each an oxygen atom or a sulfur atom,

$W$

is a divalent chain hydrocarbon group optionally having

$D_1$

is a divalent substituent,

$X_2$

is a divalent substituent,

$Y$

is a divalent substituent.

wherein

ring A is a pyridine ring optionally having substituents,
ring B is a benzene ring optionally having substituents or a monocyclic aromatic heterocycle optionally having substituents,

$X_1$ and $X_2$

are each an oxygen atom or a sulfur atom,

$W$

is a divalent chain hydrocarbon group optionally having
substituents or a divalent group represented by the formula:

\[ \text{——} W_1 - Z - W_2 \text{——} \]

wherein \( W_1 \) and \( W_2 \) are each a divalent chain hydrocarbon group or a bond, \( Z \) is a divalent hydrocarbon ring group optionally having substituents, a divalent heterocyclic group optionally having substituents, an oxygen atom, \( \text{SO}_n \) wherein \( n \) is 0, 1 or 2, or \( >\text{N-E} \) wherein \( E \) is a hydrogen atom, a hydrocarbon group optionally having substituents, a heterocyclic group optionally having substituents, a lower alkanoyl group, a lower alkoxy carbonyl group, an aralkyloxycarbonyl group, a thiocarbamoyl group, a lower alkylsulfinyl group, a lower alkylsulfonyl group, a sulfamoyl group, a mono-lower alkylsulfamoyl group, a di-lower alkylsulfamoyl group, an arylsulfamoyl group, an arylsulfinyl group, an arylsulfonyl group, an arylcarbonyl group or a carbamoyl group optionally having substituents, and when \( Z \) is an oxygen atom, \( \text{SO}_n \) or \( >\text{N-E} \), \( W_1 \) and \( W_2 \) are each a divalent chain hydrocarbon group, 

\( R \) is a hydrocarbon group optionally having substituents or a heterocyclic group optionally having substituents, 

\( R \) and \( W \) may be bonded to each other, 

\( D_1 \) and \( D_2 \) are each a bond, an oxygen atom, a sulfur atom or \( >\text{NR}_1 \) wherein \( R_1 \) is a hydrogen atom or a hydrocarbon group optionally having substituents, except for when \( D_1 \) and \( D_2 \) are each a bond, and
Y is a hydrocarbon group optionally having substituents or a heterocyclic group optionally having substituents, or a salt thereof.

[2] The compound of the above-mentioned [1], wherein Z is a divalent hydrocarbon ring group optionally having substituents or a divalent heterocyclic group optionally having substituents.

[3] The compound of the above-mentioned [1], wherein ring B is a benzene ring optionally having substituents.

[4] The compound of the above-mentioned [1], which is represented by the formula (II):

![Chemical Structure](image)

wherein each symbol in the formula is as defined in the above-mentioned [1].

[5] The compound of any of the above-mentioned [1] to [4], wherein X₁ and X₂ are each an oxygen atom.

[6] The compound of the above-mentioned [1], wherein D₁ and D₂ are each a bond or an oxygen atom, except for when D₁ and D₂ are each a bond.

[7] The compound of the above-mentioned [1], wherein W is a divalent chain hydrocarbon group optionally having substituents.

[8] The compound of the above-mentioned [1], wherein W is an ethylene group.
[9] The compound of the above-mentioned [1], wherein R is a C\textsubscript{1-6} hydrocarbon group optionally having substituents.

[10] The compound of the above-mentioned [1], wherein Y is a C\textsubscript{1-6} hydrocarbon group optionally having substituents or a saturated heterocyclic group optionally having substituents, which contains, as ring-constituting atom, 1 to 4 heteroatom(s) selected from oxygen atom, nitrogen atom and sulfur atom.

[11] The compound of the above-mentioned [1], wherein X\textsubscript{1} and X\textsubscript{2} are each an oxygen atom, D\textsubscript{1} and D\textsubscript{2} are each a bond or an oxygen atom except for when D\textsubscript{1} and D\textsubscript{2} are both a bond, W is an ethylene group, R is a C\textsubscript{1-6} alkyl group, and Y is a C\textsubscript{1-6} hydrocarbon group optionally having substituents or a saturated oxygen-containing heterocyclic group optionally having substituents, which may further contain, as ring-constituting atom, 1 to 3 heteroatom(s) selected from oxygen atom, nitrogen atom and sulfur atom.

[12] The compound of the above-mentioned [1], which is a compound selected from

\[
2-\text{[methyl}[[\text{R}]-2-[[[3-\text{methyl}-4-(2,2,2-trifluoroethoxy)]-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-\text{yl}][\text{carbonyl}][\text{amino}][\text{ethyl acetate,}}
\]

\[
\text{ethyl 2-}\text{[methyl}[[\text{R}]-2-[[[3-\text{methyl}-4-(2,2,2-trifluoroethoxy)]-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-\text{yl}][\text{carbonyl}][\text{amino}][\text{ethyl tetrahydropryan-4-yl carbonate,}}
\]

\[
2-\text{[methyl}[[2-[[[3-\text{methyl}-4-(2,2,2-trifluoroethoxy)]-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-\text{yl}][\text{carbonyl}][\text{amino}][\text{ethyl tetrahydropryan-4-yl carbonate,}}
\]

\[
\text{ethyl 2-}\text{[methyl}[[2-[[[3-\text{methyl}-4-(2,2,2-trifluoroethoxy)]-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-\text{yl}][\text{carbonyl}][\text{amino}][\text{ethyl tetrahydropryan-4-yl carbonate,}}
\]
yl]carbonyl]amino]ethyl carbonate,
ethyl 2-[[5-methoxy-2-[[4-methoxy-3,5-dimethyl-2-
pyridyl)methyl]sulfinyl]-3H-imidazo[4,5-b]pyridin-3-
yl]carbonyl] (methyl)amino]ethyl carbonate,
2-[[5-methoxy-2-[[4-methoxy-3,5-dimethyl-2-
pyridyl)methyl]sulfinyl]-3H-imidazo[4,5-b]pyridin-3-
yl]carbonyl] (methyl)amino]ethyl acetate,
2-[methyl[[2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-
pyridyl)methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl acetate,
ethyl 2-[[5-methoxy-2-[[4-methoxy-3,5-dimethyl-2-
pyridyl)methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl] (methyl)amino]ethyl carbonate,
ethyl 2-[[[(S)-5-methoxy-2-[[4-methoxy-3,5-dimethyl-2-
pyridyl)methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl] (methyl)amino]ethyl carbonate,
ethyl 2-[[2-[[4-(3-methoxypropoxy)-3-methyl-2-
pyridyl)methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl] (methyl)amino]ethyl carbonate, and
2-[[5-(difluoromethoxy)-2-[[3,4-dimethoxy-2-
pyridyl)methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl] (methyl)amino]ethyl ethyl carbonate
or a salt thereof.

[13] A compound represented by the formula (V):

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       \      /
        \    /
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          \/
           \  
            \ 
             N
              \  
               \ 
                W
                 \  
                  \ 
                   D1
                    \ 
                     \ 
                      X1
                        

     R       X
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         /       W
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(V)
wherein
ring A is a pyridine ring optionally having substituents,
ring B is a benzene ring optionally having substituents or a monocyclic aromatic heterocycle optionally having substituents,
\( X_1 \) and \( X_2 \) are each an oxygen atom or a sulfur atom,
\( W \) is a divalent chain hydrocarbon group optionally having substituents or a divalent group represented by the formula:
\[
\overline{W_1 - Z - W_2}
\]

wherein \( W_1 \) and \( W_2 \) are each a divalent chain hydrocarbon group or a bond, \( Z \) is a divalent hydrocarbon ring group optionally having substituents, a divalent heterocyclic group optionally having substituents, an oxygen atom, \( SO_n \) wherein \( n \) is 0, 1 or 2, or \( >N-E \) wherein \( E \) is a hydrogen atom, a hydrocarbon group optionally having substituents, a heterocyclic group optionally having substituents, a lower alkanoyl group, a lower alkoxy carbonyl group, an aralkyloxycarbonyl group, a thiocarbamoyl group, a lower alkylsulfanyl group, a lower alkylsulfonyl group, a sulfamoyl group, a mono-lower alkylsulfamoyl group, a di-lower alkylsulfamoyl group, an arylsulfamoyl group, an arylsulfonyl group, an arylsulfanyl group, an arylcarbonyl group or a carbamoyl group optionally having substituents, and when \( Z \) is an oxygen atom, \( SO_n \) or \( >N-E \), \( W_1 \) and \( W_2 \) are each a divalent chain hydrocarbon group,
\( R \) is a hydrocarbon group optionally having substituents.
or a heterocyclic group optionally having substituents, 
R and W 
may be bonded to each other,
D₁ and D₂ 
are each a bond, an oxygen atom, a sulfur atom or >NR₃ 
wherein R₃ is a hydrogen atom or a hydrocarbon group 
optionally having substituents, except for when D₁ and 
D₂ are each a bond, and 
Y 
is a hydrocarbon group optionally having substituents 
or a heterocyclic group optionally having substituents, 
or a salt thereof.

[14] A production method of a compound of the above-mentioned 
[1], which comprises 
(1) condensing a compound represented by the formula (III):

![Diagram](image)

(III)

wherein 
ring A is a pyridine ring optionally having substituents, 
ring B is a benzene ring optionally having substituents or a 
monocyclic aromatic heterocycle optionally having 
substituents and 
M 
is a hydrogen atom, a metal cation or a quaternary 
ammonium ion, or 
a salt thereof, with a compound represented by the formula 

(IV):

![Diagram](image)

(IV)

wherein
X is a leaving group,
X₁ and X₂ are each an oxygen atom or a sulfur atom,
W is a divalent chain hydrocarbon group optionally having substituents, or a divalent group of the formula:

\[ \begin{array}{c}
\text{——W₁——Z——W₂——} \\
\end{array} \]

wherein W₁ and W₂ are each a divalent chain hydrocarbon group or a bond, Z is a divalent hydrocarbon ring group optionally having substituents, a divalent heterocyclic group optionally having substituents, an oxygen atom, SOₙ wherein n is 0, 1 or 2, or >N−E wherein E is a hydrogen atom, a hydrocarbon group optionally having substituents, a heterocyclic group optionally having substituents, a lower alkanoyl group, a lower alkoxy carbonyl group, an aralkyloxycarbonyl group, a thiocarbamoyl group, a lower alkylsulfinyl group, a lower alkylsulfanyl group, a sulfamoyl group, a mono-lower alkylsulfamoyl group, a di-lower alkylsulfamoyl group, an arylsulfamoyl group, an arylsulfanyl group, an aryloxycarbonyl group or a carbamoyl group optionally having substituents, and when Z is an oxygen atom, SOₙ or >N−E, W₁ and W₂ are each a divalent chain hydrocarbon group,

R is a hydrocarbon group optionally having substituents or a heterocyclic group optionally having substituents,

R and W may be bonded to each other,

D₁ and D₂ are each a bond, an oxygen atom, a sulfur atom, or >NR₁
wherein \( R_1 \) is a hydrogen atom or a hydrocarbon group optionally having substituents, except for when \( D_1 \) and \( D_2 \) are each a bond, and \( Y \) is a hydrocarbon group optionally having substituents or a heterocyclic group optionally having substituents, or a salt thereof, or

(2) subjecting a compound represented by the formula (V):

![Chemical Structure](image-url)

wherein each symbol in the formula is as defined above, or a salt thereof, to an oxidization reaction.


[16] The pharmaceutical composition of the above-mentioned [15], which is an agent for the prophylaxis or treatment of peptic ulcer, gastritis, peptic esophagitis, symptomatic gastroesophageal reflux disease (symptomatic GERD) free of esophagitis, NUD, gastric cancer, gastric MALT lymphoma, Zollinger-Ellison syndrome, acid indigestion or upper gastrointestinal hemorrhage.

[17] A commercial package comprising a pharmaceutical composition of the above-mentioned [16] and written matter associated therewith, the written matter stating that the pharmaceutical composition can or should be used for the prophylaxis or treatment of peptic ulcer, gastritis, peptic
esophagitis, symptomatic gastroesophageal reflux disease (symptomatic GERD) free of esophagitis, NUD, gastric cancer, gastric MALT lymphoma, Zollinger-Ellison syndrome, acid indigestion or upper gastrointestinal hemorrhage.

[18] The pharmaceutical composition of the above-mentioned [15], which is an agent for the eradication of Helicobacter pylori.

[19] A commercial package comprising a pharmaceutical composition of the above-mentioned [18] and written matter associated therewith, the written matter stating that the pharmaceutical composition can or should be used for the eradication of Helicobacter pylori.


[24] The pharmaceutical composition of the above-mentioned
[15], further comprising at least one antibacterial agent in combination with the compound of the above-mentioned [1], wherein active components are formulated altogether in a fixed formulation, or formulated independently for concurrent administration or administration at staggered times to a single subject.

In the present invention, ring A designates a "pyridine ring optionally having substituents".

The pyridine ring of the "pyridine ring optionally having substituents" represented by ring A optionally has 1 to 4 substituents at substitutable positions thereof. As the substituent, for example, a halogen atom (e.g., fluorine, chlorine, bromine, iodine etc.), a hydrocarbon group optionally having substituents (e.g., alkyl group having 1 to 6 carbon atoms such as methyl group, ethyl group, n-propyl group etc., and the like), an amino group optionally having substituents (e.g., amino; amino group mono- or di-substituted by alkyl group having 1 to 6 carbon atoms, such as methylamino, dimethylamino, ethylamino, diethylamino group etc., and the like), an amide group (e.g., \( \text{C}_{1-3} \) acylamino group such as formamide, acetamide etc., and the like), a lower alkoxy group optionally having substituents (e.g., alkoxy group having 1 to 6 carbon atoms such as methoxy, ethoxy, 2,2,2-trifluoroethoxy, 3-methoxypropoxy group and the like), a lower alkenylenedioxy group (e.g., \( \text{C}_{1-3} \) alkenylenedioxy group such as methylenedioxy, ethylenedioxy etc., and the like) and the like can be mentioned.

As the substituent, which is the substituent of the "pyridine ring optionally having substituents" represented by ring A can have, for example, a halogen atom (e.g., fluorine, chlorine, bromine, iodine etc.), a lower alkyl group (e.g., alkyl group having 1 to 6 carbon atoms such as methyl, ethyl, propyl group and the like), a lower alkenyl group (e.g.,
alkenyl group having 2 to 6 carbon atoms such as vinyl, allyl group and the like), a lower alkynyl group (e.g., alkynyl group having 2 to 6 carbon atoms such as ethynyl, propargyl group and the like), a cycloalkyl group (e.g., cycloalkyl group having 3 to 8 carbon atoms such as cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl group and the like), a lower alkoxy group (e.g., alkoxy group having 1 to 6 carbon atoms such as methoxy, ethoxy group and the like), a nitro group, a cyano group, a hydroxy group, a thiol group, a carboxyl group, a lower alkanoyl group (e.g., formyl; C₁–C₆ alkyl-carbonyl group, such as acetyl, propionyl, butyryl group and the like), a lower alkanoyloxy group (e.g., formyloxy; C₁–C₆ alkyl-carbonyloxy group, such as acetyloxy, propionyloxy group and the like), a lower alkoxy carbonyl group (e.g., C₁–C₆ alkoxy-carbonyl group, such as methoxycarbonyl, ethoxycarbonyl, propoxycarbonyl group and the like), an aralkyloxycarbonyl group (e.g., C₇–C₁₁ aralkyloxycarbonyl group, such as benzyloxycarbonyl group and the like), an aryl group (e.g., aryl group having 6 to 14 carbon atoms such as phenyl, naphthyl group and the like), an aryl oxy group (e.g., aryloxy group having 6 to 14 carbon atoms such as phenyloxy, naphthyloxy group and the like), an aryl carbonyl group (e.g., C₆–C₁₄ aryl-carbonyl group, such as benzoyl, naphthoyl group and the like), an aryl carboxyloxy group (e.g., C₆–C₁₄ aryl-carboxyloxy group, such as benzoyloxy, naphthoyloxy group and the like), a carbamoyl group optionally having substituents (e.g., carbamoyl; carbamoyl group mono- or di-substituted by alkyl group having 1 to 6 carbon atoms, such as methyl carbamoyl, dimethyl carbamoyl group etc., and the like), an amino group optionally having substituents (e.g., amino; amino group mono- or di-substituted by alkyl group having 1 to 6 carbon atoms, such as methylamino, dimethylamino, ethylamino, diethylamino group etc., and the like) and the like, can be
mentioned, wherein the number of substituents and the position of the substitution are not particularly limited.

While the number of substituents and the position of substitution of the "pyridine ring optionally having substituents" represented by ring A are not particularly limited, 1 to 3 substituents mentioned above preferably substitute any of the 3-, 4- and 5-positions of the pyridine ring.

As the "pyridine ring optionally having substituents" represented by ring A, 3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl is preferable.

In the present invention, ring B represents a "benzene ring optionally having substituents" or an "aromatic monocyclic heterocycle optionally having substituents", which is condensed with an imidazole part. Of these, the former is preferable.

The benzene ring of the "benzene ring optionally having substituents" represented by ring B may have 1 to 4 substituents at substitutable positions thereof. As the substituent, for example, a halogen atom (e.g., fluorine, chlorine, bromine, iodine etc.), a hydrocarbon group optionally having substituents (e.g., alkyl group having 1 to 6 carbon atoms selected from methyl group, ethyl group, n-propyl group etc., and the like), an amino group optionally having substituents (e.g., amino; amino group mono- or disubstituted by alkyl group having 1 to 6 carbon atoms, such as methylamino, dimethylamino, ethylamino, diethylamino group etc., and the like), an amide group (e.g., C<sub>1-3</sub> acylamino group such as formamide, acetamide etc., and the like), a lower alkoxy group optionally having substituents (e.g., alkoxy group having 1 to 6 carbon atoms, such as methoxy, ethoxy, difluoromethoxy group etc., and the like), a lower alkylenedioxy group (e.g., C<sub>1-3</sub> alkylenedioxy group such as
methylenedioxy, ethylenedioxy etc., and the like), and the like can be mentioned.

As the substituent, which is the substituent of the "benzene ring optionally having substituents" represented by ring B can have, for example, a halogen atom (e.g., fluorine, chlorine, bromine, iodine etc.), a lower alkyl group (e.g., alkyl group having 1 to 6 carbon atoms such as methyl, ethyl, propyl group and the like), a lower alkenyl group (e.g., alkenyl group having 2 to 6 carbon atoms such as vinyl, allyl group and the like), a lower alkynyl group (e.g., alkynyl group having 2 to 6 carbon atoms such as ethynyl, propargyl group and the like), a cycloalkyl group (e.g., cycloalkyl group having 3 to 8 carbon atoms such as cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl group and the like), a lower alkoxy group (e.g., alkoxy group having 1 to 6 carbon atoms such as methoxy, ethoxy group and the like), a nitro group, a cyano group, a hydroxy group, a thiol group, a carboxyl group, a lower alkanoyl group (e.g., formyl; C₁₋₆ alkyl-carboxyl group, such as acetyl, propionyl, butyryl group and the like), a lower alkanoyloxy group (e.g., formyloxy; C₁₋₆ alkyl-carbonyloxy group, such as acetoxy, propionyloxy group and the like), a lower alkoxy carbonyl group (e.g., C₁₋₆ alkoxy-carbonyl group, such as methoxycarbonyl, ethoxycarbonyl, propoxycarbonyl group and the like), an aralkyloxycarbonyl group (e.g., C₇₋₁₇ aralkyloxycarbonyl group, such as benzoxycarbonyl group and the like), an aryl group (e.g., aryl group having 6 to 14 carbon atoms such as phenyl, naphthyl group and the like), an aryloxy group (e.g., aryloxy group having 6 to 14 carbon atoms such as phenyloxy, naphthyloxy group and the like), an arylcarbonyl group (e.g., C₆₋₁₄ aryl-carbonyl group, such as benzoyl, naphthoyl group and the like), an arylcarbonyloxy group (e.g., C₆₋₁₄ aryl-carbonyloxy group, such as benzoyloxy, naphthoxyloxy group and
the like), a carbamoyl group optionally having substituents (e.g., carbamoyl; carbamoyl group mono- or di-substituted by alkyl group having 1 to 6 carbon atoms such as methylcarbamoyl, dimethylcarbamoyl group etc., and the like), an amino group optionally having substituents (e.g., amino; amino group mono- or di-substituted by alkyl group having 1 to 6 carbon atoms such as methylamino, dimethylamino, ethylamino, diethylamino group etc., and the like) and the like can be mentioned, wherein the number of substituents and the position of the substitution are not particularly limited.

As the "benzene ring optionally having substituents" represented by ring B, a benzene ring is preferable.

As the "aromatic monocyclic heterocycle" of the "aromatic monocyclic heterocycle optionally having substituents" represented by ring B, for example, a 5- or 6-membered aromatic monocyclic heterocycle such as furan, thiophene, pyrrole, oxazole, isoxazole, thiazole, isothiazole, imidazole, pyrazole, 1,2,3-oxadiazole, 1,2,4-oxadiazole, 1,3,4-oxadiazole, furazan, 1,2,3-thiadiazole, 1,2,4-thiadiazole, 1,3,4-thiadiazole, 1,2,3-triazole, 1,2,4-triazole, tetrazole, pyridine, pyridazine, pyrimidine, pyrazine, triazine etc., and the like can be mentioned. As the "aromatic monocyclic heterocycle" represented by ring B, a pyridine ring is particularly preferable. It may have, at substitutable positions thereof, 1 to 4 substituents similar to those for the "benzene ring optionally having substituents" represented by ring B.

The position where the "aromatic monocyclic heterocycle" of the "aromatic monocyclic heterocycle optionally having substituents" is condensed with the imidazole part is not particularly limited.

In the present invention, X₁ and X₂ represent an oxygen atom and a sulfur atom, respectively. Both X₁ and X₂ preferably
represent an oxygen atom.

In the present invention, \( W \) represents a "divalent chain hydrocarbon group optionally having substituents", or the formula:

\[
\begin{align*}
\text{---} & \quad W_1 \quad - Z \quad - W_2 \quad \text{---} \\
\end{align*}
\]

wherein \( W_1 \) and \( W_2 \) are each a "divalent chain hydrocarbon group" or a bond, and \( Z \) is a divalent group such as a "divalent hydrocarbon ring group optionally having substituents", a "divalent heterocyclic group optionally having substituents", an oxygen atom, \( \text{SO}_n \) wherein \( n \) is 0, 1 or 2 or \( >N=\text{E} \) wherein \( \text{E} \) is a hydrogen atom, a hydrocarbon group optionally having substituents, a heterocyclic group optionally having substituents, a lower alkanoyl group, a lower alkoxy carbonyl group, an aralkyloxycarbonyl group, a thiocarbamoyl group, a lower alkylsulfinyl group, a lower alkyl sulfonfonyl group, a sulfamoyl group, a mono-lower alkylsulfamoyl group, a di-lower alkylsulfamoyl group, an arylsulfamoyl group, an arylsulfinyl group, an aryl sulfonfonyl group, an aryl carbonyl group, or a carbamoyl group optionally having substituents, when \( Z \) is an oxygen atom, \( \text{SO}_n \) or \( >N=\text{E} \), \( W_1 \) and \( W_2 \) are each a "divalent chain hydrocarbon group". Particularly, \( W \) is preferably a "divalent chain hydrocarbon group optionally having substituents".

As the "divalent chain hydrocarbon group" of the "divalent chain hydrocarbon group optionally having substituents" represented by \( W \) and "divalent chain hydrocarbon group" represented by \( W_1 \) and \( W_2 \), for example, a \( C_{1-6} \) alkylene group (e.g., methylene, ethylene, trimethylene etc.), a \( C_{2-6} \) alkenylene group (e.g., ethenylene etc.), a \( C_{2-6} \) alkynylene group (e.g., ethynylene etc.) and the like can be mentioned.

The divalent chain hydrocarbon group for \( W \) may have 1 to 6 substituents similar to those for the "benzene ring optionally having substituents" represented by ring B at substitutable positions thereof.
As the "divalent chain hydrocarbon group" of the
"divalent chain hydrocarbon group optionally having
substituents" represented by W and "divalent chain hydrocarbon
group" represented by W₁ and W₂, a methylene group and an
ethylene group are preferable. As W₁ an ethylene group is
particularly preferable. When Z is an oxygen atom, SOₙ or >N–E
(n and E are as defined above), the "divalent chain
hydrocarbon group" represented by W₁ is preferably a
hydrocarbon group having 2 or more carbon atoms.

As the "hydrocarbon ring" of the "divalent hydrocarbon
ring group optionally having substituents" represented by Z,
for example, an alicyclic hydrocarbon ring, an aromatic
hydrocarbon ring and the like can be mentioned, with
preference given to one having 3 to 16 carbon atoms, which may
have 1 to 4 substituents similar to those for the "benzene
ring optionally having substituents" represented by ring B at
substitutable positions thereof. As the hydrocarbon ring, for
example, cycloalkane, cycloalkene, arene and the like are used.

As a cycloalkane in the "divalent hydrocarbon ring group
optionally having substituents" represented by Z, for example,
a lower cycloalkane and the like are preferable, and, for
example, C₃₋₁₀ cycloalkane such as cyclopropane, cyclobutane,
cyclopentane, cyclohexane, cycloheptane, cyclooctane,
bicyclo[2.2.1]heptane, adamantane etc., and the like are
generally used.

As a cycloalkene in the "divalent hydrocarbon ring group
optionally having substituents" represented by Z, for example,
a lower cycloalkene is preferable, and, for example, C₄₋₉
cycloalkene such as cyclopropene, cyclobutene, cyclopentene,
cyclohexene, cycloheptene, cyclooctene etc., and the like are
generally used.

As an arene in the "divalent hydrocarbon ring group
optionally having substituents" represented by Z, for example,
a C₆-1₄ arene such as benzene, naphthalene, phenanthrene etc., and the like are preferable, and, for example, phenylene and the like are generally used.

As a heterocycle in the "divalent heterocyclic group optionally having substituents" represented by Z, a 5- to 12-membered "aromatic heterocycle" or "saturated or unsaturated non-aromatic heterocycle" containing, as ring-constituting atom (ring atom), 1 to 3 (preferably 1 or 2) kinds of at least 1 (preferably 1 to 4, more preferably 1 or 2) hetero atoms selected from oxygen atom, sulfur atom and nitrogen atom etc., and the like can be mentioned, which may have 1 to 4 substituents similar to those for the "benzene ring optionally having substituents" represented by ring B at substitutable positions thereof.

As an aromatic heterocycle in the "divalent heterocyclic group optionally having substituents" represented by Z, an aromatic monocyclic heterocycle, an aromatic fused heterocycle and the like can be mentioned.

As the "aromatic monocyclic heterocycle", for example, a 5- or 6-membered aromatic monocyclic heterocycle such as furan, thiophene, pyrrole, oxazole, isoxazole, thiazole, isothiazole, imidazole, pyrazole, 1,2,3-oxadiazole, 1,2,4-oxadiazole, 1,3,4-oxadiazole, furazan, 1,2,3-thiadiazole, 1,2,4-thiadiazole, 1,3,4-thiadiazole, 1,2,3-triazole, 1,2,4-triazole, tetrazole, pyridine, pyridazine, pyrimidine, pyrazine, triazine etc., and the like can be mentioned.

As the "aromatic fused heterocycle", for example, a 8- to 12-membered aromatic fused heterocycle such as benzofuran, isobenzofuran, benzothiophene, isobenzothiophene, indole, isoindole, 1H-indazole, benzimidazole, benzoazole, 1,2-benzisoxazole, benzothiazole, 1,2-benzisothiazole, 1H-benzotriazole, quinoline, isoquinoline, cinnoline, quinazoline, quinoxaline, phthalazine, naphthyridine, pyrazine, pteridine,
carbazole, carboline, acridine, phenoxazine, phenothiazine, phenazine, phenothiadiazine, thianthrene, phenanthridine, phenanthroline, indolizine, pyrrolo[1,2-\textbf{b}]pyridazine, pyrazolo[1,5-\textbf{a}]pyridine, imidazo[1,2-\textbf{a}]pyridine, imidazo[1,5-\textbf{a}]pyridine, imidazo[1,2-\textbf{b}]pyridazine, imidazo[1,2-\textbf{a}]pyrimidine, 1,2,4-triazolo[4,3-\textbf{a}]pyridine, 1,2,4-triazolo[4,3-\textbf{b}]pyridazine etc., and the like can be mentioned.

As a saturated or unsaturated non-aromatic heterocycle in the “divalent heterocyclic group optionally having substituents” represented by \(Z\), for example, a 3- to 8-membered (preferably 5- or 6-membered) saturated or unsaturated (preferably saturated) non-aromatic heterocycle (aliphatic heterocycle) such as oxylane, azetidine, oxetane, thietane, pyrrolidine, tetrahydrofuran, tetrahydrothiophene, piperidine, tetrahydropyran, tetrahydrothiopyran, morpholine, thiomorpholine, piperazine, azepane, oxepane, thiene, oxazepane, thiazepane, azocane, oxocane, thiocane, oxazocane, thiazocane etc., and the like can be mentioned. These may be oxo-substituted and may be, for example, 2-oxoazetidine, 2-oxopyrrolidine, 2-oxopiperidine, 2-oxazepane, 2-oxazocane, 2-oxotetrahydrofuran, 2-oxotetrahydropyran, 2-oxotetrahydrothiophene, 2-oxothiane, 2-oxopiperazine, 2-oxooxepane, 2-oxooxazepane, 2-oxothiepane, 2-oxothiazepane, 2-oxooxocane, 2-oxothiocane, 2-oxooxazocane, 2-oxothiazocane and the like.

The two bonds from the “hydrocarbon ring group” of the “divalent hydrocarbon ring group optionally having substituents” or the “heterocyclic group” of the “divalent heterocyclic group optionally having substituents” represented by \(Z\) may be present at any possible position.

The “hydrocarbon group optionally having substituents” and “heterocyclic group optionally having substituents” represented by \(E\) is as defined in the following.
As the "lower alkanoyl group" represented by E, for example, formyl, a C₁₋₆ alkyl-carbonyl group such as acetyl, propionyl, butyryl, isobutyryl etc., and the like can be used.

As the "lower alkoxy carbonyl group" represented by E, for example, a C₁₋₆ alkoxy-carbonyl group such as methoxycarbonyl, ethoxycarbonyl, propoxycarbonyl, butoxycarbonyl etc., and the like are used.

As the "aralkyloxy carbonyl" represented by E, for example, a C₇₋₁₁ aralkyloxy-carbonyl group such as benzyloxy carbonyl etc., and the like are used.

As the "lower alkylsulfinyl group" represented by E, for example, a C₁₋₆ alkylsulfinyl group such as methylsulfinyl, ethylsulfinyl etc., and the like are used.

As the "lower alkylsulfonyl group" represented by E, for example, a C₁₋₆ alkylsulfonyl group such as methylsulfonyl, ethylsulfonyl etc., and the like are used.

As the "mono-lower alkylsulfamoyl group" represented by E, for example, a mono-C₁₋₆ alkylsulfamoyl group such as methylsulfamoyl, ethylsulfamoyl etc., and the like are used.

As the "di-lower alkylsulfamoyl group" represented by E, for example, a di-C₁₋₆ alkylsulfamoyl group such as dimethylsulfamoyl, diethylsulfamoyl etc., and the like are used.

As the "arylsulfamoyl group" represented by E, for example, a C₆₋₁₀ arylsulfamoyl group such as phenylsulfamoyl, naphthylsulfamoyl etc., and the like are used.

As the "arylsulfinyl group" represented by E, for example, a C₆₋₁₀ arylsulfinyl group such as phenylsulfinyl, naphthylsulfinyl etc., and the like are used.

As the "arylsulfonyl group" represented by E, for example, a C₆₋₁₀ arylsulfonyl group such as phenylsulfonyl, naphthylsulfonyl etc., and the like are used.

As the "aryl carbonyl group" represented by E, for example,
C_{6-10} aryl-carbonyl group such as benzoyl, naphthoyl etc., and the like are used.

The "carbamoyl group optionally having substituents" represented by E is, for example, a group of the formula -CONR_2R_3 wherein R_2 and R_3 are each a hydrogen atom, a hydrocarbon group optionally having substituents or a heterocyclic group optionally having substituents, and in the formula -CONR_2R_3, R_2 and R_3 may form a ring together with the adjacent nitrogen atom, and the like.

In the present invention, R is a "hydrocarbon group optionally having substituents" or a "heterocyclic group optionally having substituents", and R can be bonded to W. Of these, a C_{1-6} hydrocarbon group optionally having substituents is preferable and a lower (C_{1-6}) alkyl group is particularly preferable. The "hydrocarbon group optionally having substituents" and "heterocyclic group optionally having substituents" represented by R are as defined in the following. A detailed explanation of the case where R is bonded to W is given in the following.

In the present invention, D_1 and D_2 are each a bond, an oxygen atom, a sulfur atom or >NR_1, and in the formula, R_1 is a hydrogen atom or a hydrocarbon group optionally having substituents. However, the present invention excludes a case where D_1 and D_2 are both respectively a bond. Among others, each of D_1 and D_2 is preferably a bond or an oxygen atom, and particularly preferably, D_1 is an oxygen atom and D_2 is an oxygen atom or a bond. The "hydrocarbon group optionally having substituents" represented by R_1 is as defined in the following.

In the present invention, Y is a "hydrocarbon group optionally having substituents" or a "heterocyclic group optionally having substituents". Of these, a C_{1-6} hydrocarbon group optionally having substituents or a saturated
heterocyclic group optionally having substituents, which contains, as ring-constituting atom, 1 to 4 hetero atoms selected from oxygen atom, sulfur atom and nitrogen atom is preferable. As Y, among others, a C₁₋₆ hydrocarbon group optionally having substituents or a saturated oxygen-containing heterocyclic group optionally having substituents, which further contains, as ring-constituting atom, 1 to 3 hetero atoms selected from oxygen atom, sulfur atom and nitrogen atom is preferable. The "hydrocarbon group optionally having substituents" and "heterocyclic group optionally having substituents" represented by Y are as defined in the following.

As the "hydrocarbon group" of the "hydrocarbon group optionally having substituents" represented by the above-mentioned E, R, R₁ and Y, for example, a saturated or unsaturated aliphatic hydrocarbon group, a saturated or unsaturated alicyclic hydrocarbon group, a saturated or unsaturated alicyclic-aliphatic hydrocarbon group, an aromatic hydrocarbon group, an aromatic-saturated or unsaturated alicyclic hydrocarbon group and the like can be mentioned, with preference given to those having 1 to 16, more preferably 1 to 6, carbon atoms. Specific examples thereof include alkyl group, alkenyl group, alkynyl group, cycloalkyl group, cycloalkenyl group, cycloalkylalkyl group, cycloalkenylalkyl group, aryl group and arylalkyl group and the like.

For example, the "alkyl group" is preferably a lower alkyl group (C₁₋₆ alkyl group) and the like, and, for example, a C₁₋₆ alkyl group such as methyl, ethyl, propyl, isopropyl, butyl, isobutyl, sec-butyl, tert-butyl, pentyl, 1-ethylpropyl, hexyl etc., and the like are generally used. For R, a lower alkyl group (C₁₋₆ alkyl group) is preferable, particularly a methyl group is preferable.

For example, the "alkenyl group" is preferably a lower alkenyl group and the like, and, for example, a C₂₋₇ alkenyl
group such as vinyl, 1-propaneryl, allyl, isopropenyl, butenyl, isobutenyl, 2,2-dimethyl-pent-4-enyl etc., and the like are generally used.

For example, the "alkynyl group" is preferably a lower alkynyl group and the like, and, for example, a C₂₋₅ alkynyl group such as ethynyl, propargyl, 1-propynyl etc., and the like are generally used.

For example, the "cycloalkyl group" is preferably a lower cycloalkyl group and the like, and, for example, a C₃₋₁₀ cycloalkyl group such as cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, bicyclo[2.2.1]heptanyl and adamantyl etc., and the like are generally used.

For example, the "cycloalkenyl group" is preferably a lower cycloalkenyl group, and, for example, a C₃₋₁₀ cycloalkenyl group such as cyclopropenyl, cyclobutenyl, cyclopentenyl, cyclohexenyl, cycloheptenyl, cyclooctenyl, bicyclo[2.2.1]hept-5-en-2-yl etc., and the like are generally used.

For example, the "cycloalkylalkyl group" is preferably a lower cycloalkylalkyl group, and, for example, a C₄₋₉ cycloalkylalkyl group such as cyclopropylmethyl, cyclopropylethyl, cyclobutylmethyl, cyclopentylmethyl, cyclohexylmethyl and cyclohexylethyl etc., and the like are generally used.

For example, the "cycloalkenylalkyl group" is preferably a lower cycloalkenylalkyl group, and, for example, C₄₋₉ cycloalkenylalkyl such as cyclopentenylmethyl, cyclohexenylmethyl, cyclohexenylethyl, cyclohexenylpropyl, cycloheptenylmethyl, cycloheptenylethyl and bicyclo[2.2.1]hept-5-en-2-ylmethyl etc., and the like are generally used.

For example, the "aryl group" is preferably a C₆₋₁₄ aryl group such as phenyl, 1-naphthyl, 2-naphthyl, biphenylyl, 2- anthryl etc., and the like, and, for example, phenyl group and
the like are generally used.

The "arylalkyl group" contains, as the aryl moiety, the "aryl group" defined above, and as the alkyl moiety, the "alkyl group" defined above. Of these, for example, a C₆₋₁₄ aryl-C₁₋₆ alkyl group is preferable, and, for example, benzyl, phenethyl and the like are generally used.

As the substituent that the "hydrocarbon group" of the "hydrocarbon group optionally having substituents" represented by the above-mentioned E, R, R₁ and Y may have, for example, a halogen atom (e.g., fluorine, chlorine, bromine, iodine etc.), a nitro group, a cyano group, a hydroxy group, a thiol group, a sulfo group, a sulphino group, a phosphono group, an optionally halogenated lower alkyl group (e.g., C₁₋₆ alkyl such as methyl, ethyl, propyl, isopropyl, butyl, isobutyl, sec-butyl, tert-butyl, pentyl, 1-ethylpropyl, hexyl and the like, a mono-, di- or tri-halogeno-C₁₋₆ alkyl group such as chloromethyl, dichloromethyl, trichloromethyl, fluoromethyl, difluoromethyl, trifluoromethyl, 2-bromoethyl, 2,2,2-trifluoroethyl, pentafluoroethyl, 3,3,3-trifluoropropyl, 4,4,4-trifluorobutyl, 5,5,5-trifluoropentyl, 6,6,6-trifluoroethyl etc., and the like), an oxo group, an amidino group, an imino group, an alkylenedioxy group (e.g., C₁₋₃ alkylenedioxy group such as methylenedioxy, ethylenedioxy etc., and the like), a lower alkoxy group (e.g., C₁₋₆ alkoxy group such as methoxy, ethoxy, propoxy, isopropoxy, butoxy, isobutoxy, pentyloxy, hexyloxy etc., and the like), an optionally halogenated lower alkoxy group (e.g., a mono-, di- or tri-halogeno-C₁₋₆ alkoxy group such as chloromethoxy, dichloromethoxy, trichloromethoxy, fluoromethoxy, difluoromethoxy, trifluoromethoxy, 2-bromoethoxy, 2,2,2-trifluoroethoxy, pentafluoroethoxy, 3,3,3-trifluoropropyloxy, 4,4,4-trifluorobutyloxy, 5,5,5-trifluoropentyloxy, 6,6,6-trifluoroethylxy etc., and the
like), a lower alkylthio group (e.g., a C₁₋₆ alkylthio group such as methylthio, ethylthio, propylthio, isopropylthio, butylthio, isobutylthio, pentylthio, hexylthio etc., and the like), a carboxyl group, a lower alkanoyl group (e.g., formyl; a C₁₋₆ alkyl-carbonyl group such as acetyl, propionyl, butyryl, isobutyryl etc., and the like), a lower alkanoyloxy group (e.g., formyloxy; a C₁₋₆ alkyl-carbonyloxy group such as acetyloxy, propionyloxy, butyryloxy, isobutyryloxy etc., and the like), a lower alkoxy carbonyl group (e.g., a C₁₋₆ alkoxy carbonyl group such as methoxycarbonyl, ethoxycarbonyl, propoxycarbonyl, butoxycarbonyl etc., and the like), aralkyloxy carbonyl group (e.g., a C₇₋₁₁ aralkyloxy-carbonyl group such as benzylxycarbonyl etc., and the like), a thiocarbamoyl group, a lower alkylsulfinyl group (e.g., a C₁₋₆ alkylsulfinyl group such as methylsulfinyl, ethylsulfinyl etc., and the like), a lower alkylsulfonyl group (e.g., a C₁₋₆ alkylsulfonyl group such as methylsulfonyl, ethylsulfonyl etc., and the like), a sulfamoyl group, a mono-lower alkylsulfamoyl group (e.g., a mono-C₁₋₆ alkylsulfamoyl group such as methylsulfamoyl, ethylsulfamoyl etc., and the like), di-lower alkylsulfamoyl group (e.g., a di-C₁₋₆ alkylsulfamoyl group such as dimethylsulfamoyl, diethylsulfamoyl etc., and the like), an arylsulfamoyl group (e.g., a C₆₋₁₀ arylsulfamoyl group such as phenylsulfamoyl, naphthylsulfamoyl etc., and the like), an aryl group (e.g., a C₆₋₁₀ aryl group such as phenyl, naphthyl etc., and the like), an aryloxy group (e.g., a C₆₋₁₀ aryloxy group such as phenyloxy, naphthyloxy etc., and the like), an arylthio group (e.g., a C₆₋₁₀ arylthio group such as phenylthio, naphthylthio etc., and the like), an arylsulfinyl group (e.g., a C₆₋₁₀ arylsulfinyl group such as phenylsulfinyl, naphthylsulfinyl etc., and the like), an arylsulfonyl group (e.g., a C₆₋₁₀ arylsulfonyl group such as phenylsulfonyl, naphthylsulfonyl etc., and the like), an arylcarbonyl group
(e.g., a C₆₋₁₀ aryl-carbonyl group such as benzoyl, naphthoyl etc., and the like), an arylcarbonyloxy group (e.g., a C₆₋₁₀ aryl-carbonyloxy group such as benzyloxy, naphthoxyloxy etc., and the like), an optionally halogenated lower alkylcarbonylamino group (e.g., an optionally halogenated C₁₋₆ alkyl-carbonylamino group such as acetylamino, trifluoroacetylamino etc., and the like), a carbamoyl group optionally having substituents (e.g., a group of the formula –CONR₂R₃ wherein R₂ and R₃ are each a hydrogen atom, a hydrocarbon group optionally having substituents or a heterocyclic group optionally having substituents and in the formula –CONR₂R₃, R₂ and R₃ may form a ring together with the adjacent nitrogen atom), an amino group optionally having substituents (e.g., a group of the formula –NR₂R₃ wherein R₂ and R₃ are as defined above and in the formula –NR₂R₃, R₂ and R₃ may form a ring together with the adjacent nitrogen atom), a ureido group optionally having substituents (e.g., a group of the formula –NHCONR₂R₃ wherein R₂ and R₃ are as defined above and in the formula –NHCONR₂R₃, R₂ and R₃ may form a ring together with the adjacent nitrogen atom), a carboxamide group optionally having substituents (e.g., a group of the formula –NR₂COR₃ wherein R₂ and R₃ are as defined above), a sulfonamide group optionally having substituents (e.g., a group of the formula –NR₂SO₂R₃ wherein R₂ and R₃ are as defined above), a heterocyclic group optionally having substituents (as defined for R₂ and R₃) and the like are used.

As the "hydrocarbon group" of the "hydrocarbon group optionally having substituents" for R₂ and R₃, for example, a lower alkyl group (e.g., alkyl group having 1 to 6 carbon atoms such as methyl, ethyl, propyl group and the like), a lower alkenyl group (e.g., alkenyl group having 2 to 6 carbon atoms such as vinyl, allyl group and the like), a lower alkynyl group (e.g., alkynyl group having 2 to 6 carbon atoms
such as ethynyl, propargyl group and the like), a cycloalkyl group (e.g., cycloalkyl group having 3 to 8 carbon atoms such as cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl group and the like), a cycloalkenyl group (e.g., cycloalkenyl group having 3 to 8 carbon atoms such as cyclobutenyl, cyclopentenyl, cyclohexenyl group and the like), a cycloalkylalkyl group (e.g., C₃-C₈ cycloalkyl – C₁–C₆ alkyl group, such as cyclopropylmethyl, cyclobutylmethyl, cyclopentylmethyl, cyclohexylmethyl group and the like), a cycloalkenylalkyl group (e.g., C₃–C₈ cycloalkenyl – C₁–C₆ alkyl group, such as cyclobutenylmethyl, cyclopentenylmethyl, cyclohexenylmethyl group and the like), an aryl group (e.g., aryl group having 6 to 14 carbon atoms such as phenyl, naphthyl group and the like), an arylalkyl group (e.g., C₆–C₁₄ aryl – C₁–C₆ alkyl group, such as benzyl, naphthylmethyl group and the like) and the like can be mentioned.

As the "heterocyclic group" of the "heterocyclic group optionally having substituents" represented by R₂ and R₃, a 5- to 12-membered monocyclic or fused heterocyclic group containing 1 or 2 kinds of 1 to 4 hetero atoms selected from nitrogen atom, sulfur atom and oxygen atom such as pyridyl, pyrroolidinyl, piperazinyl, piperidinyl, 2-oxazepinyl, furyl, decahydroisoquinolyl, quinolyl, indolyl, isoquinolyl, thienyl, imidazolyl, morpholinyl etc., and the like can be mentioned.

As the substituent for the "hydrocarbon group optionally having substituents" and "heterocyclic group optionally having substituents" for R₂ and R₃, for example, a halogen atom (e.g., fluorine, chlorine, bromine, iodine etc.), a lower alkyl group (e.g., alkyl group having 1 to 6 carbon atoms such as methyl, ethyl, propyl group and the like), a lower alkenyl group (e.g., alkenyl group having 2 to 6 carbon atoms such as vinyl, allyl group and the like), a lower alkynyl group (e.g., alkynyl group having 2 to 6 carbon atoms such as ethynyl, propargyl
group and the like), a cycloalkyl group (e.g., cycloalkyl
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group having 3 to 8 carbon atoms such as cyclopropyl,
cyclobutyl, cyclopentyl, cyclohexyl group and the like), a
lower alkoxy group (e.g., alkoxy group having 1 to 6 carbon
atoms such as methoxy, ethoxy group and the like), a nitro
group, a cyano group, a hydroxy group, a thiol group, a
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 carboxyl group, a lower alkanoyl group (e.g., formyl; \( \text{C}_1-6 \)
alkyl-carbonyl group, such as acetyl, propionyl, butyryl group
and the like), a lower alkanoyloxy group (e.g., formyloxy; \( \text{C}_1-6 \)
alkyl-carbonyloxy group, such as acetyloxy, propionyloxy group
and the like), a lower alkoxy carbonyl group (e.g., \( \text{C}_1-6 \) alkoxy-
carbonyl group, such as methoxycarbonyl, ethoxycarbonyl,
propoxycarbonyl group and the like), an aralkyloxy carbonyl
group (e.g., \( \text{C}_{7-17} \) aralkyloxy-carbonyl group, such as
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benzyloxy carbonyl group and the like), an aryl group (e.g., \( \text{C}_{6-14} \) aryl group, such as phenyl, naphthyl group and the like), an
aryloxy group (e.g., \( \text{C}_{6-14} \) aryloxy group having, such as
phenyloxy, naphthyloxy group and the like), an aryl carbonyl
group (e.g., \( \text{C}_{6-14} \) aryl-carbonyl group, such as benzoyl,
naphthoyl group and the like), an aryl carbonyloxy group (e.g.,
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\( \text{C}_{6-14} \) aryl-carbonyloxy group, such as benzyloxy, naphthyloxy
group and the like), a carbamoyl group optionally having
substituents (e.g., carbamoyl; carbamoyl group mono- or di-
substituted by alkyl group having 1 to 6 carbon atoms such as
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methylcarbamoyl, dimethylcarbamoyl group etc., and the like),
an amino group optionally having substituents (e.g., amino;
amino group mono- or di-substituted by alkyl group having 1 to
6 carbon atoms such as methylamino, dimethylamino, ethylamino,
diethylamino group etc., and the like) and the like can be
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mentioned. The number and the position of the substitutions
are not particularly limited.

As the ring formed by \( R_2 \) and \( R_3 \) together with the
adjacent nitrogen atom, for example, pyrrolidine, piperidine,
homopiperidine, morpholine, piperazine, tetrahydroquinoline, tetrahydroisoquinoline and the like can be mentioned.

The "hydrocarbon group" of the "hydrocarbon group optionally having substituents" represented by the above-mentioned E, R, R₁ and Y may have 1 to 5, preferably 1 to 3, the aforementioned substituent at substitutable positions of the hydrocarbon group, wherein, when the number of substituents is not less than 2, each substituents are the same or different.

As the "heterocyclic group" of the "heterocyclic group optionally having substituents" represented by the above-mentioned E, R and Y, a 5- to 12-membered aromatic heterocyclic group and saturated or unsaturated non-aromatic heterocyclic group containing, as ring-constituting atom (ring atom), 1 to 3 (preferably 1 or 2) kinds of at least 1 (preferably 1 to 4, more preferably 1 to 3) hetero atoms selected from oxygen atom, sulfur atom and nitrogen atom and the like can be mentioned. As the mentioned above, as the "heterocyclic group" of the "heterocyclic group optionally having substituents" represented by Y, a saturated oxygen-containing heterocyclic group containing, as ring atoms, 1 to 4, more preferably 1 to 3, hetero atoms selected from oxygen atom, sulfur atom and nitrogen atom etc., and the like are preferable, particularly a 5- to 12-membered saturated oxygen-containing heterocyclic group and the like are preferable.

As the "aromatic heterocyclic group", an aromatic monocyclic heterocyclic group, an aromatic fused heterocyclic group and the like can be mentioned.

As the "aromatic monocyclic heterocyclic group", for example, a 5- or 6-membered aromatic monocyclic heterocyclic group such as furyl, thiienyl, pyrrolyl, oxazolyl, isooxazolyl, thiazolyl, isothiazolyl, imidazolyl, pyrazolyl, 1,2,3-oxadiazolyl, 1,2,4-oxadiazolyl, 1,3,4-oxadiazolyl, furazanyl,
1,2,3-thiadiazolyl, 1,2,4-thiadiazolyl, 1,3,4-thiadiazolyl, 1,2,3-triazolyl, 1,2,4-triazolyl, tetrazolyl, pyridyl, pyridazinyl, pyrimidinyl, pyrazinyl, triazinyl etc., and the like can be mentioned.

As the “aromatic fused heterocyclic group”, for example, a 8- to 12-membered aromatic fused heterocyclic group (preferably a heterocyclic group wherein the aforementioned 5- or 6-membered aromatic monocyclic heterocyclic group is condensed with a benzene ring, or a heterocyclic group wherein the same or different two heterocyclic groups of the aforementioned 5- or 6-membered aromatic monocyclic heterocyclic group are condensed), such as benzofuranyl, isobenzofuranyl, benzothienyl, isobenzothienyl, indolyl, isoindolyl, 1H-indazolyl, benzimidazolyl, benzoazolyl, 1,2-benzoisoxazolyl, benzothiazolyl, 1,2-benzoisothiazolyl, 1H-benzotriazolyl, quinolyl, isoquinolyl, cinnolinyl, quinazolinyl, quinoxaliny1, phthalazinyl, naphthyridinyl, purinyl, pteridinyl, carbazolyl, α-carbolinyl, β-carbolinyl, γ-carbolinyl, acridinyl, phenoxazinyl, phenothiazinyl, phenazinyl, phenoxathiinyl, thianthrenyl, phenanthridinyl, phenanthrolinyl, indolizinyl, pyrrolo[1,2-b]pyridazinyl, pyrazolo[1,5-a]pyridyl, imidazo[1,2-a]pyridyl, imidazo[1,5-a]pyridyl, imidazo[1,2-b]pyridazinyl, imidazo[1,2-a]pyrimidinyl, 1,2,4-triazolo[4,3-a]pyridyl, 1,2,4-triazolo[4,3-b]pyridazinyl etc., and the like can be mentioned.

As the “saturated or unsaturated non-aromatic heterocyclic group”, for example, a 3- to 8-membered (preferably 5- or 6-membered) saturated or unsaturated (preferably saturated) non-aromatic heterocyclic group (aliphatic heterocyclic group) such as oxazolyl, azetidinyl, oxetanyl, thiethanly1, pyrrolidinyl, tetrahydrofuryl, thiolanly1, piperidinyl, tetrahydropyranyl, thianyl, morpholinyl, thiomorpholinyl, piperazinyl, azepanyl, oxepanyl, thiepanyl,
oxazepanyl, thiazepanyl, azocanyl, oxocanyl, thiocanyl, oxazocanyl, thiazocanyl and the like can be mentioned. These
may be oxo-substituted and examples thereof include 2-
oxoazetidinyl, 2-oxopyrrolidinyl, 2-oxopiperidinyl, 2-
oxazepanyl, 2-oxazocanyl, 2-oxotetrahydrofuranyl, 2-
oxotetrahydropyranyl, 2-oxothiolanyl, 2-oxothiayanl, 2-
oxopiperazinyl, 2-oxooxepanyl, 2-oxooxazepanyl, 2-oxothiepanyl,
2-oxothiazepanyl, 2-oxooxocanyl, 2-oxothiocanyl, 2-
oxooxazocanyl, 2-oxothiazocanyl and the like. A 5-membered
non-aromatic heterocyclic group such as 2-oxopyrrolidinyl and
the like is preferable.

As the substituent that the "heterocyclic group" of the
"heterocyclic group optionally having substituents"
represented by the above-mentioned E, R and Y may have, for
example, those similar to the "substituent" of the
"hydrocarbon group optionally having substituents" represented
by the aforementioned E, R, R₁ and Y and the like are used.

The "heterocyclic group" of the "heterocyclic group
optionally having substituents" represented by E, R and Y may
each have 1 to 5, preferably 1 to 3, substituents mentioned
above at substitutable positions of the heterocyclic group,
and when the number of substituents is two or more, the
substituents are the same or different.

The bond between R and W in the compound of the present
invention is explained below. When R and W are bonded, the
position of the bond between R and W is not particularly
limited as long as R and W can be bonded.

The bondable position of R is the position where the
"hydrocarbon group" and "substituent" of the "hydrocarbon
group optionally having substituents" defined above for R can
be bonded, and the position where the "heterocyclic group" and
"substituent" of the "heterocyclic group optionally having
substituents" defined above for R can be bonded.
As the bondable position of W, a bondable position of the
"divalent chain hydrocarbon group" of the "divalent chain
hydrocarbon group optionally having substituents" defined
above for W, a bondable position of the "divalent chain
hydrocarbon group" defined above for W₁ and W₂, a bondable
position of the "hydrocarbon ring" of the "hydrocarbon ring
optionally having substituents" defined above for ring Z, and
a bondable position of the "heterocyclic group" of the
"heterocyclic group optionally having substituents" defined
above for ring Z can be mentioned.

R and W can be bonded at the bondable position thereof
and can form a ring together with the adjacent nitrogen atom.
As such ring, for example, a saturated nitrogen-containing
ring (e.g., azetidine, pyrrolidine, piperidine, homopiperidine
etc.), an unsaturated nitrogen-containing ring (e.g.,
tetrahydropyridine etc.), an aromatic nitrogen-containing ring
(e.g., pyrrole etc.), a hetero ring (e.g., piperazine,
morpholine etc.) containing, besides the nitrogen atom to
which R and W are adjacent, at least one hetero atom selected
from the group consisting of nitrogen, oxygen and sulfur, a
fused ring (e.g., indole, indoline, isoindole, isoindoline,
tetrahydroquinoline, tetrahydroisoquinoline etc.) and the like
can be mentioned. Of these, a 4- to 7-membered ring is
preferable.

The ring formed by R and W, which are bonded at each
bondable position thereof, together with the adjacent nitrogen
atom may have 1 to 4 substituents at substitutable positions
thereof. When the number of substituents is 2 or more, the
substituents are the same or different. As the substituent,
the substituents of the "hydrocarbon group optionally having
substituents" and "heterocyclic group optionally having
substituents" defined for R, and the substituents of the
"divalent chain hydrocarbon group optionally having
substituents* defined for W can be mentioned. Specifically, a halogen atom (e.g., fluorine, chlorine, bromine, iodine etc.), a C\textsubscript{1-6} alkyl group such as methyl, ethyl, propyl, isopropyl, butyl, isobutyl, sec-butyl, tert-butyl, pentyl, 1-ethylpropyl, hexyl etc., and the like can be mentioned.

By the bond between R and W, for example,

![Chemical structures](image)

and the like are formed, but the ring is not limited to these. These may have substituents as defined above, and it would be understood for those of ordinary skill in the art that they may also have an isomer.

In the present invention, X represents a leaving group, such as a halogen atom, a benzotriazolyl group, a (2,5-
dioxopyrrolidin-1-yl)oxy group and the like. Of these, a halogen atom such as fluorine, chlorine, bromine, iodine and the like is preferable, and chlorine is particularly preferable.

In the present invention, M represents a hydrogen atom, a metal cation or a quaternary ammonium ion.

In the present invention, the "metal cation" is exemplified by alkali metal ion (e.g., Na\(^+\), K\(^+\), Li\(^+\), Cs\(^+\) and the like), with preference given to Na\(^+\).

In the present invention, the "quaternary ammonium ion" is exemplified by tetramethylammonium ion, tetraethylammonium ion, tetrapropylammonium ion, tetrabutylammonium ion and the like, with preference given to tetrabutylammonium ion.

In the compound (I), a pharmacologically acceptable basic salt can be formed between an acidic group in a molecule and an inorganic base or an organic base etc., and a pharmacologically acceptable acid addition salt can be formed between a basic group in a molecule and an inorganic acid or an organic acid etc.

Examples of the inorganic basic salt of compound (I) include salt with alkali metal (e.g., sodium, potassium and the like), alkaline earth metal (e.g., calcium and the like), ammonia etc., and the like, and examples of the organic basic salt of compound (I) include salt with dimethylamine, triethylamine, piperazine, pyrrolidine, piperidine, 2-phenylethylamine, benzylamine, ethanolamine, diethanolamine, pyridine, collidine etc., and the like.

Examples of the acid addition salt of compound (I) include inorganic acid salt (e.g., hydrochloride, sulfate, hydrobromide, phosphate and the like), organic acid salt (e.g., acetate, trifluoroacetate, succinate, maleate, fumarate, propionate, citrate, tartrate, lactate, oxalate, methanesulfonate, p-toluenesulfonate and the like) and the
like.

The compound (I) of the present invention encompasses hydrates. Examples of the "hydrate" include 0.5 hydrate – 5.0 hydrate. Of these, 0.5 hydrate, 1.0 hydrate, 1.5 hydrate and 2.0 hydrate are preferable.

The compound (I) of the present invention encompasses racemates and optically active compounds. As the optically active compound, such compound wherein one enantiomer is in enantiomer excess (e.e.) of not less than 90% is preferable, more preferably in enantiomer excess of not less than 99%. As an optically active form, an (R)-form represented by the formula

![Chemical Structure](image)

wherein each symbol is as defined above, is preferable.

As the preferable compounds encompassed in compound (I), for example, the following specific compounds can be mentioned.

That is,

2-[methyl[[((R)-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]ethyl acetate,

2-[methyl[[((R)-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]ethyl trimethylacetate,

2-[methyl[[((R)-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl cyclohexanecarboxylate,
2-[methyl][[(R)-2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-y1]carbonyl]amino]ethyl benzoate,
2-[methyl][2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-y1]carbonyl]amino]ethyl benzoate,
2-[methyl][[(R)-2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-y1]carbonyl]amino]ethyl 4-methoxybenzoate,
2-[methyl][[(R)-2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-y1]carbonyl]amino]ethyl 3-chlorobenzoate,
2-[methyl][[(R)-2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-y1]carbonyl]amino]ethyl 3,4-difluorobenzoate,
2-[methyl][[(R)-2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-y1]carbonyl]amino]ethyl 4-trifluoromethoxybenzoate,
2-[methyl][[(R)-2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-y1]carbonyl]amino]ethyl 4-fluorobenzoate,
2-[methyl][[(R)-2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-y1]carbonyl]amino]ethyl 3,4,5-trimethoxybenzoate,
ethyl 2-[methyl][[(R)-2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl carbonate,
isopropyl 2-[methyl([R]-2-[[[3-methyl-4-(2,2,2-
trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl carbonate,
5 isopropyl 2-[methyl([2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-
2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl carbonate,
benzyl 2-[methyl([R]-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-
2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl carbonate,
10 2-[methyl([R]-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-
pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl tetrahydropyran-4-yl carbonate,
2-methoxyethyl 2-[methyl([R]-2-[[[3-methyl-4-(2,2,2-
15 trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl carbonate,
2-[ethyl([R]-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-
pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl acetate,
20 2-[isopropyl([R]-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-
pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl acetate,
ethyl 2-[isopropyl([R]-2-[[[3-methyl-4-(2,2,2-
trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl carbonate,
25 2-[cyclohexyl([R]-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-
pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl acetate,
2-[cyclohexyl([R]-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-
30 pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl ethyl carbonate,
2-[[[R]-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-
pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
35 yl]carbonyl]amino]ethyl carbonate,
yl]carbonyl)(phenyl)amino]ethyl acetate,
2-[[2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-
pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl)(phenyl)amino]ethyl acetate,
tert-butyl [2-[methyl][(R)-2-[[3-methyl-4-(2,2,2-
trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]3-pyridyl)methyl carbonate,
2-[methyl][(R)-2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-
pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]benzyl acetate,
2-[[2-(acetyloxy)ethyl][(R)-2-[[3-methyl-4-(2,2,2-
trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl acetate,
[(2S)-1-[[R]-2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-
pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]2-
pyrrolidinyl)methyl acetate,
ethyl [methyl][(R)-2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-
pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]acetate,
2-[[5-methoxy-2-[[4-methoxy-3,5-dimethyl-2-
pyridyl]methyl]sulfinyl]-1H-benzoimidazol-1-
yl]carbonyl] (methyl)amino]ethyl benzoate,
3-[methyl][(R)-2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-
pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]propyl benzoate,
2-[methyl][2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-
pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl tetrahydropyran-4-yl carbonate,
ethyl 2-[methyl][2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-
pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl carbonate,
ethyl 2-[methyl][(S)-2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-
pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl carbonate,
ethyl 2-[[5-methoxy-2-[[{(4-methoxy-3',5'-dimethyl-2'-pyridyl)methyl]sulfinyl]-3H-imidazo[4,5-b]pyridin-3-yl]carbonyl](methyl)amino)ethyl carbonate,
2-[[5-methoxy-2-[[{(4-methoxy-3',5'-dimethyl-2'-pyridyl)methyl]sulfinyl]-3H-imidazo[4,5-b]pyridin-3-yl]carbonyl](methyl)amino)ethyl acetate,
2-[[5-methoxy-2-[[{(4-methoxy-3',5'-dimethyl-2'-pyridyl)methyl]sulfinyl]-3H-imidazo[4,5-b]pyridin-3-yl]carbonyl](phenyl)amino)ethyl acetate,
4-[[{R}-2-[[{3-methyl-4-{(2,2,2-trifluoroethoxy)-2-pyridyl}methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]butyl acetate,
ethyl 4-[[{R}-2-[[{3-methyl-4-{(2,2,2-trifluoroethoxy)-2-pyridyl}methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]butyl carbonate,
ethyl 3-[[{R}-2-[[{3-methyl-4-{(2,2,2-trifluoroethoxy)-2-pyridyl}methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]propyl carbonate,
3-[[{R}-2-[[{3-methyl-4-{(2,2,2-trifluoroethoxy)-2-pyridyl}methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]propyl acetate,
3-[[{R}-2-[[{3-methyl-4-{(2,2,2-trifluoroethoxy)-2-pyridyl}methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]propane-1,2-diyl diacetate,
diethyl 3-[[{R}-2-[[{3-methyl-4-{(2,2,2-trifluoroethoxy)-2-pyridyl}methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]propane-1,2-diyl bis carbonate,
2-[[5-methoxy-2-[[{(4-methoxy-3',5'-dimethyl-2'-pyridyl)methyl]sulfinyl}-3H-imidazo[4,5-b]pyridin-3-yl]carbonyl](methyl)amino)ethyl 3-chlorobenzoate,
2-[[{R}-2-[[{3-methyl-4-{(2,2,2-trifluoroethoxy)-2-pyridyl}methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]propane-1,2-diyl diacetate,
yl]carbonyl]amino]ethyl acetate,
2-ethoxyethyl 2-[methyl][((R)-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]ethyl carbonate,
3-methoxypropyl 2-[methyl][((R)-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]ethyl carbonate,
2-[methyl][((R)-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]ethyl N,N-dimethylglycinate,
ethyl 2-[[[5-methoxy-2-[[[4-methoxy-3,5-dimethyl-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl] (methyl) amino]ethyl carbonate,
2-[[[5-methoxy-2-[[[4-methoxy-3,5-dimethyl-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl] (phenyl) amino]ethyl acetate,
ethyl 2-[[[(S)-5-methoxy-2-[[[4-methoxy-3,5-dimethyl-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl] (methyl) amino]ethyl carbonate,
ethyl 2-[[[2-[[4-(3-methoxypropoxy)-3-methyl-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl] (methyl) amino]ethyl carbonate,
yl]carbonyl](phenyl)amino]ethyl acetate,
2-[[5-(difluoromethoxy)-2-[[3,4-dimethoxy-2-
pyridyl)methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl](methyl)amino]ethyl ethyl carbonate,
5 2-[methyl[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-
pyridyl)methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl 1-methylpiperidine-4-carboxylate,
2-[[4-(aminocarbonyl)phenyl][[3-methyl-4-(2,2,2-
trifluoroethoxy)-2-pyridyl)methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl acetate,
2-[methyl[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-
pyridyl)methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl 1-methyl-4-piperidinyl carbonate,
2-[[4-(aminocarbonyl)phenyl][2-[[3-methyl-4-(2,2,2-
trifluoroethoxy)-2-pyridyl)methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl acetate,
(−)-ethyl 2-[[5-methoxy-2-[[4-methoxy-3,5-dimethyl-2-
pyridyl)methyl]sulfinyl]-3H-imidazo[4,5-b]pyridin-3-
yl]carbonyl](methyl)amino]ethyl carbonate and
(+)−ethyl 2-[[5-methoxy-2-[[4-methoxy-3,5-dimethyl-2-
pyridyl)methyl]sulfinyl]-3H-imidazo[4,5-b]pyridin-3-
yl]carbonyl](methyl)amino]ethyl carbonate, a salt thereof and
the like can be mentioned.

Of these, the following compounds and salts thereof are
25 preferable.
2-[methyl[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-
pyridyl)methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl acetate,
ethyl 2-[methyl[[3-methyl-4-(2,2,2-trifluoroethoxy)-
2-pyridyl)methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl carbonate,
2-[methyl[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-
pyridyl)methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl tetrahydropyran-4-yl carbonate,
2-[methyl[[2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]ethyl tetrahydropyran-4-yl carbonate,
ethyl 2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]ethyl carbonate,
ethyl 2-[[5-methoxy-2-[[4-methoxy-3,5-dimethyl-2-pyridyl]methyl]sulfinyl]-3H-imidazo[4,5-b]pyridin-3-yl]carbonyl] (methyl)amino]ethyl carbonate,
2-[[5-methoxy-2-[[4-methoxy-3,5-dimethyl-2-pyridyl]methyl]sulfinyl]-3H-imidazo[4,5-b]pyridin-3-yl]carbonyl] (methyl)amino]ethyl acetate,
ethyl 2-[[5-methoxy-2-[[4-methoxy-3,5-dimethyl-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl] (methyl)amino]ethyl carbonate,
ethyl 2-[[[(S)-5-methoxy-2-[[4-methoxy-3,5-dimethyl-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl] (methyl)amino]ethyl carbonate,
ethyl 2-[[2-[[4-(3-methoxypropoxy)-3-methyl-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl] (methyl)amino]ethyl carbonate, and

The compound (I) can be produced by the following method

A or B.

(Method A)

The compound (I) or a salt thereof can be obtained by condensation of compound (III) or a salt thereof with compound
(IV) or a salt thereof in the presence or absence of a base. The salt of compound (III) and the salt of compound (IV) here are exemplified by the above-mentioned salts of compound (I). For example, acid addition salts such as inorganic acid salt (e.g., hydrochloride, sulfate, hydrobromide, phosphate and the like), organic acid salt (e.g., acetate, trifluoroacetate, succinate, maleate, fumarate, propionate, citrate, tartrate, lactate, oxalate, methanesulfonate, p-toluenesulfonate and the like), and the like can be mentioned.

wherein each symbol is as defined above. The reaction of Method A is generally conducted in a solvent, and a solvent that does not inhibit the reaction of Method A is selected as appropriate. Examples of such solvent include ethers (e.g., dioxane, tetrahydrofuran, diethyl ether, tert-butyl methyl ether, diisopropyl ether, ethylene glycol dimethyl ether and the like), esters (e.g., ethyl formate, ethyl acetate, butyl acetate and the like), halogenated hydrocarbons (e.g., dichloromethane, chloroform, carbon tetrachloride, trichlene, 1,2-dichloroethane and the like), hydrocarbons (e.g., n-hexane, benzene, toluene and the like), amides (e.g., formamide, N,N-dimethylformamide, N,N-dimethylacetamide and the like), ketones (e.g., acetone, methyl ethyl ketone, methyl isobutyl ketone and the like), nitriles (e.g., acetonitrile, propionitrile and the like) and the like, as well as dimethyl sulfoxide, sulfolane, hexamethylphosphoramide, water and the
like, which may be used alone or as a mixed solvent. The amount of the solvent to be used is not particularly limited as long as the reaction mixture can be stirred, which is generally 2- to 100-fold amount by weight, preferably 5- to 50-fold amount by weight, relative to 1 mole of compound (III) or a salt thereof.

The amount of compound (III) or a salt thereof to be used is generally 1 - 10 mole, preferably 1 - 3 mole, relative to 1 mole of compound (III) or a salt thereof.

The reaction of Method A is carried out within a temperature range of from about 0°C to 100°C, preferably 20°C to 80°C.

The reaction time of Method A varies depending on the kind of compounds (III), (IV) or a salt thereof and solvent, reaction temperature and the like, but it is generally 1 min. - 96 hrs., preferably 1 min. - 72 hrs., more preferably 15 min. - 24 hrs.

The base in Method A is, for example, an inorganic base (e.g., sodium carbonate, potassium carbonate, calcium carbonate, sodium hydrogen carbonate etc.), a tertiary amine (e.g., triethylamine, tripropylamine, tributylamine, cyclohexylidimethylamine, pyridine, lutidine, γ-collidine, N,N-dimethylaniline, N-methylpiperidine, N-methylpyrrolidine, N-methylmorpholine, 4-dimethylaminopyridine and the like); alkylene oxides (e.g., propylene oxide, epichlorohydrin etc.) and the like. The amount of the base to be used is generally 1 mole - 10 mole, preferably 1 mole - 3 mole, relative to 1 mole of compound (IV) or a salt thereof.

The compound (III) or a salt thereof can be produced according to the method described in JP-A-61-50978, USP 4,628,098 and the like or a method similar thereto.

The compound (IV) or a salt thereof can be produced according to a method known per se or a method analogous
thereof. For example, when X is a chlorine atom, compound (IV) can be obtained by reacting a compound represented by the formula (VI):

\[
\begin{align*}
X_2 & \quad R \\
Y - D_2 - C & - D_1 - W - NH
\end{align*}
\]  

(VI)

wherein each symbol is as defined above, or a salt thereof with phosgene, trichloromethyl chloroformate, bis(trichloromethyl)carbonate, thiophosgene and the like in the presence of an acid scavenger in a solvent (e.g., tetrahydrofuran, acetonitrile, dichloromethane etc.).

Alternatively, compound (IV) can be also obtained by treating ethylcarbamate, which is obtained by reacting compound (VI) or a salt thereof with ethyl chloroformate, with phosphorus oxychloride according to the method described in Synthetic Communications, vol. 17, p. 1887 (1987) or a method analogous thereto. As the salt of compound (VI), for example, acid addition salts such as inorganic acid salts (e.g., hydrochloride, sulfate, hydrobromide, phosphate etc.), organic acid salts (e.g., acetate, trifluoroacetate, succinate, maleate, fumarate, propionate, citrate, tartrate, lactate, oxalate, methanesulfonate, p-toluenesulfonate etc.), and the like can be mentioned.

As the acid scavenger used here, for example, inorganic bases (e.g., sodium carbonate, potassium carbonate, calcium carbonate, sodium hydrogen carbonate etc.), tertiary amine (e.g., triethylamine, tripropylamine, tributylamine, cyclohexylidemethylamine, pyridine, lutidine, \( \gamma \)-collidine, \( N,N \)-dimethylaniline, \( N \)-methylpiperidine, \( N \)-methylpyrrolidine, \( N \)-methylmorpholine, 4-dimethylaminopyridine etc.) and the like can be mentioned.

The compound (VI) and a salt thereof can be produced according to a method known per se or a method analogous thereto. For example, when \( D_1 \) is other than a bond, compound
(VI) can be obtained by condensing a compound represented by the formula (VII):

\[
\begin{array}{c}
\text{R} \\
\text{H--D}_1--\text{W}--\text{N}--\text{R}_4
\end{array}
\]

wherein \( \text{R} \) is a hydrogen atom or nitrogen-protecting group, and other symbols are as defined above, or a salt thereof with carboxylic acid or thionic acid represented by the formula (VIII):

\[
\begin{array}{c}
\text{X}_2 \\
\text{Y--D}_2--\text{C}--\text{OH}
\end{array}
\]

wherein each symbol is as defined above, or a reactive derivative thereof (e.g., anhydride, halide etc.), or a salt thereof in a suitable solvent (e.g., ethyl acetate, tetrahydrofuran, dichloromethane, \( \text{N},\text{N} \)-dimethylformamide etc.), followed by deprotection as necessary. As the salt of compound (VII), for example, acid addition salts such as inorganic acid salts (e.g., hydrochloride, sulfate, hydrobromide, phosphate etc.), organic acid salts (e.g., acetate, trifluoroacetate, succinate, maleate, fumarate, propionate, citrate, tartrate, lactate, oxalate, methanesulfonate, \( \text{p} \)-toluenesulfonate etc.) etc., and the like can be mentioned.

Alternatively, when \( \text{D}_1 \) is a bond, compound (VI) can be obtained by condensing carboxylic acid or thionic acid represented by the formula (IX):

\[
\begin{array}{c}
\text{X}_2 \\
\text{HO--C--W}--\text{N}--\text{R}_4
\end{array}
\]

wherein each symbol is as defined above, or a reactive derivative thereof (e.g., anhydride, halide etc.), or a salt thereof with a compound represented by \( \text{Y--D}_2--\text{H} \) in a suitable solvent (e.g., ethyl acetate, tetrahydrofuran, dichloromethane, \( \text{N},\text{N} \)-dimethylformamide etc.), followed by deprotection, as necessary. As the salt of compound (IX), for example, acid addition salts such as inorganic acid salts (e.g.,
hydrochloride, sulfate, hydrobromide, phosphate etc.), organic acid salts (e.g., acetate, trifluoroacetate, succinate, maleate, fumarate, propionate, citrate, tartrate, lactate, oxalate, methanesulfonate, p-toluenesulfonate etc.) and the like, salts with alkali metal (e.g., sodium, potassium etc.), alkaline earth metal (e.g., calcium etc.), ammonia etc., and the like, and for example, organic base such as dimethylamine, triethylamine, piperazine, pyrrolidine, piperidine, 2-phenylethylamine, benzylamine, ethanolamine, pyridine, collidine etc., and the like can be mentioned.

As the protecting group represented by R₄ in the formula (VII) and the formula (IX), for example, a formyl group, a C₁₋₆ alkyl-carbonyl group (e.g., acetyl, ethylcarbonyl etc.), a benzyl group, a tert-butylloxycarbonyl group, a benzyloxycarbonyl group, an allyloxycarbonyl group, a C₇₋₁₀ aralkyl-carbonyl group (e.g., benzylcarbonyl etc.), a trityl group and the like are used. These groups may be substituted by 1 to 3 halogen atoms (e.g., fluorine, chlorine, bromine etc.), a nitro group and the like.

As a method for removing such protecting groups, a method known per se or a method analogous thereto is used, which is, for example, a method using an acid, a base, reduction, UV light, palladium acetate etc., and the like are used. (Method B)

The compound (I) and a salt thereof can be obtained by subjecting compound (V) or a salt thereof to oxidization reaction.
wherein each symbol is as defined above.

The reaction in Method B can be carried out using an oxidant such as nitric acid, hydrogen peroxide, peroxyacid, peroxycacid ester, ozone, dinitrogen tetraoxide, iodosobenzene, N-halosuccinimide, 1-chlorobenzotriazole, tert-butyl hypochlorite, diazabicyclo[2.2.2]octane-bromine complex, sodium metaperiodate, selenium dioxide, manganese dioxide, chromic acid, cerium ammonium nitrate, bromine, chlorine, sulfuryl chloride, magnesium monoperoxypthalate and the like. The amount of the oxidant to be used is generally 0.5 mole - 2 mole, preferably 0.8 mole - 1.2 mole, per 1 mole of compound (I) or a salt thereof. The oxidation may be carried out using the above-mentioned oxidant such as hydrogen peroxide and peroxyacids in the presence of a catalyst such as vanadium acetate, vanadium oxide acetylacetonate, titanium tetrakispropoxide and the like.

The reaction of Method B is generally carried out in a solvent inert to the above-mentioned oxidation reaction.

Examples of the "inert solvent" include water, alcohols (e.g., methanol, ethanol, 1-propanol, 2-propanol etc.), ketones (e.g., acetone, methyl ethyl ketone etc.), nitriles (e.g., acetonitrile, propionitrile etc.), amides (e.g., formamide, N,N-dimethylformamide etc.), ethers (e.g., diethyl ether, tert-butyl methyl ether, diisopropyl ether, dioxane,
tetrahydrofuran etc.), sulfoxides (e.g., dimethyl sulfoxide etc.) and polar solvents (e.g., sulfolane, hexamethylphosphoramidate etc.), which may be used alone or as a mixed solvent thereof. The "inert solvent" is used in generally 1- to 100-fold amount by weight of compound (V) or a salt thereof.

The reaction temperature is generally from -80°C to 80°C, preferably from 0°C to 30°C.

The reaction time is generally 1 min. - 6 hrs., preferably 15 min. - 1 hr.

The compound (V), which is a starting material in Method B, can be obtained by a reaction similar to that in Method A, by the use of, for example, a compound represented by the following formula (X):

```
\[ \text{B} \quad \text{S} \quad \text{N} \quad \text{M} \quad \text{A} \] (X)
```

wherein each symbol is as defined above, instead of compound (III).


The salt of compound (V) is exemplified by the above-mentioned salts of the compound (I), which are acid addition salts such as inorganic acid salt (e.g., hydrochloride, sulfate, hydrobromide, phosphate and the like), organic acid salt (e.g., acetate, trifluoroacetate, succinate, maleate, fumarate, propionate, citrate, tartrate, lactate, oxalate, methanesulfonate, p-toluenesulfonate and the like) and the like.

The compound (I) or a salt thereof obtained by the above-
mentioned methods A or B can be isolated and purified from the reaction mixture by a separation means known per se (e.g., concentration, concentration under reduced pressure, solvent extraction, crystallization, recrystallization, phase transfer, chromatography and the like). Since compound (I) and a salt thereof obtained by the above-mentioned methods A or B encompass any isomers thereof, optically pure compound (I) and a salt thereof can be obtained by, for example, subjecting compound (I) or a salt thereof to optical resolution, or asymmetric oxidation of compound (V) or a salt thereof.

The method of optical resolution includes methods known per se, such as a fractional recrystallization method, a chiral column method, a diastereomer method, and so forth. Asymmetric oxidation includes methods known per se, such as the method described in WO96/02535 and the like.

The "fractional recrystallization method" includes a method in which a salt is formed between a racemate and an optically active compound [e.g., (+)-mandelic acid, (-)-mandelic acid, (+)-tartaric acid, (-)-tartaric acid, (+)-1-phenethylamine, (-)-1-phenethylamine, cinchonine, (-)-cinchonidine, brucine, etc.], which salt is separated by fractional recrystallization etc., and, if desired, subjected to a neutralization process to give a free optical isomer.

The "chiral column method" includes a method in which a racemate or a salt thereof is applied to a column for optical isomer separation (chiral column). In the case of liquid chromatography, for example, optical isomers are separated by adding a racemate to a chiral column such as ENANTIO-OVM (produced by Tosoh Corporation), the DAICEL CHIRAL series (produced by Daicel Corporation) and the like, and developing the racemate in water, a buffer (e.g., phosphate buffer), an organic solvent (e.g., hexane, ethanol, methanol, isopropanol, acetonitrile, trifluoroacetic acid, diethylamine,
triethylamine, etc.), or a solvent mixture thereof. In the case of gas chromatography, for example, a chiral column such as CP-Chirasil-DeX CB (produced by GL Science) and the like is used to separate optical isomers.

The "diastereomer method" includes a method in which a racemate and an optically active reagent are reacted to give a diastereomeric mixture, which is then subjected to ordinary separation means (e.g., fractional recrystallization, chromatography, etc.) to obtain either diastereomer, which is subjected to a chemical reaction (e.g., acid hydrolysis, base hydrolysis, hydrogenolysis, etc.) to cut off the optically active reagent moiety, whereby the desired optical isomer is obtained. Said "optically active reagent" includes, for example, optically active organic acids such as MTPA [α-

methoxy-α-(trifluoromethyl)phenylacetic acid], (-)-
methoxyacetic acid and the like, optically active alkoxymethyl halides such as (1R-endo)-2-(chloromethoxy)-
1,3,3-trimethylbicyclo[2.2.1]heptane etc., and the like.

The compound (I) and a salt thereof of the present invention are useful as a pharmaceutical agent, because they show, after in vivo administration, a superior anti-ulcer activity, a gastric acid secretion-suppressive action, a mucosa-protecting action, an anti-Helicobacter pylori action and the like, as well as low toxicity. In addition, since they are stable to acid, they do not require formulation into an enteric-coated preparation for oral administration, which in turn eliminates the cost for formulating enteric-coated preparation. Moreover, the tablet can be made smaller, which is easily swallowed by patients having difficulty in swallowing, particularly the elderly and children. Furthermore, since absorption is faster than in enteric-coated preparations, expression of gastric acid secretion-suppressive action is rapid. The preparation is long-acting because it is gradually
converted to the original compound in living organisms. Consequently, the compounds are useful as anti-ulcer agents and the like. In addition, compound (I) and a salt thereof of the present invention as prodrugs are expected to provide an effect of improvement of absorption, control of intensity of pharmacological action, reduction of side effects, improvement of uncomfortable taste, reduction of irritation, expansion of selectivity of formulation of preparations, improvement of administration route and the like as compared to the original compounds, though subject to change depending on the kind of the substituents. When enteric coating is not necessary as mentioned above, miniaturization of preparation, low cost of preparation and the like can be achieved, affording greater benefit in the industrial production. As described, compound (I) and a salt thereof have various superior effects as a prodrug. Among others, they are particularly useful as anti-ulcer agents and the like in that chemical stability can be improved and a sustained pharmacological action is attainable.

The compound (I) and a salt thereof of the present invention are useful for the prophylaxis or treatment of peptic ulcer (e.g., gastric ulcer, gastric ulcer due to post-operative stress, duodenal ulcer, anastomotic ulcer, ulcer caused by nonsteroidal anti-inflammatory agent etc.); gastritis; reflux esophagitis; symptomatic gastroesophageal reflux diseases (symptomatic GERD); NUD (Non Ulcer Dyspepsia); gastric cancer (including gastric cancer due to promoted production of interleukin-1β caused by genetic polymorphism of interleukin-1); gastric MALT lymphoma; Zollinger-Ellison syndrome; gastric hyperacidity (e.g. gastric hyperacidity due to post-operative stress); hemorrhage of upper gastrointestinal tract caused by acute stress ulcer, hemorrhagic gastritis or invasion stress (stress due to major surgery requiring intensive management after operation and
cerebrovascular disorder, external injury in the head, multiple organ failure and extensive burn requiring intensive treatment), and the like, pre-anesthetic administration, eradication of Helicobacter pylori and the like in mammals (e.g., human, simian, sheep, cattle, horse, dog, cat, rabbit, rat, mouse etc.).

The compound (I) and a salt thereof of the present invention show low toxicity and can be safely administered orally or parenterally (e.g., topical, rectal, intravenous administrations and the like) as they are or as a preparation containing a pharmaceutical composition containing a pharmacologically acceptable carrier admixed according to a method known per se, such as tablets (including sugar-coated tablets and film-coated tablets), powder, granule, capsule (including soft capsule), orally disintegrating tablet, liquid, injection, suppository, sustained-release preparation, plaster and the like.

The content of compound (I) or a salt thereof of the present invention in the pharmaceutical composition of the present invention is about 0.01 to 100% by weight relative to the entire composition. Though subject to change depending on the administration target, administration route, disease and the like, its dose is about 0.5 to 1,500 mg/day, preferably about 5 to 150 mg/day, based on the active ingredient, when, for example, the compound is orally administered as an anti-ulcer agent to an adult human (60 kg). The compound (I) or a salt thereof of the present invention may be administered once daily or in 2 or 3 divided portions per day.

The pharmacologically acceptable carrier that may be used to produce the pharmaceutical composition of the present invention includes various organic or inorganic carrier substances in common use as pharmaceutical materials, including excipients, lubricants, binders, disintegrants,
water-soluble polymers and basic inorganic salts for solid preparations; and solvents, dissolution aids, suspending agents, isotonizing agents, buffers and soothing agents for liquid preparations and the like. Other ordinary pharmaceutical additives such as preservatives, anti-oxidants, coloring agents, sweetening agents, souring agents, bubbling agents and flavorings may also be used as necessary.

Such "excipients" include, for example, lactose, sucrose, D-mannitol, starch, cornstarch, crystalline cellulose, light silicic anhydride, titanium oxide and the like.

Such "lubricants" include, for example, magnesium stearate, sucrose fatty acid esters, polyethylene glycol, talc, stearic acid and the like.

Such "binders" include, for example, hydroxypropyl cellulose, hydroxypropylmethyl cellulose, crystalline cellulose, starch, polyvinylpyrrolidone, powdered acacia, gelatin, pullulan, low-substituted hydroxypropyl cellulose and the like.

Such "disintegrants" include (1) crosslinked povidone, (2) what is called super-disintegrants such as crosslinked carmellose sodium (FMC-Asahi Chemical) and carmellose calcium (Gotoku Yakuhin) etc, (3) carboxymethyl starch sodium (e.g., product of Matsutani Chemical), (4) low-substituted hydroxypropyl cellulose (e.g., product of Shin-Etsu Chemical), (5) cornstarch, and so forth. Said "crosslinked povidone" may be any crosslinked polymer having the chemical name 1-ethenyl-2-pyrrolidinone homopolymer, including polyvinylpyrrolidone (PVPP) and 1-vinyl-2-pyrrolidinone homopolymer, and is exemplified by Colidon CL (produced by BASF), Polyplasdon XL (produced by ISP), Polyplasdon XL-10 (produced by ISP), Polyplasdon INF-10 (produced by ISP) and the like.

Such "water-soluble polymers" include, for example, ethanol-soluble water-soluble polymers [e.g., cellulose
derivatives such as hydroxypropyl cellulose (hereinafter also referred to as HPC) etc., polyvinylpyrrolidone and the like), ethanol-insoluble water-soluble polymers [e.g., cellulose derivatives such as hydroxypropylmethyl cellulose (hereinafter also referred to as HPMC) etc., methyl cellulose, carboxymethyl cellulose sodium and the like, sodium polyacrylate, polyvinyl alcohol, sodium alginate, guar gum and the like] and the like.

Such "basic inorganic salts" include, for example, basic inorganic salts of sodium, potassium, magnesium and/or calcium. Preferred are basic inorganic salts of magnesium and/or calcium. More preferred are basic inorganic salts of magnesium. Such basic inorganic salts of sodium include, for example, sodium carbonate, sodium hydrogen carbonate, disodium hydrogen phosphate and the like. Such basic inorganic salts of potassium include, for example, potassium carbonate, potassium hydrogen carbonate and the like. Such basic inorganic salts of magnesium include, for example, heavy magnesium carbonate, magnesium carbonate, magnesium oxide, magnesium hydroxide, magnesium metasilicate aluminate, magnesium silicate, magnesium aluminate, synthetic hydrotalcite $[\text{Mg}_6\text{Al}_2(\text{OH})_{16}\text{CO}_34\text{H}_2\text{O}]$, and alumina hydroxide magnesium. Preferred are heavy magnesium carbonate, magnesium carbonate, magnesium oxide, magnesium hydroxide and the like. Such basic inorganic salts of calcium include, for example, precipitated calcium carbonate, calcium hydroxide, etc.

Such "solvents" include, for example, water for injection, alcohol, propylene glycol, macrogol, sesame oil, corn oil, olive oil and the like.

Such "dissolution aids" include, for example, polyethylene glycol, propylene glycol, D-mannitol, benzyl benzoate, ethanol, trisaminomethane, cholesterol, triethanolamine, sodium carbonate, sodium citrate and the like.
Such "suspending agents" include, for example, surfactants such as stearyltriethanolamine, sodium lauryl sulfate, laurylaminopropionic acid, lecithin, benzalkonium chloride, benzethonium chloride, monostearic glycerol etc; hydrophilic polymers such as polyvinyl alcohol, polyvinylpyrrolidone, carboxymethyl cellulose sodium, methyl cellulose, hydroxymethyl cellulose, hydroxyethyl cellulose, hydroxypropyl cellulose etc., and the like.

Such "isotonicizing agents" include, for example, glucose, D-sorbitol, sodium chloride, glycerol, D-mannitol and the like.

Such "buffers" include, for example, buffer solutions of phosphates, acetates, carbonates, citrates etc, and the like.

Such "soothing agents" include, for example, benzyl alcohol and the like.

Such "preservatives" include, for example, p-oxybenzoic acid esters, chlorobutanol, benzyl alcohol, phenethyl alcohol, dehydroacetic acid, sorbic acid and the like.

Such "antioxidants" include, for example, sulfites, ascorbic acid, α-tocopherol and the like.

Such "coloring agents" include, for example, food colors such as Food Color Yellow No. 5, Food Color Red No. 2, Food Color Blue No. 2 etc; food lake colors, red oxide and the like.

Such "sweetening agents" include, for example, saccharin sodium, dipotassium glycyrrhizinate, aspartame, stevia, thaumatin and the like.

Such "souring agents" include, for example, citric acid (citric anhydride), tartaric acid, malic acid and the like.

Such "bubbling agents" include, for example, sodium bicarbonate and the like.

Such "flavorings" may be synthetic substances or naturally occurring substances, and include, for example, lemon, lime, orange, menthol, strawberry and the like.

The compound of the present invention may be prepared as
a preparation for oral administration in accordance with a method known per se, by, for example, compression-shaping in the presence of a carrier such as an excipient, a disintegrant, a binder, a lubricant, or the like, and subsequently coating the preparation as necessary by a method known per se for the purpose of taste masking, enteric dissolution or sustained release. For an enteric-coated preparation, an intermediate layer may be provided by a method known per se between the enteric layer and the drug-containing layer for the purpose of separation of the two layers.

For preparing the compound (I) or a salt thereof of the present invention as an orally disintegrating tablet, available methods include, for example, a method in which a core containing crystalline cellulose and lactose is coated with the compound (I) or a salt thereof of the present invention and, where necessary, a basic inorganic salt, and then further coated with a coating layer containing a water-soluble polymer to give a composition, which is coated with an enteric coating layer containing polyethylene glycol, further coated with an enteric coating layer containing triethyl citrate, still further coated with an enteric coating layer containing polyethylene glycol, and finally coated with mannitol to give fine granules, which are mixed with additives and shaped.

The above-mentioned "enteric coating layer" includes, for example, a layer consisting of a mixture of one or more kinds from aqueous enteric polymer substrates such as cellulose acetate phthalate (CAP), hydroxypropylmethyl cellulose phthalate, hydroxymethyl cellulose acetate succinate, methacrylic acid copolymers (e.g., Eudragit L30D-55 (trade name; produced by Rohm), Colicoat MAE30DP (trade name; produced by BASF), Polyquid PA30 (trade name; produced by Sanyo Chemical) etc), carboxymethyl methyl cellulose, shellac and
the like; sustained-release substrates such as methacrylic acid copolymers (e.g., Eudragit NE30D (trade name), Eudragit RL30D (trade name), Eudragit RS30D (trade name), etc.) and the like; water-soluble polymers; plasticizers such as triethyl citrate, polyethylene glycol, acetylated monoglycerides, triacetin, castor oil etc.; and the like; and the like.

The above-mentioned "additive" includes, for example, water-soluble sugar alcohols (e.g., sorbitol, mannitol, maltitol, reduced starch saccharides, xylitol, reduced palatinose, erythritol, etc.), crystalline cellulose (e.g., Ceolas KG 801, Avicel PH 101, Avicel PH 102, Avicel PH 301, Avicel PH 302, Avicel RC-591 (crystalline cellulose carmelllose sodium) etc), low-substituted hydroxypropyl cellulose (e.g., LH-22, LH-32, LH-23, LH-33 (Shin-Etsu Chemical), mixtures thereof etc) and the like. Furthermore, binders, souring agents, buzzing agents, sweetening agents, flavorings, lubricants, coloring agents, stabilizers, excipients, disintegrants etc. are also used.

The compound of the present invention may be used in combination with 1 to 3 other active ingredients.

Such "other active ingredients" include, for example, an antibacterial agent (e.g., anti-Helicobacter pylori active substances, imidazole compounds, bismuth salts, quinolone compounds, etc.), acid suppressant, anti-cancer agent, antiinflammatory agents such as nonsteroidal anti-inflammatory drug (NSAID) and the like. As the "other active ingredients", antibacterial agents are preferable, of which preferred are anti-Helicobacter pylori active substances, imidazole compounds and the like.

Such "anti-Helicobacter pylori active substances" include, for example, antibiotic penicillins (e.g., amoxicillin, benzylpenicillin, piperacillin, mecillinam, etc.), antibiotic cefems (e.g., cefixime, cefaclor, etc.), antibiotic macrolides
(e.g., erythromycin, clarithromycin, etc.), antibiotic
tetracyclines (e.g., tetracycline, minocycline, streptomycin,
etc.), antibiotic aminoglycosides (e.g., gentamicin, amikacin,
etc.), imipenem and so forth. Of these substances, preferred
are antibiotic penicillins, antibiotic macrolides and the like.
Particularly, a combined use of compound (I) or a salt thereof
of the present invention with antibiotic penicillin
(particularly amoxicillin) and antibiotic macrolides
(particularly clarithromycin) is preferable.

Such "imidazole compounds" include, for example,
metronidazole, miconazole and the like. Specifically, a
combined use with metronidazole is-preferable.

Such "bismuth salts" include, for example, bismuth
acetate, bismuth citrate and the like.

Such "quinolone compounds" include, for example,
ofloxacin, ciprofloxacin and the like.

Particularly, a combined use of the compound of the
present invention with an antibacterial agent is preferable.
More specifically, a combined use of the compound of the
present invention with clarithromycin and/or metronidazole is
preferable.

Such "other active ingredients" and the compound (I) or a
salt thereof of the present invention may be mixed, prepared
as a single pharmaceutical composition [e.g., tablets, powders,
granules, capsules (including soft capsules), liquids,
injectable preparations, suppositories, sustained-release
preparations, etc.], in accordance with a commonly known
method, and used in combination, and may also be prepared as
separate preparations and administered to the same subject
simultaneously or at a time interval.

Examples

The present invention is explained in detail in the
following by referring to Reference Examples and Examples. The
present invention is not limited by the Examples.

In the following Reference Examples and Examples, room temperature means about 15-30°C.

$^1$H-NMR spectra were determined with CDCl$_3$, DMSO-d$_6$ and CD$_3$OD as the solvent using Varian Gemini-200 and Mercury-300; data are shown in chemical shift $\delta$ (ppm) from the internal standard tetramethylsilane.

Other symbols in the present specification mean the following.

- s: singlet
- d: doublet
- t: triplet
- q: quartet
- m: multiplet
- br: broad
- bs: broad singlet
- bm: broad multiplet
- J: coupling constant

**Reference Example 1**

![Chemical Structure](image)

**tert-Butyl 2-hydroxyethyl(methyl)carbamate**

To a mixture of 2-(methylamino)ethanol (30.04 g) and ethyl acetate (90 mL) was dropwise added a mixture of di-tert-butyl dicarbonate (87.30 g) and ethyl acetate (10 mL) under ice-cooling. After stirring at room temperature for 2 hrs., the mixture was concentrated under reduced pressure. The residue was dissolved in ethyl acetate (150 mL), washed with water (100 mL) and dried over anhydrous magnesium sulfate. Concentration under reduced pressure gave the title compound (66.19 g) as a colorless oil.
1H-NMR (CDCl₃): 1.47 (9H, s), 2.92 (3H, s), 3.40 (2H, t, J=5.1 Hz), 3.72-3.80 (2H, m).

**Reference Example 2**

![Chemical structure](image)

2-(Methylamino)ethyl acetate hydrochloride

To a mixture of 2-(methylamino)ethanol (1.50 g) and ethyl acetate (20 mL) was added di-tert-butyl dicarbonate (4.37 g) under ice-cooling. After stirring under ice-cooling for 1.5 hrs., acetic anhydride (2.08 mL), pyridine (1.78 mL) and 4-dimethylaminopyridine (0.12 g) were added. After stirring at room temperature for 2 hrs., ethyl acetate (50 mL) was added to the reaction mixture, and the mixture was washed with water (50 mL), a 5% aqueous citric acid solution (50 mL) and saturated brine (50 mL). After drying over anhydrous magnesium sulfate, the mixture was concentrated under reduced pressure. To the residue was added a 4N hydrogen chloride - ethyl acetate solution (20 mL), and the mixture was stirred at room temperature for 2 hrs. Diethyl ether (10 mL) was added, and the precipitated solid was collected by filtration. The solid was dried under reduced pressure to give the title compound (2.93 g) as a white solid.

1H-NMR (DMSO-d₆): 2.07 (3H, s), 2.53 (3H, s), 3.12-3.17 (2H, m), 4.24-4.30 (2H, m), 9.29 (2H, br).

**Reference Example 3**

![Chemical structure](image)

2-(Methylamino)ethyl trimethylacetate hydrochloride

To a mixture of tert-butyl 2-
hydroxyethyl(methyl)carbamate (1.75 g) obtained in Reference Example 1 and ethyl acetate (15 mL) was added triethylamine (1.67 mL) and a mixture of trimethylacetyl chloride (1.35 mL), and ethyl acetate (5 mL) was dropwise added. After stirring at room temperature for 2 hrs., pyridine (1.62 mL) was added, and the mixture was stirred overnight at room temperature. Ethyl acetate (50 mL) was added to the reaction mixture, and the mixture was washed with water (50 mL), a 5% aqueous citric acid solution (50 mL) and saturated brine (50 mL), and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, a 4N hydrogen chloride – ethyl acetate solution (10 mL) was added to the residue. After stirring at room temperature for 2 hrs., diethyl ether (10 mL) was added, and the precipitated solid was collected by filtration. The solid was dried under reduced pressure to give the title compound (1.65 g) as a white solid.

^H-NMR(DMSO-d6): 1.18(9H,s), 2.56(3H,s), 3.17(2H,t,J=10.5Hz), 4.22-4.28(2H,m), 9.19(2H,br).

Reference Example 4

2-(Methylamino)ethyl cyclohexanecarboxylate hydrochloride

To a mixture of tert-butyl 2-hydroxyethyl (methyl)carbamate (1.75 g) obtained in Reference Example 1 and ethyl acetate (20 mL) were added pyridine (0.97 mL) and 4-dimethylaminopyridine (catalytic amount), and cyclohexanecarbonyl chloride (1.60 mL) was dropwise added. After stirring at room temperature for 2 hrs., pyridine (0.65 mL) and cyclohexanecarbonyl chloride (0.58 mL) were added, and the mixture was stirred overnight at room temperature. Ethyl acetate (50 mL) was added to the reaction mixture, and the
mixture was washed with water (50 mL), a 5% aqueous citric acid solution (50 mL) and saturated brine (50 mL), and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, a 4N hydrogen chloride – ethyl acetate solution (10 mL) was added to the residue. After stirring at room temperature for 2 hrs., diethyl ether (10 mL) was added, and the precipitated solid was collected by filtration. The solid was dried under reduced pressure to give the title compound (1.88 g) as a white solid.

\[ ^1H-NMR(DMSO-d_6): 1.10-1.45(5H,m), 1.54-1.73(3H,m), 1.83-1.93(2H,m), 2.29-2.42(1H,m), 2.54(3H,s), 3.12-3.18(2H,m), 4.23-4.29(2H,m), 9.23(2H,br). \]

Reference Example 5

\[
\begin{align*}
\text{H}_3\text{C} & \text{N} \\
\text{HCl} & \text{O} \\
& \text{Ph}
\end{align*}
\]

2-(Methylamino)ethyl benzoate hydrochloride

To a mixture of 2-(methylamino)ethanol (30.04 g) and ethyl acetate (90 mL) was dropwise added a mixture of di-tert-butyl dicarbonate (87.30 g) and ethyl acetate (10 mL) under ice-cooling. After stirring at room temperature for 1 hr., benzoyl chloride (61.8 g) and pyridine (38.8 mL) were added under ice-cooling. After stirring at room temperature for 1 hr., a solid was filtered off. The solid was washed with ethyl acetate (100 mL) and the filtrate and the washing were combined, which was washed with water (100 mL) and saturated brine (100 mL). After drying over anhydrous magnesium sulfate, the mixture was concentrated under reduced pressure. The residue was dissolved in ethyl acetate (100 mL), a 4N hydrogen chloride – ethyl acetate solution (200 mL) was added, and the mixture was stirred at room temperature for 30 min. Diethyl ether (100 mL) was added and a solid was collected by
filtration. The solid was washed twice with ethyl acetate (100 mL) and dried under reduced pressure at 60°C to give the title compound (57.4 g) as a white solid.

\(^1\)H-NMR (DMSO-\(d_6\)): 2.62 (3H, s), 3.32 (2H, m), 4.53 (2H, t, \(J=9.9\) Hz), 7.51–7.57 (2H, m), 7.68 (1H, m), 8.11 (2H, d, \(J=7.8\) Hz), 9.26 (2H, bs).

Reference Example 6

2-(Methylamino)ethyl 4-methoxybenzoate hydrochloride

To a mixture of tert-butyl 2-hydroxyethyl (methyl)carbamate (1.75 g) obtained in Reference Example 1 and ethyl acetate (10 mL) were added 4-methoxybenzoyl chloride (1.88 g) and pyridine (0.97 mL). After stirring at room temperature for 14 hrs., 4-methoxybenzoyl chloride (0.70 g) and pyridine (0.97 mL) were added and the mixture was stirred at room temperature for 1 hr. Ethyl acetate (80 mL) was added to the reaction mixture, and the mixture was washed with water (20 mL), a saturated aqueous sodium hydrogen carbonate solution (20 mL) and water (20 mL), and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in ethyl acetate (10 mL), and a 4N hydrogen chloride – ethyl acetate solution (10 mL) was added. After stirring at room temperature for 1 hr., diethyl ether (20 mL) was added, and the precipitated solid was collected by filtration. The solid was washed twice with ethyl acetate (15 mL) and dried under reduced pressure at 60°C to give the title compound (1.99 g) as a white solid.

\(^1\)H-NMR (DMSO-\(d_6\)): 2.62 (3H, s), 3.32 (2H, m), 4.48 (2H, t, \(J=5.0\) Hz), 7.07 (2H, d, \(J=8.7\) Hz), 8.06 (2H, d, \(J=8.7\) Hz), 9.04 (2H, bs).

Reference Example 7
2-((Methylamino)ethyl 3-chlorobenzoate hydrochloride

To a mixture of tert-butyl 2-hydroxyethyl (methyl) carbamate (1.75 g) obtained in Reference Example 1 and ethyl acetate (10 mL) were added 3-chlorobenzoyl chloride (1.92 g) and pyridine (0.97 mL). After stirring at room temperature for 1 hr., the mixture was stirred at 60°C for 6 hrs. Ethyl acetate (80 mL) was added to the reaction mixture, and the mixture was washed with water (20 mL), a saturated aqueous sodium hydrogen carbonate solution (20 mL) and water (20 mL), and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, a 4N hydrogen chloride - ethyl acetate solution (10 mL) was added to the residue. After stirring at room temperature for 22 hrs., diethyl ether (15 mL) was added, and the precipitated solid was collected by filtration. The solid was washed twice with ethyl acetate (15 mL) and dried under reduced pressure at 60°C to give the title compound (2.01 g) as a white solid.

\[^1\text{H-NMR (DMSO-d}_6\text{): 2.63 (3H, s), 3.32 (2H, m), 4.53 (2H, t, J=4.9 Hz), 7.60 (1H, t, J=8.0 Hz), 7.78 (1H, d, J=8.0 Hz), 8.05 (1H, d, J=8.0 Hz), 8.15 (1H, s), 9.07 (2H, bs).}\]

Reference Example 8

2-((Methylamino)ethyl 3,4-difluorobenzoate hydrochloride

To a mixture of tert-butyl 2-
hydroxyethyl(methyl) carbamate (1.75 g) obtained in Reference Example 1 and ethyl acetate (10 mL) were added 3,4-
difluorobenzoyl chloride (1.77 g) and pyridine (0.97 mL).
After stirring at room temperature for 3 days, ethyl acetate
(80 mL) was added to the reaction mixture. The mixture was
washed with water (20 mL), a saturated aqueous sodium hydrogen
carbonate solution (20 mL) and water (20 mL), and dried over
anhydrous magnesium sulfate. After concentration under reduced
pressure, a 4N hydrogen chloride - ethyl acetate solution (10
mL) was added to the residue. After stirring at room
temperature for 4 hrs, the mixture was concentrated under
reduced pressure. The residue was washed with ethyl acetate
(15 mL), and dried under reduced pressure at 60°C to give the
title compound (2.05 g) as a white solid.
$^1$H-NMR(DMSO-$d_6$): 2.62(3H,s), 3.32(2H,m), 4.53(2H,t,J=5.0Hz),
7.64(1H,m), 8.00(1H,m), 8.25(1H,m), 9.25(2H,bs).

**Reference Example 9**

![Chemical Structure](image)

2-((Methylamino)ethyl 4-trifluoromethoxybenzoate hydrochloride
To a mixture of tert-butyl 2-hydroxyethyl
(methyl)carbamate (1.30 g) obtained in Reference Example 1 and
ethyl acetate (10 mL) were added 4-trifluoromethoxybenzoyl
chloride (1.83 g) and pyridine (0.72 mL). The mixture was
stirred at 60°C for 25 hrs. Ethyl acetate (60 mL) was added to
the reaction mixture, and the mixture was washed with water
(30 mL), a saturated aqueous sodium hydrogen carbonate
solution (20 mL) and water (20 mL), and dried over anhydrous
magnesium sulfate. After concentration under reduced pressure,
a 4N hydrogen chloride - ethyl acetate solution (10 mL) was
added to the residue. After stirring at room temperature for
14.5 hrs., the mixture was concentrated under reduced
pressure. The residue was washed twice with ethyl acetate (15
mL), and dried under reduced pressure at 60°C to give the title compound (1.83 g) as a white solid.

\( ^{1}H\text{-NMR(DMSO-d}_6\): 2.63(3H,s), 3.31(2H,m), 4.54(2H,t,J=4.9Hz), 7.55(2H,d,J=8.5Hz), 8.24(2H,d,J=8.5Hz), 9.02(2H,bs).}

5 Reference Example 10

\[
\begin{align*}
\text{H}_3\text{C} & \text{NH} \\
\text{HCl} & \text{O} \\
\text{C} & \text{F} \\
\text{benzene ring} & \\
\end{align*}
\]

2-(Methylamino)ethyl 4-fluorobenzoate hydrochloride

To a mixture of tert-butyl 2-hydroxyethyl (methyl)carbamate (1.75 g) obtained in Reference Example 1 and ethyl acetate (10 mL) were added 4-fluorobenzoyl chloride (1.74 g) and pyridine (0.97 mL). The mixture was stirred at room temperature for 6.5 hrs. Ethyl acetate (80 mL) was added to the reaction mixture, and the mixture was washed with water (30 mL), a saturated aqueous sodium hydrogen carbonate solution (30 mL), water (30 mL) and saturated brine (30 mL), and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, a 4N hydrogen chloride – ethyl acetate solution (10 mL) was added to the residue. After stirring at room temperature for 1 hr., the precipitated solid was collected by filtration. The solid was washed twice with ethyl acetate (15 mL) and dried under reduced pressure at 60°C to give the title compound (1.89 g) as a white solid.

\( ^{1}H\text{-NMR(DMSO-d}_6\): 2.62(3H,s), 3.32(2H,m), 4.52(2H,t,J=4.9Hz), 7.34-7.44(2H,m), 8.16-8.24(2H,m), 9.18(2H,bs).}

5 Reference Example 11
2-(Methylamino)ethyl 3,4,5-trimethoxybenzoate hydrochloride

To a mixture of tert-butyl 2-hydroxyethyl (methyl)carbamate (1.75 g) obtained in Reference Example 1 and ethyl acetate (10 mL) were added 3,4,5-trimethoxybenzoyl chloride (2.54 g) and pyridine (0.97 mL). After stirring at 60°C for 14 hrs., 3,4,5-trimethoxybenzoyl chloride (1.30 g), pyridine (0.97 mL) and ethyl acetate (10 mL) were added, and the mixture was stirred at 60°C for 24 hrs. The reaction mixture was filtered and ethyl acetate (50 mL) and water (30 mL) were added to the filtrate. After partitioning, ethyl acetate layer was washed with 1N hydrochloric acid (30 mL), water (30 mL), an aqueous copper (II) sulfate solution (30 mL), water (30 mL) and saturated brine (30 mL), and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by silica gel column chromatography (eluted with ethyl acetate:hexane=1:1). A 4N hydrogen chloride - ethyl acetate solution (10 mL) was added to the purified product. After stirring at room temperature for 4 hrs, the mixture was concentrated under reduced pressure. Toluene (10 mL) was added, and the mixture was concentrated under reduced pressure. The residue was suspended in ethyl acetate, and the solid was filtrated. After washing with ethyl acetate (15 mL), the solid was dried under reduced pressure to give the title compound (1.79 g) as a white solid.

\[
{^1}H\text{-NMR (DMSO-d}_6\text{): 2.61(3H,s), 3.28-3.35(2H,m), 3.74(3H,s), 3.87(6H,s), 4.48-4.54(2H,m), 7.40(2H,s), 9.43(2H,br).}
\]

Reference Example 12
2-(Methylamino)ethyl 2-pyridinecarboxylate dihydrochloride

To a solution (100 mL) of tert-butyl 2-hydroxyethyl (methyl)carbamate (1.75 g) obtained in Reference Example 1, 2-pyridinecarbonyl chloride hydrochloride (2.67 g), pyridine (1.21 mL) and 4-dimethylaminopyridine (0.122 g) in tetrahydrofuran was dropwise added triethylamine (2.09 mL) under ice-cooling, and the mixture was stirred at room temperature for 6 hrs. Water (200 mL) was added to the reaction mixture and the mixture was extracted with ethyl acetate (150 mL). The organic layer was washed successively with a 5% aqueous copper (II) sulfate solution (100 mL), water (100 mL) and saturated brine (100 mL), dried over anhydrous sodium sulfate and evaporated under reduced pressure. The residue was dissolved in ethyl acetate (50 mL) and ethanol (100 mL), and a 4N hydrogen chloride - ethyl acetate solution (15 mL) was added. The mixture was stirred at room temperature for 1 hr. The precipitated solid was collected by filtration, washed twice with ethyl acetate (100 mL), and dried under reduced pressure at 60°C to give the title compound (1.08 g) as a white solid.

$^1$H-NMR (DMSO-d$_6$): 2.62 (3H, t, $J=5.4$ Hz), 3.35 (2H, m), 4.63 (2H, t, $J=5.0$ Hz), 5.26 (1H, bs), 7.77-7.84 (1H, m), 8.14-8.18 (1H, m), 8.36-8.40 (1H, m), 8.70-8.90 (1H, m), 9.48 (2H, br).

Reference Example 13

2-(Methylamino)ethyl methoxyacetate

To a mixture of tert-butyl 2-hydroxyethyl
(methyl)carbamate (1.75 g) obtained in Reference Example 1 and ethyl acetate (10 mL) were added methoxyacetyl chloride (1.20 g) and pyridine (0.97 mL). After stirring at room temperature for 3 hrs., ethyl acetate (70 mL) was added to the reaction mixture. The mixture was washed with water (20 mL), a saturated aqueous sodium hydrogen carbonate solution (20 mL) and water (20 mL), and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in ethyl acetate (5 mL), and a 4N hydrogen chloride - ethyl acetate solution (10 mL) was added. After stirring at room temperature for 1 hr., the mixture was concentrated under reduced pressure. Water (60 mL) and diethyl ether (30 mL) were added to the residue. After stirring, the aqueous layer was separated and taken. The aqueous layer was basified with sodium hydrogen carbonate and extracted twice with ethyl acetate (40 mL). The ethyl acetate layer was dried over anhydrous magnesium sulfate and concentrated under reduced pressure to give the title compound (1.00 g) as a colorless oil.

$^1$H-NMR(CDCl₃): 2.40(1H, bs), 3.06(3H, s), 3.44(3H, s), 3.57(2H, t, J=5.1 Hz), 3.75-3.82(2H, m), 4.13(2H, s).

**Reference Example 14**

```
H₃C\hspace{1cm}N\hspace{1cm}O\hspace{1cm}O\hspace{1cm}CH₃
```

HCl

Ethyl 2-(methylamino)ethyl carbonate hydrochloride

To a mixture of tert-butyl 2-hydroxyethyl (methyl)carbamate (1.75 g) obtained in Reference Example 1 and ethyl acetate (20 mL) were added pyridine (0.97 mL) and 4-dimethylaminopyridine (catalytic amount), and ethyl chlorocarbonate (1.25 mL) was dropwise added. The mixture was stirred overnight at room temperature and ethyl acetate (50
mL) was added. The mixture was washed with water (50 mL), a 5% aqueous citric acid solution (50 mL) and saturated brine (50 mL), and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, a 4N hydrogen chloride – ethyl acetate solution (10 mL) was added to the residue. After stirring at room temperature for 2 hrs., diethyl ether (10 mL) was added, and the precipitated solid was collected by filtration. The solid was dried under reduced pressure to give the title compound (1.66 g) as a white solid.

$^1$H-NMR (DMSO-d$_6$): 1.23 (3H, t, J=7.1Hz), 2.54 (3H, s), 3.16–3.22 (2H, m), 4.15 (2H, q, J=7.1Hz), 4.32–4.37 (2H, m), 9.25 (2H, br).

**Reference Example 15**

Isopropyl 2-(methylamino)ethyl carbonate hydrochloride

To a mixture of tert-butyl 2-hydroxyethyl (methyl)carbamate (3.50 g) obtained in Reference Example 1 and ethyl acetate (20 mL) were added isopropyl chlororcarbonate (1.35 g) and pyridine (1.94 mL) under ice-cooling. After stirring under ice-cooling for 3.5 hrs., isopropyl chlororcarbonate (1.84 g) was added, and the mixture was stirred at room temperature for 2.5 hrs. Ethyl acetate (120 mL) was added to the reaction mixture, and the mixture was washed with water (50 mL) and saturated brine (50 mL), and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, a 4N hydrogen chloride – ethyl acetate solution (10 mL) was added to the residue. After stirring at room temperature for 2 hrs., the precipitated solid was collected by filtration. The solid was washed with ethyl acetate (15 mL), and dried under reduced pressure at 60°C to give the title compound (1.38 g) as a white solid.
$^1$H-NMR (DMSO-d$_6$): 1.25 (6H, d, $J$=6.2 Hz), 2.56 (3H, s), 3.20 (2H, t, $J$=5.1 Hz), 4.32 (2H, t, $J$=5.1 Hz), 4.80 (1H, m), 8.95 (2H, bs).

**Reference Example 16**

![Chemical Structure](image)

Benzyl 2-(methylamino)ethyl carbonate hydrochloride

To a mixture of tert-butyl 2-hydroxyethyl (methyl)carbamate (1.75 g) obtained in Reference Example 1 and ethyl acetate (20 mL) were added pyridine (0.97 mL) and 4-dimethylaminopyridine (catalytic amount), and benzyl chlorocarbonate (1.57 mL) was dropwise added. After stirring at room temperature for 2 hrs., pyridine (0.65 mL) and benzyl chlorocarbonate (1.28 mL) were added. After stirring at room temperature for 5 days, pyridine (0.81 mL) was added under ice-cooling and a solution (5 mL) of benzyl chlorocarbonate (1.43 mL) in ethyl acetate was dropwise added slowly. After stirring at room temperature for 2 hrs., ethyl acetate (50 mL) was added to the mixture, washed with water (50 mL), a 5% aqueous citric acid solution (50 mL) and saturated brine (50 mL), and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, a 4N hydrogen chloride - ethyl acetate solution (10 mL) was added to the residue. After stirring at room temperature for 2 hrs., diethyl ether (10 mL) was added, and the precipitated solid was collected by filtration. The solid was dried under reduced pressure to give the title compound (1.99 g) as a white solid.

$^1$H-NMR (DMSO-d$_6$): 2.55 (3H, s), 3.21 (2H, t, $J$=5.1 Hz), 4.37 (2H, t, $J$=5.1 Hz), 5.18 (2H, s), 7.30–7.50 (5H, m), 9.07 (2H, br).

**Reference Example 17**
2-(Methylamino)ethyl tetrahydropyran-4-yl carbonate hydrochloride

To a solution (40 mL) of bis(trichloromethyl)carbonate (2.97 g) in tetrahydrofuran was dropwise added a solution (10 mL) of pyridine (2.43 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 10 min., a solution (20 mL) of tetrahydropyran-4-ol (1.91 g) in tetrahydrofuran was dropwise added slowly. After stirring at room temperature for 2 hrs., the mixture was concentrated under reduced pressure, and ethyl acetate (50 mL) and water (50 mL) were added to the residue. The ethyl acetate layer was separated and taken, washed with 0.2N hydrochloric acid (20 mL) and saturated brine (50 mL), and dried over anhydrous magnesium sulfate. Concentration under reduced pressure gave tetrahydropyran-4-yl chlorocarbonate (1.53 g). To a mixture of tert-butyl 2-hydroxyethyl(methyl)carbamate (1.40 g) obtained in Reference Example 1 and tetrahydrofuran (20 mL) was added pyridine (0.78 mL), and a solution (10 mL) of tetrahydropyran-4-yl chlorocarbonate (1.53 g) obtained above in tetrahydrofuran was dropwise added, and the mixture was stirred overnight at room temperature. After concentration of the reaction mixture under reduced pressure, water (50 mL) was added, the mixture was extracted with ethyl acetate (50 mL). The residue was washed with a 5% aqueous citric acid solution (50 mL) and saturated brine (50 mL), and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by silica gel column chromatography (eluted with ethyl acetate:hexane=4:1, then 3:2). The obtained colorless oil (2.03 g) was dissolved in diethyl ether (2 mL),
and a 4N hydrogen chloride - ethyl acetate solution (5 mL) was added. After stirring at room temperature for 30 min., diethyl ether (10 mL) was added and the mixture was stirred overnight. The precipitated solid was collected by filtration and dried under reduced pressure to give the title compound (1.20 g) as a white solid.

$^1$H-NMR (DMSO-d$_6$): 1.50-1.65 (2H, m), 1.87-1.98 (2H, m), 2.54 (3H, s), 3.20 (2H, m), 3.40-3.50 (2H, m), 3.74-3.83 (2H, m), 4.36 (2H, t, J=5.1Hz), 4.72-4.83 (1H, m), 9.32 (2H, br).

Reference Example 18

![Image](H3C\text{-}N\text{-}\text{CH}_{2}\text{-}\text{CH}_{2}\text{-}\text{O}\text{-}\text{CH}_{3})

2-Methoxyethyl 2-(methylamino)ethyl carbonate hydrochloride

To a mixture of tert-butyl 2-hydroxyethyl (methyl)carbamate (1.75 g) obtained in Reference Example 1 and ethyl acetate (20 mL) was added pyridine (1.62 mL) and a solution (5 mL) of 2-methoxyethyl chlorocarbonate (2.77 g) in ethyl acetate was dropwise added slowly, and the mixture was stirred overnight at room temperature. After concentration of the reaction mixture under reduced pressure, water (50 mL) was added, the mixture was extracted with ethyl acetate (50 mL). The mixture was washed with 5% aqueous citric acid solution (50 mL) and saturated brine (50 mL), and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in diethyl ether (2 mL), and a 4N hydrogen chloride - ethyl acetate solution (5 mL) was added. After stirring at room temperature for 30 min., diethyl ether (10 mL) was added, and the mixture was stirred overnight. The precipitated solid was collected by filtration, and dried under reduced pressure to give the title compound (1.56 g) as a white solid.
$^1$H-NMR (DMSO-d$_6$): 2.54 (3H, s), 3.19 (2H, m), 3.26 (3H, s), 3.52-
3.57 (2H, m), 4.20–4.25 (2H, m), 4.33–4.39 (2H, m), 9.26 (2H, br).

**Reference Example 19**

\[
\begin{array}{c}
\text{H}_3\text{C} \\
\text{HO} \\
\text{CH}_3
\end{array}
\begin{array}{c}
\text{N} \\
\text{O}
\end{array}
\begin{array}{c}
\text{OH} \\
\text{CH}_3
\end{array}
\]

**tert-Butyl ethyl (2-hydroxyethyl) carbamate**

To a mixture of 2-(ethylamino)ethanol (8.91 g) and ethyl acetate (100 mL) was added di-tert-butyl dicarbonate (21.8 g) under ice-cooling. After stirring at room temperature for 3 days, the mixture was washed with saturated brine (100 mL), and dried over anhydrous magnesium sulfate. Concentration under reduced pressure gave the title compound (19.0 g) as a colorless oil.

$^1$H-NMR (CDCl$_3$): 1.11 (3H, t, J=7.0 Hz), 1.47 (9H, s),
3.27 (2H, q, J=7.0 Hz), 3.37 (2H, t, J=5.2 Hz), 3.73 (2H, q, J=5.2 Hz).

**Reference Example 20**

\[
\begin{array}{c}
\text{H}_3\text{C} \\
\text{N} \\
\text{O}
\end{array}
\begin{array}{c}
\text{CH}_3
\end{array}
\]

**2-(Ethylamino)ethyl acetate hydrochloride**

To a mixture of tert-butyl ethyl (2-hydroxyethyl) carbamate (1.89 g) obtained in Reference Example 19 and ethyl acetate (20 mL) were added acetic anhydride (1.04 mL), pyridine (0.89 mL) and 4-dimethylaminopyridine (0.061 g). After stirring at room temperature for 3 hrs., ethyl acetate (50 mL) was added, and the mixture was washed with water (50 mL), a 5% aqueous citric acid solution (50 mL) and saturated brine (50 mL).

After drying over anhydrous magnesium sulfate, the mixture was concentrated under reduced pressure. A 4N hydrogen chloride - ethyl acetate solution (10 mL) was added to the residue, and
the mixture was stirred at room temperature for 1 hr. Ethyl acetate (10 mL) and diethyl ether (20 mL) were added, and the precipitated solid was collected by filtration. The solid was dried under reduced pressure to give the title compound (1.54 g) as a white solid.

\[ ^1H-NMR(DMSO-d_6): 1.22(3H,t,J=7.3Hz), 2.07(3H,s), 2.95(2H,q,J=7.3Hz), 3.15(2H,t,J=5.3Hz), 4.24-4.30(2H,m), 9.17(2H,br). \]

Reference Example 21

![Chemical Structure](image)

tert-Butyl 2-hydroxyethyl(isopropyl)carbamate

To a solution (30 mL) of 2-(isopropylamino)ethanol (10.0 g) in tetrahydrofuran was added di-tert-butyl dicarbonate (22.2 g), and the mixture was stirred at room temperature for 1 hr. The reaction mixture was concentrated under reduced pressure and water (100 mL) was added to the residue. The mixture was extracted with ethyl acetate (200 mL). The ethyl acetate layer was washed with saturated brine (100 mL), dried over anhydrous sodium sulfate and concentrated under reduced pressure to give the title compound (21.21 g) as a colorless oil.

\[ ^1H-NMR(CDCl_3): 1.12(6H,d,J=6.6Hz), 3.30(2H,t,J=5.0Hz), 3.71(2H,t,J=5.0Hz), 3.80-4.30(1H,m). \]

Reference Example 22

![Chemical Structure](image)

2-(Isopropylamino)ethyl acetate hydrochloride

To a solution (15 mL) of tert-butyl 2-hydroxyethyl
(isopropyl)carbamate (5.0 g) obtained in Reference Example 21 in tetrahydrofuran were added pyridine (6.0 mL) and acetic anhydride (2.79 mL) and the mixture was stirred at room temperature for 18 hrs. The reaction mixture was concentrated under reduced pressure, water (50 mL) was added to the residue, and the mixture was extracted with ethyl acetate (100 mL). The ethyl acetate layer was washed with a 5% aqueous citric acid solution (50 mL) and saturated brine (50 mL), dried over anhydrous sodium sulfate and concentrated under reduced pressure. The obtained colorless oil was dissolved in a 4N hydrogen chloride - ethyl acetate solution (10 mL), and the mixture was stirred at room temperature for 1 hr. The precipitated solid was collected by filtration, and dried under reduced pressure to give the title compound (3.14 g) as a colorless solid.

$^1$H-NMR (DMSO-d$_6$): 1.25 (6H, d, J=6.6 Hz), 2.08 (3H, s), 3.10-3.40 (3H, m), 4.29 (2H, t, J=6.0 Hz), 9.11 (2H, br).

Reference Example 23

![Chemical Structure](image)

Ethyl 2-(isopropylamino)ethyl carbonate hydrochloride

To a solution (15 mL) of tert-butyl 2-hydroxyethyl (isopropyl)carbamate (5.0 g) obtained in Reference Example 21 in tetrahydrofuran were added pyridine (6.0 mL) and ethyl chlorocarbonate (2.81 mL) and the mixture was stirred at room temperature for 18 hrs. The reaction mixture was concentrated under reduced pressure, and water (50 mL) was added to the residue, and the mixture was extracted with ethyl acetate (100 mL). The ethyl acetate layer was washed with a 5% aqueous citric acid solution (50 mL) and saturated brine (50 mL), dried over anhydrous sodium sulfate and the mixture was
concentrated under reduced pressure. The obtained colorless oil was dissolved in a 4N hydrogen chloride - ethyl acetate solution (10 mL), and the mixture was stirred at room temperature for 1 hr. The precipitated solid was collected by filtration and dried under reduced pressure to give the title compound (3.34 g) as a colorless solid.

$^1$H-NMR(DMSO-d$_6$): 1.20-1.30(9H,m), 3.10-3.40(3H,m), 4.17(2H,q,J=7.4Hz), 4.37(2H,t,J=5.6Hz), 9.13(2H,br).

Reference Example 24

\[
\begin{align*}
\text{H}_3\text{C} & \quad \text{O} \\
\text{H}_2\text{C} & \quad \text{N} \\
\text{CH}_3 & \quad \text{OH}
\end{align*}
\]

tert-Butyl cyclohexyl(2-hydroxyethyl) carbamate

To a solution (200 mL) of 2-(cyclohexylamino)ethanol (14.3 g) in ethanol was dropwise added di-tert-butyl dicarbonate (21.8 g). After stirring at room temperature for 2 days, the mixture was concentrated under reduced pressure. The residue was dissolved in ethyl acetate (200 mL), washed with water (100 mL) and saturated brine (100 mL), and dried over anhydrous sodium sulfate. Concentration under reduced pressure gave the title compound (24.2 g) as a colorless oil.

$^1$H-NMR(CDC$_3$): 1.26-1.39(4H,m), 1.47(9H,s), 1.61-1.81(6H,m), 3.30-3.40(2H,m), 3.69(2H,t,J=5.4Hz), 3.66-3.90(2H,br).

Reference Example 25

\[
\begin{align*}
\text{N} & \quad \text{O} \\
\text{HCl} & \quad \text{CH}_3
\end{align*}
\]

2-(Cyclohexylamino)ethyl acetate hydrochloride

To a solution (50 mL) of tert-butyl cyclohexyl(2-hydroxyethyl) carbamate (2.43 g) obtained in Reference Example
24 in tetrahydrofuran were added pyridine (1.05 mL), acetic anhydride (1.23 mL) and 4-dimethylaminopyridine (0.122 g) under ice-cooling, and the mixture was stirred at room temperature for 12 hrs. Ethyl acetate (100 mL) was added to the reaction mixture and the mixture was washed successively with a saturated aqueous sodium hydrogen carbonate solution (100 mL), a 5% aqueous copper (II) sulfate solution (100 mL) and saturated brine (100 mL), and dried over anhydrous sodium sulfate. The mixture was concentrated under reduced pressure.

The residue was dissolved in ethyl acetate (15 mL), and a 4N hydrogen chloride - ethyl acetate solution (15 mL) was added. After stirring at room temperature for 3 hrs., diisopropyl ether (20 mL) was added, and the precipitated solid was collected by filtration to give the title compound (1.78 g) as a white solid.

$^1$H-NMR (DMSO-d$_6$): 1.05-2.03 (10H, m), 2.07 (3H, s), 2.90-3.10 (1H, m), 3.17 (2H, t, $J$=5.2 Hz), 4.29 (2H, t, $J$=5.2 Hz), 9.19 (2H, br).

Reference Example 26

2-(Cyclohexylamino)ethyl ethyl carbonate hydrochloride

To a solution (50 mL) of tert-butyl cyclohexyl(2-hydroxyethyl)carbamate (2.43 g) obtained in Reference Example 24 in tetrahydrofuran were added pyridine (1.45 mL), ethyl chlorocarbonate (1.71 mL) and 4-dimethylaminopyridine (0.122 g) under ice-cooling, and the mixture was stirred at room temperature for 15 hrs. Ethyl acetate (100 mL) was added to the reaction mixture, and the mixture was washed successively with a saturated aqueous sodium hydrogen carbonate solution (100 mL), a 5% aqueous copper (II) sulfate solution (100 mL), water (100 mL) and saturated brine (100 mL), and dried over
anhydrous sodium sulfate. The mixture was concentrated under reduced pressure and the residue was dissolved in ethyl acetate (15 mL). A 4N hydrogen chloride – ethyl acetate solution (15 mL) was added. After stirring at room temperature for 3 hrs., diisopropyl ether (20 mL) was added, and the precipitated solid was collected by filtration to give the title compound (2.12 g) as a white solid.

$^1$H-NMR (DMSO-d$_6$): 1.01–2.08 (10H, m), 1.23 (3H, t, J=7.0Hz), 2.90–3.10 (1H, m), 3.21 (2H, t, J=5.2Hz), 4.16 (2H, q, J=7.0Hz), 4.39 (2H, t, J=5.2Hz), 9.27 (2H, br).

Reference Example 27

\[ \text{HCl} \quad \text{O} \quad \text{CH}_3 \]

2-Anilinoethyl acetate hydrochloride

To a solution (700 mL) of 2-anilinoethanol (137 g) in tetrahydrofuran were added pyridine (97.1 mL), acetic anhydride (113.2 mL) and 4-dimethylaminopyridine (12.22 g) under ice-cooling, and the mixture was stirred at room temperature for 20 hrs. Ethyl acetate (1 L) was added to the reaction mixture and the mixture was washed successively with water (1 L), a saturated aqueous sodium hydrogen carbonate solution (1 L), a 5% aqueous copper (II) sulfate solution (1 L) and saturated brine (1 L), dried over anhydrous sodium sulfate, and evaporated under reduced pressure. To a solution of the obtained residue in ethyl acetate (700 mL) was added a 4N hydrogen chloride – ethyl acetate solution (250 mL) under ice-cooling, and the precipitated solid was collected by filtration to give the title compound (156 g) as a white solid.

$^1$H-NMR (CD$_3$OD): 2.11 (3H, s), 3.71–3.76 (2H, m), 4.32–4.37 (2H, m), 7.49–7.64 (5H, m).
Reference Example 28

![Chemical structure](image)

tert-Butyl [2-(methylamino)-3-pyridyl]methyl carbonate

To a solution (50 mL) of [2-(methylamino)-3-pyridyl]methanol (2 g: synthesized according to the method described in WO 01/32652) in tetrahydrofuran were added di-tert-butyl dicarbonate (3.48 g) and 4-dimethylaminopyridine (0.18 g) and the mixture was refluxed for 1 hr. Water (30 mL) was added to the reaction mixture and extracted with ethyl acetate (50 mL). The obtained organic layer was washed with saturated brine (50 mL), and dried over anhydrous sodium sulfate. The residue obtained by concentration under reduced pressure was purified by flash silica gel column chromatography (eluted with ethyl acetate:hexane=1:5) to give the title compound (1.51 g) as a white solid.

$^1$H-NMR (CDCl$_3$): 1.49 (9H, s), 3.02 (3H, d, J=4.8 Hz), 4.99 (2H, s), 5.00 (1H, bs), 6.55 (1H, dd, J=7.0, 5.0 Hz), 7.37 (1H, dd, J=7.0, 1.8 Hz), 8.16 (1H, dd, J=5.0, 1.8 Hz).

Reference Example 29

![Chemical structure](image)

2-(Methylamino)benzyl acetate

To a solution (50 mL) of [2-(methylamino)phenyl]methanol (1.37 g: synthesized according to the method described in WO 01/32652) in tetrahydrofuran were added pyridine (1.05 mL), acetic anhydride (1.23 mL) and 4-dimethylaminopyridine (0.18
g), and the mixture was stirred at room temperature for 8 hrs. Water (100 mL) was added to the reaction mixture, and the mixture was extracted with ethyl acetate (100 mL). The organic layer was washed successively with a 5% aqueous copper (II) sulfate solution (50 mL), a saturated aqueous sodium hydrogen carbonate solution (50 mL) and saturated brine (50 mL), and dried over anhydrous sodium sulfate. The solvent was evaporated under reduced pressure and the obtained residue was purified by flash silica gel column chromatography (eluted with ethyl acetate:hexane=1:5, then 1:3) to give the title compound (0.38 g) as a white solid.

$^1$H-NMR (CDCl$_3$): 2.08 (3H, s), 2.87 (3H, s), 4.40 (1H, br), 5.08 (2H, s), 6.64–6.74 (2H, m), 7.17–7.32 (2H, m).

**Reference Example 30**

![Chemical structure](image)

2-[(2-Acetyloxyethyl)amino]ethyl acetate hydrochloride

To a mixture of 2,2'-iminodiethanol (2.10 g) and ethyl acetate (20 mL) was added di-tert-butyl dicarbonate (4.37 g) under ice-cooling. After stirring for 1.5 hrs. under ice-cooling, acetic anhydride (2.08 mL), pyridine (1.78 mL) and 4-dimethylaminopyridine (0.12 g) were added. After stirring at room temperature for 2 hrs., ethyl acetate (50 mL) was added to the reaction mixture and the mixture was washed with water (50 mL), a 5% aqueous citric acid solution (50 mL) and saturated brine (50 mL). After drying over anhydrous magnesium sulfate, the mixture was concentrated under reduced pressure. A 4N hydrogen chloride – ethyl acetate solution (20 mL) was added to the residue, and the mixture was stirred at room temperature for 2 hrs. Diethyl ether (10 mL) was added, and the precipitated solid was collected by filtration. The solid
was dried under reduced pressure to give the title compound (6.18 g) as a white solid.

^{1}H-NMR (DMSO-d_{6}): 2.07 (6H, s), 3.23 (4H, t, J=5.3 Hz), 4.27-4.33 (4H, m), 9.40 (2H, br).

**Reference Example 31**

(S)-2-Pyrrolidinylmethyl acetate hydrochloride

To a mixture of (S)-2-pyrrolidinylmethanol (1.01 g) and ethyl acetate (10 mL) was added di-tert-butyl dicarbonate (2.18 g) under ice-cooling. After stirring for 1 hr. under ice-cooling, acetic anhydride (1.04 mL), pyridine (0.89 mL) and 4-dimethylaminopyridine (0.061 g) were added. After stirring at room temperature for 1 hr., ethyl acetate (50 mL) was added to the reaction mixture, and the mixture was washed with water (50 mL), a 5% aqueous citric acid solution (50 mL) and saturated brine (50 mL). After drying over anhydrous magnesium sulfate, the mixture was concentrated under reduced pressure. A 4N hydrogen chloride - ethyl acetate solution (10 mL) was added to the residue, and the mixture was stirred at room temperature for 1 hr. Diethyl ether (10 mL) was added and the precipitated solid was collected by filtration. The solid was dried under reduced pressure to give the title compound (1.68 g) as a pale-brown solid.

^{1}H-NMR (DMSO-d_{6}): 1.56-2.10 (4H, m), 2.06 (3H, s), 3.05-3.24 (2H, m), 3.63-3.68 (1H, m), 4.15 (1H, dd, J=11.8, 8.1 Hz), 4.26 (1H, dd, J=11.8, 4.1 Hz), 9.21 (1H, br), 9.87 (1H, br).

**Reference Example 32**
3-(Methylamino)propyl benzoate hydrochloride

To a mixture of 3-amino-1-propanol (0.75 g) and ethyl acetate (2.25 mL) was added a solution (0.25 mL) of di-tert-butyl dicarbonate (2.18 g) in ethyl acetate under ice-cooling. After stirring at room temperature for 21.5 hrs., benzoyl chloride (1.30 mL), pyridine (0.98 mL) and 4-dimethylaminopyridine (0.012 g) were added. After stirring at room temperature for 5 hrs., ethyl acetate (32.5 mL) was added to the reaction mixture, and the mixture was washed with water (12.5 mL) and saturated brine (12.5 mL). After drying over anhydrous magnesium sulfate, the mixture was concentrated under reduced pressure. The residue was dissolved in N,N-dimethylformamide (20 mL), and methyl iodide (5 mL) was added. 60% sodium hydride (0.4 g) was added under ice-cooling. After stirring at room temperature for 3 hrs., the reaction mixture was poured into an ice-cooled aqueous ammonium chloride solution (60 mL). The mixture was extracted with diethyl ether (80 mL) and washed with saturated brine (30 mL). After drying over anhydrous magnesium sulfate, the mixture was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (ethyl acetate:hexane=2:1, then ethyl acetate, then acetone:ethyl acetate=1:9) to give 3-[(tert-butoxycarbonyl)(methyl)amino]propyl benzoate (2.52 g) as a colorless oil. A 4N hydrogen chloride - ethyl acetate solution (10 mL) was added, and the mixture was stirred at room temperature for 1 hr. After concentration under reduced pressure, ethyl acetate (10 mL) was added to the residue and the precipitated solid was collected by filtration. After washing with diethyl ether (10 mL), the solid was dried under
reduced pressure to give the title compound (1.73 g) as a colorless solid.

\(^1\)H-NMR(DMSO-\(d_6\)): 2.02-2.16(2H, m), 2.56(3H, s), 3.05(2H, t, \(\text{J}=7.3\) Hz), 4.35(2H, t, \(\text{J}=6.1\) Hz), 7.51(2H, m), 7.65-

7.73(1H, m), 8.01(2H, d, \(\text{J}=7.2\) Hz), 8.95(2H, br).

**Reference Example 33**

\[
\begin{array}{c}
\text{H}_2\text{C} & \text{O} & \text{N} & \text{CH}_3 \\
\text{O} & \text{O} & \text{O} & \text{CH}_3
\end{array}
\]

2-[Ethoxycarbonyl] (methyl)amino]ethyl ethyl carbonate

To a solution (1000 mL) of 2-(methylamino)ethanol (100 g) in ethyl acetate was added pyridine (222 mL), ethyl chlorocarbonate (240 mL) was dropwise added over 2 hr. under ice-cooling. After the completion of the dropwise addition, the reaction mixture was stirred at room temperature for 18 hrs. Water (300 mL) was added, and the ethyl acetate layer was separated and washed with 1N hydrochloric acid (200 mL) and saturated brine (200 mL). After drying over anhydrous sodium sulfate, the mixture was concentrated under reduced pressure, and the residue was evaporated under reduced pressure to give the title compound (180 g) as a colorless fraction having a boiling point of 95-100°C (pressure: 0.1-0.2 mmHg).

\(^1\)H-NMR(CDCl\(_3\)): 1.20-1.40(6H, m), 2.97(3H, s), 3.50-3.60(2H, m), 4.05-4.35(6H, m).

**Reference Example 34**

\[
\begin{array}{c}
\text{Cl} & \text{N} & \text{CH}_3 \\
\text{O} & \text{O} & \text{O} & \text{CH}_3
\end{array}
\]

2-[(Chlorocarbonyl) (methyl)amino]ethyl ethyl carbonate

To a solution (1500 mL) of 2-

[(ethoxycarbonyl) (methyl)amino]ethyl ethyl carbonate (150 g)
obtained in Reference Example 33 in acetonitrile was added phosphorus oxychloride (200 mL), and the mixture was refluxed for 4 days. The reaction mixture was concentrated under reduced pressure and the residue was added to a mixture of water (500 mL) – ice (700 g) – ethyl acetate (300 mL) by portions with stirring. After stirring for 1 min., saturated brine (500 mL) was added, and the mixture was extracted with ethyl acetate (500 mL). The ethyl acetate layer was washed successively with saturated brine (300 mL), a saturated aqueous sodium hydrogen carbonate solution (300 mL) and saturated brine (300 mL), dried over anhydrous sodium sulfate and concentrated under reduced pressure. The residue was evaporated under reduced pressure to give the title compound (77 g) as a colorless fraction having a boiling point of 100-105°C (pressure: 0.1-0.2 mmHg).

$^1$H-NMR (CDCl$_3$): 1.33 (3H, t, $\textit{J}$=7.2Hz), 3.12 (3H×0.4, s), 3.22 (3H×0.6, s), 3.68 (2H×0.6, t, $\textit{J}$=4.8Hz), 3.78 (2H×0.4, t, $\textit{J}$=4.8Hz), 4.23 (2H, q, $\textit{J}$=7.2Hz), 4.30-4.40 (2H, m).

Reference Example 35

tert-Butyl 4-hydroxybutylcarbamate

To a mixture of 4-aminobutanol (3.57 g) and ethyl acetate (9 mL) was dropwise added a mixture of di-tert-butyl dicarbonate (8.73 g) and ethyl acetate (1 mL) under ice-cooling. After stirring at room temperature for 24 hrs., the mixture was concentrated under reduced pressure. The residue was dissolved in ethyl acetate (200 mL), and the mixture was washed with water (50 mL), 1N hydrochloric acid (40 mL), water (30 mL) and saturated brine (30 mL) and dried over anhydrous magnesium sulfate. Concentration under reduced pressure gave the title compound (7.54 g) as a colorless oil.
H-NMR (CDCl₃): 1.44 (9H, s), 1.47-1.61 (4H, m), 3.07-3.22 (2H, m), 3.61-3.76 (2H, m), 4.62 (1H, bs).

Reference Example 36

\[
\begin{align*}
\text{H}_3\text{C} & \quad \text{O} \quad \text{N} \quad \text{H} \quad \text{O} \\
\text{H}_3\text{C} & \quad \text{CH}_3
\end{align*}
\]

4-[(tert-Butoxycarbonyl)amino]butyl acetate

To a mixture of tert-butyl 4-hydroxybutylcarbamate (3.83 g) obtained in Reference Example 35 and ethyl acetate (20 mL) were added pyridine (1.80 mL) and acetic anhydride (2.27 g), and the mixture was stirred at room temperature for 19 hrs.

Ethyl acetate (100 mL) was added to the reaction mixture, and the mixture was washed with water (50 mL), an aqueous copper sulfate solution (30 mL), water (30 mL) and saturated brine (30 mL) and dried over anhydrous magnesium sulfate. Concentration under reduced pressure gave the title compound (4.55 g) as a colorless oil.

H-NMR (CDCl₃): 1.44 (9H, s), 1.51-1.69 (4H, m), 2.05 (3H, s), 3.15 (2H, m), 4.07 (2H, t, J=6.5 Hz), 4.55 (1H, bs).

Reference Example 37

\[
\begin{align*}
\text{H}_3\text{C} & \quad \text{N} \quad \text{H} \\
\text{HCl} & \quad \text{O} \quad \text{CH}_3
\end{align*}
\]

4-(Methylamino)butyl acetate hydrochloride

To a solution (20 mL) of 4-[(tert-butoxycarbonyl)amino]butyl acetate (4.50 g) obtained in Reference Example 36 and methyl iodide (4.85 mL) in N,N-dimethylformamide was added sodium hydride (60% in oil, 0.94 g) under ice-cooling. After stirring at room temperature for 4 hrs., the reaction mixture was poured into an ice - aqueous ammonium chloride solution. The mixture was extracted with
diethyl ether (120 mL), and the diethyl ether layer was washed with saturated brine (30 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by silica gel column chromatography (eluted with ethyl acetate:hexane=1:9). To the purified product was added a 4N hydrogen chloride – ethyl acetate solution (20 mL), and the mixture was stirred at room temperature for 2 hrs. Diethyl ether (40 mL) was added, and the precipitated solid was collected by filtration. The solid was dried under reduced pressure to give the title compound (2.28 g) as a white solid.

$^1$H-NMR (DMSO-d$_6$): 1.58–1.70 (4H, m), 2.01 (3H, s), 2.50 (3H, s), 2.82–2.90 (2H, m), 4.00 (2H, t, J= 6.0 Hz), 8.90 (2H, br).

**Reference Example 38**

![](image)

4-[(tert-Butoxycarbonyl)amino]butyl ethyl carbonate

To a mixture of tert-butyl 4-hydroxybutylcarbamate (3.71 g) obtained in Reference Example 35 and ethyl acetate (20 mL) were added pyridine (1.71 mL) and ethyl chlorocarbonate (2.55 g) under ice-cooling, and the mixture was stirred at room temperature for 24 hrs. Ethyl acetate (100 mL) was added to the reaction mixture, and the mixture was washed with water (50 mL), an aqueous copper sulfate solution (30 mL), water (30 mL) and saturated brine (30 mL) and dried over anhydrous magnesium sulfate. Concentration under reduced pressure gave the title compound (4.92 g) as a colorless oil.

$^1$H-NMR (CDCl$_3$): 1.31 (3H, t, J= 7.1 Hz), 1.44 (9H, s), 1.46–1.80 (4H, m), 3.15 (2H, m), 4.11–4.25 (4H, m), 4.54 (1H, bs).

**Reference Example 39**
Ethyl 4-(methylamino)butyl carbonate hydrochloride

To a solution (20 mL) of 4-[(tert-butoxycarbonylamino)butyl ethyl carbonate (4.90 g) obtained in Reference Example 38 and methyl iodide (4.67 mL) in N,N-dimethylformamide was added sodium hydride (60% in oil, 0.90 g) under ice-cooling. After stirring at room temperature for 6 hrs., the reaction mixture was poured into an ice-aqueous ammonium chloride solution, and extracted with diethyl ether (120 mL). The diethyl ether layer was washed with saturated brine (30 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by silica gel column chromatography (eluted with ethyl acetate:hexane=1:9). To the purified product was added a 4N hydrogen chloride–ethyl acetate solution (20 mL), and the mixture was stirred at room temperature for 2 hrs. Diethyl ether (40 mL) was added, and the precipitated solid was collected by filtration. The solid was dried under reduced pressure to give the title compound (2.86 g) as a white solid.

\( ^1 \text{H-NMR(DMSO-}\text{d}_6): 1.21(3\text{H,t,}J=7.1\text{Hz}), 1.51-1.73(4\text{H,m}), 2.50(3\text{H,s}), 2.82-2.94(2\text{H,m}), 4.05-4.15(4\text{H,m}), 8.88(2\text{H,br}). \)

**Reference Example 40**

tert-Butyl 3-hydroxypropylcarbamate

To a mixture of 3-aminopropanol (7.51 g) and ethyl acetate (30 mL) was dropwise added a mixture of di-tert-butyl dicarbonate (21.8 g) and ethyl acetate (3 mL) under ice-cooling. After stirring at room temperature for 22 hrs., the
mixture was concentrated under reduced pressure. The residue was dissolved in ethyl acetate (200 mL), washed with water (80 mL), 1N hydrochloric acid (60 mL), water (50 mL) and saturated brine (50 mL), and dried over anhydrous sodium sulfate.

Concentration under reduced pressure gave the title compound (16.01 g) as a colorless oil.

$^1$H-NMR (CDCl$_3$): 1.45 (9H, s), 1.62-1.70 (2H, m), 3.24 (2H, q, $J$=6.6Hz), 3.66 (2H, q, $J$=5.1Hz), 4.73 (1H, bs).

**Reference Example 41**

![chemical structure](image)

3-[(tert-Butyloxycarbonyl)amino]propyl acetate

To a mixture of tert-butyl 3-hydroxypropylcarbamate (8.00 g) obtained in Reference Example 40 and ethyl acetate (50 mL) were added pyridine (4.06 mL) and acetic anhydride (5.13 g), and the mixture was stirred at room temperature for 21 hrs. Ethyl acetate (200 mL) was added to the reaction mixture, and the mixture was washed with water (100 mL), an aqueous copper sulfate solution (40 mL), water (60 mL) and saturated brine (60 mL), and dried over anhydrous sodium sulfate.

Concentration under reduced pressure gave the title compound (8.34 g) as a colorless oil.

$^1$H-NMR (CDCl$_3$): 1.44 (9H, s), 1.77-1.86 (2H, m), 2.06 (3H, s), 3.20 (2H, q, $J$=6.3Hz), 4.12 (2H, t, $J$=6.3Hz), 4.67 (1H, bs).

**Reference Example 42**

![chemical structure](image)

3-(Methylamino)propyl acetate hydrochloride

To a solution (80 mL) of 3-[(tert-butyloxycarbonyl)amino]propyl acetate (17.28 g) obtained in Reference Example 41 and methyl iodide (19.8 mL) in N,N-
dimethylformamide was added sodium hydride (60% in oil, 3.82 g) under ice-cooling. After stirring at room temperature for 15 hrs., the reaction mixture was poured into an ice - aqueous ammonium chloride solution and extracted with diethyl ether (300 mL). The diethyl ether layer was washed with saturated brine (100 mL), and dried over anhydrous sodium sulfate. After concentration under reduced pressure, the residue was purified by silica gel column chromatography (eluted with ethyl acetate:hexane=1:8). To the purified product was added a 4N hydrogen chloride - ethyl acetate solution (40 mL), and the mixture was stirred at room temperature for 2 hrs. Diethyl ether (100 mL) was added, and the precipitated solid was collected by filtration. The solid was dried under reduced pressure to give the title compound (2.93 g) as a white solid.

1H-NMR(DMSO-d6): 1.85-1.97(2H,m), 2.02(3H,s), 2.50(3H,s), 2.87-2.96(2H,m), 4.06(2H,t,J=6.3Hz), 8.87(2H,br).

Reference Example 43

\[
\text{H}_3\text{C} - \overset{-}{\text{O}}\text{N} - \overset{-}{\text{O}}\text{O} - \overset{-}{\text{O}}\text{O}\text{CH}_3
\]

3-[(tert-Butoxycarbonyl)amino]propyl ethyl carbonate

To a mixture of tert-butyl 3-hydroxypropylcarbamate (8.00 g) obtained in Reference Example 40 and ethyl acetate (50 mL) were added pyridine (4.06 mL) and ethyl chlorocarbonate (5.95 g) under ice-cooling, and the mixture was stirred at room temperature for 24 hrs. Ethyl acetate (100 mL) was added to the reaction mixture, and the mixture was washed with water (50 mL), an aqueous copper sulfate solution (30 mL), water (30 mL) and saturated brine (30 mL), and dried over anhydrous sodium sulfate. Concentration under reduced pressure gave the title compound (9.31 g) as a colorless oil.

1H-NMR(CDCl3): 1.31(3H,t,J=7.1Hz), 1.44(9H,s), 1.82-1.90(2H,m), 3.22(2H,t,J=6.3Hz), 4.15-4.23(4H,m), 4.68(1H,bs).
Reference Example 44

\[
\begin{align*}
&\text{H}_3\text{C} - \text{N} - \text{O} - \text{O} - \text{CH}_3 \\
&\text{HCl}
\end{align*}
\]

Ethyl 3-(methylamino)propyl carbonate hydrochloride

To a solution (40 mL) of 3-[(tert-butoxycarbonyl)amino]propyl ethyl carbonate (9.31 g) obtained in Reference Example 43 and methyl iodide (9.00 mL) in N,N-dimethylformamide was added sodium hydride (60% in oil, 1.82 g) under ice-cooling. After stirring at room temperature for 12 hrs., the reaction mixture was poured into an ice- aqueous ammonium chloride solution and the mixture was extracted with diethyl ether (200 mL). The diethyl ether layer was washed with saturated brine (100 mL), and dried over anhydrous sodium sulfate. After concentration under reduced pressure, the residue was purified by silica gel column chromatography (eluted with ethyl acetate:hexane=1:8). To the purified product was added a 4N hydrogen chloride- ethyl acetate solution (40 mL), and the mixture was stirred at room temperature for 2 hrs. Diethyl ether (200 mL) was added, and the precipitated solid was collected by filtration. The solid was dried under reduced pressure to give the title compound (4.98 g) as a white solid.

\[^1H\text{-NMR (DMSO-d}_6\text{): 1.21(3H,t,J=7.1Hz), 1.91-2.00(2H,m), 2.50(3H,s), 2.88-2.98(2H,m), 4.08-4.16(4H,m), 8.90(2H,br).}\]

Reference Example 45

\[
\begin{align*}
&\text{H}_3\text{C} - \text{O} - \text{CH}_3 \\
&\text{H}_3\text{C} - \text{N} - \text{O} - \text{OH} - \text{OH}
\end{align*}
\]

tert-Butyl (2,3-dihydroxypropyl)methylcarbamate

To a mixture of 3-(methylamino)-1,2-propanediol (24.5 g)
and ethyl acetate (50 mL) was dropwise added a mixture of di-
tert-butyl dicarbonate (51.4 g) and ethyl acetate (10 mL) 
under ice-cooling. After stirring at room temperature for 15 
hrs., the mixture was concentrated under reduced pressure. The 
residue was dissolved in ethyl acetate (150 mL), and the 
solution was washed with water (80 mL), 1N hydrochloric acid 
(60 mL), water (50 mL) and saturated brine (50 mL), and dried 
over anhydrous sodium sulfate. Concentration under reduced 
pressure gave the title compound (26.9 g) as a colorless oil.

\[ \text{H-NMR (CDCl}_3\text{): 1.47 (9H, s), 2.92 (3H, s), 3.20-3.36 (2H, m),} \\
3.41 (2H, bs), 3.50-3.62 (2H, m), 3.73-3.88 (1H, m). \]

**Reference Example 46**

\[ \text{3-([Methylamino])propane-1,2-diyl diacetate hydrochloride} \]

To a mixture of tert-butyl (2,3-
dihydroxypropyl)methylcarbamate (10.26 g) obtained in 
Reference Example 45 and ethyl acetate (50 mL) were added 
pyridine (10.11 mL) and acetic anhydride (12.76 g), and the 
mixture was stirred at room temperature for 24 hrs. Ethyl 
acetate (300 mL) was added to the reaction mixture, and the 
mixture was washed with water (150 mL), an aqueous copper 
sulfate solution (100 mL), water (100 mL) and saturated brine 
(100 mL), and dried over anhydrous sodium sulfate. After 
concentration under reduced pressure, the residue was purified 
by silica gel column chromatography (eluted with ethyl 
acetate:hexane=1:8). To the purified product was added a 4N 
hydrogen chloride - ethyl acetate solution (40 mL), and the 
mixture was stirred at room temperature for 3 hrs. Diethyl 
ether (100 mL) was added, and the precipitated solid was
collected by filtration. The solid was dried under reduced pressure to give the title compound (2.76 g) as a white solid. 

$^1$H-NMR (DMSO-d$_6$): 2.03 (3H, s), 2.07 (3H, s), 2.55 (3H, s), 3.18 – 3.22 (2H, m), 4.09 – 4.28 (2H, m), 5.20 – 5.27 (1H, m), 9.01 (2H, br).

Reference Example 47

Diethyl 3-(methylamino)propane-1,2-diyldibiscarbonate hydrochloride

To a mixture of tert-butyl (2,3-dihydroxypropyl)methylcarbamate (15.53 g) obtained in Reference Example 45 and ethyl acetate (100 mL) were added pyridine (18.35 mL) and ethyl chlorocarbonate (24.62 g) under ice-cooling, and the mixture was stirred at room temperature for 96 hrs. Ethyl acetate (300 mL) was added to the reaction mixture, and the mixture was washed with water (150 mL), an aqueous copper sulfate solution (100 mL), water (100 mL) and saturated brine (100 mL), and dried over anhydrous sodium sulfate. After concentration under reduced pressure, the residue was purified by silica gel column chromatography (eluted with ethyl acetate:hexane=1:6). To the purified product was added a 4N hydrogen chloride – ethyl acetate solution (80 mL), and the mixture was stirred at room temperature for 3 hrs. Diethyl ether (200 mL) was added, and the precipitated solid was collected by filtration. The solid was dried under reduced pressure to give the title compound (5.93 g) as a white solid.

$^1$H-NMR (DMSO-d$_6$): 1.20 – 1.28 (6H, m), 2.57 (3H, s), 3.12 – 3.28 (2H, m), 4.10 – 4.43 (6H, m), 5.13 – 5.22 (1H, m), 9.14 (2H, br).
Reference Example 48

\[
\begin{align*}
\text{H}_3\text{C} & \quad \text{N} \\
& \quad \text{O} \\
& \quad \text{O} \\
& \quad \text{O} \\
& \quad \text{CH}_3 \\
\text{HCl}
\end{align*}
\]

2-Ethoxyethyl 2-((methylamino)ethyl carbonate hydrochloride

To a solution (20 mL) of bis(trichloromethyl)carbonate (2.97 g) in tetrahydrofuran was dropwise added a solution (10 mL) of 2-ethoxyethanol (1.80 g) in tetrahydrofuran under ice-cooling. Then a solution (10 mL) of pyridine (2.43 mL) in tetrahydrofuran was added dropwise, and the mixture was stirred at room temperature for 2 hrs. The reaction mixture was concentrated under reduced pressure and water (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with 0.2N hydrochloric acid (20 mL) and saturated brine (50 mL), dried over anhydrous magnesium sulfate, and concentrated under reduced pressure to give 2-ethoxyethyl chlorocarbonate (1.29 g). A solution (15 mL) of tert-butyl 2-hydroxyethyl(methyl)carbamate (1.23 g) obtained in Reference Example 1 in tetrahydrofuran was added pyridine (0.68 mL), and a solution (5 mL) of 2-ethoxyethyl chlorocarbonate obtained above in tetrahydrofuran was dropwise added to the mixture, and the mixture was stirred at room temperature for 3 days. After concentration of the reaction mixture under reduced pressure, water (50 mL) was added thereto and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with a 5% aqueous citric acid solution (50 mL) and saturated brine (50 mL), dried over anhydrous magnesium sulfate. The mixture was concentrated under reduced pressure and the residue was purified by silica gel column chromatography (eluted with ethyl acetate:hexane=1:5, then 2:3). The purified product (1.60 g) was dissolved in diethyl
ether (3 mL) and a 4N hydrogen chloride - ethyl acetate solution (3 mL) was added. The mixture was stirred overnight at room temperature, and the precipitated solid was collected by filtration and dried under reduced pressure to give the title compound (0.94 g) as a white solid.

$^1$H-NMR (DMSO-d$_6$): 1.10 (3H, t, J=7.0 Hz), 2.57 (3H, s), 3.18-3.25 (2H, m), 3.44 (2H, q, J=7.0 Hz), 3.56-3.60 (2H, m), 4.19-4.24 (2H, m), 4.30-4.37 (2H, m), 8.79 (2H, br).

Reference Example 49

3-Methoxypropyl 2-(methylamino)ethyl carbonate hydrochloride

To a mixture of lithium aluminum hydride (2.85 g) and diethyl ether (100 mL) was dropwise added slowly a solution (50 mL) of methyl 3-methoxypropanoate (11.8 g) in tetrahydrofuran under ice-cooling. After stirring at room temperature for 1 hr., the mixture was again ice-cooled and water (3 mL) and a 10% aqueous sodium hydroxide solution (3 mL) were dropwise added. The mixture was allowed to reach room temperature, and water (9 mL) was dropwise added. The mixture was stirred for a while. The precipitate was filtered off and the filtrate was concentrated under reduced pressure to give 3-methoxypropanol (7.64 g) as a colorless oil.

$^1$H-NMR (CDCl$_3$): 1.83 (2H, quintet, J=5.8 Hz), 2.43 (1H, t, J=5.3 Hz), 3.36 (3H, s), 3.57 (2H, t, J=6.0 Hz), 3.77 (2H, q, J=5.5 Hz).

To a solution (50 mL) of bis(trichloromethyl)carbonate (4.45 g) in tetrahydrofuran was dropwise added N-ethylidiisopropylamine (5.75 mL) under ice-cooling. After stirring for a while, a solution (15 mL) of 3-methoxypropanol (2.70 g) obtained above in tetrahydrofuran was dropwise added. The mixture was stirred for 30 min. under ice-cooling and at
room temperature for 1 day. After concentration of the reaction mixture under reduced pressure, diluted hydrochloric acid (50 mL) was added to the residue, and the mixture was extracted with ethyl acetate (80 mL). The ethyl acetate layer was washed with 0.2N hydrochloric acid (30 mL) and saturated brine (30 mL), dried over anhydrous magnesium sulfate and concentrated under reduced pressure to give 3-methoxypropyl chlorocarbonate (4.39 g). To a solution (20 mL) of tert-butyl 2-hydroxyethyl(methyl)carbamate (1.75 g) obtained in Reference Example 1 in tetrahydrofuran was added pyridine (0.97 mL) and a solution (5 mL) of a 3-methoxypropyl chlorocarbonate (1.83 g) obtained above in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 2 hrs. A solution (5 mL) of pyridine (0.65 mL) and 3-methoxypropyl chlorocarbonate (1.22 g) in tetrahydrofuran was added and the mixture was further stirred for 1 hr. The reaction mixture was concentrated under reduced pressure and water (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (80 mL), and the ethyl acetate layer was washed with a 5% aqueous citric acid solution (50 mL) and saturated brine (50 mL), dried over anhydrous magnesium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (eluted with ethyl acetate:hexane=1:9, then 3:7). The purified product (3.40 g) was dissolved in diethyl ether (5 mL) and a 4N hydrogen chloride - ethyl acetate solution (5 mL) was added. The mixture was stirred overnight at room temperature and the reaction mixture was concentrated under reduced pressure. Diethyl ether was added for crystallization to give the title compound (2.06 g) as a colorless solid.

$^1$H-NMR (DMSO-d$_6$): 1.78-1.90 (2H, m), 2.54 (3H, s), 3.15-3.25 (2H, m), 3.23 (3H, s), 3.33-3.42 (2H, m), 4.16 (2H, t, J=6.0Hz), 4.36 (2H, t, J=6.0Hz), 9.27 (2H, br).
Reference Example 50

\[
\text{H}_2\text{C} - \overset{\text{N}}{\text{O}} - \overset{\text{O}}{\text{N}} - \text{CH}_3 \\
2\text{HCl}
\]

2-(Methylamino)ethyl N,N-dimethylglycinate dihydrochloride

A mixture of tert-butyl 2-hydroxyethyl(methyl) carbamate (3.50 g) obtained in Reference Example 1, N,N-dimethylglycine hydrochloride (5.29 g), 1-ethyl-3-[3-(dimethylamino)propyl] carbodiimide hydrochloride (7.67 g), triethylamine (5.58 mL), 4-dimethylaminopyridine (1.22 g) and N,N-dimethylformamide (50 mL) was stirred overnight at room temperature. The reaction mixture was concentrated under reduced pressure and a saturated aqueous sodium hydrogen carbonate solution (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (100 mL). The ethyl acetate layer was washed with saturated brine (50 mL), dried over anhydrous magnesium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (eluted with methanol:ethyl acetate=5:95, then 20:80). 1N Hydrochloric acid (24 mL) was added to the purified product (2.46 g), and the mixture was stirred overnight at room temperature. The reaction mixture was concentrated under reduced pressure to give the title compound (2.14 g) as a colorless solid.

\[\text{H}^1\text{NMR (DMSO-}d_6\text{): 2.52 (3H, s), 2.85 (6H, s), 3.20 (2H, m), 4.30 (2H, s), 4.43-4.49 (2H, m), 9.60 (2H, br), 10.81 (1H, br)}\]

Reference Example 51

\[
\text{H}_3\text{C} - \overset{\text{N}}{\text{O}} - \overset{\text{S}}{\text{CH}_3} \\
\text{HCl}
\]

S-[2-(Methylamino)ethyl] thioacetate hydrochloride
To a solution (50 mL) of tert-butyl 2-hydroxyethyl(methyl)carbamate (3.50 g) obtained in Reference Example 1, thioacetic acid (1.72 mL) and triphenylphosphine (7.87 g) in tetrahydrofuran was dropwise added slowly a solution (10 mL) of diisopropyl azodicarboxylate (5.91 mL) in tetrahydrofuran under ice-cooling. The mixture was stirred under ice-cooling for 1 hr. and at room temperature for 2 hrs. The reaction mixture was again ice-cooled and a solution (10 mL) of triphenylphosphine (7.87 g) and diisopropyl azodicarboxylate (5.91 mL) in tetrahydrofuran was added. The mixture was stirred under ice-cooling for 30 min. Thioacetic acid (1.14 mL) was added and the mixture was stirred under ice-cooling for 30 min. and at room temperature overnight. The reaction mixture was concentrated under reduced pressure and hexane and diisopropyl ether were added to the residue. The precipitate was filtered off and the filtrate was concentrated under reduced pressure. This step was repeated and a saturated aqueous sodium hydrogen carbonate solution (50 mL) was added. The mixture was extracted with ethyl acetate (100 mL). The ethyl acetate layer was washed with saturated brine (50 mL), dried over anhydrous magnesium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (eluted with ethyl acetate:hexane=5:95, and then 15:85). A 4N hydrogen chloride – ethyl acetate solution (10 mL) was added to the purified product (4.47 g) and the mixture was stirred overnight at room temperature. The reaction mixture was concentrated under reduced pressure and ethyl acetate and diethyl ether were added to the residue for crystallization to give the title compound (1.79 g) as a pale-yellow solid.

$^1$H-NMR (DMSO-d$_6$): 2.38 (3H, s), 2.52 (3H, s), 2.96-3.08 (2H, m), 3.12-3.20 (2H, m), 9.35 (2H, br)

Reference Example 52
Ethyl 2-[2-(methylamino)ethoxy]ethyl carbonate hydrochloride

To a mixture of 2-(2-aminoethoxy)ethanol (99.52 g) and ethyl acetate (200 mL) was dropwise added a mixture of di-tert-butyl dicarbonate (208.57 g) and ethyl acetate (50 mL) under ice-cooling. After stirring at room temperature for 60 hrs., the mixture was concentrated under reduced pressure. The residue was dissolved in ethyl acetate (500 mL), washed with water (200 mL), 1N hydrochloric acid (200 mL), water (300 mL) and saturated brine (300 mL), and dried over anhydrous sodium sulfate. Concentration under reduced pressure gave tert-butyl [2-(2-hydroxyethoxy)ethyl]carbamate (169.2 g) as a colorless oil.

$^1$H-NMR (CDCl$_3$): 1.45 (9H, s), 3.33 (2H, q, J=5.1Hz), 3.54–3.59 (4H, m),
3.74 (2H, q, J=5.1Hz), 4.88 (2H, bs).

To a mixture of tert-butyl [2-(2-hydroxyethoxy)ethyl]carbamate (53.93 g) obtained above and ethyl acetate (350 mL) were added pyridine (53.78 mL) and ethyl chlorocarbonate (70.57 g) under ice-cooling, and the mixture was stirred at room temperature for 96 hrs. Ethyl acetate (500 mL) was added to the reaction mixture, and the mixture was washed with water (500 mL), an aqueous copper sulfate solution (200 mL), water (300 mL) and saturated brine (300 mL) and dried over anhydrous sodium sulfate. Concentration under reduced pressure gave 2-[2-[(tert-butoxycarbonyl)amino]ethoxy]ethyl ethyl carbonate (93.19 g) as a colorless oil.

$^1$H-NMR (CDCl$_3$): 1.32 (3H, t, J=7.2Hz), 1.44 (9H, s), 3.32 (2H, t, J=5.1Hz), 3.54 (2H, t, J=5.1Hz), 3.67–3.74 (2H, m), 4.21 (2H, q, J=7.2Hz), 4.26–4.31 (2H, m), 4.91 (1H, bs).

To a solution (350 mL) of 2-[2-[(tert-
butoxy carbonyl) amino] ethoxy] ethyl ethyl carbonate (93.15 g) obtained above and methyl iodide (83.6 mL) in N,N-
dimethylformamide was added sodium hydride (60% in oil, 16.12 g) under ice-cooling. After stirring at room temperature for
24 hrs., the reaction mixture was poured into an ice - aqueous ammonium chloride solution, and extracted with diethyl ether
(800 mL). The diethyl ether layer was washed with saturated brine (300 mL), and dried over anhydrous magnesium sulfate.
After concentration under reduced pressure, the residue was
purified by silica gel column chromatography (eluted with ethyl acetate:hexane=1:8). To the purified product was added a
4N hydrogen chloride - ethyl acetate solution (300 mL) was added, and the mixture was stirred at room temperature for 2 hrs. Diethyl ether (300 mL) was added, and the precipitated solid was collected by filtration. The solid was dried under reduced pressure to give the title compound (33.21 g) as a white solid.

\[ ^1H-NMR(\text{DMSO-d}_6): 1.21(3H,t,J=7.2Hz), 2.51(3H,s), 3.02-3.09(2H,m), 3.65-3.72(4H,m), 4.12(2H,q,J=7.2Hz),
4.22(2H,t,J=4.5Hz), 9.06(2H,br). \]

**Reference Example 53**

```
H3C
\( \text{N} \)
O
\( \text{NH} \)
\( \text{O} \)
\( \text{O} \)
\( \text{O} \)
\( \text{CH}_3 \)
```

Ethyl 2-[methyl[[2-(methylamino)ethoxy]carbonyl]amino]ethyl carbonate hydrochloride

To a solution (100 mL) of bis(trichloromethyl)carbonate (11.87 g) in tetrahydrofuran was dropwise added a solution (20 mL) of pyridine (9.71 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., a solution (20 mL) of tert-butyl 2-hydroxyethyl(methyl)carbamate (17.52 g) obtained in Reference Example 1 in tetrahydrofuran
was dropwise added and the mixture was stirred at room
temperature for 15 hrs. After concentration under reduced
pressure, water (500 mL) and anhydrous sodium sulfate were
added to the residue. After filtration, the filtrate was
concentrated under reduced pressure. To the obtained residue
were added a solution (50 mL) of 2-(methylamino)ethanol (5.00
g) in ethyl acetate and triethylamine (10.0 mL) under ice-
cooling and the mixture was stirred at room temperature for 15
hrs. Ethyl acetate (300 mL) was added to the reaction mixture,
was washed with water (150 mL) and saturated brine (200 mL) and
dried over anhydrous sodium sulfate. After concentration under
reduced pressure, to a mixture of the residue and ethyl
acetate (100 mL) were added pyridine (2.91 mL) and ethyl
chlorocarbonate (3.44 g) under ice-cooling, and the mixture
was stirred at room temperature for 48 hrs. Ethyl acetate (200
mL) was added to the reaction mixture, washed with water (100
mL), an aqueous copper sulfate solution (50 mL), water (50 mL)
and saturated brine (50 mL), and dried over anhydrous sodium
sulfate. The mixture was concentrated under reduced pressure
and the residue was purified by silica gel column
chromatography (eluted with ethyl acetate:hexane=1:3). To the
purified product was added a 4N hydrogen chloride - ethyl
acetate solution (30 mL), and the mixture was stirred at room
temperature for 3 hrs. Diethyl ether (100 mL) was added, and
the precipitated solid was collected by filtration. The solid
was dried under reduced pressure to give the title compound
(2.90 g) as a white solid.

$^1$H-NMR (DMSO-$d_6$): 1.21 (3H, t, $J=7.2$ Hz), 2.57 (3H, bs), 2.86 (1.5H, s),
2.93 (1.5H, s), 3.16 (2H, bs), 3.34 (1H, bs), 3.48 (1H, t, $J=5.1$ Hz),
3.58 (1H, t, $J=5.1$ Hz), 4.12 (2H, q, $J=7.2$ Hz), 4.16-4.24 (4H, m),
8.94 (1H, br).

Reference Example 54
2-(Methylamino)ethyl 1-methylpiperidine-4-carboxylate dihydrochloride

A mixture of ethyl piperidine-4-carboxylate (4.72 g), methyl iodide (2.24 mL), potassium carbonate (8.29 g) and acetonitrile (50 mL) was stirred at room temperature for 2 hrs. The reaction mixture was concentrated under reduced pressure and water (150 mL) was added. The mixture was extracted with ethyl acetate (150 mL). The ethyl acetate layer was washed with saturated brine (100 mL), dried over anhydrous magnesium sulfate, and concentrated under reduced pressure. A 1N aqueous sodium hydroxide solution (20 mL) was added to the residue (2.64 g), and the mixture was stirred overnight at room temperature. The reaction mixture was neutralized by adding 1N hydrochloric acid (20 mL) and the mixture was concentrated under reduced pressure. Ethanol was added to the residue, and the precipitate was filtered off. The filtrate was concentrated under reduced pressure. This step was repeated and ethanol and ethyl acetate were added to the residue for crystallization to give 1-methylpiperidine-4-carboxylic acid (1.79 g) as a colorless solid.

$^1$H-NMR (CD$_3$OD): 1.80-1.98 (2H, m), 2.00-2.14 (2H, m), 2.28-2.42 (1H, m), 2.78 (3H, s), 2.88-3.04 (2H, m), 3.32-3.44 (2H, m).

A mixture of 1-methylpiperidine-4-carboxylic acid (1.72 g) obtained above, tert-butyl 2-hydroxyethyl(methyl)carbamate (1.75 g) obtained in Reference Example 1, 1-ethyl-3-[3-(dimethylamino)propyl]carbodiimide hydrochloride (2.30 g), 4-dimethylaminopyridine (0.24 g) and acetonitrile (50 mL) was stirred at room temperature for 16 hrs. The reaction mixture
was concentrated under reduced pressure and a saturated aqueous sodium hydrogen carbonate solution (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (100 mL). The ethyl acetate layer was washed with saturated brine (50 mL), dried over anhydrous magnesium sulfate and concentrated under reduced pressure. The residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=50:50, then 80:20). 1N Hydrochloric acid (25 mL) was added to the purified product (2.73 g), and the mixture was stirred overnight at room temperature. The reaction mixture was concentrated under reduced pressure and isopropanol was added. The mixture was again concentrated under reduced pressure and the precipitated solid was collected by filtration to give the title compound (1.72 g) as a colorless solid.

\[ ^1H-NMR(DMSO-d_6): 1.70-2.20(4H,m), 2.40-3.50(13H,m), 4.31(2H,m), 9.25(2H,br), 10.77(1H,br). \]

**Reference Example 55**

![Chemical Structure](image)

\[ 2-[[4-(Aminocarbonyl)phenyl]amino]ethyl acetate \]

A mixture of 4-fluorobenzonitrile (6.06 g), 2-aminoethanol (3.71 g), potassium carbonate (8.29 g) and dimethyl sulfoxide (50 mL) was stirred at 100°C overnight. Water (200 mL) was added to the reaction mixture and the mixture was extracted with ethyl acetate (200 mL×4). The ethyl acetate layer was washed with saturated brine (100 mL), dried over anhydrous magnesium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (eluted with ethyl acetate:hexane=30:70, then 50:50, then 80:20, then ethyl acetate) to give 4-[(2-
hydroxyethyl)amino]benzonitrile (5.89 g) as a yellow solid. 

\[^1\text{H-NMR(CDC}_3\text{)}\]: 2.04 (1H, t, J=4.8Hz), 3.33 (2H, m), 3.86 (2H, q, J=4.8Hz), 4.66 (1H, br), 6.58 (2H, d, J=8.7Hz), 7.39 (2H, d, J=8.7Hz).

A mixture of 4-{[(2-hydroxyethyl)amino]benzonitrile (0.81 g) obtained above, potassium hydroxide (1.12 g) and tert-butanol (20 mL) was stirred at 100°C for 1 hr. Water (100 mL) was added to the reaction mixture, and extracted with ethyl acetate (100 mL). The ethyl acetate layer was washed with saturated brine (80 mL), dried over anhydrous magnesium sulfate and concentrated under reduced pressure. To a solution (10 mL) of the residue (0.83 g), pyridine (0.49 mL) and 4-dimethylaminopyridine (0.061 g) in tetrahydrofuran was dropwise added a solution (1 mL) of acetic anhydride (0.57 mL) in tetrahydrofuran. The mixture was stirred at room temperature for 1 hr., water (80 mL) was added, and the mixture was extracted with ethyl acetate (100 mL). The ethyl acetate layer was washed with saturated brine (80 mL), dried over anhydrous magnesium sulfate and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (eluted with ethyl acetate:hexane=30:70, then 60:40) to give the title compound (0.68 g) as a colorless solid.

\[^1\text{H-NMR(CDC}_3\text{)}\]: 2.08 (3H, s), 3.44 (2H, q, J=5.6Hz), 4.29 (2H, t, J=5.4Hz), 4.48 (1H, br), 6.59 (2H, d, J=8.9Hz), 7.43 (2H, d, J=8.9Hz).

Reference Example 56

\[\text{H}_3\text{C}\]
\[\text{N}\]
\[\text{O}\]
\[\text{O}\]
\[\text{CH}_3\]

2HCl

2-(Methylamino)ethyl 1-methyl-4-piperidinyl carbonate dihydrochloride
To a solution (40 mL) of N,N'-carbonyldiimidazole (3.36 g) in tetrahydrofuran was dropwise added slowly a solution (10 mL) of tert-butyl 2-hydroxyethyl(methyl)carbamate (3.30 g) obtained in Reference Example 1 in tetrahydrofuran under ice-cooling. The mixture was stirred under ice-cooling for 40 min. and at room temperature for 2 hrs. N,N'-Carbonyldiimidazole (0.31 g) was added and the mixture was further stirred for 3 days. The reaction mixture was concentrated under reduced pressure and ethyl acetate (150 mL) was added to the residue. The mixture was washed with saturated brine (100 mL×2), water (50 mL×3) and saturated brine (50 mL), dried over anhydrous magnesium sulfate and concentrated under reduced pressure to give 2-[(tert-butoxycarbonyl)(methyl)amino]ethyl 1H-imidazole-1-carboxylate (5.24 g) as a colorless oil.

H-NMR (CDCl₃): 1.39 (9H×0.5, s), 1.42 (9H×0.5, s), 2.94 (3H, m), 3.63 (2H, m), 4.51 (2H, t, J=5.3 Hz), 7.06 (1H, m), 7.42 (1H, m), 8.13 (1H, s).

A mixture of 2-[(tert-butoxycarbonyl)(methyl)amino]ethyl 1H-imidazole-1-carboxylate (1.35 g) obtained above, 1-methyl-4-piperidinol (1.38 g) and acetonitrile (20 mL) was stirred overnight at room temperature. 1-Methyl-4-piperidinol (0.92 g) was added and the mixture was stirred overnight. The reaction mixture was concentrated under reduced pressure and a saturated aqueous sodium hydrogen carbonate solution (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (100 mL). The ethyl acetate layer was washed with saturated brine (50 mL), dried over anhydrous magnesium sulfate and concentrated under reduced pressure. 1N Hydrochloric acid (12 mL) was added to the residue (1.60 g), and the mixture was stirred overnight at room temperature. The reaction mixture was concentrated under reduced pressure, water, isopropanol and ethyl acetate were added, and the precipitated solid was collected by filtration to give the
title compound (1.09 g) as a colorless solid.

$^1$H-NMR (DMSO-d$_6$): 1.85-2.20 (4H, m), 2.55 (3H, s), 2.70 (3H×0.5, s), 2.73 (3H×0.5, s), 2.90-3.50 (6H, m), 4.38 (2H, m), 4.65-5.00 (1H, m), 9.21 (2H, br), 11.10 (1H, br).

Example 1

![Chemical Structure Image]

2-[(Methyl{[(R)-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl}amino)ethyl acetate

To a solution (30 mL) of bis(trichloromethyl)carbonate (0.50 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.40 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., 2-(methylamino)ethyl acetate hydrochloride (0.77 g) obtained in Reference Example 2 was added. A solution (1 mL) of triethylamine (0.70 mL) in tetrahydrofuran was dropwise added and the mixture was stirred at room temperature for 1 hr. After concentration under reduced pressure, water (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. The mixture was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.11 g),
triethylamine (0.84 mL) and 4-dimethylaminopyridine (catalytic amount) were added, and the mixture was stirred at 60°C overnight. After concentration under reduced pressure, water (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:1, then ethyl acetate), and further by silica gel column chromatography (eluted with ethyl acetate:hexane=2:1, then ethyl acetate, then acetone:ethyl acetate=1:4, then 1:1) to give the title compound (1.13 g) as a yellow amorphous solid.

$^1$H-NMR (CDCl$_3$): 2.10 (3H, s), 2.24 (3H, s), 3.09 (3H, bs), 3.60–4.00 (2H, br), 4.25–4.50 (4H, m), 4.89 (1H, d, J=13.3 Hz), 5.05 (1H, d, J=13.3 Hz), 6.65 (1H, d, J=5.5 Hz), 7.35–7.51 (3H, m), 7.80–7.90 (1H, m), 8.35 (1H, d, J=5.5 Hz).

**Example 2**

![Chemical Structure](image)


To a solution (30 mL) of bis(trichloromethyl)carbonate (0.50 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.40 mL) in tetrahydrofuran under ice-
cooling. After stirring under ice-cooling for 1 hr., 2-
(methylamino)ethyl trimethylacetate hydrochloride (0.98 g)
obtained in Reference Example 3 was added. A solution (1 mL)
of triethylamine (0.70 mL) in tetrahydrofuran was dropwise
added, and the mixture was stirred overnight at room
temperature. After concentration under reduced pressure, water
(50 mL) was added to the residue. The mixture was extracted
with ethyl acetate (50 mL). The ethyl acetate layer was washed
with saturated brine (50 mL), and dried over anhydrous
magnesium sulfate. The layer was concentrated under reduced
pressure, and the residue was dissolved in tetrahydrofuran (20
mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-
pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.11 g),
triethylamine (0.84 mL) and 4-dimethylaminopyridine (0.037 g)
were added, and the mixture was stirred overnight at 60°C.
After concentration under reduced pressure, water (50 mL) was
added to the residue. The mixture was extracted with ethyl
acetate (50 mL). The ethyl acetate layer was washed with
saturated brine (50 mL) and dried over anhydrous magnesium
sulfate. After concentration under reduced pressure, the
residue was purified by flash silica gel column chromatography
(eluted with acetone:hexane=1:3, then 3:2). Crystallization
from acetone-diisopropyl ether and recrystallization from
acetone-diisopropyl ether gave the title compound (1.01 g) as a
colorless solid.

1H-NMR (CDCl₃): 1.23 (9H, s), 2.23 (3H, s), 3.08 (3H, bs), 3.40–
4.30 (2H, br), 4.30–4.50 (4H, m), 4.80–5.20 (2H, br),
6.64 (1H, d, J=5.7Hz), 7.35–7.50 (3H, m), 7.78–7.88 (1H, m),
8.35 (1H, d, J=5.7Hz).

Example 3

To a solution (30 mL) of bis(trichloromethyl)carbonate (0.50 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.40 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., 2-(methylamino)ethyl cyclohexane carboxylate hydrochloride (1.11 g) obtained in Reference Example 4 was added. A solution (1 mL) of triethylamine (0.70 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 1 hr. After concentration under reduced pressure, water (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.11 g), triethylamine (0.84 mL) and 4-dimethylaminopyridine (0.037 g) were added, and the mixture was stirred overnight at 60°C. After concentration under reduced pressure, water (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium
sulfate. After concentration under reduced pressure, the residue was purified by flash silica gel column chromatography (eluted with acetone:hexane=1:3, then 3:2). Crystallization from acetone-diisopropyl ether and recrystallization from acetone-diisopropyl ether gave the title compound (1.11 g) as a colorless solid.

$^1$H-NMR (CDCl$_3$): 1.10–1.55 (5H, m), 1.55–1.82 (3H, m), 1.84–1.98 (2H, m), 2.23 (3H, s), 2.27–2.40 (1H, m), 3.08 (3H, bs), 3.40–4.30 (2H, br), 4.30–4.50 (4H, m), 4.80–5.15 (2H, br), 6.64 (1H, d, J=5.4Hz), 7.35–7.48 (3H, m), 7.84 (1H, d, J=6.9Hz), 8.34 (1H, d, J=5.4Hz).

Example 4

![Chemical Structure](image)


To a solution (30 mL) of bis(trichloromethyl)carbonate (0.50 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.40 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 1 hr., 2-(methylamino)ethyl benzoate hydrochloride (1.08 g) obtained in Reference Example 5 was added. A solution (1 mL) of triethylamine (0.70 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred overnight at room temperature. After concentration under reduced pressure, water (50 mL) was
added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.11 g), triethylamine (0.84 mL) and 4-dimethylaminopyridine (0.037 g) were added, and the mixture was stirred overnight at 60°C. After concentration under reduced pressure, water (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by flash silica gel column chromatography (eluted with acetone:hexane=1:3, then 3:2). Crystallization from acetone-diethyl ether and recrystallization from acetone-diethyl ether gave the title compound (1.09 g) as a colorless solid.

$^{1}$H-NMR (CDCl$_3$): 2.22 (3H, s), 3.12 (3H, bs), 3.50–4.30 (2H, br), 4.37 (2H, q, $J$=7.8 Hz), 4.68 (2H, m), 4.80–5.20 (2H, br), 6.63 (1H, d, $J$=5.7 Hz), 7.26–7.48 (5H, m), 7.53–7.61 (1H, m), 7.82 (1H, d, $J$=8.1 Hz), 8.04 (2H, d, $J$=7.2 Hz), 8.33 (1H, d, $J$=5.7 Hz).

Example 5

To a solution (30 mL) of bis(trichloromethyl)carbonate (0.99 g) in tetrahydrofuran was dropwise added a solution (2 mL) of pyridine (0.81 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., 2-(methylamino)ethyl benzoate hydrochloride (2.16 g) obtained in Reference Example 5 was added. After addition of a solution (2 mL) of triethylamine (1.39 mL) in tetrahydrofuran, the mixture was stirred at room temperature for 1 hr. After concentration under reduced pressure, ethyl acetate (100 mL) and water (100 mL) were added to the residue, and the mixture was stirred. The ethyl acetate layer was separated and taken, washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in tetrahydrofuran (40 mL). 2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (2.90 g), triethylamine (2.20 mL) and 4-dimethylaminopyridine (0.096 g) were added, and the mixture was stirred at 60°C for 2 hr. After concentration under reduced pressure, ethyl acetate (150 mL) and water (80 mL) were added to the residue, and the mixture was stirred. The ethyl acetate layer was separated and taken, washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by silica gel column chromatography (eluted with ethyl acetate:hexane=1:1, then ethyl acetate). Recrystallization from acetone gave the title compound (2.62 g) as a colorless solid.
8.06 (2H, d, J=6.0 Hz), 8.35 (1H, d, J=5.7 Hz).

**Example 6**

![Chemical Structure](image)

2-[[Methyl](((R)-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino)ethyl 4-methoxybenzoate

To a solution (18 mL) of bis(trichloromethyl)carbonate (0.584 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.49 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 40 min., 2-(methylamino)ethyl 4-methoxybenzoate hydrochloride (1.48 g) obtained in Reference Example 6 was added. A solution (1 mL) of triethylamine (0.84 mL) in tetrahydrofuran was added and the mixture was stirred at room temperature for 80 min. After concentration under reduced pressure, ethyl acetate (80 mL) and water (50 mL) were added to the residue and the mixture was stirred. The ethyl acetate layer was separated and taken, washed with saturated brine (30 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in tetrahydrofuran (25 mL). (R)-2-[[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.55 g), triethylamine (1.17 mL) and 4-dimethylaminopyridine (0.051 g)
were added, and the mixture was stirred at 60°C for 3 hrs. After concentration under reduced pressure, ethyl acetate (150 mL) and water (50 mL) were added to the residue, and the mixture was stirred. The ethyl acetate layer was separated and taken, washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by silica gel column chromatography (eluted with ethyl acetate:hexane=1:1, then ethyl acetate). Recrystallization from ethyl acetate-hexane gave the title compound (1.08 g) as a colorless solid.

\(^1\)H-NMR (CDCl\(_3\)) : 2.22 (3H, s), 3.11 (3H, bs), 3.68–3.90 (2H, bm), 3.85 (3H, s), 4.37 (2H, q, J=7.9Hz), 4.58–4.72 (2H, m), 4.82–5.14 (2H, bm), 6.63 (1H, d, J=5.7Hz), 6.91 (2H, d, J=9.0Hz), 7.27–7.40 (3H, m), 7.82 (1H, m), 7.99 (2H, d, J=9.0Hz), 8.33 (1H, d, J=5.7Hz).

**Example 7**

![Chemical Structure]


To a solution (20 mL) of bis(trichloromethyl)carbonate (0.582 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.49 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., 2-
(methylamino)ethyl 3-chlorobenzoate hydrochloride (1.50 g) obtained in Reference Example 7 was added. A solution (1 mL) of triethylamine (0.84 mL) in tetrahydrofuran was added and the mixture was stirred at room temperature for 2 hrs. After concentration under reduced pressure, ethyl acetate (80 mL) and water (40 mL) were added to the residue and the mixture was stirred. The ethyl acetate layer was separated and taken, washed with saturated brine (25 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.44 g), triethylamine (1.09 mL) and 4-dimethylaminopyridine (0.048 g) were added, and the mixture was stirred at 60°C for 3 hrs. After concentration under reduced pressure, ethyl acetate (80 mL) and water (40 mL) were added to the residue and the mixture was stirred. The ethyl acetate layer was separated and taken, washed with saturated brine (30 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:2, then 1:1) to give the title compound (0.84 g) as colorless syrup.

$^1$H-NMR (CDCl$_3$): 2.21 (3H, s), 3.12 (3H, bs), 3.78-4.08 (2H, bm), 4.38 (2H, q, J=7.8Hz), 4.64-5.08 (4H, bm), 6.64 (1H, d, J=5.2Hz), 7.34-7.42 (4H, m), 7.56 (1H, m), 7.82 (1H, m), 7.94 (1H, d, J=7.6Hz), 8.02 (1H, s), 8.34 (1H, d, J=5.2Hz).

Example 8
2-[[Methyl-[[[R]-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]ethyl 3,4-difluorobenzoate

To a solution (20 mL) of bis(trichloromethyl)carbonate (0.582 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.49 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., 2-(methylamino)ethyl 3,4-difluorobenzoate hydrochloride (1.51 g) obtained in Reference Example 8 was added. A solution (1 mL) of triethylamine (0.84 mL) in tetrahydrofuran was added and the mixture was stirred at room temperature for 3 hrs. After concentration under reduced pressure, ethyl acetate (80 mL) and water (50 mL) were added to the residue and the mixture was stirred. The ethyl acetate layer was separated and taken, washed with saturated brine (30 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (25 mL). (R)-2-[[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.71 g), triethylamine (1.29 mL) and 4-dimethylaminopyridine (0.056 g) were added, and the mixture was stirred at 60°C for 17 hrs. After concentration under reduced pressure, ethyl acetate (100
mL) and water (50 mL) were added to the residue, and the mixture was stirred. The ethyl acetate layer was separated and taken, and the aqueous layer was extracted with ethyl acetate (20 mL). Ethyl acetate layers were combined, washed with saturated brine (30 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by silica gel column chromatography (eluted with ethyl acetate:hexane=1:1, then 2:1), and by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:1). Crystallization from acetone-diisopropyl ether and recrystallization from ethyl acetate-hexane gave the title compound (1.37 g) as a colorless solid.

$^1$H-NMR (CDCl$_3$): 2.21 (3H, s), 3.11 (3H, bs), 3.82-4.08 (2H, bm), 4.38 (2H, q, J=7.8 Hz), 4.60-5.14 (4H, bm), 6.63 (1H, d, J=5.7 Hz), 7.20 (1H, m), 7.33-7.41 (3H, m), 7.78-7.92 (3H, m), 8.33 (1H, d, J=5.7 Hz).

**Example 9**

![Chemical Structure](image)

2-{Methyl[[(R)-2-[[[3-methyl-4-[(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino}ethyl 4-trifluoromethoxybenzoate

To a solution (20 mL) of bis(trichloromethyl)carbonate
(0.582 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.49 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., 2-(methylamino)ethyl 4-trifluoromethoxybenzoate hydrochloride (1.79 g) obtained in Reference Example 9 was added. A solution (1 mL) of triethylamine (0.84 mL) in tetrahydrofuran was added and the mixture was stirred at room temperature for 1.5 hrs. After concentration under reduced pressure, ethyl acetate (80 mL) and water (50 mL) were added to the residue and the mixture was stirred. The ethyl acetate layer was separated and taken, washed with saturated brine (30 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in tetrahydrofuran (25 mL). (R)-2-[[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.57 g), triethylamine (1.18 mL) and 4-dimethylaminopyridine (0.052 g) were added, and the mixture was stirred at 60°C for 4.5 hrs. After concentration under reduced pressure, ethyl acetate (100 mL) and water (50 mL) were added to the residue, and the mixture was stirred. The ethyl acetate layer was separated and taken, and the aqueous layer was extracted with ethyl acetate (30 mL). The ethyl acetate layers were combined, washed with saturated brine (30 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by silica gel column chromatography (eluted with ethyl acetate:hexane=1:1), and further by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:1) to give the title compound (1.44 g) as colorless syrup.

$^1$H-NMR (CDCl$_3$): 2.22 (3H, s), 3.11 (3H, bs), 3.85-4.05 (2H, bm), 4.38 (2H, q, $J=7.8$ Hz), 4.60-5.12 (4H, bm), 6.64 (1H, d, $J=5.7$ Hz), 7.24 (2H, d, $J=8.7$ Hz), 7.25-7.40 (3H, m), 7.82 (1H, d, $J=7.2$ Hz), 8.09 (2H, d, $J=8.7$ Hz), 8.33 (1H, d, $J=5.7$ Hz).
Example 10

2-[[R]-2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]ethyl 4-fluorobenzoate

To a solution (20 mL) of bis(trichloromethyl)carbonate (0.582 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.49 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., 2-[(methylamino)ethyl 4-fluorobenzoate hydrochloride (1.40 g) obtained in Reference Example 10 was added. A solution (1 mL) of triethylamine (0.84 mL) in tetrahydrofuran was added and the mixture was stirred at room temperature for 2 hrs. After concentration under reduced pressure, ethyl acetate (80 mL) and water (40 mL) were added to the residue and the mixture was stirred. The ethyl acetate layer was separated and taken, washed with saturated brine (30 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.32 g), triethylamine (1.00 mL) and 4-dimethylaminopyridine (0.049 g) were added, and the mixture was stirred at 60°C for 14.5 hrs.
After concentration under reduced pressure, ethyl acetate (150 mL) and water (50 mL) were added to the residue, and the mixture was stirred. The ethyl acetate layer was separated and taken, washed with saturated brine (30 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was crystallized from ethyl acetate:hexane=1:1 and collected by filtration. Recrystallization from acetone gave the title compound (1.39 g) as a colorless solid.

$^1$H-NMR (CDCl$_3$): 2.22 (3H, s), 3.12 (3H, bs), 3.78-4.20 (2H, bm), 4.38 (2H, q, J=7.8 Hz), 4.58-5.08 (4H, bm), 6.65 (1H, d, J=5.6 Hz), 7.11 (2H, t, J=8.4 Hz), 7.28-7.44 (3H, m), 7.81-7.86 (1H, m), 8.03-8.11 (2H, m), 8.35 (1H, d, J=5.6 Hz).

**Example 11**

![Chemical Structure](image)


To a solution (30 mL) of bis(trichloromethyl)carbonate (0.60 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.49 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 10 min., 2-
(methylamino)ethyl 3,4,5-triethoxybenzoate hydrochloride (1.22 g) obtained in Reference Example 11 was added. A solution (1 mL) of triethylamine (0.84 mL) in tetrahydrofuran was dropwise added and the mixture was stirred at room temperature for 1 hr. After concentration under reduced pressure, water (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with dilute hydrochloric acid (20 mL) and saturated brine (50 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.11 g), triethylamine (0.84 mL) and 4-dimethylaminopyridine (0.037 g) were added, and the mixture was stirred at 60°C for 3 hrs. and at room temperature for 2 days. After concentration under reduced pressure, water (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by flash silica gel column chromatography (eluted with acetone:hexane=1:3, then 3:2) to give the title compound (1.56 g) as a yellow amorphous solid.

1H-NMR (CDCl₃): 2.21 (3H, s), 3.12 (3H, bs), 3.50–4.30 (2H, br), 3.83 (6H, s), 3.90 (3H, s), 4.38 (2H, q, J=7.8 Hz), 4.67 (2H, m), 4.80–5.15 (2H, br), 6.64 (1H, d, J=5.7 Hz), 7.25–7.40 (5H, m), 7.78–7.86 (1H, m), 8.33 (1H, d, J=5.7 Hz).

Example 12
2-Methyl[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole-1-yl]carbonylamino]ethyl 2-pyridinecarboxylate

To a solution (30 mL) of bis(trichloromethyl)carbonate (0.422 g) in tetrahydrofuran was dropwise added pyridine (0.345 mL) under ice-cooling. After stirring under ice-cooling for 30 min., 2-(methylamino)ethyl 2-pyridinecarboxylate dihydrochloride (1.08 g) obtained in Reference Example 12 was added. After dropwise addition of triethylamine (1.19 mL), the mixture was stirred at room temperature for 2 hrs. The precipitated solid was filtered off and the filtrate was concentrated under reduced pressure. The residue was dissolved in tetrahydrofuran (10 mL), and (R)-2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.31 g), triethylamine (0.99 mL) and 4-dimethylaminopyridine (0.043 g) were added. The mixture was stirred at 60°C for 24 hrs. Ethyl acetate (100 mL) was added to the reaction mixture, and the mixture was washed with water (100 mL) and saturated brine (100 mL), dried over anhydrous sodium sulfate, and concentrated under reduced pressure. The residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=4:1). Crystallization from acetone-diethyl ether gave the title compound (0.9 g) as a white solid.
$^1$H-NMR (CDCl$_3$): 2.22 (3H, s), 3.16 (3H, s), 3.80-4.20 (2H, m),
4.38 (2H, q, J=7.8 Hz), 4.60-5.10 (4H, m), 6.64 (1H, d, J=5.8 Hz), 7.29-
7.40 (2H, m), 7.47-7.52 (2H, m), 7.81-7.89 (2H, m),
8.14 (1H, d, J=7.8 Hz), 8.34 (1H, d, J=5.8 Hz), 8.75-8.79 (1H, m).

Example 13

\[
\text{\begin{center}
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\end{center}}
\]

2-[Methyl[[(\text{R})-2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-\text{pyridyl}]methyl]sulfinyl]-1H-benzimidazol-1-\text{yl} carbonyl]amino]ethyl methoxyacetate

To a solution (15 mL) of bis(trichloromethyl)carbonate (0.652 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.55 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., 2-(methylamino)ethyl methoxyacetate (0.99 g) obtained in

Reference Example 13 was added. The mixture was stirred at room temperature for 3 hrs. After concentration under reduced pressure, ethyl acetate (80 mL) and water (50 mL) were added to the residue and the mixture was stirred. The ethyl acetate layer was separated and taken, washed with saturated brine (30 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in tetrahydrofuran (15 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.13 g), triethylamine (0.86 mL) and 4-
dimethylaminopyridine (0.037 g) were added, and the mixture was stirred at 60°C for 4 days. After concentration under reduced pressure, ethyl acetate (80 mL) and water (30 mL) were added to the residue, and the mixture was stirred. The ethyl acetate layer was separated and taken, and the ethyl acetate layer was washed with a saturated aqueous sodium hydrogen carbonate solution (30 mL) and water (30 mL), and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by silica gel column chromatography (eluted with ethyl acetate, then acetone:ethyl acetate=1:3), and further by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:1, then 3:1) to give the title compound (0.588 g) as colorless syrup.

\(^{1}\text{H-NMR (CDCl}_3\): 2.32 (3H, s), 2.68 (3H, s), 3.48 (3H, s), 3.69-4.02 (4H, m), 4.38 (2H, q, J=7.8 Hz), 4.67 (2H, t, J=6.6 Hz), 4.99 (1H, d, J=13.9 Hz), 5.12 (1H, d, J=13.9 Hz), 6.63 (1H, d, J=5.7 Hz), 7.29-7.46 (2H, m), 7.62 (1H, m), 7.81 (1H, m), 8.25 (1H, d, J=5.7 Hz).

**Example 14**

![Chemical Structure](image)


To a solution (40 mL) of bis(trichloromethyl)carbonate (1.31 g) in tetrahydrofuran was dropwise added a solution (2
mL) of pyridine (1.07 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 10 min., ethyl 2-(methylamino)ethyl carbonate hydrochloride (2.02 g) obtained in Reference Example 14 was added. A solution (2 mL) of triethylamine (1.84 mL) in tetrahydrofuran was dropwise added and the mixture was stirred at room temperature for 1 hr. After concentration under reduced pressure, water (100 mL) was added to the residue, and the mixture was extracted with ethyl acetate (100 mL). The ethyl acetate layer was washed with 0.2N hydrochloric acid (50 mL) and saturated brine (100 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in tetrahydrofuran (50 mL). (R)-2-[[[[3-Methyl-4-(2,2,2-trifluorooethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (3.69 g), triethylamine (2.09 mL) and 4-dimethylaminopyridine (0.12 g) were added, and the mixture was stirred at 60°C for 6 hrs. and at room temperature for 8 hrs. After concentration under reduced pressure, water (100 mL) was added to the residue, and the mixture was extracted with ethyl acetate (100 mL). The ethyl acetate layer was washed with saturated brine (100 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=3:7, then ethyl acetate). Crystallization from diethyl ether and recrystallization from diethyl ether gave the title compound (3.84 g) as a colorless solid.

\(^1\)H-NMR (CDCl\(_3\)): 1.32 (3H, t, J=7.2 Hz), 2.23 (3H, s), 3.10 (3H, bs), 3.50-4.20 (2H, br), 4.22 (2H, q, J=7.2 Hz), 4.39 (2H, q, J=7.9 Hz), 4.45 (2H, m), 4.80-5.15 (2H, br), 6.65 (1H, d, J=5.6 Hz), 7.36-7.50 (3H, m), 7.84 (1H, d, J=7.8 Hz), 8.35 (1H, d, J=5.6 Hz).

Example 15

To a solution (30 mL) of bis(trichloromethyl)carbonate (0.50 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.40 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 1 hr., isopropyl 2-(methylamino)ethyl carbonate hydrochloride (0.99 g) obtained in Reference Example 15 was added. A solution (1 mL) of triethylamine (0.70 mL) in tetrahydrofuran was dropwise added and the mixture was stirred at room temperature for 1 hr. Bis(trichloromethyl)carbonate (0.50 g), a solution (1 mL) of pyridine (0.40 mL) in tetrahydrofuran and a solution (1 mL) of triethylamine (0.70 mL) in tetrahydrofuran were successively added and the mixture was stirred at room temperature for 1 hr. After concentration under reduced pressure, water (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.11 g),
triethylamine (0.84 mL) and 4-dimethylaminopyridine (0.037 g) were added, and the mixture was stirred at 60°C for 12 hrs. and at room temperature for 3 days. After concentration under reduced pressure, water (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by flash silica gel column chromatography (eluted with acetone:hexane=1:3, then 3:2), and further by basic silica gel column chromatography (eluted with ethyl acetate:hexane=3:7, then ethyl acetate). Crystallization from diethyl ether and recrystallization from acetone-diisopropyl ether gave the title compound (0.58 g) as a colorless solid.

\[ ^1H-\text{NMR}(\text{CDCl}_3): 1.31(6\text{H}, d, J=6.3\text{Hz}), 2.23(3\text{H}, s), 3.08(3\text{H}, bs), 3.40-4.30(2\text{H}, br), 4.37(2\text{H}, q, J=7.9\text{Hz}), 4.32-4.53(2\text{H}, m), 4.80-5.20(3\text{H}, m), 6.63(1\text{H}, d, J=5.7\text{Hz}), 7.35-7.50(3\text{H}, m), 7.83(1\text{H}, d, J=7.2\text{Hz}), 8.34(1\text{H}, d, J=5.7\text{Hz}). \]

**Example 16**

![Chemical Structure](image)


To a solution (20 mL) of bis(trichloromethyl)carbonate (0.582 g) in tetrahydrofuran was dropwise added a solution (1
mL) of pyridine (0.49 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., isopropyl 2-((methylamino)ethyl carbonate hydrochloride (1.18 g) obtained in Reference Example 15 was added. A solution (1 mL) of triethylamine (0.84 mL) in tetrahydrofuran was added and the mixture was stirred at room temperature for 2 hrs. After concentration under reduced pressure, ethyl acetate (80 mL) and water (30 mL) were added to the residue, and the mixture was stirred. The ethyl acetate layer was separated and taken, washed with saturated brine (30 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in tetrahydrofuran (25 mL). 2-[(3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl)methyl]sulfinyl]-1H-benzimidazole (1.73 g), triethylamine (1.31 mL) and 4-dimethylaminopyridine (0.057 g) were added, and the mixture was stirred at 60°C for 5 hrs. After concentration under reduced pressure, ethyl acetate (100 mL) and water (50 mL) were added to the residue, and the mixture was stirred. The ethyl acetate layer was separated and taken, washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:1), and further by silica gel column chromatography (eluted with ethyl acetate:hexane=1:1, then 2:1). Crystallization from diisopropyl ether-hexane and recrystallization from diisopropyl ether gave the title compound (1.20 g) as a colorless solid.

$^{1}$H-NMR (CDCl₃): 1.31 (6H, d, J=6.6 Hz), 2.23 (3H, s), 3.08 (3H, bs), 3.50–3.90 (2H, bm), 4.38 (2H, q, J=7.8 Hz), 4.36–4.58 (2H, bm), 4.79–5.15 (3H, m), 6.64 (1H, d, J=5.7 Hz), 7.35–7.48 (3H, m), 7.83 (1H, d, J=7.5 Hz), 8.34 (1H, d, J=5.7 Hz).

Example 17

To a solution (30 mL) of bis(trichloromethyl)carbonate (0.50 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.40 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 1 hr., benzyl 2-(methylamino)ethyl carbonate hydrochloride (1.08 g) obtained in Reference Example 16 was added. A solution (1 mL) of triethylamine (0.70 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred overnight at room temperature. After concentration under reduced pressure, water (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.11 g), triethylamine (0.84 mL) and 4-dimethylaminopyridine (0.037 g) were added, and the mixture was stirred overnight at 60°C.
After concentration under reduced pressure, water (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by flash silica gel column chromatography (eluted with acetone:hexane=1:3, then 3:2). Crystallization from acetone-diethyl ether and recrystallization from acetone-diethyl ether gave the title compound (1.17 g) as a colorless solid.

\[ ^1H-NMR (CDCl_3): 2.22 (3H, s), 3.05 (3H, bs), 3.50-4.20 (2H, br), 4.37 (2H, q, J=7.8 Hz), 4.46 (2H, m), 4.80-5.10 (2H, br), 5.17 (2H, s), 6.62 (1H, d, J=5.6 Hz), 7.26-7.48 (8H, m), 7.77-7.88 (1H, m), 8.33 (1H, d, J=5.6 Hz). \]

**Example 18**


To a solution (20 mL) of bis(trichloromethyl)carbonate (0.48 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.39 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 20 min., 2-
(methylamino)ethyl tetrahydropyran-4-yl carbonate hydrochloride (0.96 g) obtained in Reference Example 17 was added. A solution (1 mL) of triethylamine (0.67 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 2 hrs. After concentration under reduced pressure, water (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with 0.2N hydrochloric acid (20 mL) and saturated brine (50 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.26 g), triethylamine (0.71 mL) and 4-dimethylaminopyridine (0.042 g) were added, and the mixture was stirred at 60°C for 6 hrs. and at room temperature for 8 hrs. After concentration under reduced pressure, water (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=3:7, then ethyl acetate). Crystallization from diethyl ether and recrystallization from acetone-diisopropyl ether gave the title compound (1.45 g) as a colorless solid. 

$^1$H-NMR(CDCl$_3$): 1.64-1.81 (2H, m), 1.92-2.03 (2H, m), 2.23 (3H, s), 3.09 (3H, bs), 3.40-4.30 (2H, br), 3.45-3.57 (2H, m), 3.87-3.97 (2H, m), 4.38 (2H, q, $J$=7.8Hz), 4.45 (2H, m), 4.77-5.15 (3H, m), 6.64 (1H, d, $J$=5.7Hz), 7.35-7.50 (3H, m), 7.83 (1H, d, $J$=6.9Hz), 8.35 (1H, d, $J$=5.7Hz).

Example 19

To a solution (20 mL) of bis(trichloromethyl)carbonate (0.59 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.49 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 10 min., 2-methoxyethyl 2-(methylamino)ethyl carbonate hydrochloride (1.07 g) obtained in Reference Example 18 was added. A solution (1 mL) of triethylamine (0.84 mL) in tetrahydrofuran was dropwise added and the mixture was stirred at room temperature for 1 hr. After concentration under reduced pressure, water (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with 0.2N hydrochloric acid (20 mL) and saturated brine (50 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.85 g), triethylamine (1.05 mL) and 4-dimethylaminopyridine (0.061 g)
were added, and the mixture was stirred at 60°C for 6 hrs. and at room temperature for 8 hrs. After concentration under reduced pressure, water (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=3:7, then ethyl acetate). Crystallization from ethyl acetate-diethyl ether and recrystallization from ethyl acetate-diisopropyl ether gave the title compound (1.39 g) as a colorless solid.

1H-NMR(CDCl3): 2.23(3H,s), 3.09(3H,bs), 3.37(3H,s), 3.50–4.20(2H,br), 3.59–3.65(2H,m), 4.28–4.33(2H,m), 4.38(2H,q,J=7.8Hz), 4.46(2H,m), 4.80–5.15(2H,br), 6.64(1H,d,J=5.7Hz), 7.35–7.47(3H,m), 7.83(1H,d,J=7.8Hz), 8.34(1H,d,J=5.7Hz).

Example 20

![Molecule Structure]


To a solution (30 mL) of bis(trichloromethyl)carbonate (0.59 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.49 mL) in tetrahydrofuran under ice-
cooling. After stirring under ice-cooling for 10 min., 2- (ethylamino)ethyl acetate hydrochloride (0.67 g) obtained in Reference Example 20 was added. A solution (1 mL) of triethylamine (0.84 mL) in tetrahydrofuran was dropwise added and the mixture was stirred at room temperature for 1 hr. After concentration under reduced pressure, water (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl)methyl]sulfinyl]-1H-benimidazole (1.11 g), triethylamine (0.84 mL) and 4-dimethylaminopyridine (0.037 g) were added, and the mixture was stirred overnight at 60°C. After concentration under reduced pressure, water (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=3:7, then ethyl acetate) to give the title compound (1.58 g) as a yellow amorphous solid.

$^1$H-NMR (CDCl$_3$): 1.25 (3H, m), 2.08 (3H, s), 2.23 (3H, s), 3.30–4.10 (4H, br), 4.23–4.45 (2H, m), 4.38 (2H, q, J=7.8 Hz), 4.75–5.20 (2H, br), 6.64 (1H, d, J=5.7 Hz), 7.35–7.46 (3H, m), 7.84 (1H, d, J=6.9 Hz), 8.36 (1H, d, J=5.7 Hz).

Example 21

To a solution (10 mL) of bis(trichloromethyl)carbonate (0.543 g) in tetrahydrofuran was dropwise added a solution (5 mL) of pyridine (0.445 mL) in tetrahydrofuran under ice-cooling, and the mixture was stirred at 0°C for 30 min. 2-(Isopropylamino)ethyl acetate hydrochloride (1.0 g) obtained in Reference Example 22 was added. A solution (5 mL) of triethylamine (0.805 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 30 min. The reaction mixture was concentrated under reduced pressure, water (30 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (30 mL), dried over anhydrous sodium sulfate, and concentrated under reduced pressure. The obtained oil was dissolved in tetrahydrofuran (5 mL), and added to a solution (20 mL) of (R)-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.73 g), triethylamine (1.53 mL) and 4-dimethylaminopyridine (0.134 g) in tetrahydrofuran. The mixture was stirred at 40°C for 12 hrs. The reaction mixture was concentrated under reduced pressure and water (30 mL) was added to the residue. The mixture was extracted with ethyl
acetate (50 mL). The ethyl acetate layer was washed with saturated brine (30 mL), dried over anhydrous sodium sulfate, and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (eluted with ethyl acetate:hexane=2:1, then ethyl acetate) to give the title compound (1.50 g) as a pale-yellow amorphous solid.

$^1$H-NMR(CDCl$_3$): 1.20-1.40 (6H, m), 2.05 (3H×0.4, s), 2.11 (3H×0.6, s), 2.18 (3H×0.6, s), 2.27 (3H×0.4, s), 3.40-3.60 (1H, m), 3.70-4.60 (6H, m), 4.70-5.25 (2H, m), 6.65 (1H, d, J=5.8Hz), 7.30-7.50 (3H, m), 7.75-7.90 (1H, m), 8.37 (1H, d, J=5.8Hz).

**Example 22**

![Chemical Structure]


To a solution (10 mL) of bis(trichloromethyl)carbonate (0.467 g) in tetrahydrofuran was dropwise added a solution (5 mL) of pyridine (0.381 mL) in tetrahydrofuran under ice-cooling, and the mixture was stirred at 0°C for 30 min. Ethyl 2-(isopropylamino)ethyl carbonate hydrochloride (1.0 g) obtained in Reference Example 23 was added to the reaction mixture. A solution (5 mL) of triethylamine (0.69 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at 0°C for 15 min. and at room temperature for 30 min.
The reaction mixture was concentrated under reduced pressure and water (30 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (30 mL), dried over anhydrous sodium sulfate, and concentrated under reduced pressure. The obtained oil was dissolved in tetrahydrofuran (5 mL), and added to a solution (20 mL) of \( \text{R}-2\-[[\text{3-methyl-4-}(2,2,2\text{-trifluoroethoxy)}\-2\text{-pyridyl}]\text{methyl}sulfinyl]-1\text{-H-benzimidazole} \) (1.48 g), triethylamine (1.32 mL) and 4-dimethylaminopyridine (0.115 g) in tetrahydrofuran, and the mixture was stirred at 40°C for 12 hrs. The reaction mixture was concentrated under reduced pressure and water (30 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (30 mL), dried over anhydrous sodium sulfate, and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (eluted with ethyl acetate:hexane=2:1, then ethyl acetate) to give the title compound (1.20 g) as a pale-yellow amorphous solid.

\(^{1}H\text{-NMR(CDCl}_{3}\): 1.20–1.40 (9H, m), 2.17 (3H×0.6, s), 2.27 (3H×0.4, s), 3.40–3.70 (1H, m), 3.75–4.65 (8H, m), 4.70–5.30 (2H, m), 6.64 (1H, d, \( J=5.8\text{Hz} \)), 7.35–7.55 (3H, m), 7.75–7.90 (1H, m), 8.38 (1H, d, \( J=5.8\text{Hz} \)).

Example 23

![Diagram of chemical structure]

To a solution (10 mL) of bis(trichloromethyl)carbonate (0.593 g) in tetrahydrofuran was dropwise added pyridine (0.485 mL) under ice-cooling. After stirring under ice-cooling for 30 min., 2-(cyclohexylamino)ethyl acetate hydrochloride (1.33 g) obtained in Reference Example 25 was added. Triethylamine (0.84 mL) was dropwise added, and the mixture was stirred at room temperature for 2 hrs. Ethyl acetate (50 mL) was added to the reaction mixture and the mixture was washed with water (50 mL) and saturated brine (50 mL), dried over anhydrous magnesium sulfate and concentrated under reduced pressure. The residue was dissolved in tetrahydrofuran (20 mL), and (R)-2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.61 g), triethylamine (1.21 mL) and 4-dimethylaminopyridine (0.053 g) were added. The mixture was stirred at 60°C for 24 hrs. Ethyl acetate (50 mL) was added to the reaction mixture, and the mixture was washed with water (20 mL) and saturated brine (50 mL), dried over anhydrous sodium sulfate, and concentrated under reduced pressure. The residue was purified by flash silica gel column chromatography (eluted with ethyl acetate:hexane=1:4, then ethyl acetate) to give the title compound (2.12 g) as a pale-yellow amorphous solid.

$^{1}$H-NMR (CDCl$_3$): 1.00-2.42 (16H, m), 3.30-3.70 (2H, m), 3.80-4.00 (1H, m), 4.27-4.42 (2H, m), 4.40 (2H, q, $J$=8.2Hz), 4.78 (1H×0.5, d, $J$=13.2Hz), 4.97 (2H×0.5, s), 5.20 (1H×0.5, d, $J$=13.2Hz), 6.67 (1H, d, $J$=5.8Hz), 7.36-7.46 (3H, m), 7.81-7.91 (1H, m), 8.39 (1H, d, $J$=5.8Hz).

Example 24

To a solution (10 mL) of bis(trichloromethyl)carbonate (0.238 g) in tetrahydrofuran was dropwise added pyridine (0.20 mL) under ice-cooling. After stirring under ice-cooling for 30 min., 2-(cyclohexylamino)ethyl ethyl carbonate hydrochloride (0.605 g) obtained in Reference Example 26 was added. Triethylamine (0.335 mL) was dropwise added, and the mixture was stirred at room temperature for 2 hrs. Ethyl acetate (50 mL) was added to the reaction mixture, and the mixture was washed with water (50 mL) and saturated brine (50 mL), dried over anhydrous magnesium sulfate and concentrated under reduced pressure. The residue was dissolved in tetrahydrofuran (10 mL), and (R)-2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (0.60 g), triethylamine (0.45 mL) and 4-dimethylaminopyridine (0.02 g) were added. The mixture was stirred at 60°C for 24 hrs. Ethyl acetate (50 mL) was added to the reaction mixture, and the mixture was washed with water (20 mL) and saturated brine (50 mL), dried over anhydrous sodium sulfate, and concentrated under reduced pressure. The residue was purified by flash silica gel column chromatography (eluted with ethyl
acetate: hexane=1:4, then ethyl acetate) to give the title compound (0.92 g) as a pale-yellow amorphous solid.

$^1$H-NMR (CDCl$_3$): 1.02-2.27 (16H, m), 3.40-4.60 (9H, m), 4.78 (1H×0.5, d, J=13.2 Hz), 4.97 (2H×0.5, s), 5.44 (1H×0.5, d, J=13.2 Hz), 6.69 (1H, d, J=5.6 Hz), 7.32-7.54 (3H, m), 7.80-7.91 (1H, m), 8.38 (1H, d, J= 5.6 Hz).

**Example 25**

![Chemical Structure](image)

2-[[[(R)-2-[[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl](phenyl)amino]ethyl acetate

To a solution (350 mL) of bis(trichloromethyl)carbonate (13.4 g) in tetrahydrofuran was dropwise added pyridine (10.38 mL) under ice-cooling. After stirring under ice-cooling for 30 min., 2-anilinoethyl acetate hydrochloride (25.9 g) obtained in Reference Example 27 was added. Triethylamine (18.4 mL) was dropwise added, and the mixture was stirred at room temperature for 2 hrs. After concentration under reduced pressure, ethyl acetate (500 mL) and water (500 mL) were added to the residue, and the mixture was stirred. The ethyl acetate layer was separated and taken, washed with saturated brine (500 mL), dried over anhydrous magnesium sulfate and concentrated under reduced pressure to give 2-[(chlorocarbonyl) (phenyl)amino]ethyl acetate. This was dissolved in tetrahydrofuran (300 mL), (R)-2-[[3-methyl-4-
(2,2,2-trifluoroethoxy)-2-pyridyl[methyl]sulfinyl]-1H-benzimidazole (41.2 g), triethylamine (15.6 mL) and 4-dimethylaminopyridine (1.363 g) were added, and the mixture was stirred at 60°C for 3 hrs. Ethyl acetate (800 mL) was added to the reaction mixture, and the mixture was washed twice with water (800 mL) and with saturated brine (800 mL), dried over anhydrous sodium sulfate, and concentrated under reduced pressure. The residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=3:7, then 1:1). Crystallization from diethyl ether gave the title compound (54.1 g) as a white solid.

$^1$H-NMR(CDC$_3$): 2.00 (3H, s), 2.25 (3H, s), 4.15-4.48 (6H, m), 4.83 (1H, d, J=13.6 Hz), 5.05 (1H, d, J=13.6 Hz), 6.67 (1H, d, J=5.4 Hz), 7.03-7.45 (8H, m), 7.64-7.69 (1H, m), 8.40 (1H, d, J=5.4 Hz).

**Example 26**

![Chemical structure](image)

2-[[2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl](phenyl)amino]ethyl acetate

To a solution (10 mL) of 2-[(chlorocarbonyl) (phenyl)amino]ethyl acetate (0.58 g) prepared in the same manner as in Example 25 in tetrahydrofuran were added 2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (0.739 g), triethylamine (0.558 mL) and 4-dimethylaminopyridine (0.024
g), and the mixture was stirred at 60°C for 15 hrs. Ethyl acetate (30 mL) was added to the reaction mixture, and the mixture was washed with water (50 mL) and saturated brine (50 mL), dried over anhydrous sodium sulfate, and concentrated under reduced pressure. The residue was purified by flash silica gel column chromatography (eluted with acetone:hexane=1:4, then 3:2). Crystallization from diethyl ether gave the title compound (0.779 g) as a white solid.

$^1$H-NMR (CDCl$_3$): 1.99 (3H, s), 2.25 (3H, s), 4.20–4.48 (6H, m), 4.83 (1H, d, $J$=13.6Hz), 5.05 (1H, d, $J$=13.6Hz), 6.67 (1H, d, $J$=5.8Hz), 7.03–7.45 (8H, m), 7.64–7.69 (1H, m), 8.40 (1H, d, $J$=5.8Hz).

**Example 27**

![Chemical Structure](image)


To a solution (20 mL) of bis(trichloromethyl)carbonate (0.30 g) in tetrahydrofuran was dropwise added pyridine (0.24 mL) under ice-cooling. After stirring under ice-cooling for 30 min., tert-butyl [2-(methylamino)-3-pyridyl]methyl carbonate (0.71 g) obtained in Reference Example 28 was added, and the mixture was stirred at room temperature for 2 hrs. The precipitated solid was filtered off and the filtrate was concentrated under reduced pressure. The residue was dissolved in tetrahydrofuran (20 mL), (R)-2-[[[3-methyl-4-(2,2,2-
trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (0.92 g), triethylamine (0.70 mL) and 4-dimethylaminopyridine (0.031 g) were added, and the mixture was stirred at 60°C for 1 hr. Water (50 mL) was added to the reaction mixture and the mixture was extracted twice with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL), dried over anhydrous sodium sulfate, and concentrated under reduced pressure. The residue was purified by flash silica gel column chromatography (eluted with acetone:hexane=1:2), and further by basic silica gel column chromatography (eluted with ethyl acetate) to give the title compound (0.38 g) as a pale-yellow amorphous solid.

1H-NMR (CDCl₃): 1.46 (9H, s), 2.25 (3H, s), 3.54 (3H, s), 4.37 (2H, q, J=8.0 Hz), 4.95 (2H, s), 5.15 (1H, d, J=14.0 Hz), 5.27 (1H, d, J=14.0 Hz), 6.63 (1H, d, J=5.4 Hz), 7.26-7.45 (3H, m), 7.69-7.87 (3H, m), 8.33 (1H, d, J=5.4 Hz), 8.44-8.46 (1H, m).

Example 28

![Chemical Structure]


To a solution (30 mL) of bis(trichloromethyl)carbonate (1.46 g) in tetrahydrofuran was dropwise added pyridine (1.16 mL) under ice-cooling. After stirring under ice-cooling for 30 min., 2-(methylamino)benzyl acetate (2.57 g) obtained in Reference Example 29 was added. The mixture was stirred at
room temperature for 3 hrs. The precipitated solid was filtered off and the filtrate was concentrated under reduced pressure. The residue was dissolved in tetrahydrofuran (40 mL), (R)-2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (4.41 g), triethylamine (3.33 mL) and 4-dimethylaminopyridine (0.15 g) were added, and the mixture was stirred at 60°C for 18 hrs. Water (100 mL) was added to the reaction mixture, and the mixture was extracted with ethyl acetate (100 mL). The ethyl acetate layer was washed with saturated brine (100 mL), dried over anhydrous sodium sulfate, and concentrated under reduced pressure. The residue was purified by flash silica gel column chromatography (eluted with acetone:hexane=1:4, then 1:2). Crystallization from ethyl acetate-diethyl ether-hexane gave the title compound (2.76 g) as a white solid.

$^1$H-NMR (CDCl$_3$): 2.10 (3H, s), 2.00–2.30 (3H, br), 3.20–3.50 (3H, br), 4.38 (2H, q, J=7.6 Hz), 4.70–5.20 (2H, m), 5.20–5.50 (2H, m), 6.65 (1H, d, J=5.4 Hz), 7.10–7.82 (8H, m), 8.38 (1H, d, J=5.4 Hz).

**Example 29**

![Chemical Structure](image)


To a solution (30 mL) of bis(trichloromethyl)carbonate (0.50 g) in tetrahydrofuran was dropwise added a solution (1
mL) of pyridine (0.40 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 10 min., 2-[(2-acetyloxyethyl)amino]ethyl acetate hydrochloride (1.13 g) obtained in Reference Example 30 was added. A solution (1 mL) of triethylamine (0.70 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 2 hrs. The precipitated solid was filtered off and the filtrate was concentrated under reduced pressure. Ethyl acetate (20 mL) was added to the residue, the precipitated solid was filtered off and the filtrate was concentrated under reduced pressure. The residue was dissolved in tetrahydrofuran (30 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfanyl]-1H-benzimidazole (1.48 g), triethylamine (1.12 mL) and 4-dimethylaminopyridine (catalytic amount) were added, and the mixture was stirred at 60°C overnight. After concentration under reduced pressure, water (50 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by silica gel column chromatography (eluted with ethyl acetate:hexane=1:1, then ethyl acetate), and further by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:1, then ethyl acetate). The resulting product was dissolved in ethyl acetate (20 mL), activated carbon was added and the mixture was stirred overnight. The activated carbon was filtered off and the filtrate was concentrated under reduced pressure to give the title compound (1.60 g) as a yellow amorphous solid.

$^1$H-NMR (CDCl$_3$): 2.06 (3H, s), 2.08 (3H, s), 2.24 (3H, s), 3.40-4.45 (8H, m), 4.39 (2H, q, J=7.9 Hz), 4.88 (1H, d, J=13.2 Hz), 5.05 (1H, d, J=13.2 Hz), 6.66 (1H, d, J=5.6 Hz), 7.38-7.50 (3H, m), 7.87 (1H, d, J=6.9 Hz), 8.36 (1H, d, J=5.6 Hz).
Example 30

\[
(2S)-1-\left[(R)-2-\left[\left[3\text{-Methyl}\right]-4\text{-}(2,2,2\text{-trifluoroethoxy})-2\text{-}
pyridyl\right]\text{methyl}\right]\text{sulfinyl}\right]-1H\text{-benzimidazol-1-y1}\right]\text{carbonyl}\right]-2-
pyrrolidinyl\right]\text{methyl acetate}
\]

To a solution (30 mL) of bis(trichloromethyl)carbonate (0.50 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.40 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 1 hr., (S)-2-pyrrolidinylmethyl acetate hydrochloride (0.90 g) obtained in Reference Example 31 was added. A solution (1 mL) of triethylamine (0.70 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 2 hrs. After concentration under reduced pressure, water (50 mL) was added to the residue, and the mixture was extracted with ethyl acetate (50 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-\left[\left[3\text{-Methyl}\right]-4\text{-}(2,2,2\text{-trifluoroethoxy})-2\text{-pyridyl}\right]\text{methyl}\right]\text{sulfinyl\right]\text{-}
1H\text{-benzimidazole (1.11 g), triethylamine (0.84 mL) and 4-
dimethylaminopyridine (0.037 g) were added, and the mixture was stirred at 60\degree C for 1 day and at room temperature for 2 days. After concentration under reduced pressure, water (50 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous
magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:1, then ethyl acetate) and further by silica gel column chromatography (eluted with ethyl acetate:hexane=3:1, then ethyl acetate, then acetone:ethyl acetate=1:4, then 2:3) to give the title compound (0.80 g) as a pale-yellow amorphous solid.

$^1$H-NMR (CDCl$_3$): 1.80–2.30 (4H, m), 2.09 (3H, s), 2.30 (3H, s), 3.39 (1H, m), 3.50–3.62 (1H, m), 4.20–4.45 (4H, m), 4.58 (1H, m), 4.89 (1H, d, J=13.5Hz), 4.96 (1H, d, J=13.5Hz), 6.65 (1H, d, J=5.9Hz), 7.36–7.48 (3H, m), 7.89 (1H, d, J=8.7Hz), 8.38 (1H, d, J=5.9Hz).

**Example 31**

![Chemical Structure](attachment:image.png)


To a solution (30 mL) of bis(trichloromethyl)carbonate (0.50 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.40 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., sarcosine ethyl ester hydrochloride (0.77 g) was added. A solution (1 mL) of triethylamine (0.70 mL) in tetrahydrofuran was dropwise added and the mixture was stirred at room temperature for 1 hr. The precipitated solid was filtered off and the filtrate was concentrated under reduced pressure.

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Water (50 mL) was added to the residue, and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in tetrahydrofuran (33 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl][methyl]sulfinyl]-1H-benzimidazole sodium (1.37 g) and 4-dimethylaminopyridine (catalytic amount) were added, and the mixture was stirred at 60°C overnight. After concentration under reduced pressure, water (50 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:1, then ethyl acetate) to give the title compound (0.40 g) as a yellow amorphous solid.

$^1$H-NMR (CDCl$_3$): 1.33 (3H, t, J=7.1 Hz), 2.24 (3H, s), 3.10 (3H, bs), 3.70–4.30 (2H, br), 4.28 (2H, q, J=7.1 Hz), 4.38 (2H, q, J=7.8 Hz), 4.82–5.10 (2H, br), 6.63 (1H, d, J=5.5 Hz), 7.34–7.52 (2H, m), 7.70–7.90 (2H, m), 8.32 (1H, d, J=5.5 Hz).

**Example 32**

![Chemical Structure](image)

2-[[5-Methoxy-2-[[4-methoxy-3,5-dimethyl-2-}
pyridyl)sulfinyl]-1H-benzoimidazol-1-yl]carbonyl](methyl)amino)ethyl benzoate

To a solution (10 mL) of bis(trichloromethyl)carbonate (0.344 g) in tetrahydrofuran was dropwise added a solution (5 mL) of pyridine (0.281 mL) in tetrahydrofuran under ice-cooling, and the mixture was stirred at 0°C for 30 min. 2-(Methylamino)ethyl benzoate hydrochloride (0.750 g) obtained in Reference Example 5 was added. A solution (5 mL) of triethylamine (0.485 mL) in tetrahydrofuran was added, and the mixture was stirred at 0°C for 1 hr. and at room temperature for 30 min. The reaction mixture was concentrated under reduced pressure and water (30 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (30 mL), dried over anhydrous sodium sulfate, and concentrated under reduced pressure. The obtained oil was dissolved in tetrahydrofuran (5 mL), added to a solution (10 mL) of 5-methoxy-2-[[4-methoxy-3,5-dimethyl-2-pyridyl)methyl]sulfinyl]-1H-benzoimidazole (1.0 g), triethylamine (0.808 mL) and 4-dimethylaminopyridine (0.071 g) in tetrahydrofuran, and the mixture was stirred at 40°C for 18 hrs. The reaction mixture was concentrated under reduced pressure and water (30 mL) was added to the residue. The mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (30 mL), dried over anhydrous sodium sulfate, and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (eluted with ethyl acetate:hexane=1:1, then ethyl acetate) to give a 1:1 mixture (1.50 g) of the title compound and 2-[[6-methoxy-2-[[4-methoxy-3,5-dimethyl-2-pyridyl)methyl]sulfinyl]-1H-benzoimidazol-1-yl]carbonyl](methyl)amino)ethyl benzoate as a pale-yellow amorphous solid.
$^1$H-NMR (CDCl$_3$): 2.05-2.35 (6H, m), 3.00-3.30 (3H, br), 3.60-4.40 (8H, m), 4.60-5.10 (4H, m), 6.80-7.00 (2H, m), 7.20-7.70 (4H, m), 7.95-8.25 (3H, m).

**Example 33**

![Chemical Structure](image)


To a solution (20 mL) of bis(trichloromethyl)carbonate (0.582 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.485 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 1 hr., 3-(methylamino)propyl benzoate hydrochloride (1.38 g) obtained in Reference Example 32 was added. A solution (1 mL) of triethylamine (0.84 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 2 hrs. After concentration under reduced pressure, water (40 mL) was added to the residue, and the mixture was extracted with ethyl acetate (80 mL). The ethyl acetate layer was washed with saturated brine (25 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-
pyridyl)methyl]sulfinyl]-1H-benzimidazole (1.63 g), triethylamine (1.23 mL) and 4-dimethylaminopyridine (0.054 g) were added, and the mixture was stirred at 60°C for 4 hrs. After concentration under reduced pressure, water (40 mL) was added to the residue, and the mixture was extracted with ethyl acetate (80 mL). The ethyl acetate layer was washed with saturated brine (30 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:2, then 1:1) to give the title compound (1.26 g) as a yellow amorphous solid.

$^1$H-NMR (CDCl$_3$): 2.21 (3H, s), 2.20-2.30 (2H, bm), 3.06 (3H, bs), 3.60-3.75 (2H, bm), 4.36 (2H, q, J=7.8 Hz), 4.30-4.50 (2H, bm), 4.80-5.15 (2H, bm), 6.62 (1H, d, J=5.7 Hz), 7.26-7.44 (5H, m), 7.54 (1H, m), 7.81 (1H, m), 7.93-8.03 (2H, bm), 8.35 (1H, d, J=5.7 Hz).

**Example 34**

2-[Methyl[[2-[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]ethyl tetrahydroxypyranyl-4-yl carbonate

To a solution (20 mL) of bis(trichloromethyl)carbonate (0.582 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.485 mL) in tetrahydrofuran under ice-
cooling. After stirring under ice-cooling for 20 min., 2-(methylamino)ethyl tetrahydropyran-4-yl carbonate hydrochloride (1.43 g) obtained in Reference Example 17 was added. A solution (1 mL) of triethylamine (0.84 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 3 hrs. After concentration under reduced pressure, water (30 mL) was added to the residue, and the mixture was extracted with ethyl acetate (80 mL). The ethyl acetate layer was washed with saturated brine (20 mL), dried over anhydrous magnesium sulfate and concentrated under reduced pressure. The residue was dissolved in tetrahydrofuran (20 mL). 2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.63 g), triethylamine (1.23 mL) and 4-dimethylaminopyridine (0.027 g) were added, and the mixture was stirred at 60°C for 17.5 hrs. After concentration under reduced pressure, water (50 mL) was added to the residue, and the mixture was extracted with ethyl acetate (120 mL). The ethyl acetate layer was washed with saturated brine (30 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:2, then 1:1), then by silica gel column chromatography (eluted with ethyl acetate:hexane=1:1, then 2:1). Crystallization from diethyl ether gave the title compound (1.23 g) as a colorless solid.

$^1$H-NMR (CDCl$_3$): 1.64-1.81 (2H,m), 1.92-2.03 (2H,m), 2.23 (3H,s), 3.10 (3H,bs), 3.40-4.30 (2H,br), 3.46-3.59 (2H,m), 3.87-3.99 (2H,m), 4.39 (2H,q,J=7.9Hz), 4.45 (2H,m), 4.77-5.15 (3H,m), 6.65 (1H,d,J=5.4Hz), 7.35-7.50 (3H,m), 7.85 (1H,m), 8.36 (1H,d,J=5.4Hz).

Example 35

To a solution (20 mL) of bis(trichloromethyl)carbonate (0.582 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.485 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., ethyl 2-(methylamino)ethyl carbonate hydrochloride (1.10 g) obtained in Reference Example 14 was added. A solution (1 mL) of triethylamine (0.84 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 3 hrs. After concentration under reduced pressure, water (30 mL) was added to the residue, and the mixture was extracted with ethyl acetate (80 mL). The ethyl acetate layer was washed with saturated brine (30 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). 2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.63 g), triethylamine (1.23 mL), 4-dimethylaminopyridine (0.054 g) was added, and the mixture was stirred at 60°C for 14 hrs. After concentration under reduced pressure, water (40 mL) was added to the residue, and the mixture was extracted with ethyl acetate (100 mL). The ethyl acetate layer was washed with
saturated brine (30 mL), and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:2, then 1:1), and then by silica gel column chromatography (eluted with ethyl acetate:hexane=1:1, then 2:1) to give the title compound (1.27 g) as a yellow amorphous solid.

1H-NMR (CDCl3): 1.32 (3H, t, J=7.1 Hz), 2.23 (3H, s), 3.09 (3H, bs), 3.50–4.76 (4H, br), 4.21 (2H, q, J=7.1 Hz), 4.38 (2H, q, J=7.9 Hz), 4.84–5.14 (2H, m), 6.64 (1H, d, J=5.6 Hz), 7.36–7.46 (3H, m), 7.83 (1H, d, J=7.2 Hz), 8.34 (1H, d, J=5.6 Hz).

**Example 36**

![Chemical Structure]


To a solution (20 mL) of bis(trichloromethyl)carbonate (0.582 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.485 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 1 hr., ethyl 2-(methylamino)ethyl carbonate hydrochloride (1.10 g) obtained in Reference Example 14 was added. A solution (1 mL) of triethylamine (0.84 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 2 hrs.

After concentration under reduced pressure, water (30 mL) was
added to the residue, and the mixture was extracted with ethyl acetate (80 mL). The ethyl acetate layer was washed with saturated brine (30 mL), and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (S)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.15 g), triethylamine (0.87 mL) and 4-dimethylaminopyridine (0.035 g) were added, and the mixture was stirred at 60°C for 12 hrs.

After concentration under reduced pressure, water (30 mL) was added to the residue, and the mixture was extracted with ethyl acetate (100 mL). The ethyl acetate layer was washed with saturated brine (30 mL), and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:2, then 1:1).

Crystallization from diethyl ether gave the title compound (0.40 g) as a colorless solid.

\(^1\)H-NMR (CDCl\(_3\)): 1.32 (3H, t, J=7.2 Hz), 2.23 (3H, s), 3.10 (3H, bs), 3.50-4.56 (4H, br), 4.22 (2H, q, J=7.2 Hz), 4.38 (2H, q, J=7.9 Hz), 4.84-5.14 (2H, m), 6.65 (1H, d, J=5.6 Hz), 7.34-7.50 (3H, m), 7.85 (1H, m), 8.36 (1H, d, J=5.6 Hz).

**Example 37**

![Chemical Structure](image_url)
Ethyl 2-[[5-methoxy-2-[[4-methoxy-3,5-dimethyl-2-
pyridyl)methyl]sulfinyl]-3H-imidazo[4,5-b]pyridin-3-
yl]carbonyl[(methyl)amino]ethyl carbonate

To a solution (20 mL) of bis(trichloromethyl)carbonate
(0.582 g) in tetrahydrofuran was dropwise added a solution (1
mL) of pyridine (0.485 mL) in tetrahydrofuran under ice-
cooling. After stirring under ice-cooling for 30 min., ethyl
2-(methylamino)ethyl carbonate hydrochloride (1.10 g) obtained
in Reference Example 14 was added. A solution (1 mL) of
triethylamine (0.84 mL) in tetrahydrofuran was dropwise added,
and the mixture was stirred at room temperature for 2.5 hrs.
After concentration under reduced pressure, water (30 mL) was
added to the residue, and the mixture was extracted with ethyl
acetate (80 mL). The ethyl acetate layer was washed with
saturated brine (30 mL) and dried over anhydrous magnesium
sulfate. The layer was concentrated under reduced pressure,
and the residue was dissolved in tetrahydrofuran (20 mL). 5-
Methoxy-2-[[4-methoxy-3,5-dimethyl-2-
pyridyl)methyl]sulfinyl]-1H-imidazo[4,5-b]pyridine (1.44 g)
synthesized by the method described in JP-A-63-146882,
triethylamine (1.16 mL) and 4-dimethylaminopyridine (0.049 g)
were added, and the mixture was stirred at 60°C for 6 hrs.
After concentration under reduced pressure, water (30 mL) was
added to the residue, and the mixture was extracted with ethyl
acetate (100 mL). The ethyl acetate layer was washed with
saturated brine (30 mL) and dried over anhydrous magnesium
sulfate. After concentration under reduced pressure, the
residue was purified by basic silica gel column chromatography
(eluted with ethyl acetate:hexane=1:2, then 1:1).

Crystallization from diethyl ether gave the title compound
(0.721 g) as a colorless solid.

$^1$H-NMR (CDCl$_3$): 1.25-1.34 (3H, m), 2.23 (6H, s), 3.15, 3.32 (total
3H, s), 3.72 (3H, s), 3.90-4.53 (9H, m), 4.86 (1H, d, $J$=13.4 Hz),

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4.95 (1H, d, J=13.4 Hz), 6.79 (1H, d, J=8.7 Hz), 7.95 (1H, d, J=8.7 Hz), 8.22 (1H, s).

**Example 38**

![Chemical Structure](image)

5 2-[[[5-Methoxy-2-][(4-methoxy-3,5-dimethyl-2-pyridyl)methyl]sulfinyl]-3H-imidazo[4,5-b]pyridin-3-yl]carbonyl](methyl)amino)ethyl acetate

To a solution (20 mL) of bis(trichloromethyl)carbonate (0.582 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.485 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., 2-(methylamino)ethyl acetate hydrochloride (0.922 g) obtained in Reference Example 2 was added. A solution (1 mL) of triethylamine (0.84 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 2 hrs. After concentration under reduced pressure, water (30 mL) was added to the residue, and the mixture was extracted with ethyl acetate (80 mL). The ethyl acetate layer was washed with saturated brine (30 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in tetrahydrofuran (10 mL). 5-Methoxy-2-[[[4-methoxy-3,5-dimethyl-2-pyridyl)methyl]sulfinyl]-1H-imidazo[4,5-b]pyridine (0.85 g) synthesized by the method described in JP-A-63-146882, triethylamine (0.70 mL) and 4-dimethylaminopyridine (0.025 g) were added, and the mixture...
was stirred at 60°C for 5 hrs. After concentration under reduced pressure, water (30 mL) was added to the residue, and the mixture was extracted with ethyl acetate (90 mL). The ethyl acetate layer was washed with saturated brine (30 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:2, then 1:1). Crystallization from diethyl ether gave the title compound (0.173 g) as a colorless solid.

\[ \text{H-NMR (CDCl}_3\text{): 2.04, 2.09 (total 3H, s), 2.24 (6H, s),} \]
\[ 3.13, 3.30 (\text{total 3H, s}), 3.45-3.97 (2H, m), 3.72 (3H, s), 3.97 (3H, s), \]
\[ 4.15-4.50 (2H, m), 4.85 (1H, d, J=13.1Hz), 4.96 (1H, d, J=13.1Hz), \]
\[ 6.80 (1H, d, J=8.9Hz), 7.96 (1H, d, J=8.9Hz), 8.22 (1H, s). \]

**Example 39**

![Chemical Structure](image)

2-[[5-Methoxy-2-[[4-methoxy-3,5-dimethyl-2-pyridyl)methyl]sulfanyl]-3H-imidazo[4,5-b]pyridin-3-yl]carbonyl](phenyl)amino]ethyl acetate

To a solution (10 mL) of bis(trichloromethyl)carbonate (0.291 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.243 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., 2-anilinoethyl acetate hydrochloride (0.647 g) obtained in Reference Example 27 was added. A solution (1 mL) of triethylamine (0.419 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 3
hrs. After concentration under reduced pressure, water (20 mL) was added to the residue, and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (15 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in tetrahydrofuran (10 mL). 5-Methoxy-2-[[[(4-methoxy-3,5-dimethyl-2-pyridyl)methyl]sulfonyl]-1H-imidazo[4,5-b]pyridine (0.867 g) synthesized by the method described in JP-A-63-146882, triethylamine (0.697 mL) and 4-dimethylaminopyridine (0.020 g) was added, and the mixture was stirred at 60°C for 10 hrs. After concentration under reduced pressure, water (20 mL) was added to the residue, and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (15 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:1). Crystallization from diethyl ether gave the title compound (0.311 g) as a colorless solid.

^1H-NMR (CDCl₃): 1.96 (3H, s), 2.23 (3H, s), 2.25 (3H, s), 3.72 (3H, s), 4.01 (3H, s), 4.12-4.52 (4H, m), 4.78-5.22 (2H, m), 6.62 (1H, d, J=8.7Hz), 7.02-7.18 (3H, m), 7.32-7.48 (2H, m), 7.73 (1H, d, J=8.7Hz), 8.26 (1H, s).

**Example 40**

To a solution (20 mL) of bis(trichloromethyl)carbonate (0.59 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.49 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., 4-(methylamino)butyl acetate hydrochloride (1.08 g) obtained in Reference Example 37 was added. A solution (1 mL) of triethylamine (0.84 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 3 hrs. After concentration under reduced pressure, water (50 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfanyl]-1H-benzimidazole (1.02 g), triethylamine (0.77 mL) and 4-dimethylaminopyridine (catalytic amount) were added, and the mixture was stirred at 60°C overnight. After concentration under reduced pressure, water (50 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:2, then 1:1) to give the title compound (0.93 g) as a yellow amorphous solid.

^1H-NMR(CDCI₃): 1.65-1.85 (4H, m), 2.03 (3H, s), 2.23 (3H, s), 3.02 (3H, bs), 3.45-3.63 (2H, m), 4.03-4.13 (2H, m), 4.37 (2H, q, J=7.8Hz), 4.85-5.13 (2H, m), 6.64 (1H, d, J=5.6Hz), 7.36-
7.46 (3H, m), 7.84 (1H, d, J=8.4 Hz), 8.35 (1H, d, J=5.6 Hz).

**Example 41**

![Chemical Structure Image]


To a solution (20 mL) of bis(trichloromethyl)carbonate (0.59 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.49 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., ethyl 4-(methylamino)butyl carbonate hydrochloride (1.27 g) obtained in Reference Example 39 was added. A solution (1 mL) of triethylamine (0.84 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 3 hrs.

After concentration under reduced pressure, water (50 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.26 g), triethylamine (0.95 mL) and 4-dimethylaminopyridine (catalytic amount) were added, and the mixture was stirred at 60°C
overnight. After concentration under reduced pressure, water (50 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:2, then 1:1) to give the title compound (1.08 g) as a yellow amorphous solid.

^1^H-NMR (CDCl₃): 1.31 (3H, t, J=7.2 Hz), 1.73−1.91 (4H, m), 2.23 (3H, s), 3.01 (3H, bs), 3.50−3.62 (2H, m), 4.15−4.22 (4H, m), 4.38 (2H, q, J=7.8 Hz), 4.87−5.13 (2H, m), 6.64 (1H, d, J=5.4 Hz), 7.35−7.46 (3H, m), 7.83 (1H, d, J=7.8 Hz), 8.35 (1H, d, J=5.4 Hz).

**Example 42**

![Chemical structure](image)


To a solution (20 mL) of bis(trichloromethyl)carbonate (0.59 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.49 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., ethyl 3-(methylamino)propyl carbonate hydrochloride (1.18 g) obtained in Reference Example 44 was added. A solution (1 mL) of triethylamine (0.84 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 3
hrs. After concentration under reduced pressure, water (50 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.10 g), triethylamine (0.83 mL) and 4-dimethylaminopyridine (catalytic amount) were added, and the mixture was stirred at 60°C overnight. After concentration under reduced pressure, water (50 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:2, then 1:1) to give the title compound (0.88 g) as a yellow amorphous solid.

^H-NMR (CDCl$_3$): 1.29 (3H, t, J=7.2 Hz), 2.10-2.20 (2H, m), 2.22 (3H, s), 3.02 (3H, bs), 3.55-3.77 (2H, m), 4.14-4.30 (4H, m), 4.37 (2H, q, J=7.8 Hz), 4.83-5.13 (2H, m), 6.64 (1H, d, J=5.6 Hz), 7.35-7.46 (3H, m), 7.82 (1H, d, J=8.1 Hz), 8.35 (1H, d, J=5.6 Hz).

Example 43

To a solution (40 mL) of bis(trichloromethyl)carbonate (1.19 g) in tetrahydrofuran was dropwise added a solution (2 mL) of pyridine (0.95 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., 3-(methylamino)propyl acetate hydrochloride (1.90 g) obtained in Reference Example 42 was added. A solution (2 mL) of triethylamine (1.68 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 3 hrs. After concentration under reduced pressure, water (100 mL) was added to the residue, and the mixture was extracted with ethyl acetate (100 mL). The ethyl acetate layer was washed with saturated brine (100 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in tetrahydrofuran (40 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.99 g), triethylamine (1.50 mL) and 4-dimethylaminopyridine (catalytic amount) were added, and the mixture was stirred at 60°C overnight. After concentration under reduced pressure, water (100 mL) was added to the residue, and the mixture was extracted with ethyl acetate (100 mL). The ethyl acetate layer was washed with saturated brine (100 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:2, then 1:1) to give the title compound (1.22 g) as a yellow amorphous solid.

^H-NMR (CDCl₃): 1.97 (3H, s), 2.05-2.15 (2H, m), 2.22 (3H, s), 3.03 (3H, bs), 3.42-3.72 (2H, m), 4.10-4.22 (2H, m), 4.37 (2H, q, J=7.8 Hz), 4.85-5.13 (2H, m), 6.64 (1H, d, J=5.6 Hz), 7.24-7.44 (3H, m), 7.83 (1H, d, J=7.5 Hz), 8.35 (1H, d, J=5.6 Hz).
Example 44

\[
\begin{align*}
\text{3-}[\text{Methyl}][[(\text{R})-2-[[3\text{-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl}]	ext{methyl}]\text{sulfinyl}]-1\text{H-benzimidazol-1-yl}]\text{carbonyl}+\text{amino}]\text{propane-1,2-diyl diacetate}
\end{align*}
\]

To a solution (20 mL) of bis(trichloromethyl)carbonate (0.59 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.49 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., 3-(methylamino)propane-1,2-diyl diacetate hydrochloride (1.35 g) obtained in Reference Example 46 was added. A solution (1 mL) of triethylamine (0.84 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 3 hrs. After concentration under reduced pressure, water (50 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.27 g), triethylamine (0.96 mL) and 4-dimethylaminopyridine (catalytic amount) were added, and the mixture was stirred at 60°C overnight. After concentration under reduced pressure, water (50 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed
with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:2, then 1:1) to give the title compound (0.64 g) as a yellow amorphous solid.

$^1$H-NMR (CDCl$_3$): 2.05 (3H, s), 2.13 (3H, s), 2.23 (3H, s), 3.07 (3H, bs), 3.42-3.95 (2H, m), 4.06-4.43 (2H, m), 4.38 (2H, q, $J=7.8$ Hz), 4.85-5.05 (2H, m), 5.42-5.50 (1H, m), 6.63-6.66 (1H, m), 7.38-7.51 (3H, m), 7.78-7.85 (1H, m), 8.33-8.36 (1H, m).

**Example 45**

\[
\text{Diethyl 3-[methyl[[(R)-2-[[[3-methyl-4-(2,2,2-
trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]propane-1,2-diyl biscarbonate}
\]

To a solution (20 mL) of bis(trichloromethyl)carbonate (0.59 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.49 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., diethyl 3-(methylamino)propane-1,2-diyl biscarbonate hydrochloride (1.71 g) obtained in Reference Example 47 was added. A solution (1 mL) of triethylamine (0.84 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 3 hrs. After concentration under reduced
pressure, water (50 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfanyl]-1H-benzimidazole (1.53 g), triethylamine (1.16 mL) and 4-dimethylaminopyridine (catalytic amount) were added, and the mixture was stirred at 60°C overnight. After concentration under reduced pressure, water (50 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:2, then 1:1) to give the title compound (1.42 g) as a yellow amorphous solid.

$^1$H-NMR (CDCl$_3$): 1.28-1.34 (6H, m), 2.22 (3H, s), 3.07 (3H, bs), 3.42-4.60 (10H, m), 4.85-5.08 (2H, m), 5.30-5.42 (1H, m), 6.62-6.64 (1H, m), 7.37-7.42 (3H, m), 7.80-7.83 (1H, m), 8.32-8.35 (1H, m).

**Example 46**
pyridyl)methyl)sulfinyl]-3H-imidazo[4,5-b]pyridin-3-yl]carbonyl](methyl)amino)ethyl 3-chlorobenzoate

To a solution (7 mL) of bis(trichloromethyl)carbonate (0.194 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.162 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., 2-(methylamino)ethyl 3-chlorobenzoate hydrochloride (0.50 g) obtained in Reference Example 7 was added. A solution (1 mL) of triethylamine (0.279 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 2.5 hrs. After concentration under reduced pressure, water (15 mL) was added to the residue, and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (15 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in tetrahydrofuran (10 mL). 5-Methoxy-2-[[4-methoxy-3,5-dimethyl-2-pyridyl]methyl)sulfinyl]-1H-imidazo[4,5-b]pyridine (0.445 g) synthesized by the method described in JP-A-63-146882, triethylamine (0.357 mL) and 4-dimethylaminopyridine (0.012 g) were added, and the mixture was stirred at 60°C for 14 hrs. After concentration under reduced pressure, water (30 mL) was added to the residue, and the mixture was extracted with ethyl acetate (70 mL). The ethyl acetate layer was washed with saturated brine (20 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:2, then 1:1) to give the title compound (0.360 g) as a colorless amorphous solid.

^1H-NMR (CDCl3): 2.21 (3H, s), 2.23 (3H, s), 3.32, 3.38 (total 3H, s), 3.72 (3H, s), 3.81 (3H, s), 3.92-4.09 (2H, m), 4.50-4.73 (2H, m), 4.87 (1H, d, J=13.4 Hz), 4.94 (1H, d, J=13.4 Hz), 6.77 (1H, d, J=8.8 Hz), 7.36 (1H, m), 7.52 (1H, m), 7.80-8.03 (3H, m), 8.20 (1H, s).
Example 47


To a solution (20 mL) of bis(trichloromethyl)carbonate (0.582 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.485 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 1 hr., 2-(methylamino)ethyl acetate hydrochloride (0.922 g) obtained in Reference Example 2 was added. A solution (1 mL) of triethylamine (0.84 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 2.5 hrs. After concentration under reduced pressure, water (40 mL) was added to the residue, and the mixture was extracted with ethyl acetate (80 mL). The ethyl acetate layer was washed with saturated brine (25 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in tetrahydrofuran (15 mL). 2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.10 g), triethylamine (0.84 mL) and 4-dimethylaminopyridine (0.036 g) were added, and the mixture was stirred at 60°C for 4.5 hrs. After concentration under reduced pressure, water (40 mL) was added to the residue, and the mixture was extracted with ethyl acetate (80 mL). The ethyl acetate layer was washed with saturated brine (30 mL)
and dried over anhydrous magnesium sulfate. After
concentration under reduced pressure, the residue was purified
by silica gel column chromatography (eluted with ethyl
acetate:hexane=1:1, then 2:1) to give the title compound (1.18
g) as a colorless solid.

\[ ^1H-NMR(CDCl_3): 2.10(3H,s), 2.24(3H,s), 3.09(3H,bs), 3.60-
4.00(2H,br), 4.25-4.50(2H,m), 4.38(2H, q,J=7.8Hz), 4.84-
5.18(2H,m), 6.64(1H,d,J=5.6Hz), 7.36-7.48(3H,m),
7.85(1H,d,J=7.8Hz), 8.35(1H,d,J=5.6Hz). \]

**Example 48**

![Chemical Structure](image)

Ethyl 2-\{methyl[[[(R)-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-
2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino\}ethyl carbonate

A solution of (R)-2-\{[[3-methyl-4-(2,2,2-
trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole
(130 g), triethylamine (63.8 mL), 4-dimethylaminopyridine
(0.86 g) and 2-\{(chlorocarbonyl)\(\text{methyl}\)amino\}\(\text{ethyl}
\text{ethy}
\text{carbonate (84.8 g obtained in Reference Example 34 in
tetrahydrofuran (813 mL) was stirred at 45-50°C for 18 hrs.
The reaction mixture was concentrated under reduced pressure
and water (300 mL) was added to the residue, and the mixture
was extracted with ethyl acetate (700 mL). The ethyl acetate
layer was washed 3 times with saturated brine (300 mL), and
anhydrous magnesium sulfate (130 g) and activated carbon (13

g) were added. The mixture was stirred at room temperature for
30 min. and filtered. The filtrate was concentrated under
reduced pressure and the residue was dissolved in diethyl
ether (600 mL) containing triethylamine (0.49 mL), and the
mixture was concentrated under reduced pressure. This step was
further repeated twice. The obtained oily substance was
dissolved in ethanol (200 mL) containing triethylamine (2.45
mL) and water (120 mL) was dropwise added under ice-cooling.
The precipitated crystals were collected by filtration, washed
3 times with ice-cooled ethanol-water (volume ratio 1:1, 150
mL) and dried to give the title compound (172.2 g) as a
colorless solid. ¹H-NMR(CDCl₃) showed the same chart as with
the compound obtained in Example 14.

Example 49

2-Ethoxyethyl 2-[methyl([(R)-2-[[[3-methyl-4-(2,2,2-
trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino)ethyl carbonate

To a solution (20 mL) of bis(trichloromethyl)carbonate
(0.43 g) in tetrahydrofuran was dropwise added a solution (1
mL) of pyridine (0.35 mL) in tetrahydrofuran under ice-
cooling. After stirring under ice-cooling for 10 min., 2-
ethoxyethyl 2-(methylamino)ethyl carbonate hydrochloride (0.82
g) obtained in Reference Example 48 was added. A solution (1 mL) of triethylamine (0.60 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 3 days. After concentration under reduced pressure, water (50 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with 0.2N hydrochloric acid (20 mL) and saturated brine (50 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.11 g), triethylamine (0.63 mL) and 4-dimethylaminopyridine (0.037 g) were added, and the mixture was stirred at 60°C for 6 hrs. and at room temperature for 11 hrs. After concentration under reduced pressure, water (50 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=3:7, then ethyl acetate:hexane=7:3) to give the title compound (1.39 g) as a yellow amorphous solid.

^H-NMR (CDCl₃): 1.19 (3H, t, J=6.9 Hz), 2.23 (3H, s), 3.09 (3H, bs), 3.40-4.20 (2H, br), 3.53 (2H, q, J=6.9 Hz), 3.63-3.69 (2H, m), 4.27-4.34 (2H, m), 4.39 (2H, q, J=7.8 Hz), 4.47 (2H, m), 4.80-5.20 (2H, m), 6.65 (1H, d, J=5.6 Hz), 7.30-7.52 (3H, m), 7.84 (1H, d, J=7.5 Hz), 8.35 (1H, d, J=5.6 Hz).

Example 50

To a solution (20 mL) of bis(trichloromethyl)carbonate (0.53 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.44 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 5 min., 3-methoxypropyl 2-(methylamino)ethyl carbonate hydrochloride (0.82 g) obtained in Reference Example 49 was added. A solution (1 mL) of triethylamine (0.75 mL) in tetrahydrofuran was dropwise added and the mixture was stirred at room temperature for 1 hr. After concentration under reduced pressure, water (50 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with 0.2N hydrochloric acid (20 mL) and saturated brine (50 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.11 g), triethylamine (0.63 mL) and 4-dimethylaminopyridine (0.037 g) were added, and the mixture was stirred at 60°C for 6 hrs. and
at room temperature for 6 hrs. After concentration under reduced pressure, water (50 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=3:7, then ethyl acetate:hexane=7:3). Crystallization from diethyl ether gave the title compound (0.70 g) as a colorless solid.

\(^1\)H-NMR (CDCl\(_3\)): 1.94 (2H, quintet, J=6.2 Hz), 2.23 (3H, s), 3.09 (3H, bs), 3.31 (3H, s), 3.40-4.20 (2H, br), 3.44 (2H, t, J=6.2 Hz), 4.25 (2H, t, J=6.5 Hz), 4.38 (2H, q, J=7.8 Hz), 4.44 (2H, m), 4.80-5.20 (2H, m), 6.64 (1H, d, J=5.6 Hz), 7.35-7.48 (3H, m), 7.83 (1H, d, J=7.8 Hz), 8.34 (1H, d, J=5.6 Hz).

Example 51

![Chemical Structure](image)

dihydrochloride (1.06 g) obtained in Reference Example 50 was added to tetrahydrofuran (40 mL) and the mixture was stirred for a while, to which bis(trichloromethyl)carbonate (0.77 g) was added. After ice-cooling, a solution (5 mL) of
triethylamine (2.17 mL) in tetrahydrofuran was dropwise added and the mixture was stirred at room temperature for 3 hrs. The precipitated solid was filtered off and ethyl acetate (80 mL) was added. The mixture was washed with an ice-cooled aqueous sodium hydrogen carbonate solution (50 mL) and saturated brine (50 mL×2) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-
benzimidazole (1.11 g), triethylamine (0.63 mL) and 4-
dimethylaminopyridine (0.037 g) were added, and the mixture was stirred at 60°C for 6 hrs. and at room temperature for 3 days. 4-Dimethylaminopyridine (0.037 g) was added, and the mixture was further stirred at 60°C for 6 hrs. After concentration under reduced pressure, an aqueous sodium hydrogen carbonate solution (50 mL) was added to the residue, and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:1, then ethyl acetate, then methanol:ethyl acetate=1:19). Crystallization from diethyl ether gave the title compound (0.41 g) as a colorless solid.

$^1$H-NMR (CDCl$_3$): 2.23 (3H, s), 2.35 (6H, s), 3.08 (3H, bs), 3.21 (2H, s), 3.50-4.20 (2H, br), 4.38 (2H, q, J=7.8 Hz), 4.44 (2H, m), 4.80-5.18 (2H, m), 6.64 (1H, d, J=5.6 Hz), 7.36-7.48 (3H, m), 7.84 (1H, d, J=6.9 Hz), 8.35 (1H, d, J=5.6 Hz).

**Example 52**
S-[2-{Methyl[[R]-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino}ethyl] thioacetate

S-[2-(Methylamino)ethyl] thioacetate hydrochloride (0.75 g) obtained in Reference Example 51 was added to tetrahydrofuran (30 mL) and the mixture was stirred for a while, to which bis(trichloromethyl)carbonate (0.66 g) was added. After ice-cooling, a solution (10 mL) of triethylamine (1.85 mL) in tetrahydrofuran was dropwise added and the mixture was stirred under ice-cooling for 30 min. and at room temperature for 30 min. The precipitated solid was filtered off and ethyl acetate (50 mL) was added to the filtrate. The mixture was washed with ice-cooled 0.2N hydrochloric acid (20 mL) and saturated brine (50 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (0.96 g), triethylamine (0.54 mL) and 4-dimethylaminopyridine (0.032 g) were added, and the mixture was stirred at 60°C for 6 hrs. and at room temperature for 8 hrs. After concentration under reduced pressure, water (50 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL)
and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by silica gel column chromatography (eluted with acetone:hexane=3:7, then acetone:hexane=7:3) to give the title compound (1.19 g) as a yellow amorphous solid.

$^1$H-NMR (CDCl$_3$): 2.23 (3H, s), 2.34 (3H, s), 3.10 (3H, bs), 3.22 (2H, t, J=6.6 Hz), 3.67 (2H, m), 4.38 (2H, q, J=7.8 Hz), 4.80-5.20 (2H, m), 6.64 (1H, d, J=5.7 Hz), 7.35-7.50 (3H, m), 7.83 (1H, d, J=6.9 Hz), 8.35 (1H, d, J=5.7 Hz).

**Example 53**

![Chemical Structure Image]


To a solution (40 mL) of bis(trichloromethyl)carbonate (1.19 g) in tetrahydrofuran was dropwise added a solution (2 mL) of pyridine (0.95 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., ethyl 2-[(3-methylamino)ethoxy]ethyl carbonate hydrochloride (2.73 g) obtained in Reference Example 52 was added. A solution (2 mL) of triethylamine (1.68 mL) in tetrahydrofuran was dropwise
added, and the mixture was stirred at room temperature for 3 hrs. After concentration under reduced pressure, water (100 mL) was added to the residue, and the mixture was extracted with ethyl acetate (100 mL). The ethyl acetate layer was washed with saturated brine (100 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in tetrahydrofuran (40 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (2.80 g), triethylamine (2.11 mL) and 4-dimethylaminopyridine (catalytic amount) were added, and the mixture was stirred at 60°C overnight. After concentration under reduced pressure, water (100 mL) was added to the residue, and the mixture was extracted with ethyl acetate (100 mL). The ethyl acetate layer was washed with saturated brine (100 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:2, then 1:1) to give the title compound (2.19 g) as a yellow amorphous solid.

$^1$H-NMR (CDCl$_3$): 1.28 (3H, t, J=7.2Hz), 2.24 (3H, s), 3.10 (3H, bs), 3.38-3.80 (6H, m), 4.18 (2H, q, J=7.2Hz), 4.27-4.34 (2H, m), 4.38 (2H, q, J=8.4Hz), 4.83-5.30 (2H, m), 6.65 (1H, d, J=5.7Hz), 7.35-7.50 (3H, m), 7.84 (1H, d, J=7.8Hz), 8.36 (1H, d, J=5.7Hz).

Example 54

To a solution (20 mL) of bis(trichloromethyl)carbonate (0.59 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.49 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., ethyl 2-[methyl[[2-(methylamino)ethoxy]carbonyl]amino]ethyl carbonate hydrochloride (1.71 g) obtained in Reference Example 53 was added. A solution (1 mL) of triethylamine (0.84 mL) in tetrahydrofuran was dropwise added and the mixture was stirred at room temperature for 3 hrs. After concentration under reduced pressure, water (50 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was
dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.59 g), triethylamine (1.20 mL) and 4-dimethylaminopyridine (catalytic amount) were added, and the mixture was stirred at 60°C overnight. After concentration under reduced pressure, water (50 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:2, then 1:1) to give the title compound (1.62 g) as a yellow amorphous solid.

$^1$H-NMR (CDCl$_3$): 1.24-1.31 (3H,m), 2.24 (3H,bs), 2.97-2.99 (3H,m), 3.10 (3H,bs), 3.55-3.58 (2H,m), 4.09-4.50 (10H,m), 4.88-5.08 (2H,m), 6.65 (1H,t,J=5.7Hz), 7.36-7.48 (3H,m), 7.85 (1H,d,J=6.9Hz), 8.36 (1H,d,J=5.7Hz).

**Example 55**

![Chemical Structure]

Ethyl 2-[[5-methoxy-2-[[4-methoxy-3,5-dimethyl-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl](methyl)amino)ethyl carbonate

To a solution (10 mL) of bis(trichloromethyl)carbonate
(0.291 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.243 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 1 hr., ethyl 2-(methylamino)ethyl carbonate hydrochloride (0.551 g) obtained in Reference Example 14 was added. A solution (1 mL) of triethylamine (0.418 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 2 hrs. After concentration under reduced pressure, water (15 mL) was added to the residue, and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (15 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in tetrahydrofuran (10 mL). 5-Methoxy-2-\[\{(4-methoxy-3,5-dimethyl-2-pyridyl)methyl\}sulfinyl\]-1H-benzimidazole (0.817 g), triethylamine (0.661 mL) and 4-dimethylaminopyridine (0.012 g) were added, and the mixture was stirred at 60°C for 12 hrs. After concentration under reduced pressure, water (20 mL) was added to the residue, and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (15 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:2, then 1:1) to give a 3:2 mixture (0.92 g) of the title compound and ethyl 2-\[\{(6-methoxy-2-\[\{(4-methoxy-3,5-dimethyl-2-pyridyl)methyl\}sulfinyl\]-1H-benzimidazol-1-yl}carbonyl\}(methyl)amino)ethyl carbonate as a pale-yellow amorphous solid.

$^1$H-NMR (CDCl$_3$): 1.27-1.34 (3H,m), 2.10-2.30 (3H,m), 2.23 (3H,s), 2.99-3.23 (3H,m), 3.40-3.85 (2H,m), 3.69 (6/5H,s), 3.71 (9/5H,s), 3.86 (6/5H,s), 3.88 (9/5H,s), 4.14-4.25 (2H,m), 4.38-4.60 (2H,m), 4.82-5.06 (2H,m), 6.92-7.08 (7/5H,m), 7.33 (3/5H,d,J=9.0Hz), 7.66 (1H,m), 8.21 (1H,s).
Example 56

2-[[5-Methoxy-2-[(4-methoxy-3,5-dimethyl-2-pyridyl)methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]phenyl)amino]ethyl acetate

To a solution (10 mL) of bis(trichloromethyl)carbonate (0.291 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.243 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., 2-anilinoethyl acetate hydrochloride (0.647 g) obtained in Reference Example 27 was added. A solution (1 mL) of triethylamine (0.419 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 3 hrs. After concentration under reduced pressure, water (20 mL) was added to the residue, and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (15 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in tetrahydrofuran (10 mL). 5-Methoxy-2-[[4-methoxy-3,5-dimethyl-2-pyridyl)methyl]sulfinyl]-1H-benzimidazole (0.829 g), triethylamine (0.669 mL) and 4-dimethylaminopyridine (0.012 g) were added, and the mixture was stirred at 60°C for 14 hrs. After concentration under reduced pressure, water (40 mL) was added to the residue, and the mixture was extracted with ethyl acetate (80 mL). The
ethyl acetate layer was washed with saturated brine (15 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:2) to give a 1:1 mixture (1.10 g) of the title compound and 2-[[6-methoxy-2-[[4-methoxy-3,5-dimethyl-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]phenyl)amino]ethyl acetate as a colorless amorphous solid.

$^1$H-NMR (CDCl$_3$): 1.99 (3H, s), 2.19 (1.5H, s), 2.21 (1.5H, s), 2.25 (3H, s), 3.70 (1.5H, s), 3.71 (3H, s), 3.78 (1.5H, s), 3.84 (1.5H, s), 4.15-4.56 (4H, m), 4.74-4.80 (1H, m), 4.91-4.98 (1H, m), 6.83-6.91 (1.5H, m), 7.04-7.19 (3.5H, m), 7.25-7.53 (2.5H, m), 7.51 (0.5H, d, J=8.7Hz), 8.25 (1H, s).

15 Example 57

![Chemical Structure]


To a solution (10 mL) of (S)-5-methoxy-2-[[4-methoxy-3,5-dimethyl-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.34 g) synthesized by the method described in Example 1 of Japanese Patent Application under PCT laid-open under kohyo
No. 10-504290 in tetrahydrofuran were added 2-
[(chlorocarbonyl)(methyl)amino]ethyl ethyl carbonate (0.9 mL)
 obtained in Reference Example 34, triethylamine (1.08 mL) and
4-dimethylaminopyridine (0.010 g), and the mixture was stirred
at 60°C for 6 hrs. After concentration under reduced pressure,
water (30 mL) was added to the residue and the mixture was
extracted with ethyl acetate (50 mL). The ethyl acetate layer
was washed with saturated brine (15 mL) and dried over
anhydrous magnesium sulfate. After concentration under reduced
pressure, the residue was purified by basic silica gel column
chromatography (eluted with ethyl acetate:hexane=1:2, then
1:1) to give a 3:2 mixture (0.92 g) of the title compound and
ethyl 2-[[[(S)-6-methoxy-2-[[[(4-methoxy-3,5-dimethyl-2-
pyridyl)methyl]sulfinyl]-1H-benzimidazol-1-
[24]
yl]carbonyl](methyl)amino]ethyl carbonate as a pale-yellow
amorphous solid.

\[ \text{H}^{-}\text{NMR (CDCl}_3\text{): 1.25-1.34 (3H,m), 2.10-2.30 (3H,m), 2.23 (3H,s),}
\]
\[ 2.99-3.23 (3H,m), 3.40-3.85 (2H,m), 3.69 (6/5H,s), 3.71 (9/5H,s),
\]
\[ 3.86 (6/5H,s), 3.88 (9/5H,s), 4.14-4.25 (2H,m), 4.38-4.60 (2H,m),
\]
\[ 4.79-5.05 (2H,m), 6.92-7.08 (7/5H,m), 7.33 (3/5H,d, J=9.3 Hz),
\]
\[ 7.65 (1H,m), 8.21 (1H,s). \]

**Example 58**

![Chemical Structure](image-url)
Ethyl 2-[[2-[[4-(3-methoxypropoxy)-3-methyl-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl](methyl)amino)ethyl carbonate

To a solution (10 mL) of bis(trichloromethyl)carbonate (0.291 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.243 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 30 min., ethyl 2-(methylamino)ethyl carbonate hydrochloride (0.551 g) obtained in Reference Example 14 was added. A solution (1 mL) of triethylamine (0.418 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 2.5 hrs. After concentration under reduced pressure, water (15 mL) was added to the residue, and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (15 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in tetrahydrofuran (10 mL). 2-[[4-(3-Methoxypropoxy)-3-methyl-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (0.723 g), triethylamine (0.528 mL) and 4-dimethylaminopyridine (0.012 g) were added, and the mixture was stirred at 60°C for 17 hrs. After concentration under reduced pressure, water (40 mL) was added to the residue, and the mixture was extracted with ethyl acetate (80 mL). The ethyl acetate layer was washed with saturated brine (15 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:2), then by silica gel column chromatography (eluted with ethyl acetate:hexane=1:1, then ethyl acetate) to give the title compound (0.44 g) as a colorless amorphous solid.

$^1$H-NMR (CDCl$_3$): 1.31 (3H, t, J=7.1Hz), 2.05 (2H, m), 2.18 (3H, s), 3.08 (3H, bs), 3.34 (3H, s), 3.54 (2H, t, J=6.1Hz), 3.61-4.01 (2H, m), 188
4.08 (2H, t, J=6.3Hz), 4.21 (2H, t, J=7.1Hz), 4.38–4.54 (2H, m), 4.81–
5.12 (2H, m), 6.68 (1H, d, J=5.6Hz), 7.34–7.48 (3H, m),
7.83 (1H, d, J=7.8Hz), 8.27 (1H, d, J=5.6Hz).

**Example 59**

![Chemical Structure](image)

2-[[2-[[4-(3-Methoxypropoxy)-3-methyl-2-
pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]phenyl)amino)ethyl acetate.

To a solution (10 mL) of bis(trichloromethyl)carbonate
(0.291 g) in tetrahydrofuran was dropwise added a solution (1
mL) of pyridine (0.243 mL) in tetrahydrofuran under ice-
cooling. After stirring under ice-cooling for 30 min., 2-
anilinoethyl acetate hydrochloride (0.647 g) obtained in
Reference Example 27 was added. A solution (1 mL) of
triethylamine (0.419 mL) in tetrahydrofuran was dropwise
added, and the mixture was stirred at room temperature for 3
hrs. After concentration under reduced pressure, water (20 mL)
was added to the residue, and the mixture was extracted with
ethyl acetate (50 mL). The ethyl acetate layer was washed with
saturated brine (15 mL) and dried over anhydrous magnesium
sulfate. After concentration under reduced pressure, the
residue was dissolved in tetrahydrofuran (10 mL). 2-[[4-(3-
Methoxypropoxy)-3-methyl-2-pyridyl]methyl]sulfinyl]-1H-
benzimidazole (0.877 g), triethylamine (0.641 mL) and 4-
dimethylaminopyridine (0.012 g) were added, and the mixture
was stirred at 60°C for 16 hrs. After concentration under reduced pressure, water (40 mL) was added to the residue, and the mixture was extracted with ethyl acetate (80 mL). The ethyl acetate layer was washed with saturated brine (15 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:2), then by silica gel column chromatography (eluted with ethyl acetate) to give the title compound (0.93 g) as a colorless amorphous solid.

\[ ^1H\text{-NMR (CDCl}_3\text{): 1.99 (3H, s), 2.07 (3H, s), 2.19 (3H, s), 3.35 (3H, s), 3.54 (2H, t, J=6.2Hz), 4.09 (2H, t, J=6.2Hz), 4.14-4.40 (4H, m), 4.80 (1H, d, J=13.7Hz), 5.00 (1H, d, J=13.7Hz), 6.71 (1H, d, J=5.7Hz), 7.03-7.34 (7H, m), 7.38 (1H, m), 7.65 (1H, m), 8.32 (1H, d, J=5.7Hz).} \]

**Example 60**

![Chemical structure diagram]

To a solution (8 mL) of bis(trichloromethyl)carbonate (0.174 g) in tetrahydrofuran was dropwise added a solution (1 mL) of pyridine (0.146 mL) in tetrahydrofuran under ice-cooling. After stirring under ice-cooling for 1 hr., ethyl 2-
(methylamino)ethyl carbonate hydrochloride (0.330 g) obtained in Reference Example 14 was added. A solution (1 mL) of triethylamine (0.250 mL) in tetrahydrofuran was dropwise added, and the mixture was stirred at room temperature for 3 hrs. After concentration under reduced pressure, water (10 mL) was added to the residue, and the mixture was extracted with ethyl acetate (30 mL). The ethyl acetate layer was washed with saturated brine (10 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in tetrahydrofuran (8 mL). 5-(Difluoromethoxy)-2-[[3,4-dimethoxy-2-pyridyl)methyl]sulfinyl]-1H-benzimidazole (0.432 g), triethylamine (0.279 mL) and 4-dimethylaminopyridine (0.008 g) were added, and the mixture was stirred at 60°C for 17.5 hrs. After concentration under reduced pressure, water (20 mL) was added to the residue, and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (10 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:2, then 1:1), then by silica gel column chromatography (eluted with ethyl acetate:hexane=2:1, then ethyl acetate) to give a 1:1 mixture (0.09 g) of the title compound and 2-[[6-(difluoromethoxy)-2-[[3,4-dimethoxy-2-pyridyl)methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl)methylamino)ethyl ethyl carbonate as a pale-yellow amorphous solid.

$^1$H-NMR (CDCl$_3$): 1.31 (3H, t, J=7.2 Hz), 3.06 (3H, s), 3.42-3.98 (2H, m), 3.87 (3H, s), 3.90 (3H, s), 4.21 (2H, q, J=7.2 Hz), 4.36-4.54 (2H, m), 4.90 (1H, d, J=13.2 Hz), 4.98 (1H, d, J=13.2 Hz), 6.54 (0.5H, t, J=73.5 Hz), 6.61 (0.5H, t, J=73.5 Hz), 6.78 (1H, d, J=5.3 Hz), 7.15-7.25 (1.5H, m), 7.44 (0.5H, d, J=9.0 Hz), 7.59 (0.5H, s), 7.80 (0.5H, d, J=9.0 Hz), 8.17 (1H, d, J=5.3 Hz).
Example 61

\[
\text{2-[Methyl} [(\text{R})-2-[[3\text{-methyl-4-}(2,2,2\text{-trifluorooethoxy})-2-\text{pyridyl}]\text{methyl}]\text{sulfinyl}]\text{-1H-benzimidazol-1-yl]}\text{carbonyl]amino} \text{ethyl 1-methylpiperidine-4-carboxylate}
\]

2-(Methylamino)ethyl 1-methylpiperidine-4-carboxylate dihydrochloride (0.98 g) obtained in Reference Example 54 was added to tetrahydrofuran (50 mL) and the mixture was stirred for a while, to which bis(trichloromethyl)carbonate (0.53 g) was added. After ice-cooling, a solution (50 mL) of triethylamine (2.01 mL) in tetrahydrofuran was dropwise added and the mixture was stirred at room temperature for 3 hrs. Ethyl acetate (100 mL) was added and the mixture was washed with an aqueous sodium hydrogen carbonate solution (100 mL) and saturated brine (80 mL) and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[3-Methyl-4-}(2,2,2-trifluorooethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (0.74 g), triethylamine (0.56 mL) and 4-dimethylaminopyridine (0.049 g) were added, and the mixture was stirred at 60°C overnight. After concentration under reduced pressure, an aqueous sodium
hydrogen carbonate solution (50 mL) was added to the residue, and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate: hexane = 7:3, then ethyl acetate, then methanol:ethyl acetate = 1:19) to give the title compound (0.78 g) as a yellow-green amorphous solid.

\[ ^1H-NMR(CDCl_3): 1.65-2.05(6H, m), 2.23(3H, s), 2.25(3H, s), 2.24-2.38(1H, m), 2.75-2.85(2H, m), 3.07(3H, bs), 3.40-4.10(2H, br), 4.38(2H, q, J=7.8Hz), 4.40(2H, m), 4.80-5.10(2H, br), 6.64(1H, d, J=5.6Hz), 7.36-7.47(3H, m), 7.84(1H, d, J=7.8Hz), 8.35(1H, d, J=5.6Hz). \]

**Example 62**

![Chemical Structure](image)


To a solution (20 mL) of bis(trichloromethyl)carbonate (0.45 g) in tetrahydrofuran was dropwise added a solution (10 mL) of 2-[[4-(aminocarbonyl)phenyl]amino]ethyl acetate (0.67 g) obtained in Reference Example 55 and triethylamine (0.63 mL) in tetrahydrofuran under ice-cooling, and the mixture was
stirred at room temperature for 1 hr. After concentration under reduced pressure, water (50 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with 0.2N hydrochloric acid (20 mL) and saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in tetrahydrofuran (30 mL). (R)-2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl)methyl]sulfinyl]-1H-benzimidazole (1.11 g), triethylamine (0.63 mL) and 4-dimethylaminopyridine (0.037 g) were added, and the mixture was stirred at 60°C for 30 min. and at room temperature overnight. After concentration under reduced pressure, an aqueous sodium hydrogen carbonate solution (50 mL) was added to the residue, and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=4:6, then 6:4, then 8:2) to give the title compound (1.26 g) as a yellow amorphous solid.

^H-NMR (CDCl₃): 1.99 (3H, s), 2.26 (3H, s), 4.15-4.55 (4H, m), 4.41 (2H, q, J=7.9 Hz), 4.80-5.20 (2H, br), 6.69 (1H, d, J=5.7 Hz), 7.26-7.38 (3H, m), 7.48 (2H, d, J=8.9 Hz), 7.54 (2H, d, J=8.9 Hz), 7.66-7.73 (1H, m), 8.39 (1H, d, J=5.7 Hz).

Example 63
2-[Methyl][[(R)-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonylamino]ethyl 1-methyl-4-piperidinyl carbonate
dihydrochloride (1.01 g) obtained in Reference Example 56 was added to tetrahydrofuran (30 mL) and, after stirring for a while, ice-cooled. Bis(trichloromethyl)carbonate (0.69 g) was added and a solution (10 mL) of triethylamine (1.95 mL) in tetrahydrofuran was dropwise added. After stirring under ice-cooling for 1 hr. and at room temperature for 1 hr., the precipitated solid was filtered off. After concentration under reduced pressure, ethyl acetate (50 mL) was added, and the mixture was washed with an ice-cooled aqueous sodium hydrogen carbonate solution (50 mL) and saturated brine (50 mL), and dried over anhydrous magnesium sulfate. The layer was concentrated under reduced pressure, and the residue was dissolved in tetrahydrofuran (20 mL). (R)-2-[[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (1.11 g), triethylamine (0.63 mL) and 4-dimethylaminopyridine (0.037 g) were added, and the mixture
was stirred at 60°C overnight. After concentration under reduced pressure, an aqueous sodium hydrogen carbonate solution (50 mL) was added to the residue, and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (50 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=1:1, then ethyl acetate, then methanol:ethyl acetate=1:19) to give the title compound (0.70 g) as a yellow amorphous solid.

\[ ^1H\text{-NMR (CDCl}_3\text{): 1.70-1.86 (2H, m), 1.90-2.04 (2H, m), 2.23 (3H, s), 2.28 (3H, s), 2.10-2.35 (2H, m), 2.60-2.72 (2H, m), 3.08 (3H, bs), 3.40-4.20 (2H, br), 4.39 (2H, q, J=7.9 Hz), 4.44 (2H, m), 4.60-4.74 (1H, m), 4.80-5.15 (2H, br), 6.65 (1H, d, J=5.9 Hz), 7.35-7.52 (3H, m), 7.84 (1H, d, J=7.5 Hz), 8.35 (1H, d, J=5.9 Hz).} \]

Example 64

\[
\begin{align*}
\text{O} & \hspace{1cm} \text{N} \\
\text{O} & \hspace{1cm} \text{S} \\
\text{O} & \hspace{1cm} \text{N} \\
\text{H}_2\text{N} & \hspace{1cm} \text{O} \hspace{1cm} \text{CH}_3 \\
\end{align*}
\]


To a solution (5 mL) of bis(trichloromethyl)carbonate (0.12 g) in tetrahydrofuran was dropwise added a solution (5 mL) of 2-[[4-(aminocarbonyl)phenyl]amino]ethyl acetate (0.22 g) obtained in Reference Example 55 and triethylamine (0.17
mL) in tetrahydrofuran under ice–cooling, and the mixture was stirred at room temperature for 30 min. Water (20 mL) was added, and the mixture was extracted with ethyl acetate (30 mL). The ethyl acetate layer was washed with saturated brine (20 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was dissolved in tetrahydrofuran (10 mL). 2-[[3-Methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazole (0.37 g), triethylamine (0.28 mL) and 4-dimethylaminopyridine (0.012 g) were added, and the mixture was stirred at 60°C for 1 hr. After concentration under reduced pressure, an aqueous sodium hydrogen carbonate solution (20 mL) was added to the residue, and the mixture was extracted with ethyl acetate (30 mL). The ethyl acetate layer was washed with saturated brine (20 mL) and dried over anhydrous magnesium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate: hexane=3:7, then 5:5, then 8:2) to give the title compound (0.34 g) as a pale–yellow amorphous solid.

\(^1\text{H}-\text{NMR (CDCl}_3\text{):} 1.99 (3\text{H}, s), 2.26 (3\text{H}, s), 4.15–4.55 (4\text{H}, m), 4.41 (2\text{H}, q, \text{J}=7.9\text{Hz}), 4.80–5.20 (2\text{H}, \text{br}), 6.69 (1\text{H}, d, \text{J}=5.9\text{Hz}), 7.26–7.40 (3\text{H}, m), 7.47 (2\text{H}, d, \text{J}=8.8\text{Hz}), 7.54 (2\text{H}, d, \text{J}=8.8\text{Hz}), 7.65–7.74 (1\text{H}, m), 8.38 (1\text{H}, d, \text{J}=5.9\text{Hz}).

Example 65
(-)-Ethyl 2-[[5-methoxy-2-[[4-methoxy-3,5-dimethyl-2-pyridyl]methyl]sulfinyl]-3H-imidazo[4,5-b]pyridin-3-yl]carbonyl](methyl)amino)ethyl carbonate

5-Methoxy-2-[[4-methoxy-3,5-dimethyl-2-pyridyl]methyl]sulfinyl]-1H-imidazo[4,5-b]pyridine synthesized according to the method described in JP-A-63-146882 was subjected to preparative HPLC for optical resolution to give a (-) enantiomeric form (0.10 g) thereof. To a solution (5 mL) of this form in tetrahydrofuran were added 2-[(chlorocarbonyl](methyl)amino)ethyl ethyl carbonate (0.081 g) obtained in Reference Example 34, triethylamine (0.080 mL) and 4-dimethylaminopyridine (0.007 g) and the mixture was stirred at 50°C for 18 hrs. After concentration under reduced pressure, water (30 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (30 mL) and dried over anhydrous sodium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=2:1) to give the title compound (0.053 g) as a colorless oil.

^1H-NMR (CDCl3): 1.30 (3H, t, J=7.1Hz), 2.24 (6H, s), 3.15, 3.32 (total 3H, s), 3.73 (3H, s), 3.90-4.55 (9H, m), 4.85 (1H, d, J=13.2Hz), 4.97 (1H, d, J=13.2Hz), 6.80 (1H, d, J=8.8Hz), 7.96 (1H, d, J=8.8Hz),
8.23(1H, s).

Example 66

(+)-Ethyl 2-[[5-methoxy-2-[(4-methoxy-3,5-dimethyl-2-pyridyl)methyl]sulfinyl]-3H-imidazo[4,5-b]pyridin-3-yl]carbonyl](methyl)amino)ethyl carbonate

5-Methoxy-2-[[4-(methoxy-3,5-dimethyl-2-pyridyl)methyl]sulfinyl]-1H-imidazo[4,5-b]pyridine synthesized according to the method described in JP-A-63-146882 was subjected to preparative HPLC for optical resolution to give a (+) enantiomeric form (0.10 g) thereof. To a solution (5 mL) of this form in tetrahydrofuran were added 2-[(chlorocarbonyl)(methyl)amino]ethyl ethyl carbonate (0.081 g) obtained in Reference Example 34, triethylamine (0.080 mL) and 4-dimethylaminopyridine (0.007 g) and the mixture was stirred at 50°C for 18 hrs. After concentration under reduced pressure, water (30 mL) was added to the residue and the mixture was extracted with ethyl acetate (50 mL). The ethyl acetate layer was washed with saturated brine (30 mL) and dried over anhydrous sodium sulfate. After concentration under reduced pressure, the residue was purified by basic silica gel column chromatography (eluted with ethyl acetate:hexane=2:1) to give a 2:1 mixture (0.115 g) of the title compound and (+)-ethyl 2-[[5-methoxy-2-[(4-methoxy-3,5-dimethyl-2-
pyridyl)methyl[sulfinyl]-1H-imidazo[4,5-b]pyridin-1-yl]carbonyl](methyl)amino)ethy]l carbonate as a colorless oil.

$^1$H-NMR (CDCl$_3$): 1.20-1.38 (3H, m), 2.24 (6H, s), 3.08, 3.15, 3.33 (total 3H, s), 3.73 (3H, s), 3.88-4.55 (9H, m), 4.78-5.05 (2H, m), 6.80, 6.86 (1H, d, J=8.8 Hz), 7.76, 7.96 (1H, d, J=8.8 Hz), 8.21, 8.22 (total 1H, s).

**Preparation Example**

According to the following formulation and using a centrifugal rolling granulator, a dusting powder consisting of the remaining components was coated on sucrose·starch spherical granules while spraying a hydroxypropyl cellulose solution, thereby producing spherical granules, which spherical granules were vacuum dried and passed through a round sieve to give granules.

<table>
<thead>
<tr>
<th>Composition in 300 mg of granules</th>
<th>(mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>sucrose·starch spherical granules</td>
<td>10.0</td>
</tr>
<tr>
<td>compound of Example 1</td>
<td>30.0</td>
</tr>
<tr>
<td>magnesium carbonate</td>
<td>22.4</td>
</tr>
<tr>
<td>purified sucrose</td>
<td>59.8</td>
</tr>
<tr>
<td>corn starch</td>
<td>36.4</td>
</tr>
<tr>
<td>low substituted hydroxypropyl cellulose</td>
<td>40.0</td>
</tr>
<tr>
<td>hydroxypropyl cellulose</td>
<td>1.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>300.0</td>
</tr>
</tbody>
</table>

**Industrial Applicability**

The compound of the present invention is converted to a proton pump inhibitor in living organisms to show a superior anti-ulcer activity, a gastric acid secretion inhibitory action, a mucosa-protecting action, an anti-*Helicobacter pylori* action and the like. Since it shows low toxicity, the compound is useful as a pharmaceutical product. In addition, it is stable to acid, which obviates the need to formulate an
enteric-coated preparation, which in turn reduces the cost for producing an enteric preparation, and reduces the size of preparation to facilitate swallowing for patients having difficulty in swallowing, particularly for the elderly and children. Inasmuch as the compound shows faster absorption than enteric-coated preparations, a gastric acid secretion-inhibitory action is rapidly expressed, and since it is gradually converted to conventionally known proton pump inhibitor in living organisms the compound is sustainable and useful as an anti-ulcer drug and the like.

This application is based on patent application Nos. 2002-175086 and 2003-41085 filed in Japan, the contents of which are hereby incorporated by reference.
CLAIMS

1. An imidazole compound represented by the formula (I):

\[
\begin{array}{c}
\text{B} \\
\text{N} \\
\text{N} \\
\text{S} \\
\text{O} \\
\text{N} \\
\text{A} \\
\text{W} \\
\text{X}_1 \\
\text{D}_1 \\
\text{X}_2 \\
\text{D}_2 \\
\text{Y}
\end{array}
\]

wherein
ring A is a pyridine ring optionally having substituents,
ring B is a benzene ring optionally having substituents or a monocyclic aromatic heterocycle optionally having substituents,

5 \( \text{X}_1 \) and \( \text{X}_2 \)
are each an oxygen atom or a sulfur atom,

W is a divalent chain hydrocarbon group optionally having substituents or a divalent group represented by the formula:

\[
\begin{array}{c}
\text{W}_1 \\
\text{Z} \\
\text{W}_2
\end{array}
\]

wherein \( \text{W}_1 \) and \( \text{W}_2 \) are each a divalent chain hydrocarbon group or a bond, \( \text{Z} \) is a divalent hydrocarbon ring group optionally having substituents, a divalent heterocyclic group optionally having substituents, an oxygen atom, \( \text{SO}_n \) wherein \( n \) is 0, 1 or 2, or \( \text{N}^+\text{E}^- \) wherein \( \text{E} \) is a hydrogen atom, a hydrocarbon group optionally having substituents, a heterocyclic group optionally having

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substituents, a lower alkanoyl group, a lower alkoxy carbonyl group, an aralkyloxycarbonyl group, a thiocarbamoyl group, a lower alkylsulfinyl group, a lower alkylsulfonyl group, a sulfamoyl group, a mono-lower alkylsulfamoyl group, a di-lower alkylsulfamoyl group, an arylsulfamoyl group, an arylsulfinyl group, an arylsulfonyl group, an arylcarbonyl group or a carbamoyl group optionally having substituents, and when Z is an oxygen atom, \( \text{SO}_n \) or \( \text{>N-E} \), \( W_1 \) and \( W_2 \) are each a divalent chain hydrocarbon group,

\[ R \]

is a hydrocarbon group optionally having substituents or a heterocyclic group optionally having substituents,

\[ R \text{ and } W \]

may be bonded to each other,

\[ D_1 \text{ and } D_2 \]

are each a bond, an oxygen atom, a sulfur atom or \( \text{>NR}_1 \) wherein \( R_1 \) is a hydrogen atom or a hydrocarbon group optionally having substituents, except for when \( D_1 \) and \( D_2 \) are each a bond, and

\[ Y \]

is a hydrocarbon group optionally having substituents or a heterocyclic group optionally having substituents, or a salt thereof.

2. The compound of claim 1, wherein \( Z \) is a divalent hydrocarbon ring group optionally having substituents or a divalent heterocyclic group optionally having substituents.

3. The compound of claim 1, wherein ring B is a benzene ring optionally having substituents.

4. The compound of claim 1, which is represented by the formula (II):
wherein each symbol in the formula is as defined in claim 1.

5. The compound of any of claims 1 to 4, wherein \( X_1 \) and \( X_2 \) are each an oxygen atom.

6. The compound of claim 1, wherein \( D_1 \) and \( D_2 \) are each a bond or an oxygen atom, except for when \( D_1 \) and \( D_2 \) are each a bond.

7. The compound of claim 1, wherein \( W \) is a divalent chain hydrocarbon group optionally having substituents.

8. The compound of claim 1, wherein \( W \) is an ethylene group.

9. The compound of claim 1, wherein \( R \) is a \( C_{1-6} \) hydrocarbon group optionally having substituents.

10. The compound of claim 1, wherein \( Y \) is a \( C_{1-6} \) hydrocarbon group optionally having substituents or a saturated heterocyclic group optionally having substituents, which contains, as ring-constituting atom, 1 to 4 heteroatom(s) selected from oxygen atom, nitrogen atom and sulfur atom.

11. The compound of claim 1, wherein \( X_1 \) and \( X_2 \) are each an
oxygen atom, D₁ and D₂ are each a bond or an oxygen atom except for when D₁ and D₂ are both a bond, W is an ethylene group, R is a C₁-₆ alkyl group, and Y is a C₁-₆ hydrocarbon group optionally having substituents or a saturated oxygen-containing heterocyclic group optionally having substituents, which may further contain, as ring-constituting atom, 1 to 3 heteroatom(s) selected from oxygen atom, nitrogen atom and sulfur atom.

12. The compound of claim 1, which is a compound selected from
2-[methyl[[[(R)-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]ethyl acetate,
ethyl 2-[methyl[[[(R)-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]ethyl carbonate,
2-[methyl[[[(R)-2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]ethyl tetrahydropyran-4-yl carbonate,
2-[methyl[[2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]ethyl tetrahydropyran-4-yl carbonate,
ethyl 2-[methyl[[2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-yl]carbonyl]amino]ethyl carbonate,
ethyl 2-[[[5-methoxy-2-[[[4-methoxy-3,5-dimethyl-2-pyridyl]methyl]sulfinyl]-3H-imidazo[4,5-b]pyridin-3-yl]carbonyl] (methyl)amino]ethyl carbonate,
2-[[[5-methoxy-2-[[[4-methoxy-3,5-dimethyl-2-pyridyl]methyl]sulfinyl]-3H-imidazo[4,5-b]pyridin-3-yl]carbonyl] (methyl)amino]ethyl acetate,
2-[methyl[[2-[[[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl]amino]ethyl acetate,
ethyl 2-[[[5-methoxy-2-[[[(4-methoxy-3,5-dimethyl-2-
pyridyl)methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl] (methyl)amino]ethyl carbonate,
ethyl 2-[[[(S)-5-methoxy-2-[[[(4-methoxy-3,5-dimethyl-2-
pyridyl)methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl] (methyl)amino]ethyl carbonate,
ethyl 2-[[2-[[4-(3-methoxypropoxy)-3-methyl-2-
pyridyl]methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl] (methyl)amino]ethyl carbonate, and
2-[[5-(difluoromethoxy)-2-[[3,4-dimethoxy-2-
pyridyl)methyl]sulfinyl]-1H-benzimidazol-1-
yl]carbonyl] (methyl)amino]ethyl ethyl carbonate,
or a salt thereof.

13. A compound represented by the formula (V):

![Chemical structure diagram]

wherein

ring A is a pyridine ring optionally having substituents,
ring B is a benzene ring optionally having substituents or a
monocyclic aromatic heterocycle optionally having
substituents,
X₁ and X₂
are each an oxygen atom or a sulfur atom,
W is a divalent chain hydrocarbon group optionally having substituents or a divalent group represented by the formula:

\[ \overline{W_1-Z-W_2} \]

wherein \( W_1 \) and \( W_2 \) are each a divalent chain hydrocarbon group or a bond, \( Z \) is a divalent hydrocarbon ring group optionally having substituents, a divalent heterocyclic group optionally having substituents, an oxygen atom, \( SO_n \) wherein \( n \) is 0, 1 or 2, or \( >N-E \) wherein \( E \) is a hydrogen atom, a hydrocarbon group optionally having substituents, a heterocyclic group optionally having substituents, a lower alkanoyl group, a lower alkoxy carbonyl group, an aralkyloxycarbonyl group, a thiocarbamoyl group, a lower alkylsuffinyl group, a lower alkylsulfonyl group, a sulfamoyl group, a mono-lower alkylsulfamoyl group, a di-lower alkylsulfamoyl group, an arylsulfamoyl group, an arylsulfinyl group, an arylsulfonyl group, an arylcarbonyl group or a carbamoyl group optionally having substituents, and when \( Z \) is an oxygen atom, \( SO_n \) or \( >N-E \), \( W_1 \) and \( W_2 \) are each a divalent chain hydrocarbon group,

R is a hydrocarbon group optionally having substituents or a heterocyclic group optionally having substituents,

\( R \) and \( W \)

may be bonded to each other,

\( D_1 \) and \( D_2 \)

are each a bond, an oxygen atom, a sulfur atom or \( >NR_1 \) wherein \( R_1 \) is a hydrogen atom or a hydrocarbon group optionally having substituents, except for when \( D_1 \) and \( D_2 \)
are each a bond, and

\( Y \) is a hydrocarbon group optionally having substituents or a heterocyclic group optionally having substituents, or a salt thereof.

14. A production method of a compound of claim 1, which comprises

(1) condensing a compound represented by the formula (III):

![Chemical structure](image)

(III)

wherein

ring \( A \) is a pyridine ring optionally having substituents,
ring \( B \) is a benzene ring optionally having substituents or a monocyclic aromatic heterocycle optionally having substituents, and

\( M \) is a hydrogen atom, a metal cation or a quaternary ammonium ion,

or a salt thereof, with a compound represented by the formula (IV):

![Chemical structure](image)

(IV)

wherein

\( X \) is a leaving group,

\( X_1 \) and \( X_2 \) are each an oxygen atom or a sulfur atom,

\( W \) is a divalent chain hydrocarbon group optionally having substituents, or a divalent group of the formula:
wherein \( W_1 \) and \( W_2 \) are each a divalent chain hydrocarbon group or a bond, \( Z \) is a divalent hydrocarbon ring group optionally having substituents, a divalent heterocyclic group optionally having substituents, an oxygen atom, \( \text{SO}_n \) wherein \( n \) is 0, 1 or 2, or \( >\text{N-}E \) wherein \( E \) is a hydrogen atom, a hydrocarbon group optionally having substituents, a heterocyclic group optionally having substituents, a lower alkanoyl group, a lower alkoxy carbonyl group, an aralkyloxy carbonyl group, a thiocarbamoyl group, a lower alkylsulfinyl group, a lower alkylsulfonyl group, a sulfamoyl group, a mono-lower alkylsulfamoyl group, a di-lower alkylsulfamoyl group, an arylsulfamoyl group, an ary1sulfinyl group, an ary1sulfonyl group, an aryl carbonyl group or a carbamoyl group optionally having substituents, and when \( Z \) is an oxygen atom, \( \text{SO}_n \) or \( >\text{N-}E \), \( W_1 \) and \( W_2 \) are each a divalent chain hydrocarbon group, 

\( R \) is a hydrocarbon group optionally having substituents or a heterocyclic group optionally having substituents, 

\( R \) and \( W \) may be bonded to each other, 

\( D_1 \) and \( D_2 \) are each a bond, an oxygen atom, a sulfur atom, or \( >\text{NR}_1 \) wherein \( R_1 \) is a hydrogen atom or a hydrocarbon group optionally having substituents, except for when \( D_1 \) and \( D_2 \) are each a bond, and 

\( Y \) is a hydrocarbon group optionally having substituents or a heterocyclic group optionally having substituents, or
a salt thereof, or
(2) subjecting a compound represented by the formula (V):

\[
\begin{array}{c}
\text{B} \\
\text{N} \\
\text{S} \\
\text{N} \\
\text{A} \\
\text{R} \\
\text{W} \\
\text{D}_1 \\
\text{D}_2 \\
\text{Y} \\
\end{array}
\]

\[(V)\]

wherein each symbol in the formula is as defined above, or a salt thereof, to an oxidization reaction.


16. The pharmaceutical composition of claim 15, which is an agent for the prophylaxis or treatment of peptic ulcer, gastritis, peptic esophagitis, symptomatic gastroesophageal reflux disease (symptomatic GERD) free of esophagitis, NUD, gastric cancer, gastric MALT lymphoma, Zollinger-Ellison syndrome, acid indigestion or upper gastrointestinal hemorrhage.

17. A commercial package comprising a pharmaceutical composition of claim 16 and written matter associated therewith, the written matter stating that the pharmaceutical composition can or should be used for the prophylaxis or treatment of peptic ulcer, gastritis, peptic esophagitis, symptomatic gastroesophageal reflux disease (symptomatic GERD) free of esophagitis, NUD, gastric cancer, gastric MALT
lymphoma, Zollinger-Ellison syndrome, acid indigestion or upper gastrointestinal hemorrhage.

18. The pharmaceutical composition of claim 15, which is an agent for the eradication of Helicobacter pylori.

19. A commercial package comprising a pharmaceutical composition of claim 18 and written matter associated therewith, the written matter stating that the pharmaceutical composition can or should be used for the eradication of Helicobacter pylori.

20. A method for the prophylaxis or treatment of peptic ulcer, gastritis, peptic esophagitis, symptomatic gastroesophageal reflux disease (symptomatic GERD) free of esophagitis, NUD, gastric cancer, gastric MALT lymphoma, Zollinger-Ellison syndrome, acid indigestion or upper gastrointestinal hemorrhage in an animal, which comprises administering an effective amount of a compound of claim 1 to the animal.

21. A method for eradicating Helicobacter pylori from an animal infected with Helicobacter pylori, which comprises administering an effective amount of a compound of claim 1 to the animal.

22. Use of a compound of claim 1 for the production of a prophylactic or therapeutic agent of peptic ulcer, gastritis, peptic esophagitis, symptomatic gastroesophageal reflux disease (symptomatic GERD) free of esophagitis, NUD, gastric cancer, gastric MALT lymphoma, Zollinger-Ellison syndrome, acid indigestion or upper gastrointestinal hemorrhage.

23. Use of a compound of claim 1 for the production of an
agent for eradicating *Helicobacter pylori*.

24. The pharmaceutical composition of claim 15, further comprising at least one antibacterial agent in combination with the compound of claim 1, wherein active components are formulated altogether in a fixed formulation, or formulated independently for concurrent administration or administration at staggered times to a single subject.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61K31/4439 A61P1/04 C07D401/12 C07D401/14 C07D405/14 C07D471/04

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)
IPC 7 C07D A61K A61P

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, BEILSTEIN Data, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Category</th>
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<th>Relevant to claim No.</th>
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[] Further documents are listed in the continuation of box C.  
[ ] Patent family members are listed in 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 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.
  * "S" document member of the same patent family

Date of the actual completion of the international search 1 September 2003

Date of mailing of the international search report 10/09/2003

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Authorized officer
Johnson, C

Form PCT/ISA/210 (second sheet) (July 1992)
# INTERNATIONAL SEARCH REPORT

**Box I** Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. **X** Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:
   
   Although claims 20,21 are directed to a method of treatment of the human/animal body, the search has been carried out and based on the alleged effects of the compound/composition.

2. **☐** Claims Nos.: because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. **☐** Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box II** Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. **☐** As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. **☐** As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. **☐** As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. **☐** No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

- **☐** The additional search fees were accompanied by the applicant's protest.
- **☐** No protest accompanied the payment of additional search fees.

Form PCT/ISA210 (continuation of first sheet (1))(July 1998)
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