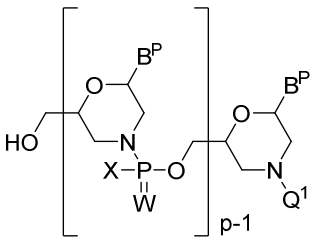
Claims

1. A method for producing a compound of general formula [C-1-1] comprising

Step 1) a compound of general formula [B-1-1]:



[B-1-1]

wherein

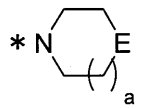
each B^P is the same or different and represents an optionally protected nucleic acid base,

p represents an integer from 1 to 10,

Q^1 represents a removable group under an acidic condition,

each W is the same or different and represents an oxygen atom or a sulfur atom,

each X is the same or different and represents a hydroxyl group substituted with a removable group under a neutral condition, 1,1,3,3-tetra(C_{1-6} alkyl)guanidyl, C_{1-6} alkoxy, di(C_{1-6} alkyl)amino, mono(amino-C_{1-6} alkyl substituted with a removable group under a basic condition)amino, di(amino-C_{1-6} alkyl substituted with a removable group under a basic condition)amino, or a substituent represented by general formula [2]:



[2]

wherein

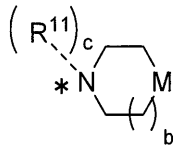
* represents a binding position with a phosphorus atom,

a represents an integer from 0 to 2,

E represents CH_2, CH-A^1, or N-A^2,

A^1 represents C_{1-6} alkyl, mono(C_{1-6} alkyl)amino-C_{1-6}

alkyl substituted with a removable group under a basic condition, di(C_{1-6} alkyl)amino-C_{1-6} alkyl, tri(C_{1-6} alkyl)ammonio-C_{1-6} alkyl, amino substituted with a removable group under a basic condition, mono(C_{1-6} alkyl)amino substituted with a removable group under a basic condition, di(C_{1-6} alkyl)amino, tri(C_{1-6} alkyl)ammonio, amino substituted with amidino substituted with a removable group under a basic condition, or a substituent represented by general formula [3]:



[3]

wherein

* represents a binding position with E,

b represents an integer from 0 to 2,

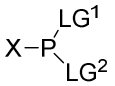
c represents 0 or 1,

R^{11} represents C_{1-6} alkyl, and

M represents CH_2, an oxygen atom, a sulfur atom, or N-(a removable group under a basic condition), and

A^2 represents C_{1-6} alkyl, mono(C_{1-6} alkyl)amino-C_{1-6} alkyl substituted with a removable group under a basic condition, di(C_{1-6} alkyl)amino-C_{1-6} alkyl, tri(C_{1-6} alkyl)ammonio-C_{1-6} alkyl, a removable group under a basic condition, aryl, or heteroaryl,

is reacted with a compound of general formula [P]:



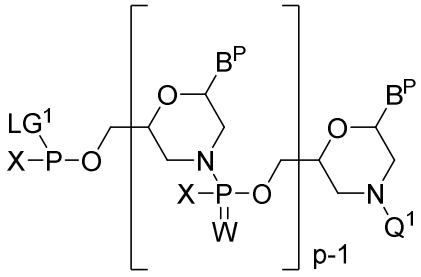
[P]

wherein

X is as defined above, and

LG^1 and LG^2 are the same or different and represent a

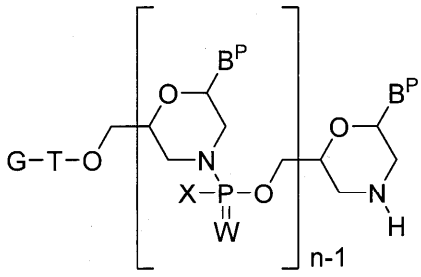
halogen,
to form a compound of general formula [B-1-2]:



[B-1-2]

wherein p, B^P, Q^1, W, X and LG^1 are as defined above, and

Step 2) the compound of general formula [B-1-2] is reacted with a compound of general formula [A-1]:



[A-1]

wherein

B^P, W and X are as defined above, and

G represents

(1) a silyl substituent,

(2) long-chain alkyl-carbonyl,

(3) benzoyl substituted with 1 to 5 long-chain alkyloxy and/or long-chain alkenyloxy, or

(4) a substituent represented by the following general formula [7]:



[7]

wherein

* represents a binding position with T,

Z represents

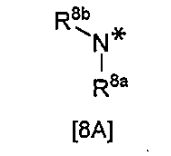
(1) (soluble polymer soluble in an organic solvent)-oxy,

(2) (soluble polymer soluble in an organic solvent)-amino,

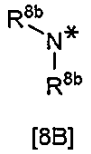
(3) long-chain alkyloxy,

(4) a solid phase carrier, or

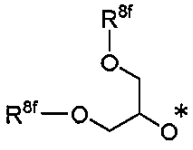
(5) a substituent represented by one of the following general formulae [8A] to [8N]:



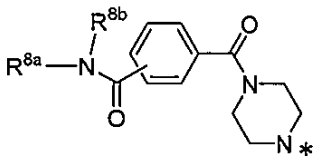
[8A]



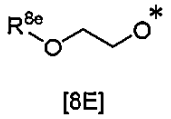
[8B]



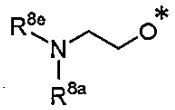
[8C]



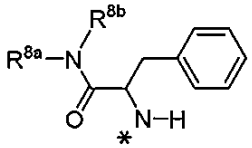
[8D]



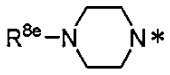
[8E]



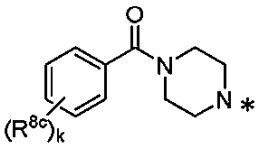
[8F]



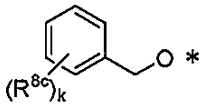
[8G]



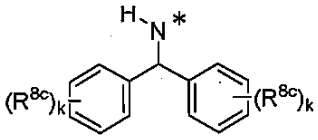
[8H]



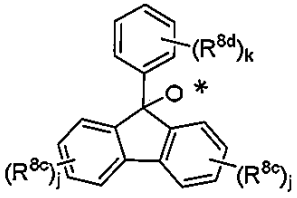
[8I]



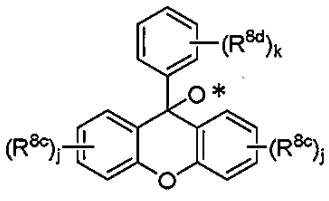
[8J]



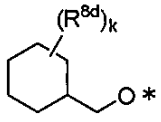
[8K]



[8L]



[8M]



[8N]

wherein

* represents a binding position with L,

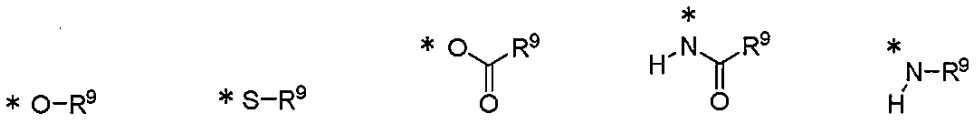
j represents an integer from 0 to 4,

k represents an integer from 0 to 5,

R^{8a} represents a hydrogen atom or C_{1-6} alkyl,

R^{8b} is the same or different and each represent long-chain alkyl,

R^{8c} is the same or different and each represent a substituent represented by one of the following general formulae [9A] to [9E]:



[9A] [9B] [9C] [9D] [9E]

wherein

* represents a binding position, and

R^9 represents long-chain alkyl and/or long-chain alkenyl,

R^{8d} is the same or different and each represent a hydrogen atom, a halogen, long-chain alkyl optionally substituted with 1 to 13 halogens, or long-chain alkyloxy optionally substituted with 1 to 13 halogens,

R^{8e} represents

(1) long-chain alkyl,

(2) long-chain alkyl-carbonyl, or

(3) benzoyl substituted with 1 to 5 long-chain alkyloxy and/or long-chain alkenyloxy, and

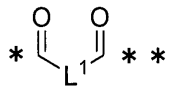
R^{8f} represents

(1) long-chain alkyl,

(2) long-chain alkyl-carbonyl, or

(3) long-chain alkenyl-carbonyl, and

L represents a substituent represented by general formula [10]:



[10]

wherein

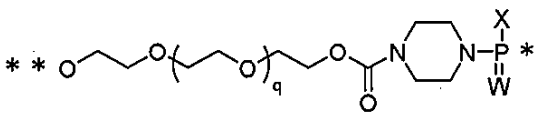
* represents a binding position with Z,

** represents a binding position with T, and

L^1 represents an optionally substituted C_{2-10} alkylene or an optionally substituted C_{6-10} arylene, and

n is an integer from 1 to 50,

T represents a single bond or a substituent group represented by general formula [11]:



[11]

wherein

X and W are as defined above,

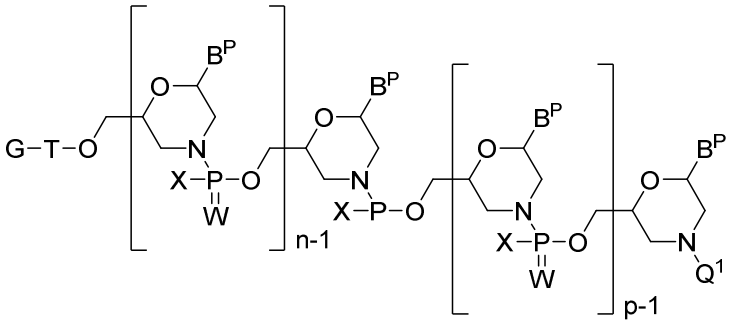
* represents a binding position with O,

** represents a binding position with G, and

q represents an integer from 0 to 10,

provided that T is a single bond when G is a silyl substituent,

to form a compound of general formula [C-1-1]:

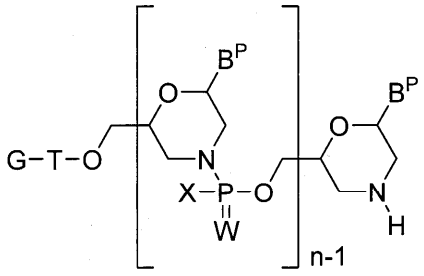


[C-1-1]

wherein n, p, B^P, Q^1, G, T, W, and X are as defined above.

2. A method for producing a compound of general formula [C-1-1] comprising

Step 1') a compound of general formula [A-1]:



[A-1]

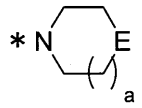
wherein

each B^P is the same or different and represents an optionally protected nucleic acid base,

n is an integer from 1 to 50,

each W is the same or different and represents an oxygen atom or a sulfur atom,

each X is the same or different and represents a hydroxyl group substituted with a removable group under a neutral condition, 1,1,3,3-tetra(C_{1-6} alkyl)guanidyl, C_{1-6} alkoxy, di(C_{1-6} alkyl)amino, mono(amino-C_{1-6} alkyl substituted with a removable group under a basic condition)amino, di(amino-C_{1-6} alkyl substituted with a removable group under a basic condition)amino, or a substituent represented by general formula [2]:



[2]

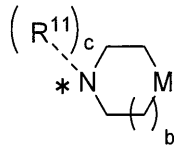
wherein

* represents a binding position with a phosphorus atom,

a represents an integer from 0 to 2,

E represents CH_2, CH-A^1, or N-A^2,

A^1 represents C_{1-6} alkyl, mono(C_{1-6} alkyl)amino-C_{1-6} alkyl substituted with a removable group under a basic condition, di(C_{1-6} alkyl)amino-C_{1-6} alkyl, tri(C_{1-6} alkyl)ammonio-C_{1-6} alkyl, amino substituted with a removable group under a basic condition, mono(C_{1-6} alkyl)amino substituted with a removable group under a basic condition, di(C_{1-6} alkyl)amino, tri(C_{1-6} alkyl)ammonio, amino substituted with amidino substituted with a removable group under a basic condition, or a substituent represented by general formula [3]:



[3]

wherein

* represents a binding position with E,

b represents an integer from 0 to 2,

c represents 0 or 1,

R^{11} represents C_{1-6} alkyl, and

M represents CH_2, an oxygen atom, a sulfur atom, or N-(a removable group under a basic condition), and

A^2 represents C_{1-6} alkyl, mono(C_{1-6} alkyl)amino-C_{1-6} alkyl substituted with a removable group under a basic condition, di(C_{1-6} alkyl)amino-C_{1-6} alkyl, tri(C_{1-6} alkyl)ammonio-C_{1-6} alkyl, a removable group under a basic condition, aryl, or heteroaryl,

G represents

(1) a silyl substituent,

(2) long-chain alkyl-carbonyl,

(3) benzoyl substituted with 1 to 5 long-chain alkyloxy and/or long-chain alkenyloxy, or

(4) a substituent represented by the following general formula [7]:

Z—L *

[7]

wherein

* represents a binding position with T,

Z represents

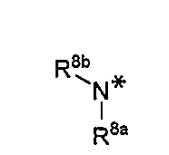
(1) (soluble polymer soluble in an organic solvent)-oxy,

(2) (soluble polymer soluble in an organic solvent)-amino,

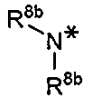
(3) long-chain alkyloxy,

(4) a solid phase carrier, or

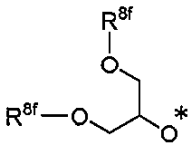
(5) a substituent represented by one of the following general formulae [8A] to [8N]:



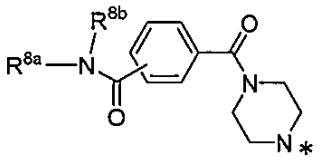
[8A]



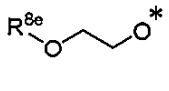
[8B]



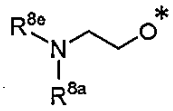
[8C]



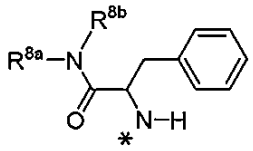
[8D]



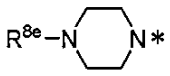
[8E]



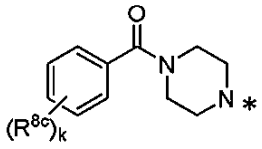
[8F]



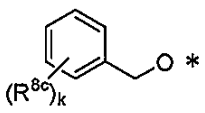
[8G]



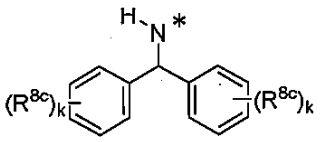
[8H]



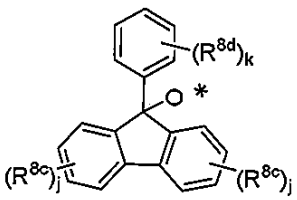
[8I]



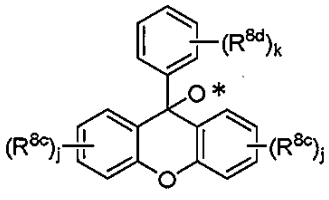
[8J]



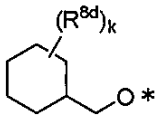
[8K]



[8L]



[8M]



[8N]

wherein

* represents a binding position with L,

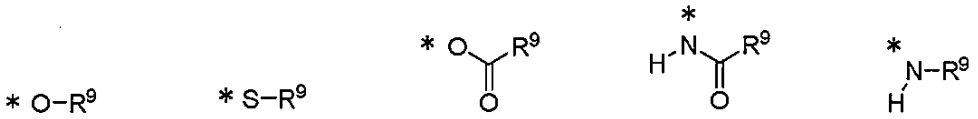
j represents an integer from 0 to 4,

k represents an integer from 0 to 5,

R^{8a} represents a hydrogen atom or C_{1-6} alkyl,

R^{8b} is the same or different and each represent long-chain alkyl,

R^{8c} is the same or different and each represent a substituent represented by one of the following general formulae [9A] to [9E]:



[9A] [9B] [9C] [9D] [9E]

wherein

* represents a binding position, and

R^{9} represents long-chain alkyl and/or long-chain alkenyl,

R^{8d} is the same or different and each represent a hydrogen atom, a halogen, long-chain alkyl optionally substituted with 1 to 13 halogens, or long-chain alkyloxy optionally substituted with 1 to 13 halogens,

R^{8e} represents

(1) long-chain alkyl,

(2) long-chain alkyl-carbonyl, or

(3) benzoyl substituted with 1 to 5 long-chain alkyloxy and/or long-chain alkenyloxy, and

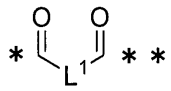
R^{8f} represents

(1) long-chain alkyl,

(2) long-chain alkyl-carbonyl, or

(3) long-chain alkenyl-carbonyl, and

L represents a substituent represented by general formula [10]:



[10]

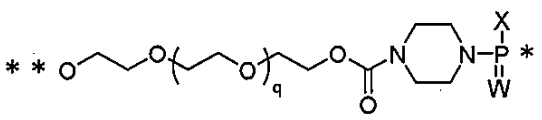
wherein

* represents a binding position with Z,

** represents a binding position with T, and

L^1 represents an optionally substituted C_{2-10} alkylene or an optionally substituted C_{6-10} arylene, and

T represents a single bond or a substituent group represented by general formula [11]:



[11]

wherein

X and W are as defined above,

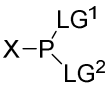
* represents a binding position with O,

** represents a binding position with G, and

q represents an integer from 0 to 10,

provided that T is a single bond when G is a silyl substituent,

is reacted with a compound of general formula [P]:

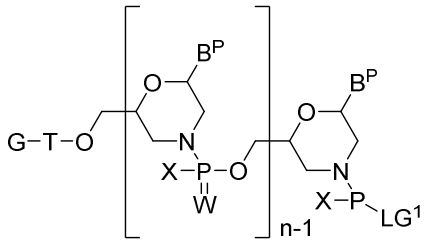


[P]

wherein X is as defined above,

LG^1 and LG^2 are the same or different and represent a halogen,

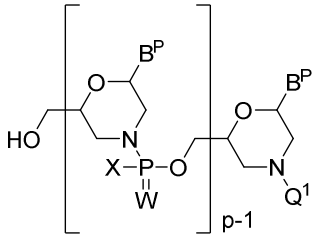
to form a compound of general formula [A-1-3]:



[A-1-3]

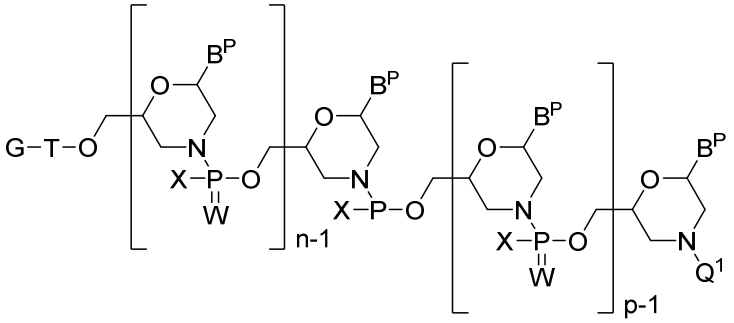
wherein n, B^P, W, X, G, T and LG^1 are as defined above, and

Step 2') the compound of general formula [A-1-3] is reacted with a compound of general formula [B-1-1]:



[B-1-1]

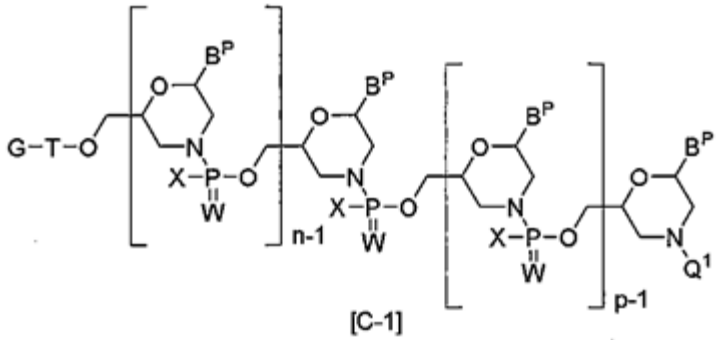
wherein p, B^P, W, and X are as defined above, and Q^1 represents a removable group under an acidic condition, to form a compound of general formula [C-1-1]:



[C-1-1]

wherein n, p, B^P, Q^1, G, T, W, and X are as defined above.

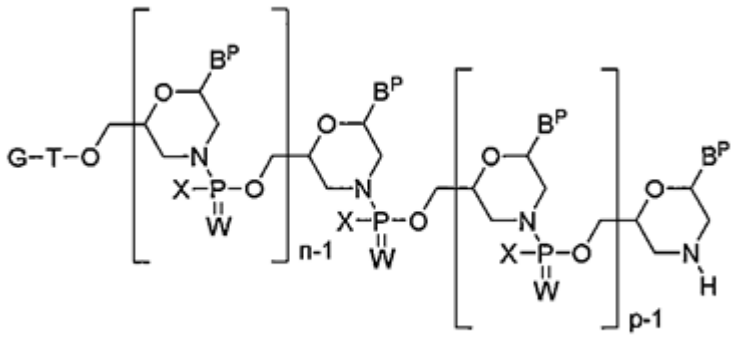
3. The method according to claim 1 or 2, comprising further a step wherein the compound of general formula [C-1-1] formed by the method according to claim 1 or 2, is treated with an oxidizing agent to form a compound of general formula [C-1]:



[C-1]

wherein n, p, B^P, Q^1, G, T, W, and X are as defined in claims 1 and 2.

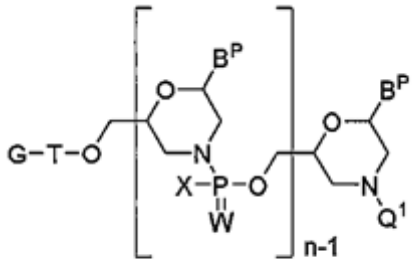
4. The method according to claim 1 or 2, comprising further a step wherein a continuous reaction to remove Q^1 in situ is carried out by adding a solution containing an acid to a reaction mixture containing the compound [C-1] formed by the method according to claim 3, to form a compound of general formula [E-1]:



[E-1]

wherein n, p, B^P, Q^1, G, T, W, and X are as defined in claims 1 and 2.

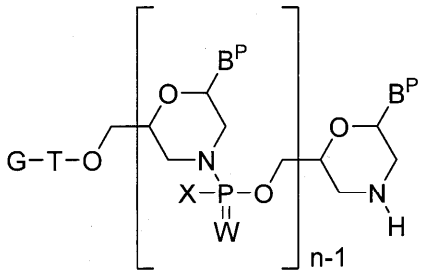
5. The method according to claim 1 or 2, comprising further removing Q^1 from the compound [A-1-1]:



[A-1-1]

wherein n, B^P, Q^1, G, T, W, and X are as defined in claims 1 and 2,

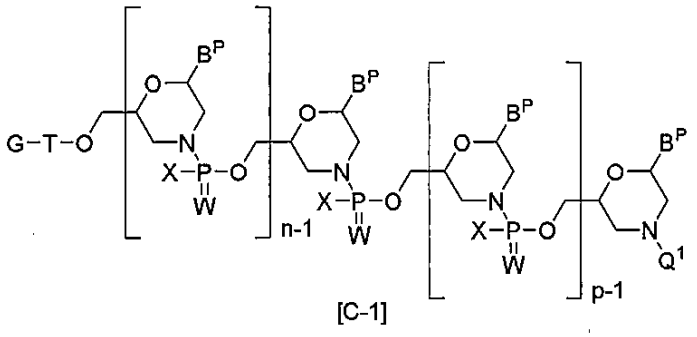
to form a compound of general formula [A-1]:



[A-1]

wherein B^P, W, X, G, T and n are as defined above.

6. A method for producing a compound of general formula [C-1]:



[C-1]

wherein

each B^P is the same or different and represents an

optionally protected nucleic acid base,

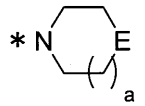
n is an integer from 1 to 50,

p represents an integer from 1 to 10,

Q^1 represents a removable group under an acidic condition,

each W is the same or different and represents an oxygen atom or a sulfur atom,

each X is the same or different and represents a hydroxyl group substituted with a removable group under a neutral condition, 1,1,3,3-tetra(C_{1-6} alkyl)guanidyl, C_{1-6} alkoxy, di(C_{1-6} alkyl)amino, mono(amino-C_{1-6} alkyl substituted with a removable group under a basic condition)amino, di(amino-C_{1-6} alkyl substituted with a removable group under a basic condition)amino, or a substituent represented by general formula [2]:



[2]

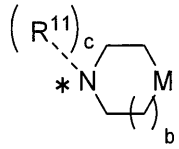
wherein

* represents a binding position with a phosphorus atom,

a represents an integer from 0 to 2,

E represents CH_2, CH-A^1, or N-A^2,

A^1 represents C_{1-6} alkyl, mono(C_{1-6} alkyl)amino-C_{1-6} alkyl substituted with a removable group under a basic condition, di(C_{1-6} alkyl)amino-C_{1-6} alkyl, tri(C_{1-6} alkyl)ammonio-C_{1-6} alkyl, amino substituted with a removable group under a basic condition, mono(C_{1-6} alkyl)amino substituted with a removable group under a basic condition, di(C_{1-6} alkyl)amino, tri(C_{1-6} alkyl)ammonio, amino substituted with amidino substituted with a removable group under a basic condition, or a substituent represented by general formula [3]:



[3]

wherein

* represents a binding position with E,

b represents an integer from 0 to 2,

c represents 0 or 1,

R^{11} represents C_{1-6} alkyl, and

M represents CH_2, an oxygen atom, a sulfur atom, or N-(a removable group under a basic condition), and

A^2 represents C_{1-6} alkyl, mono(C_{1-6} alkyl)amino-C_{1-6} alkyl substituted with a removable group under a basic condition, di(C_{1-6} alkyl)amino-C_{1-6} alkyl, tri(C_{1-6} alkyl)ammonio-C_{1-6} alkyl, a removable group under a basic condition, aryl, or heteroaryl,

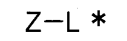
G represents

(1) a silyl substituent,

(2) long-chain alkyl-carbonyl,

(3) benzoyl substituted with 1 to 5 long-chain alkyloxy and/or long-chain alkenyloxy, or

(4) a substituent represented by the following general formula [7]:



[7]

wherein

* represents a binding position with T,

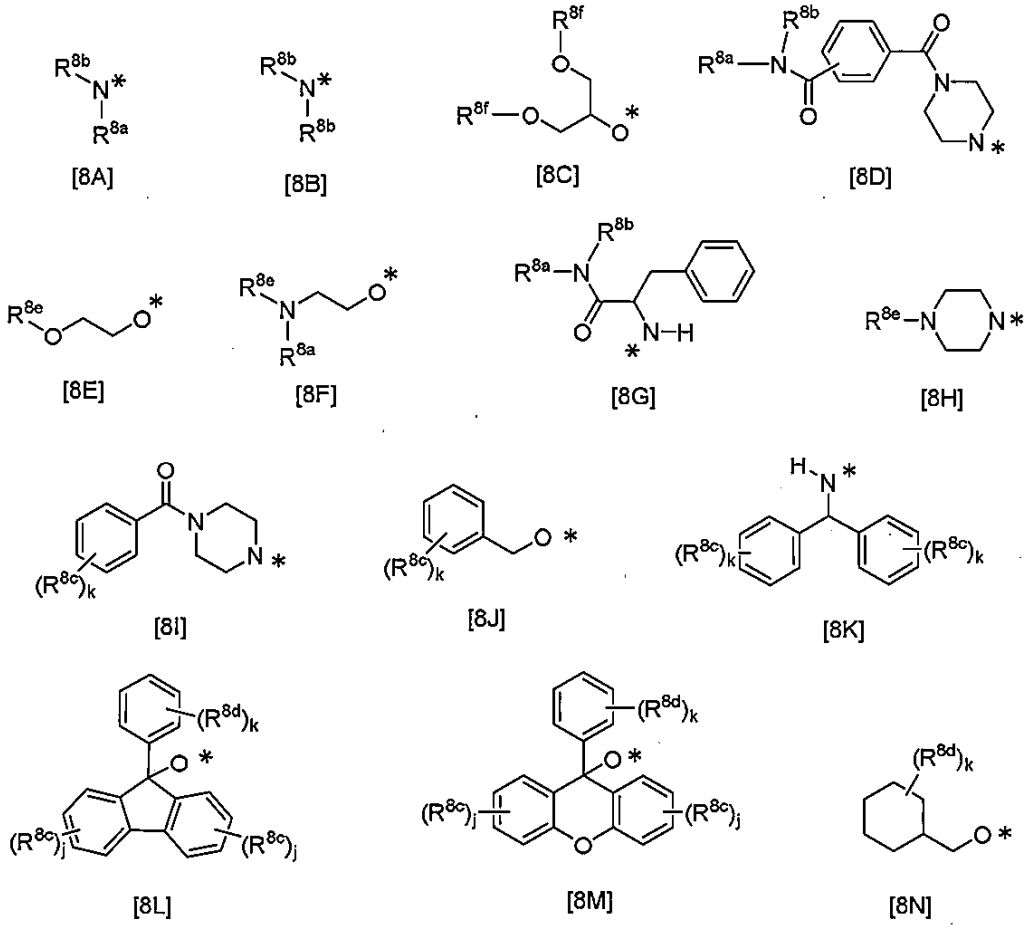
Z represents

(1) (soluble polymer soluble in an organic solvent)-oxy,

(2) (soluble polymer soluble in an organic solvent)-amino,

(3) long-chain alkyloxy, or

(5) a substituent represented by one of the following general formulae [8A] to [8N]:



wherein

* represents a binding position with L,

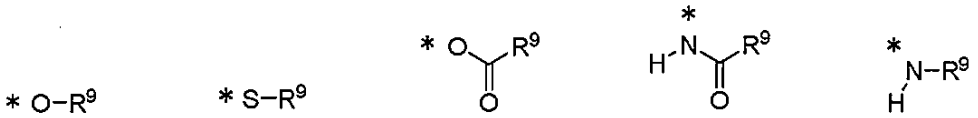
j represents an integer from 0 to 4,

k represents an integer from 0 to 5,

R^{8a} represents a hydrogen atom or C_{1-6} alkyl,

R^{8b} is the same or different and each represent long-chain alkyl,

R^{8c} is the same or different and each represent a substituent represented by one of the following general formulae [9A] to [9E]:



[9A] [9B] [9C] [9D] [9E]

wherein

* represents a binding position, and

R^9 represents long-chain alkyl and/or long-chain alkenyl,

R^{8d} is the same or different and each represent a hydrogen atom, a halogen, long-chain alkyl optionally substituted with 1 to 13 halogens, or long-chain alkyloxy optionally substituted with 1 to 13 halogens,

R^{8e} represents

(1) long-chain alkyl,

(2) long-chain alkyl-carbonyl, or

(3) benzoyl substituted with 1 to 5 long-chain alkyloxy and/or long-chain alkenyloxy, and

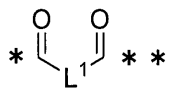
R^{8f} represents

(1) long-chain alkyl,

(2) long-chain alkyl-carbonyl, or

(3) long-chain alkenyl-carbonyl, and

L represents a substituent represented by general formula [10]:



[10]

wherein

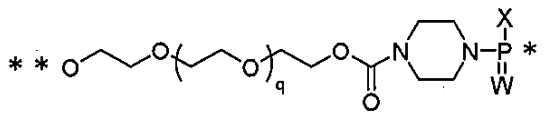
* represents a binding position with Z,

** represents a binding position with T, and

L^1 represents an optionally substituted C_{2-10} alkylene or an optionally substituted C_{6-10}

arylene, and

T represents a single bond or a substituent group represented by general formula [11]:



[11]

wherein

X and W are as defined above,

* represents a binding position with O,

** represents a binding position with G, and

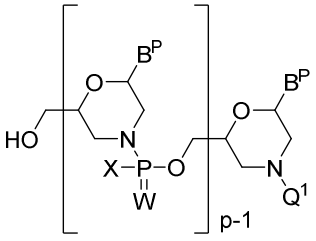
q represents an integer from 0 to 10,

provided that T is a single bond when G is a silyl substituent,

wherein the method comprises

Step 1)

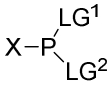
a compound of general formula [B-1-1]:



[B-1-1]

wherein p, B^P, Q^1, W, and X are as defined above,

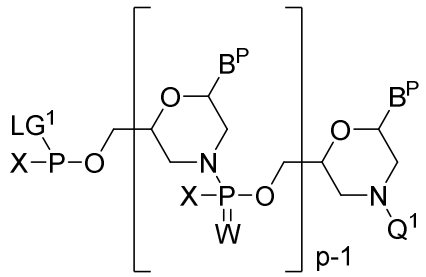
is reacted with a compound of general formula [P]:



[P]

wherein X is as defined above, and LG^1 and LG^2 are the same or different and represent a halogen,

to form a compound of general formula [B-1-2]:

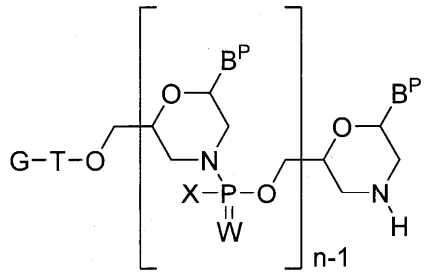


[B-1-2]

wherein p, B^P, Q^1, W, X and LG^1 are as defined above,

Step 2)

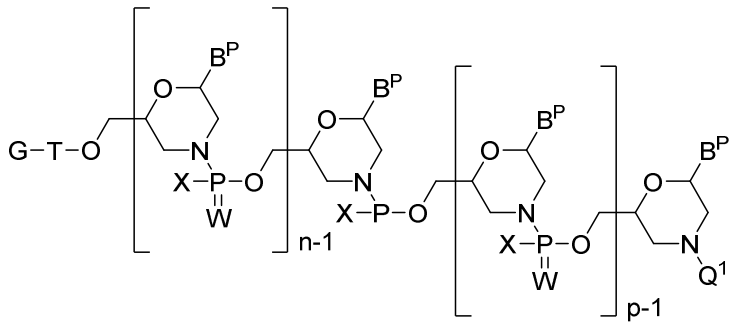
the compound of general formula [B-1-2] is reacted with a compound of general formula [A-1]:



[A-1]

wherein n, B^P, G, T, W and X are as defined above,

to form a compound of general formula [C-1-1]:



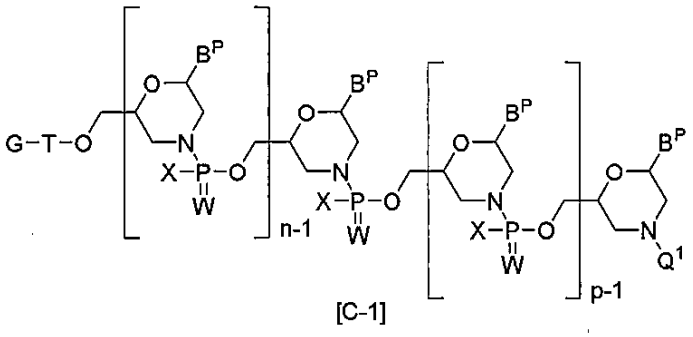
[C-1-1]

wherein n, p, B^P, Q^1, G, T, W, and X are as defined above, and

Step 3)

the compound of general formula [C-1-1] is treated with an oxidizing agent.

7. A method for producing a compound of general formula [C-1]:



[C-1]

wherein

each B^P is the same or different and represents an optionally protected nucleic acid base,

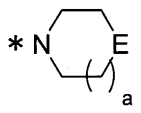
n is an integer from 1 to 50,

p represents an integer from 1 to 10,

Q^1 represents a removable group under an acidic condition,

each W is the same or different and represents an oxygen atom or a sulfur atom,

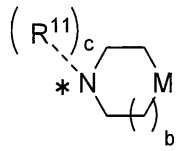
each X is the same or different and represents a hydroxyl group substituted with a removable group under a neutral condition, 1,1,3,3-tetra(C_{1-6} alkyl)guanidyl, C_{1-6} alkoxy, di(C_{1-6} alkyl)amino, mono(amino-C_{1-6} alkyl substituted with a removable group under a basic condition)amino, di(amino-C_{1-6} alkyl substituted with a removable group under a basic condition)amino, or a substituent represented by general formula [2]:



[2]

wherein

* represents a binding position with a phosphorus atom,
a represents an integer from 0 to 2,
E represents CH_2, CH–A^1, or N–A^2,
A^1 represents C_{1-6} alkyl, mono(C_{1-6} alkyl)amino–C_{1-6} alkyl substituted with a removable group under a basic condition, di(C_{1-6} alkyl)amino–C_{1-6} alkyl, tri(C_{1-6} alkyl)ammonio–C_{1-6} alkyl, amino substituted with a removable group under a basic condition, mono(C_{1-6} alkyl)amino substituted with a removable group under a basic condition, di(C_{1-6} alkyl)amino, tri(C_{1-6} alkyl)ammonio, amino substituted with amidino substituted with a removable group under a basic condition, or a substituent represented by general formula [3]:



[3]

wherein

* represents a binding position with E,

b represents an integer from 0 to 2,

c represents 0 or 1,

R^{11} represents C_{1-6} alkyl, and

M represents CH_2, an oxygen atom, a sulfur atom, or N–(a removable group under a basic condition), and

A^2 represents C_{1-6} alkyl, mono(C_{1-6} alkyl)amino–C_{1-6} alkyl substituted with a removable group under a basic condition, di(C_{1-6} alkyl)amino–C_{1-6} alkyl, tri(C_{1-6} alkyl)ammonio–C_{1-6} alkyl, a removable group under a basic condition, aryl, or heteroaryl,

G represents

(1) a silyl substituent,

(2) long-chain alkyl-carbonyl,

(3) benzoyl substituted with 1 to 5 long-chain alkyloxy and/or long-chain alkenyloxy, or

(4) a substituent represented by the following general

formula [7]:



[7]

wherein

* represents a binding position with T,

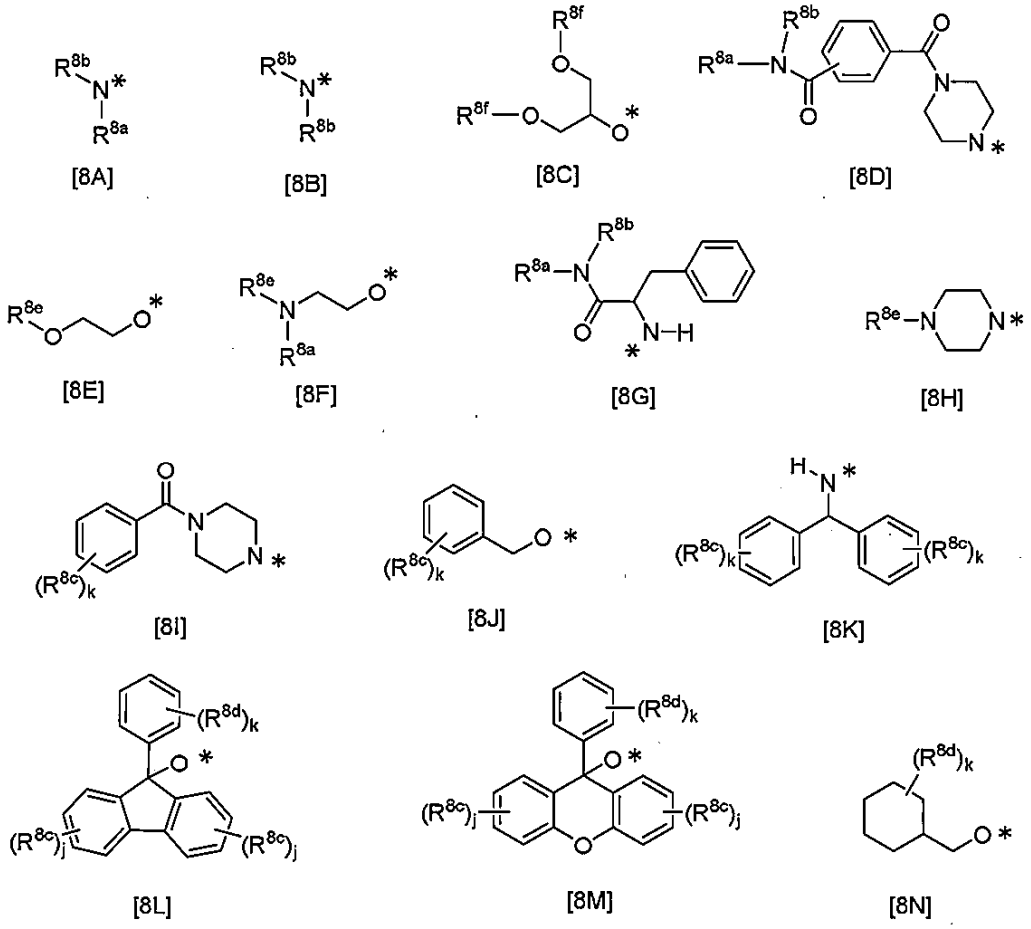
Z represents

(1) (soluble polymer soluble in an organic solvent)-oxy,

(2) (soluble polymer soluble in an organic solvent)-amino,

(3) long-chain alkyloxy, or

(5) a substituent represented by one of the following general formulae [8A] to [8N]:



wherein

* represents a binding position with L,

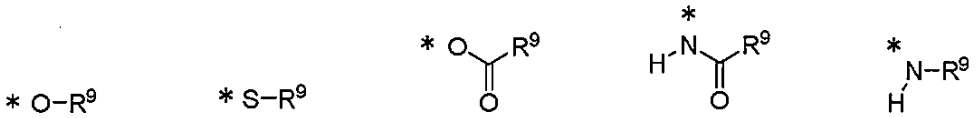
j represents an integer from 0 to 4,

k represents an integer from 0 to 5,

R^{8a} represents a hydrogen atom or C_{1-6} alkyl,

R^{8b} is the same or different and each represent long-chain alkyl,

R^{8c} is the same or different and each represent a substituent represented by one of the following general formulae [9A] to [9E]:



[9A] [9B] [9C] [9D] [9E]

wherein

* represents a binding position, and

R^9 represents long-chain alkyl and/or long-chain alkenyl,

R^{8d} is the same or different and each represent a hydrogen atom, a halogen, long-chain alkyl optionally substituted with 1 to 13 halogens, or long-chain alkyloxy optionally substituted with 1 to 13 halogens,

R^{8e} represents

(1) long-chain alkyl,

(2) long-chain alkyl-carbonyl, or

(3) benzoyl substituted with 1 to 5 long-chain alkyloxy and/or long-chain alkenyloxy, and

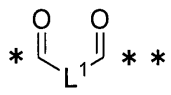
R^{8f} represents

(1) long-chain alkyl,

(2) long-chain alkyl-carbonyl, or

(3) long-chain alkenyl-carbonyl, and

L represents a substituent represented by general formula [10]:



[10]

wherein

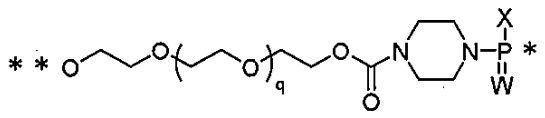
* represents a binding position with Z,

** represents a binding position with T, and

L^1 represents an optionally substituted C_{2-10} alkylene or an optionally substituted C_{6-10}

arylene, and

T represents a single bond or a substituent group represented by general formula [11]:



[11]

wherein

X and W are as defined above,

* represents a binding position with O,

** represents a binding position with G, and

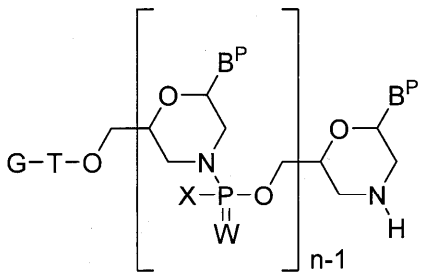
q represents an integer from 0 to 10,

provided that T is a single bond when G is a silyl substituent,

wherein the method comprises

Step 1')

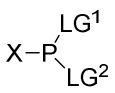
the compound of general formula [A-1]:



[A-1]

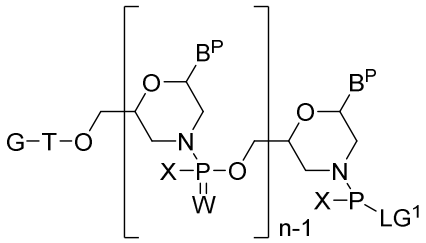
wherein n, B^P, W, X, G and T are as defined above,

is reacted with a compound of general formula [P]:



[P]

wherein X is as defined above, and LG^1 and LG^2 are the same or different and represent a halogen,
to form a compound of general formula [A-1-3]:

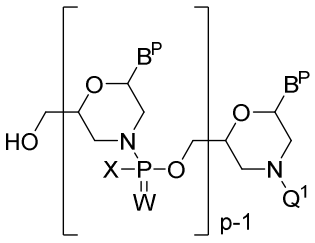


[A-1-3]

wherein n, B^P, W, X, G, T and LG^1 are as defined above,

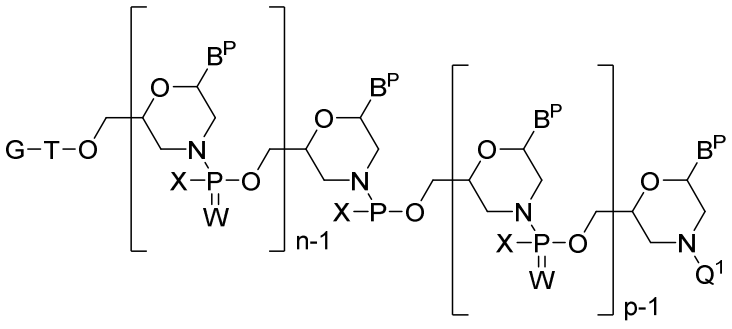
Step 2')

the compound of general formula [A-1-3] is reacted with a compound of general formula [B-1-1]:



[B-1-1]

wherein p, B^P, Q^1, W and X are as defined above,
to form a compound of general formula [C-1-1]:



[C-1-1]

wherein n, p, B^P, Q^1, G, T, W, and X are as defined above, and

Step 3')

the compound [C-1-1] is treated with an oxidizing agent.

8. The method according to any one of claims 1, 3, 4, 5 or 6, wherein the method comprises

supplying a solution containing a compound of general formula [A-1] and a solution containing a compound of general formula [B-1-2] to a flow reactor to form a compound of general formula [C-1-1].

9. The method according to any one of claims 2, 3, 4, 5 or 7, wherein the method comprises

supplying a solution containing a compound of general formula [A-1-3] and a solution containing a compound of general formula [B-1-1] to a flow reactor to form a compound of general formula [C-1-1].

10. The method according to claim 6, wherein the method comprises

supplying a solution containing a compound of general formula [B-1-1] and a solution containing a compound of general formula [P] to a flow reactor to form a compound of general formula [B-1-2], and

supplying a solution containing the compound of general formula [A-1] and a solution containing a compound of general formula [B-1-2] to a subsequent flow reactor to form a compound of general formula [C-1-1].

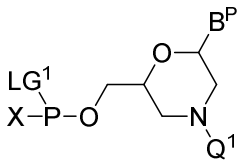
11. The method according to claim 7, wherein the method comprises

supplying a solution containing a compound of general formula [A-1] and a solution containing a compound of general formula [P] to a flow reactor to form a compound of general formula [A-1-3], and

supplying a solution containing the compound of general

formula [A-1-3] and a solution containing a compound of general formula [B-1-1] to a subsequent flow reactor to form a compound of general formula [C-1-1].

12. A method for producing a compound of general formula [B-0-1]:



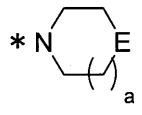
[B-0-1]

wherein

each B^P is the same or different and represents an optionally protected nucleic acid base,

Q^1 represents a removable group under an acidic condition,

each X is the same or different and represents a hydroxyl group substituted with a removable group under a neutral condition, 1,1,3,3-tetra(C_{1-6} alkyl)guanidyl, C_{1-6} alkoxy, di(C_{1-6} alkyl)amino, mono(amino-C_{1-6} alkyl substituted with a removable group under a basic condition)amino, di(amino-C_{1-6} alkyl substituted with a removable group under a basic condition)amino, or a substituent represented by general formula [2]:



[2]

wherein

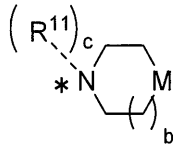
* represents a binding position with a phosphorus atom,

a represents an integer from 0 to 2,

E represents CH_2, CH-A^1, or N-A^2,

A^1 represents C_{1-6} alkyl, mono(C_{1-6} alkyl)amino-C_{1-6} alkyl substituted with a removable group under a basic condition,

di(C_{1-6} alkyl)amino-C_{1-6} alkyl, tri(C_{1-6} alkyl)ammonio-C_{1-6} alkyl, amino substituted with a removable group under a basic condition, mono(C_{1-6} alkyl)amino substituted with a removable group under a basic condition, di(C_{1-6} alkyl)amino, tri(C_{1-6} alkyl)ammonio, amino substituted with amidino substituted with a removable group under a basic condition, or a substituent represented by general formula [3]:



[3]

wherein

* represents a binding position with E,

b represents an integer from 0 to 2,

c represents 0 or 1,

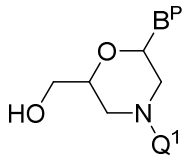
R^{11} represents C_{1-6} alkyl, and

M represents CH_2, an oxygen atom, a sulfur atom, or N-(a removable group under a basic condition), and

A^2 represents C_{1-6} alkyl, mono(C_{1-6} alkyl)amino-C_{1-6} alkyl substituted with a removable group under a basic condition, di(C_{1-6} alkyl)amino-C_{1-6} alkyl, tri(C_{1-6} alkyl)ammonio-C_{1-6} alkyl, a removable group under a basic condition, aryl, or heteroaryl,

LG^1 represents a halogen,

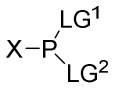
wherein the method comprises reacting a compound of general formula [B-0]:



[B-0]

wherein B^P and Q^1 are as defied above,

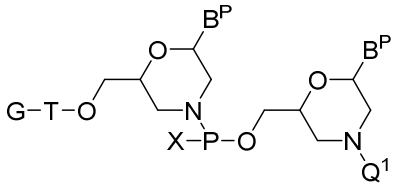
with a compound of general formula [P]:



[P]

wherein X and LG^1 are as defined above, and LG^2 represents a halogen.

13. A method for producing a compound of general formula [C-0-1]:



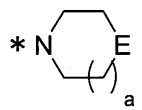
[C-0-1]

wherein

each B^P is the same or different and represents an optionally protected nucleic acid base,

Q^1 represents a removable group under an acidic condition,

X represents a hydroxyl group substituted with a removable group under a neutral condition, 1,1,3,3-tetra(C_{1-6} alkyl)guanidyl, C_{1-6} alkoxy, di(C_{1-6} alkyl)amino, mono(amino-C_{1-6} alkyl substituted with a removable group under a basic condition)amino, di(amino-C_{1-6} alkyl substituted with a removable group under a basic condition)amino, or a substituent represented by general formula [2]:



[2]

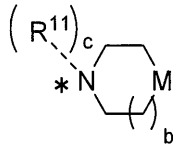
wherein

* represents a binding position with a phosphorus atom,

a represents an integer from 0 to 2,

E represents CH_2, CH–A^1, or N–A^2,

A^1 represents C_{1-6} alkyl, mono(C_{1-6} alkyl)amino–C_{1-6} alkyl substituted with a removable group under a basic condition, di(C_{1-6} alkyl)amino–C_{1-6} alkyl, tri(C_{1-6} alkyl)ammonio–C_{1-6} alkyl, amino substituted with a removable group under a basic condition, mono(C_{1-6} alkyl)amino substituted with a removable group under a basic condition, di(C_{1-6} alkyl)amino, tri(C_{1-6} alkyl)ammonio, amino substituted with amidino substituted with a removable group under a basic condition, or a substituent represented by general formula [3]:



[3]

wherein

* represents a binding position with E,

b represents an integer from 0 to 2,

c represents 0 or 1,

R^{11} represents C_{1-6} alkyl, and

M represents CH_2, an oxygen atom, a sulfur atom, or N–(a removable group under a basic condition), and

A^2 represents C_{1-6} alkyl, mono(C_{1-6} alkyl)amino–C_{1-6} alkyl substituted with a removable group under a basic condition, di(C_{1-6} alkyl)amino–C_{1-6} alkyl, tri(C_{1-6} alkyl)ammonio–C_{1-6} alkyl, a removable group under a basic condition, aryl, or heteroaryl,

G represents

(1) a silyl substituent,

(2) long-chain alkyl-carbonyl,

(3) benzoyl substituted with 1 to 5 long-chain alkyloxy and/or long-chain alkenyloxy, or

(4) a substituent represented by the following general formula [7]:

Z–L *

[7]

wherein

* represents a binding position with T,

Z represents

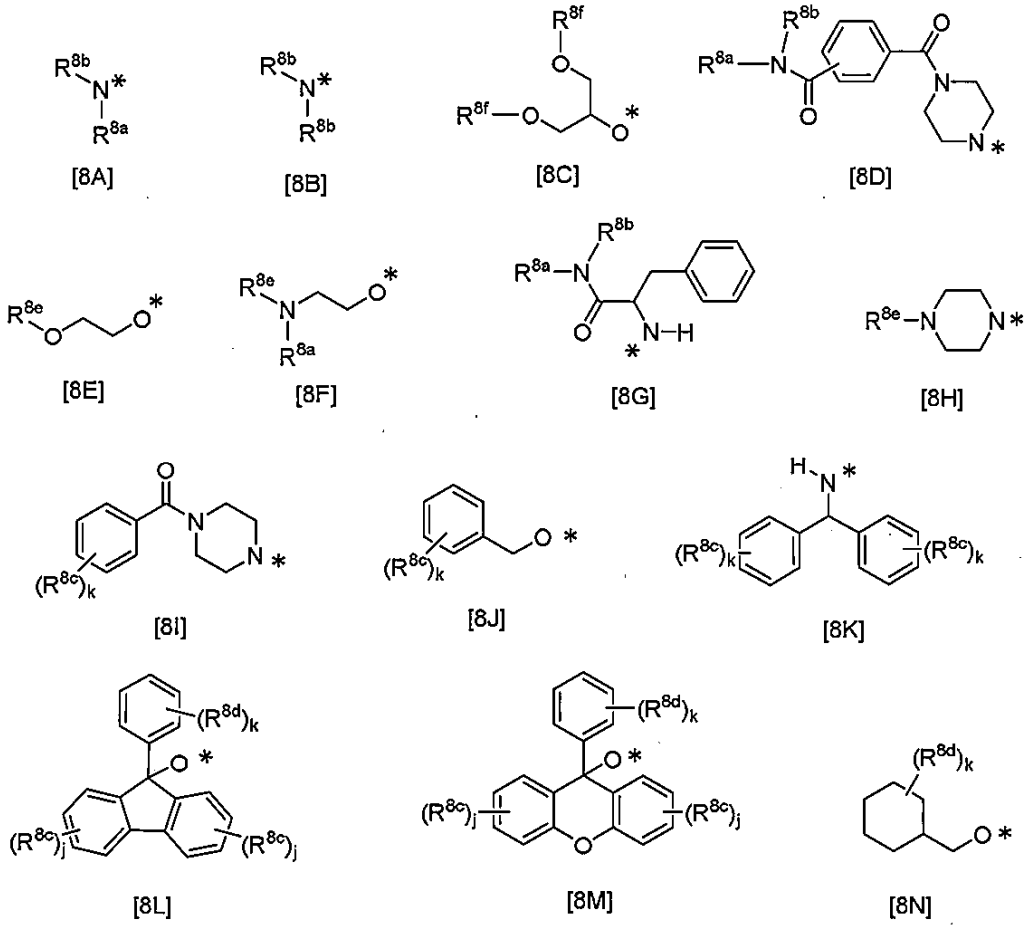
(1) (soluble polymer soluble in an organic solvent)-oxy,

(2) (soluble polymer soluble in an organic solvent)-amino,

(3) long-chain alkyloxy,

(4) a solid phase carrier, or

(5) a substituent represented by one of the following general formulae [8A] to [8N]:



wherein

* represents a binding position with L,

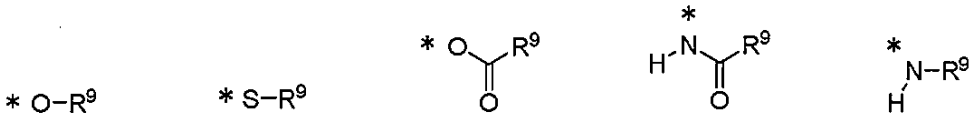
j represents an integer from 0 to 4,

k represents an integer from 0 to 5,

R^{8a} represents a hydrogen atom or C_{1-6} alkyl,

R^{8b} is the same or different and each represent long-chain alkyl,

R^{8c} is the same or different and each represent a substituent represented by one of the following general formulae [9A] to [9E]:



[9A] [9B] [9C] [9D] [9E]

wherein

* represents a binding position, and

R^9 represents long-chain alkyl and/or long-chain alkenyl,

R^{8d} is the same or different and each represent a hydrogen atom, a halogen, long-chain alkyl optionally substituted with 1 to 13 halogens, or long-chain alkyloxy optionally substituted with 1 to 13 halogens,

R^{8e} represents

(1) long-chain alkyl,

(2) long-chain alkyl-carbonyl, or

(3) benzoyl substituted with 1 to 5 long-chain alkyloxy and/or long-chain alkenyloxy, and

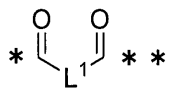
R^{8f} represents

(1) long-chain alkyl,

(2) long-chain alkyl-carbonyl, or

(3) long-chain alkenyl-carbonyl, and

L represents a substituent represented by general formula [10]:



[10]

wherein

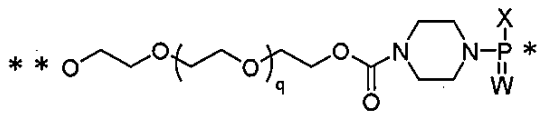
* represents a binding position with Z,

** represents a binding position with T, and

L^1 represents an optionally substituted C_{2-10} alkylene or an optionally substituted C_{6-10}

arylene, and

T represents a single bond or a substituent group represented by general formula [11]:



[11]

wherein

X and W are as defined above,

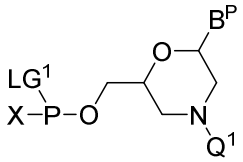
* represents a binding position with O,

** represents a binding position with G, and

q represents an integer from 0 to 10,

provided that T is a single bond when G is a silyl substituent,

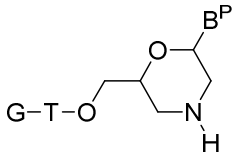
wherein the method comprises reacting a compound of general formula [B-0-1]:



[B-0-1]

wherein B^P, Q^1, and X are as defied above, and LG^1 represents a halogen,

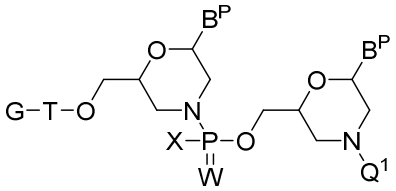
with a compound of general formula [A-0]:



[A-0]

wherein B^P, G and T are as defined above.

14. A method for producing a compound of general formula [C-0]:



[C-0]

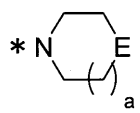
wherein

each B^P is the same or different and represents an optionally protected nucleic acid base,

Q^1 represents a removable group under an acidic condition,

each W is the same or different and represents an oxygen atom or a sulfur atom,

X represents a hydroxyl group substituted with a removable group under a neutral condition, 1,1,3,3-tetra(C_{1-6} alkyl)guanidyl, C_{1-6} alkoxy, di(C_{1-6} alkyl)amino, mono(amino-C_{1-6} alkyl substituted with a removable group under a basic condition)amino, di(amino-C_{1-6} alkyl substituted with a removable group under a basic condition)amino, or a substituent represented by general formula [2]:



[2]

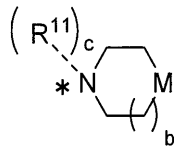
wherein

* represents a binding position with a phosphorus atom,

a represents an integer from 0 to 2,

E represents CH_2, CH–A^1, or N–A^2,

A^1 represents C_{1-6} alkyl, mono(C_{1-6} alkyl)amino–C_{1-6} alkyl substituted with a removable group under a basic condition, di(C_{1-6} alkyl)amino–C_{1-6} alkyl, tri(C_{1-6} alkyl)ammonio–C_{1-6} alkyl, amino substituted with a removable group under a basic condition, mono(C_{1-6} alkyl)amino substituted with a removable group under a basic condition, di(C_{1-6} alkyl)amino, tri(C_{1-6} alkyl)ammonio, amino substituted with amidino substituted with a removable group under a basic condition, or a substituent represented by general formula [3]:



[3]

wherein

* represents a binding position with E,

b represents an integer from 0 to 2,

c represents 0 or 1,

R^{11} represents C_{1-6} alkyl, and

M represents CH_2, an oxygen atom, a sulfur atom, or N–(a removable group under a basic condition), and

A^2 represents C_{1-6} alkyl, mono(C_{1-6} alkyl)amino–C_{1-6} alkyl substituted with a removable group under a basic condition, di(C_{1-6} alkyl)amino–C_{1-6} alkyl, tri(C_{1-6} alkyl)ammonio–C_{1-6} alkyl, a removable group under a basic condition, aryl, or heteroaryl,

G represents

(1) a silyl substituent,

(2) long-chain alkyl-carbonyl,

(3) benzoyl substituted with 1 to 5 long-chain alkyloxy and/or long-chain alkenyloxy, or

(4) a substituent represented by the following general formula [7]:



[7]

wherein

* represents a binding position with T,

Z represents

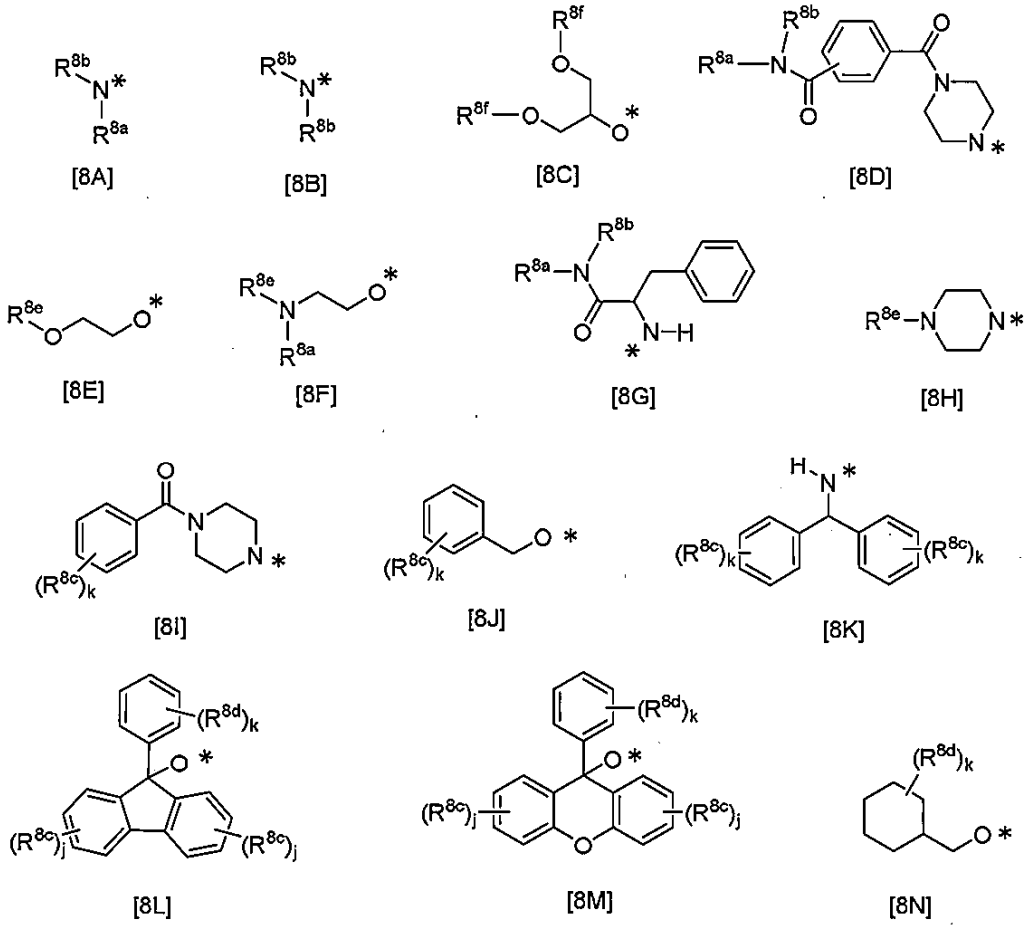
(1) (soluble polymer soluble in an organic solvent)-oxy,

(2) (soluble polymer soluble in an organic solvent)-amino,

(3) long-chain alkyloxy,

(4) a solid phase carrier, or

(5) a substituent represented by one of the following general formulae [8A] to [8N]:



wherein

* represents a binding position with L,

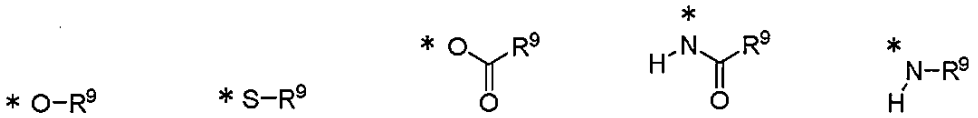
j represents an integer from 0 to 4,

k represents an integer from 0 to 5,

R^{8a} represents a hydrogen atom or C_{1-6} alkyl,

R^{8b} is the same or different and each represent long-chain alkyl,

R^{8c} is the same or different and each represent a substituent represented by one of the following general formulae [9A] to [9E]:



[9A] [9B] [9C] [9D] [9E]

wherein

* represents a binding position, and

R^9 represents long-chain alkyl and/or long-chain alkenyl,

R^{8d} is the same or different and each represent a hydrogen atom, a halogen, long-chain alkyl optionally substituted with 1 to 13 halogens, or long-chain alkyloxy optionally substituted with 1 to 13 halogens,

R^{8e} represents

(1) long-chain alkyl,

(2) long-chain alkyl-carbonyl, or

(3) benzoyl substituted with 1 to 5 long-chain alkyloxy and/or long-chain alkenyloxy, and

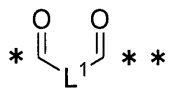
R^{8f} represents

(1) long-chain alkyl,

(2) long-chain alkyl-carbonyl, or

(3) long-chain alkenyl-carbonyl, and

L represents a substituent represented by general formula [10]:



[10]

wherein

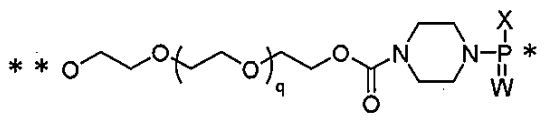
* represents a binding position with Z,

** represents a binding position with T, and

L^1 represents an optionally substituted C_{2-10} alkylene or an optionally substituted C_{6-10}

arylene, and

T represents a single bond or a substituent group represented by general formula [11]:



[11]

wherein

X and W are as defined above,

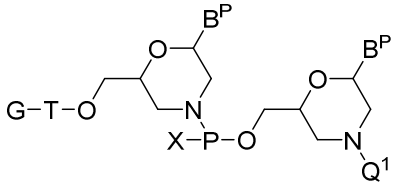
* represents a binding position with O,

** represents a binding position with G, and

q represents an integer from 0 to 10,

provided that T is a single bond when G is a silyl substituent,

wherein the method comprises treating a compound of general formula [C-0-1]:



[C-0-1]

wherein B^P, Q^1, G, T and X are as defined above,
with an oxidizing agent.

15. The method according to any one of claims 1 to 11 and 13 to 14, wherein

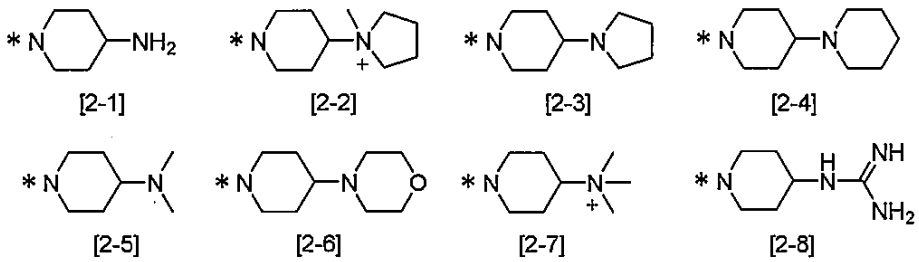
B^P is an optionally protected nucleic acid base,

Q^1 is a removable group under an acidic condition,

W is an oxygen atom or a sulfur atom,

X is di(C_{1-6} alkyl)amino or selected from among

substituents represented by general formulae [2-1] to [2-8]:



wherein * represents a binding position with a phosphorus atom

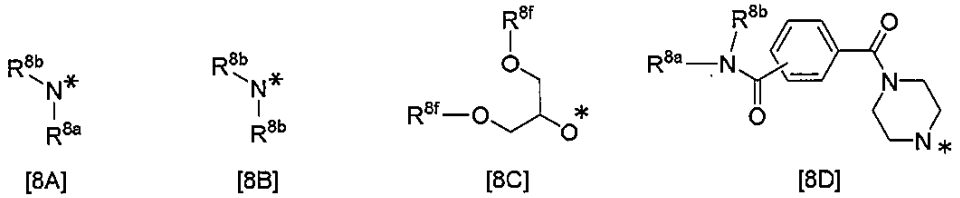
G represents a substituent represented by general formula [7]:


[7]

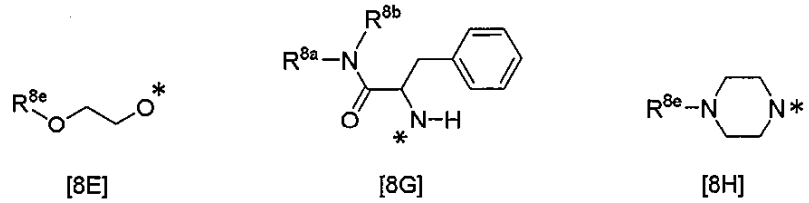
wherein

* represents a binding position with T,

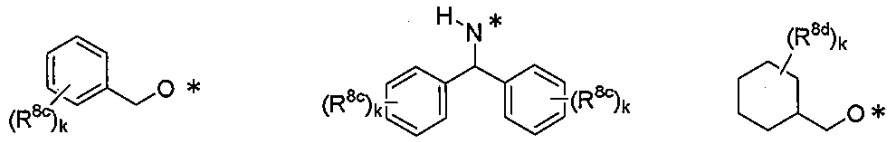
Z is a substituent represented by one of general formulae [8A] to [8D], [8E], [8G], [8H], [8J], [8K], and [8N]:



[8A] [8B] [8C] [8D]



[8E] [8G] [8H]



[8J] [8K] [8N]

wherein

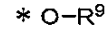
* represents a binding position with L,

k represents an integer from 0 to 5,

R^{8a} represents a hydrogen atom or C_{1-6} alkyl,

R^{8b} is the same or different and each represent long-chain alkyl,

R^{8c} is the same or different and each represent a substituent represented by the following general formula [9A]:



[9A]

wherein

* represents a binding position, and

R^9 represents long-chain alkyl and/or long-chain alkenyl,

R^{8d} is the same or different and each represent a hydrogen atom, a halogen, long-chain alkyl optionally substituted with 1 to 13 halogens, or long-chain alkyloxy optionally substituted with 1 to 13 halogens,

R^{8e} represents

(1) long-chain alkyl,

(2) long-chain alkyl-carbonyl, or

(3) benzoyl substituted with 1 to 5 long-chain alkyloxy and/or long-chain alkenyloxy, and

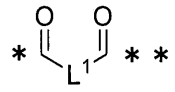
R^{8f} represents

(1) long-chain alkyl,

(2) long-chain alkyl-carbonyl, or

(3) long-chain alkenyl-carbonyl, and

L represents a substituent represented by general formula [10]:



[10]

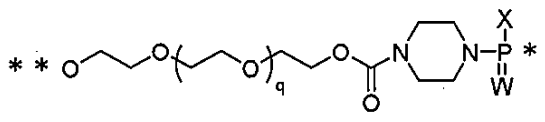
wherein

* represents a binding position with Z,

** represents a binding position with an oxygen atom, and

L^1 represents an optionally substituted C_{2-10} alkylene or an optionally substituted C_{6-10} arylene,

T is a single bond or a substituent represented by the following general formula [11]:



[11]

wherein

X and W are as defined above,

* represents a binding position with O,

** represents a binding position with G, and

q represents an integer from 0 to 10, and

n is 1 to 25.

16. The method according to any one of claims 1 to 11 and 13 to 15, wherein

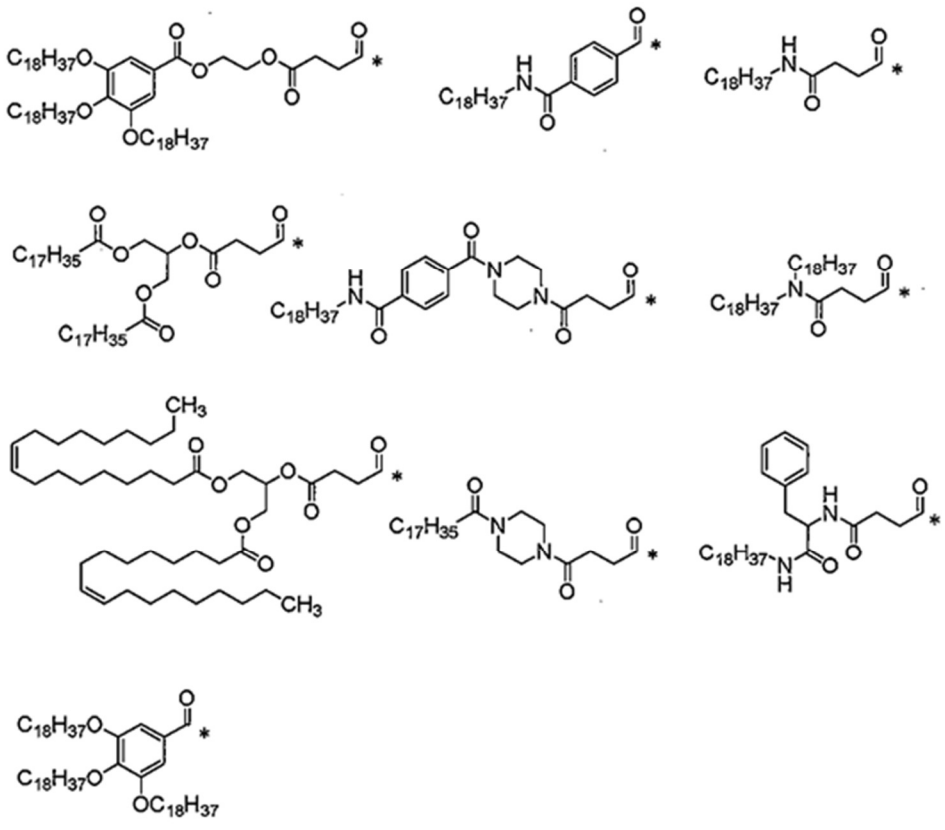
B^P represents an optionally protected nucleic acid base,

Q^1 is H or a removable group under an acidic condition,

W is an oxygen atom,

X is di(C_{1-6} alkyl)amino,

G is selected from the group consisting of the formulae:



wherein * represents a binding position with T,

T is a single bond,

n is an integer from 1 to 25.

17. The method according to any one of claims 4 to 11 and 13

to 16, comprising removing Q^1 from a compound wherein Q^1 is trityl, monomethoxytrityl or dimethoxytrityl, and n, B^P, W, X, G and T are as defined above,
in the presence of trifluoroacetic acid and 2,2,2-trifluoroethanol, and optionally, triisopropylsilane or ethanol.

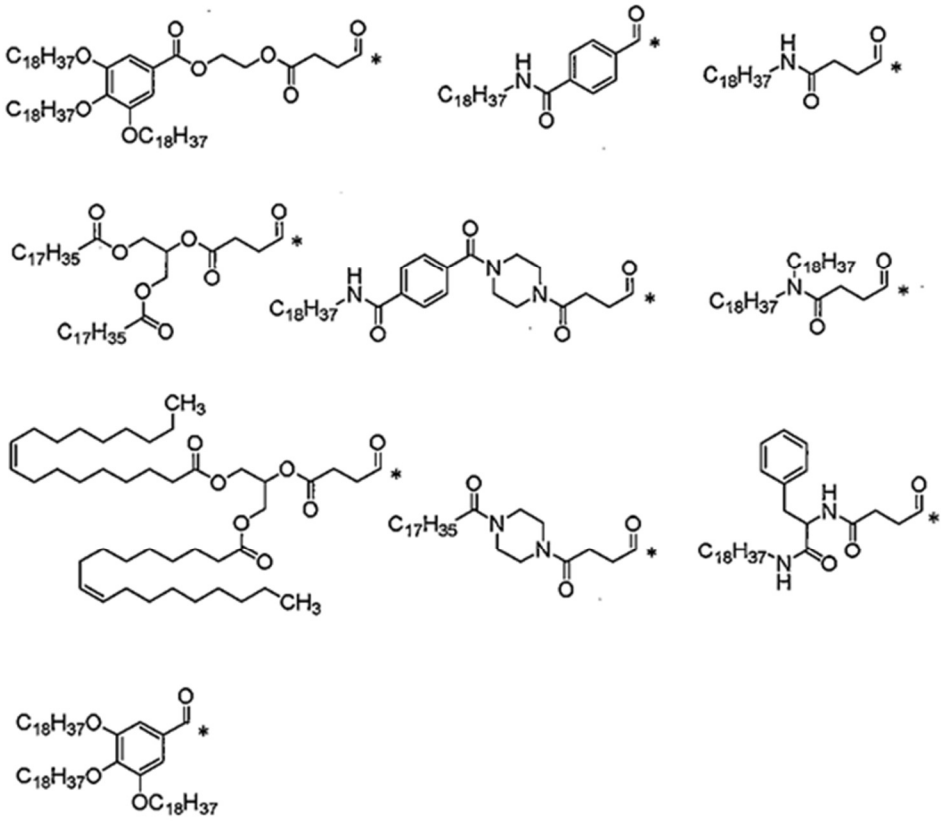
18. The method according to any one of claims 1 to 17, wherein the optionally protected nucleic acid base is independently adenine, guanine, hypoxanthine, cytosine, thymine, uracil or a modified base thereof.

19. The method according to any one of claims 1 to 17, wherein the protected nucleic acid base is a nucleic acid base wherein an amino group and/or a hydroxyl group of the nucleic acid base is protected with a protecting group, and

the protecting group of the amino group is independently selected from the group consisting of benzoyl, 4-methoxybenzoyl, acetyl, propionyl, butylyl, isobutylyl, phenylacetyl, phenoxyacetyl, 4-tert-butylphenoxyacetyl, 4-isopropylphenoxyacetyl, and (dimethylamino)methylene, and

the protecting group of the hydroxy group is independently selected from the group consisting of 2-cyanoethyl, 4-nitrophenethyl, phenylsulfonylethyl, methylsulfonylethyl, trimethylsilylethyl, phenyl optionally substituted with 1 to 5 electron-withdrawing groups at any substitutable positions, diphenylcarbamoyl, dimethylcarbamoyl, diethylcarbamoyl, methylphenylcarbamoyl, 1-pyrolidinylcarbamoyl, morpholinocarbamoyl, 4-(tert-butylcarboxy)benzyl, 4-[(dimethylamino)carboxy]benzyl, and 4-(phenylcarboxy)benzyl.

20. The method according to any one of claims 1 to 11 and 13 to 19, wherein G is selected from the group consisting of the formulae:



wherein * represents a binding position with T, and T is a single bond.

21. The method according to any one of claims 1 to 20, wherein X is di(C_{1-6} alkyl)amino.

22. The method according to any one of claims 1 to 11 and 13 to 21, wherein W is an oxygen atom.

23. The method according to any one of claims 3 to 4, 6 to 7, 10 to 11 and 14, wherein the oxidizing agent is iodine or magnesium monoperoxyphthalate hexahydrate.