(a) P_7 is H or a hydroxyl protecting group, and R_7 and R_8, together with the atoms to which each is attached, combine to form a double bond;

or

(b) P_7 and R_7 combine to form a bond, and R_8 is H or OP";

(i) each P_6 is independently H or a hydroxyl protecting group, or both P_6, together with the atoms to which each is attached, combine to form a ketal or acetal; X is =O or X combines with the carbon atom, to which it is attached, to form $-(CH(OP_9))-$, where P_9 is H or a hydroxyl protecting group; and each R_{11} is $-OP_{10}$, or both R_{11} combine to form oxo, where P_{10} is alkyl or a hydroxyl protecting group;

(ii) both P_6 and X, together with the atoms to which each is attached, combine to form ketal, P_7 and R_7 combine to form a bond, and R_8 is H or OP"; and each R_{11} is $-OP_{10}$, or both R_{11} combine to form oxo, where P_{10} is alkyl or a hydroxyl protecting group; or

(iii) both P_6 and both R_{11}, together with the atoms to which they are attached, combine to form acetal; and X is =O or X combines with the carbon atom, to which it is attached, to form $-(CH(OP_9))-$, where P_9 is H or a hydroxyl protecting group;

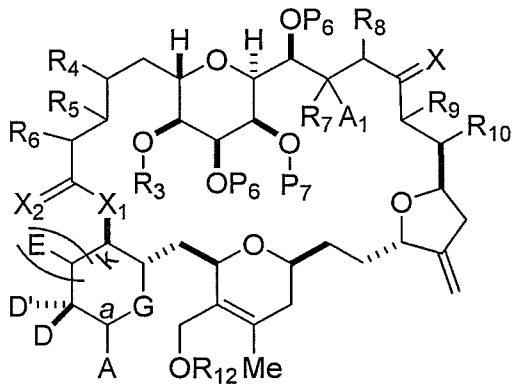
R_9 is H, OP", SO_2R_c or $COOR_c$, , and R_{10} is H; or R_9 and R_{10}, together with the atoms to which each is attached, combine to form a double bond;

each P", when present, is independently H or a hydroxyl protecting group; and

P_8 is H or silyl;

and

the compound of formula (IB) is of the following structure:



(IB)

or a salt or a tautomer thereof;

where

R_{12} is optionally substituted acyl; and

(B) producing the halichondrin macrolide or the analog thereof from compound (IB).

In certain embodiments, producing the compound of formula (IB) includes reacting the compound of formula (IA) with $R_{12}OH$ and a Lewis acid (e.g., an oxophilic Lewis acid (e.g., boron trifluoride or a solvate thereof). In particular embodiments, producing the halichondrin macrolide or the analog thereof includes reacting the compound of formula (IB) with an allylic reducing agent. In further embodiments, R_3 and R_5 combine to form a bond, and each of R_4 and R_6 is H. In some embodiments, R_5 and R_6, together with the

both R_{11} combine to form oxo, where P_{10} is alkyl or a hydroxyl protecting group;

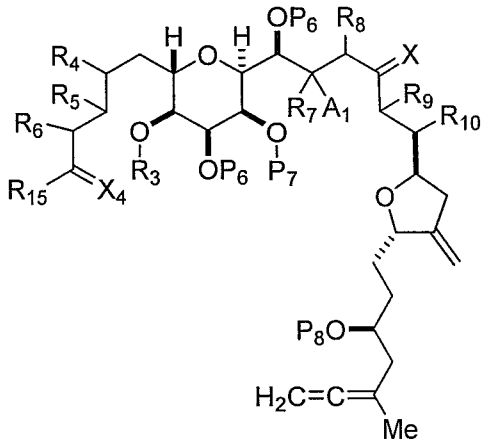
or

(ii) both P_6 and both R_{11}, together with the atoms to which they are attached, combine to form an acetal;

P_7 is a hydroxyl protecting group; and

X_2 is a halogen or pseudohalogen.

The structure of the compound of formula (IN) is as follows:



(IN),

or a salt or tautomer thereof,

where

R_3 and R_5 combine to form a bond, and each of R_4 and R_6 is H; or R_3 is H or a hydroxyl protecting group, R_5 and one of R_4 and R_6, together with the atoms to which each is attached, combine to form a double bond, and the remaining R_4 or R_6 is H;

A_1 and R_7 combine to form oxo, P_7 is H or a hydroxyl protecting group, and R_8 is H;

or

A_1 is H or OP", and:

(i) P_7 is H or a hydroxyl protecting group, and R_7 and R_8, together with the atoms to which each is attached, combine to form a double bond;

or

(ii) P_7 and R_7 combine to form a bond, and R_8 is H or OP";

each P", when present, is independently H or a hydroxyl protecting group;

each P_6 is independently H or a hydroxyl protecting group, or both P_6, together with the atoms to which each is attached, combine to form a ketal or acetal, and X is =O or X combines with the carbon atom, to which it is attached, to form –(CH(OP$_9$))–, where P_9 is H or a hydroxyl protecting group; or both P_6 and X, together with the atoms to which each is attached, combine to form ketal; where, when both P_6 and X, together with the atoms to which each is attached, combine to form ketal, P_7 and R_7 combine to form a bond, and R_8 is H or OP";

R_9 is H, SO_2R_C, or $COOR_C$, and R_{10} is H, wherein, when R_9 is SO_2R_C, R_C is optionally substituted aryl or optionally substituted non-enolizable alkyl, and when R_9 is $COOR_C$, R_C is optionally substituted alkyl, optionally substituted aryl, or optionally substituted arylalkyl; or R_9 and R_{10}, together with the atoms to which each is attached, combine to form a double bond;

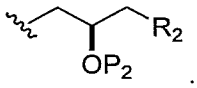
R_{15} is H or $-OP_{11}$, where P_{11} is H, a hydroxyl protecting group, or optionally substituted alkyl;

X_4 is =O or, together with the carbon atom to which it is attached, is $-CH_2-$, provided that when R_{15} is H, X_4 is =O; and

P_8 is H or silyl.

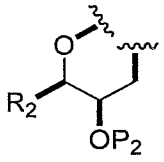
In some embodiments, each P_A is H, or both P_A combine to form a cyclic protected diol. In other embodiments, A_1 is H. In yet other embodiments, each R_{11} is $-OP_{10}$, where P_{10} is alkyl. In still other embodiments, R_9 is H or SO_2R_C, and R_{10} is H. In certain embodiments, R_9 is SO_2R_C.In further embodiments, P_8 is silyl. In particular embodiments, P_6 is a hydroxyl protecting group, and X is =O or X combines with the carbon atom, to which it is attached, to form $-(CH(OP_9))-$. In certain embodiments, R_3 and R_5 combine to form a bond, and each of R_4 and R_6 is H. In further embodiments, R_5 and R_6, together with the atom to which each is attached, combine to form a double bond, R_4 is H, and R_3 is a hydroxyl protecting group. In yet further embodiments, R_7 and P_7 combine to form a bond, and R_8 is H. In still further embodiments, P_7 is a hydroxyl protecting group, and R_7 and R_8, together with the atoms to which each is attached, combine to form a double bond. In certain embodiments, A_3 is H. In particular embodiments, A_2 is H.

In further embodiments, the stereogenic center designated by *a* is (*R*), and A is of the following structure:



In yet further embodiments, k is 0 and X_1 is $-CH_2-$. In still further embodiments, R_2 is $-(CH_2)_nNP_3P_4$ or $-(CH_2)_nOP_5$, wherein n is 0.

In other embodiments, A and D combine to form the following structure:



where, the bond to oxygen atom originates at the carbon atom, to which D is attached in formula (IA), and where R_2 is $-(CH_2)_nNP_3P_4$ or $-(CH_2)_nOP_5$, wherein n is 2.

In yet other embodiments, k is 1, and E is optionally substituted alkyl. In still other embodiments, X_1 is $-O-$.

In certain embodiments of the compound of formula (IA), (IB), (IC), (IE), (IJ), or (IN), k is 0, D is H, D' is OP_1, and A is of the following structure:

