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## Amphidinolide B: Total Synthesis, Structural Investigation and Biological Evaluation

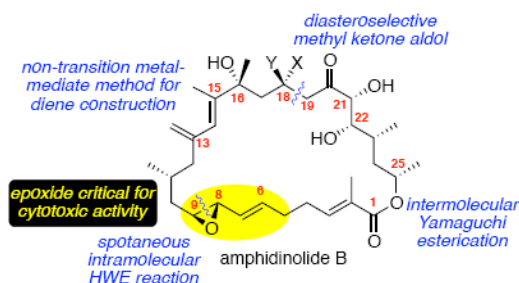
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### Abstract



The total synthesis of amphidinolide B<sub>1</sub> and the proposed structure of amphidinolide B<sub>2</sub> has been accomplished. Key aspects of this work include the development of a practical, non-transition metal mediated method for the construction of the C<sub>13</sub>-C<sub>15</sub> diene, the identification of  $\alpha$ -chelation and dipole minimization models for diastereoselective methyl ketone aldol reactions, the discovery of a spontaneous Horner-Wadsworth-Emmons macrocyclization strategy and the development of a novel late stage method for construction of an allylic epoxide moiety. The originally proposed structure for amphidinolide B<sub>2</sub> and diastereomers thereof display potent anti-tumor activities with IC<sub>50</sub> values ranging from 3.3 nM to 94.5 nM against human solid and blood tumor cells. Of the different stereoisomers, the proposed structure of amphidinolide B<sub>2</sub> is over 12-fold more potent than the C<sub>8,9</sub>-epimer and C<sub>18</sub>-epimer in human DU145 prostate cancer cells. These data suggest that the epoxide stereochemistry is a significant factor for anticancer activity.

### Introduction

First reported in 1986, the amphidinolide family of natural products has long captured the attention of the scientific community.<sup>1</sup> To date, over thirty members of this family have been isolated.<sup>2</sup> Given their fascinating structures and diverse biological activity, these targets have attracted considerable attention in both the synthetic<sup>3,4,5</sup> and biological communities.<sup>6</sup>

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**SUPPORTING INFORMATION.** Copies of <sup>1</sup>H and <sup>13</sup>C spectra for all new compounds are provided. X-ray crystallographic data (CIF) for compound **109** is also provided. This material is available free of charge via the Internet at <http://pubs.acs.org>.

From this diverse broad collection of compounds, the amphidinolide B sub-family possesses some of the most intriguing structural features and biological activity. Kobayashi and co-workers reported the isolation of the 26-membered macrolide (amphidinolide B) from the dinoflagellate *Amphidinium* sp. in small amounts (Figure 1).<sup>2b</sup> The planar original structure was proposed as compound **1**. Subsequent re-isolation by Shimizu and co-workers as well as structure determination through X-ray crystallographic analysis by Clardy and co-workers provided the relative stereochemistry of amphidinolide B (which was renamed amphidinolide B<sub>1</sub>) as compound **2**.<sup>2c</sup> In addition, the location of the methyl moiety of the dienyl system was reassigned to the C<sub>15</sub> position. Absolute configuration of **2** was later established via degradation.<sup>2d</sup> Shimizu and co-workers also reported the isolation of two related members of this family – amphidinolide B<sub>2</sub> (**3**) & B<sub>3</sub> (**4**) and proposed their structures based on analogy to **2** and comparison on NMR spectra. More recently, Kobayashi and co-workers reported the isolation of additional members of this subfamily – amphidinolide B<sub>4</sub> and B<sub>5</sub> (**5** and **6**)<sup>2e</sup> as well as amphidinolides B<sub>6</sub> and B<sub>7</sub> (not shown).<sup>2f</sup> Structurally related amphidinolides G and H [e.g. amphidinolide H<sub>1</sub> (**7**) and amphidinolide G<sub>1</sub> (**8**)] have also been reported.<sup>2p-r</sup> In particular, amphidinolide B<sub>1</sub> (**2**) has proven to be the most cytotoxic member of the amphidinolide family - demonstrating impressive potency in early cancer screening [IC<sub>50</sub> levels: L1210 murine leukemia cell line (0.14 ng/mL),<sup>2b</sup> human colon tumor HCT 116 cell line (0.12 μg/mL)<sup>2c</sup> and KB cancer cell line (4.2 ng/mL)].<sup>1f</sup>

In addition to the intriguing biological activity, macrolide **2** has a compelling architecture – nine stereogenic centers embedded within a 26-membered macrocycle including a reactive allylic epoxide moiety at C<sub>6</sub>-C<sub>9</sub> and a highly substituted diene moiety at C<sub>13</sub>-C<sub>15</sub>. Consequently, this target **2** has attracted considerable synthetic attention from numerous laboratories<sup>7</sup> including our own.<sup>8,9,10</sup> In 2008, we reported the first total synthesis of amphidinolide B<sub>1</sub> (**2**) as well as the proposed structure of amphidinolide B<sub>2</sub> (**3**) which we established to be incorrect.<sup>4</sup> Subsequent to our efforts, Fürstner and coworkers published their synthesis of **2** in 2009<sup>5</sup> and more recently Nishiyama and co-workers completed their total synthesis in 2012.<sup>11</sup> It should be noted that Fürstner reported the first syntheses of related amphidinolides G and H in 2007.<sup>3aa</sup> Herein, we disclose a full account of our work and the biological evaluation of synthesized analogues of amphidinolide B.

## Results and Discussion

Our initial retrosynthetic strategy is shown in Scheme 1. We intended to install the fragile allylic epoxide moiety at a late stage from the corresponding C<sub>7</sub>-C<sub>9</sub> enone motif. Macrolactonization of the corresponding seco acid **9** under Mitsunobu conditions<sup>12</sup> could form the key 26-membered ring system. The C<sub>8</sub>-C<sub>9</sub> bond would be accessible from a HWE olefination with the keto phosphonate **11** and aldehyde **10**. The C<sub>18</sub> stereogenic center could be constructed by a chelation-controlled aldol condensation between aldehyde **12** and α-benzyloxy ketone **13**. The aldehyde **12** would be derived from the styrenyl compound **14** through a regioselective oxidative cleavage. The diene could be accessed from the coupling of an allylic metallo species such as **15** and the methyl ketone **16**.

Synthesis of the nucleophilic components **24-25** and styrenyl compound **16** are shown in Scheme 2. The methyl ketone **16** could be prepared in 4 steps from (*L*)-lactic acid (**17**). Using Seebach chemistry,<sup>13</sup> stereochemistry originally contained in the hydroxyl acid **17** was transferred cleanly to the lactone **20** with high levels of diastereoselectivity. Treatment of the lactone with MeLi yielded the α-hydroxy methyl ketone which was protected as its TES ether **16**. For the nucleophilic component **15**, we envisioned multiple options including phosphonate **25** and Peterson-type approaches (e.g. **24**). Starting from the commercially available oxazolidinone **21** and known iodide **22**,<sup>14</sup> Evans alkylation followed by reduction

and protection generated the allyl silane **24**. Bromination at C<sub>14</sub> using NBS followed by Arbuzov reaction generated the allyl phosphonate **25** in 55% yield over two steps.

With the coupling partners in hand, we envisioned multiple options for their combination (Scheme 3). One of the initial approaches we explored was a phosphonate olefination strategy. Unfortunately, using a range of bases (*n*-BuLi, *t*-BuLi, *s*-BuLi, KHMDs) we were unable to facilitate the olefination. An alternative strategy involving a Peterson olefination could arise at the same target **26**. Anions derived from allyl trimethylsilanes can attack a carbonyl electrophile through either  $\alpha$ -attack or  $\gamma$ -attack.<sup>15</sup> Using conditions developed by Magnus and co-workers,<sup>16</sup> we observed exclusive formation of the vinyl silane product **27** derived from reactivity in the  $\gamma$  position. A modified procedure using MgBr<sub>2</sub><sup>17</sup> failed to override this preference. While the vinyl silane product **27** is in theory still a viable intermediate in the synthesis of the diene **26**, we were unable to facilitate the subsequent conversion to the target diene.<sup>18</sup> We also explored a Sakurai-type approach<sup>19</sup> to C-C bond formation using allyl silane **24**. Treatment of **24** and **16** under a range of Lewis acidic conditions (e.g. TMSOTf, BF<sub>3</sub>•Et<sub>2</sub>O, Me<sub>2</sub>AlCl, AlMe<sub>3</sub>, SnCl<sub>4</sub>) did not provide any of the desired coupled material **28**. Fortunately, treatment with freshly distilled TiCl<sub>4</sub> did facilitate the C<sub>14</sub>-C<sub>15</sub> bond construction in up to 65% yield and 6:1 dr (stereochemistry at C<sub>15</sub> undetermined). While effective, this reaction did prove to be scale dependent (typically providing 50-65% yield at 0.65 mmol scale, but 20-30% yield at 2.0 mmol scale). Despite considerable effort to ascertain the nature of the scale dependence, we were unable to fully address this shortcoming. Consequently, this transformation was often run in parallel batches to bring through sufficient amounts of material. Subsequent elimination of the 3° alcohol **28** was best facilitated using SOCl<sub>2</sub> and pyridine in toluene at -78°C to yield the desired diene in near quantitative yield as a 2.2:1 ratio of diene regioisomers (rr) (**26:29**). The diene rr was not impacted by use of a single C<sub>15</sub> stereoisomer of alcohol **28**. Use of alternate conditions (MsCl, POCl<sub>3</sub>, Tf<sub>2</sub>O, Burgess reagent, Martin's sulfurane) led to no product formation or inferior levels of regioselectivity. While these diene regioisomers **26** and **29** were not readily separable by column chromatography, removal of the silyl protecting group provided the corresponding regioisomeric diols **30** and **31** that were separable.

The functionalization of the polyene is shown in Scheme 4. Mitsunobu-type conversion of the C<sub>10</sub> alcohol into the corresponding nitrile followed by silyl protection yielded **14**. Next, we required the selective functionalization of the C<sub>18</sub>-C<sub>19</sub> alkene in the presence of the less sterically hindered 1,1-disubstituted alkene at C<sub>13</sub> and the more electron rich alkene at C<sub>14</sub>-C<sub>15</sub>. We had hoped that regioselective dihydroxylation at C<sub>18</sub>-C<sub>19</sub> could be possible by exploiting a  $\pi$ -stacking interaction between the phenyl ring and aromatic systems present in Sharpless ligands. While this sort of phenomenon has been used previously to explain enhanced enantioselectivity<sup>20</sup> and even diastereoselectivity<sup>21</sup> in Sharpless asymmetric dihydroxylation, we were unaware of prior examples to exploit purely a regioselective directing effect. To our delight, the AD Mix  $\beta^*$  [the \* denotation represents higher percentages of K<sub>2</sub>OsO<sub>4</sub>•2H<sub>2</sub>O and (DHQD)<sub>2</sub>PHAL as compared to the commercial amounts] provided excellent regioselectivity for the desired location. As hypothesized, use of standard OsO<sub>4</sub> / NMO conditions provided a complex mixture of products. Interestingly, AD Mix  $\alpha^*$  also proved to be a poor reagent of this transformation. While we can rationalize the poor outcome of the ligandless system, a rationale for the reactivity differences between the pseudo-enantiomeric ligand systems is less obvious. One possible explanation may be that the C<sub>16</sub> stereocenter exerts a pronounced influence on the conformation of the neighboring alkenes – resulting in a mismatched interaction between the (DHQ)<sub>2</sub>PHAL ligand in AD mix  $\alpha$  and the desired alkene. It is also clear that a conformational change occurs between the unconjugated system **33** and the conjugated system **14** – dihydroxylation of polyene **33** results in a regioselective oxidation at C<sub>18</sub>-C<sub>19</sub>; however, the reaction does not

show any diastereoselectivity. Periodate cleavage under standard conditions yielded the aldehydes **12** and **35**.

Synthesis of the eastern subunit<sup>4</sup> and southern fragment are shown in Scheme 5. Evans *syn* glycolate reaction between oxazolidinone **36**<sup>22</sup> and readily available aldehyde **37**<sup>8</sup> provided the desired product in reasonable diastereoselectivity (7:1 dr) and good yield. After TES silylation, subsequent conversion to the thioester with lithium thiolate followed by cuprate addition yielded the methyl ketone **13**. This strategy for synthesis of the C<sub>19</sub>-C<sub>26</sub> subunit has been subsequently exploited by Früstner and co-workers.<sup>3aa,5</sup> The carboxylic acid **11** was available in four straightforward steps from the commercially available ester **38**.

With the subunits now constructed, our efforts shifted towards their combination. We were particularly focused initially on addressing the critical diastereoselectivity in the methyl ketone aldol reaction between **12** and **13**. Prior to our entry into the field, Pattenden<sup>7e</sup> and Kobayashi<sup>7k</sup> had independently explored related coupling strategies with limited success (Scheme 6). In both cases, poor diastereoselectivity was observed (3:2 dr) as well as low chemical yield (50% in Kobayashi's case, no chemical yield reported in Pattenden's example). Stereocontrolling models for  $\beta$ -silyloxy aldehydes such as **40** and **44** have been proposed;<sup>23</sup> however, it is unclear if the tertiary nature of the C<sub>16</sub> silyl ether is compatible with that analysis. In addition, models have been developed for exploiting the stereochemical controlling nature of  $\alpha$ -chiral ketones (albeit primarily on ethyl ketone substrates). We had hypothesized the poor stereocontrol in these pioneering examples by Pattenden and Kobayashi could be attributed to the absence of a chelating protecting group at C<sub>21</sub>, which rigidifies the facial selectivity of the enolate in the aldol transition state. Compelling evidence of the potential for this strategy can be found in Chakraborty's related work towards amphidinolides G and H (which lack the C<sub>16</sub> hydroxyl functionality).<sup>24</sup> Pioneering precedent for the stereocontrolling ability of  $\alpha$ -oxy enolates had been reported by Paterson,<sup>25</sup> Heathcock<sup>26</sup> and Masamune;<sup>27</sup> however, the majority of the examples are on ethyl ketones. Aldol reactions using methyl ketones have been reported to proceed through both chair and boat transition states – which could lead to an erosion in stereoinduction.<sup>28</sup> White,<sup>29</sup> Trost<sup>30</sup> and Evans<sup>31</sup> reported some of the earliest successful examples in this area. Other laboratories have subsequently explored this transformation with varying degrees of stereocontrol.<sup>32</sup>

Our exploration into the diastereoselective aldol reaction is detailed in Scheme 7. We initially employed the unconjugated diene **35** as a model for the actual system. To our considerable disappointment, this substrate **35** performed poorly in the transformation – providing low diastereoselectivity (2:1 dr) in modest chemical yield (60%) (Eq. 1). Similar results were observed with the achiral aldehyde 3,3-dimethylbutanal (2-3:1 dr) (Eq. 2). Undeterred by these discouraging model studies, we next studied the conjugated diene system **12** (Eq. 3). We were delighted to see that this transformation proceeded with high levels of stereocontrol – we only observed a single diastereomer in 69% yield. The configuration of the newly established stereocenter was confirmed by advanced Mosher ester method.<sup>33</sup> The subtle nature of the controlling influences of this aldol reaction warrants further comment. We are hesitant to put forth a model for the controlling influences of this transformation; however, it is important to note that both the tri-substituted alkene at C<sub>14</sub>-C<sub>15</sub> and the chelating protecting group at C<sub>21</sub> appear to work in concert to influence the stereochemical outcome of the aldol reaction. The C<sub>16</sub> silyl ether does not appear to exert considerable influence as this chelation strategy has subsequently proven useful in amphidinolide G/H series by both Fürstner<sup>3aa,5</sup> and Zhao<sup>34</sup> which does not contain the C<sub>16</sub> alcohol moiety.

The construction of the macrocyclization precursor is shown in Scheme 8. Silylation of the C<sub>18</sub> alcohol proceeded smoothly with TBSOTf and a large excess of triethylamine.<sup>35</sup> Interestingly, use of near stoichiometric amounts of an amine base [e.g. 2,6-lutidine (1.2 equiv.)] led to elimination (≈20%) and alkene isomerization (≈10%). Regioselective reduction of the C<sub>9</sub> nitrile was accomplished with DIBAL-H. Horner-Wadsworth-Emmons olefination of the resultant aldehyde using Ba(OH)<sub>2</sub><sup>36</sup> yielded the desired α,β-unsaturated ketone in good yield and excellent *E/Z* selectivity. Alternate conditions on related systems (DBU, LiCl or KHMDs, THF) were less effective for this olefination.<sup>37</sup> Subsequent selective cleavage of the C<sub>25</sub> TES ether produced the key Mitsunobu macrolactonization<sup>12</sup> precursor. Unfortunately, this substrate was resistant to all effort to facilitate the macrocycle formation under these stereochemically invertive conditions.

Based on our frustrations with facilitating a successful Mitsunobu macrolactonization, we decided a reorganization of our strategy for macrocyclic formation was needed. Specifically, we turned to inverting the C<sub>25</sub> stereocenter prior to coupling, forming the C<sub>1</sub> ester bond in an intermolecular fashion and constructing the C<sub>8</sub>-C<sub>9</sub> alkene through an intramolecular pathway. Towards this end, synthesis of a modified methyl ketone **54** was necessary (Scheme 9). Selective TES removal could be accomplished under aqueous acidic conditions in excellent yield. Martin's modified Mitsunobu conditions proceeded smoothly to give the inverted C<sub>25</sub> ester. Finally, saponification of the PNB moiety with Ba(OH)<sub>2</sub>•8H<sub>2</sub>O and methanol followed by TMS protection revealed the coupling partner **54**.

Synthesis of the modified aldehyde coupling partner is illustrated in Scheme 10. Reduction of the C<sub>9</sub> nitrile to its corresponding alcohol was accomplished via DIBAL-H reduction to the aldehyde followed by NaBH<sub>4</sub> reduction to the alcohol and protection as its acetate. Regioselective functionalization at C<sub>18</sub> was again accomplished using Sharpless AD conditions followed by periodate cleavage to reveal the C<sub>18</sub> aldehyde.

While the original route to the aldehydes **12** and **57** was effective, it suffered from logistical practicality - notably the titanium-mediated coupling of the allyl silane proved to be a scale dependent reaction and the thionyl chloride elimination step gave a mixture of olefin products. Consequently, we sought to develop a more scalable approach to this subunit (Scheme 11). Starting from the commercially available Oppolzer sultam derivative **59**, cuprate addition in accord with conditions developed by Paquette<sup>38</sup> cleanly generated the key C<sub>11</sub> stereocenter in compound **60**. After functional group manipulation to provide aldehyde **61**, we were gratified to find that key sequential Wittig / Horner-Wadsworth-Emmons (HWE) reactions cleanly introduced the triene **63** as a single stereoisomer. After DIBAL-H reduction, the resulting trienyl alcohol proved remarkably reactive to Sharpless asymmetric epoxidation conditions (proceeding at -78 °C to -50 °C) to provide epoxide **64**. In fact, if this reaction was performed at higher temperatures (e.g. -20 °C), another product was observed that appeared to be the result of a 1,2-alkyl shift to produce an aldehyde.<sup>39</sup> Subsequent Red-Al reduction provided the diol **65**. Finally, protecting group exchange followed by 1° TES deprotection and oxidation provided the C<sub>9</sub>-C<sub>18</sub> subunit **57**. The high efficiency of this route (11.5% overall yield) provided us with access to gram quantities of aldehyde **57**.

With these modified coupling partners in hand, we revisited our aldol coupling strategy (Scheme 12). We were pleased to observe that similar levels of diastereoselectivity continued to be observed using the LDA conditions (62% yield, >20:1 dr). Silylation of the C<sub>18</sub> alcohol proved significantly more complicated than expected. Use of TBSOTf led to significant exchange of the C<sub>25</sub> TMS ether to the corresponding TBS ether. Use of TESOTf minimized this problem – providing a 95% yield of a 5:1 ratio of the C<sub>25</sub> TMS to C<sub>25</sub> TES. Both of these compounds were productive intermediates and could be converted to the



corresponding C<sub>25</sub> alcohol using HOAc/THF/H<sub>2</sub>O conditions. Intermolecular Yamaguchi esterification provided the phosphonate **71**. Next, removal of the C<sub>9</sub> acetate was cleanly accomplished using Ba(OH)<sub>2</sub>•8H<sub>2</sub>O. Subsequent oxidation using TPAP provided the aldehyde cyclization precursor **73**. Interestingly, this compound proved to be surprisingly reactive -leading to spontaneous macrocyclization under the TPAP conditions. Ba(OH)<sub>2</sub>•8H<sub>2</sub>O was added to drive this transformation to completion with an 85% overall yield from the alcohol **72**.

With the macrocycle in hand, the remaining challenges to be addressed were the successful incorporation of the C<sub>6</sub>-C<sub>9</sub> allylic epoxide and global deprotection (Scheme 13). CBS reduction<sup>40</sup> proceeded smoothly to provide the desired allylic alcohol **75** in excellent diastereoselectivity. Subsequent Sharpless asymmetric epoxidation<sup>41</sup> provided the desired epoxide **76** in 10:1 dr. Incorporation of the alkene could be best accomplished by inversion at C<sub>7</sub> to provide the selenide **77**<sup>42</sup> followed by TPAP mediated oxidation<sup>43</sup> to the selenoxide and syn elimination to yield the allylic epoxide as a single olefin geometry. Despite compelling precedent from Nicolaou and co-workers for a related deprotection in the synthesis of amphidinolide N,<sup>2v</sup> we were unable to effect PMB removal using DDQ under buffered aqueous or anhydrous conditions. Based on this unfortunate result, it became clear that an alternate C<sub>21</sub> protecting group strategy was necessary to complete the total synthesis of amphidinolide B<sub>1</sub>.

We initially considered a 3,4-dimethoxybenzyl (DMB) protecting group as a viable alternative to the C<sub>21</sub> PMB group as DMB groups are more readily oxidized by DDQ (Scheme 14). We synthesized the necessary C<sub>19</sub>-C<sub>26</sub> subunit via an analogous route as described previously. Interestingly, aldol reaction with the C<sub>18</sub> aldehyde **82** proceeded smoothly, but in significantly lower diastereoselectivity (4:1 dr). We are unsure as to the cause of this difference between the PMB and DMB series. Next, we explored the possibility of deprotecting the C<sub>21</sub> DMB group using DDQ. Interestingly, treatment of **83** with DDQ under buffer aqueous conditions led to formation of the acetal **86** in modest yield, but as a single diastereomer. This product is likely the result of initial oxidation to the oxonium ion followed by nucleophilic attack by the C<sub>22</sub> OTES ether. Subsequent silyl migration to the C<sub>18</sub> position would produce the observed product **86**. Despite this encouraging early result, we were unable to increase the chemical yield of this transformation through variation of oxidant or reaction conditions. Consequently, this approach was abandoned.

Given our setbacks with benzyl-derived protection at C<sub>21</sub>, we revisited our central strategy for stereocontrol at C<sub>18</sub> through the C<sub>21</sub> chelation model described previously (Scheme 15). Traditionally, silyl protecting groups are not viewed as moieties that participate in chelation;<sup>44</sup> however, it is important to acknowledge work by Heathcock,<sup>45</sup> Eliel and Frye,<sup>46</sup> Willard<sup>47</sup> and Evans<sup>48</sup> which showed that silyl chelation is feasible under certain conditions. We were particularly drawn to Heathcock's work in the area in which TMEDA was a key additive in their chelation-controlled aldol reaction (Eq. 1). Alternatively, a dipole minimization stereocontrol model produced the alternate facial attack on the aldehyde (Eq. 2). Silyl protection at C<sub>21</sub> would simplify the endgame deprotection sequence and circumvent the problematic DDQ deprotection strategy.

The synthesis of the C<sub>21</sub> silyl methyl ketone **98** is shown in Scheme 16. One attractive advantage to this strategy is that it greatly simplifies the synthesis of the methyl ketone as differential protection at C<sub>21</sub> and C<sub>22</sub> is no longer needed. Olefination of aldehyde **37** provided the α,β-unsaturated enone **93**. Sharpless dihydroxylation under buffered conditions yielded the diol in good diastereoselectivity. Bis-silyl protection using TESOTf cleanly

provided the tris-TES methyl ketone **95**. The C<sub>25</sub> TES could be cleanly removed using HOAc/THF/H<sub>2</sub>O conditions followed by inversion and protection as its C<sub>25</sub> TMS ether.

Exploration of the key aldol reaction on the C<sub>21</sub> silyl series generated intriguing results (Table 1). Initial studies with the C<sub>25</sub> epimer **95** exhibited poor diastereoselectivity, but good reactivity under the Heathcock's TMEDA conditions (Entry 1). It should be noted that the replacement of THF with Et<sub>2</sub>O led to a dramatic decrease in chemical yield (Entry 2). Interestingly, use of the required C<sub>25</sub> stereochemistry for amphidinolide B led to a more stereoselective aldol process (Entries 3-6). If the reaction was conducted at -78°C, the transformation appeared to proceed through a dipole minimization model to yield the 18*R* stereochemistry as the major product (5:1 **103:100**). If the otherwise identical transformation was conducted at -40°C, the stereoselectivity for the transformation reversed to now favor the 18*S* stereochemistry. This divergent stereocontrol model could be attributed to reversible nature of aldol reactions.<sup>49</sup> A similar phenomenon was observed with the aldehyde **57** (Entries 5 and 6). While unexpected, these results opened the door for the synthesis of both amphidinolide B<sub>1</sub> and B<sub>2</sub>.

Synthesis of the macrocycle using the aldol products was accomplished based on close analogy to our C<sub>21</sub> PMB series (Scheme 18). TES protection at C<sub>18</sub> using TESCl / DMAP conditions followed by C<sub>25</sub> desilylation revealed the C<sub>25</sub> alcohol. Yamaguchi esterification followed by saponification of the acetate protecting group produced the C<sub>9</sub> alcohol. As employed in our previous macrocyclization, TPAP oxidation produced the reactive aldehyde, which appeared to undergo spontaneous macrocyclization. The cyclization could be driven to completion by addition of Ba(OH)<sub>2</sub>·8H<sub>2</sub>O for 18*S* series and LiCl / Hunig's base for the 18*R* series for optimal yields. While the yields for these macrocyclizations were not as high as the C<sub>21</sub> PMB series, the ability to successfully close the macrocycle was gratifying. Fortuitously, macrocycle **109** produced crystals suitable for X-ray crystallographic analysis – thereby confirming the stereochemical assignment (Figure 2).

With the macrocycle in hand and the stereochemistry firmly established, the remaining hurdles for completing the synthesis were incorporation of the allylic epoxide moiety and global deprotection. We first advanced the 18*S* stereoisomer, which would lead to the synthesis of amphidinolide B<sub>2</sub> (Scheme 19). CBS reduction produced the allylic alcohol in good diastereoselectivity. Although epoxidation under tartrate-mediated Sharpless conditions as used previously proved ineffective, titanium-mediated epoxidation (in the absence of tartrate ligand) produced the epoxide alcohols in modest diastereoselectivity (2:1 dr, 74% yield). Given the increased steric demands of the Ti-tartrate complex, we attribute the reactivity difference between the C<sub>20</sub> OPMB series and the C<sub>20</sub> OTEs series to a conformational change to the macrocycle, which increases the steric hinderance surrounding the allylic alcohol moiety. While we cannot rigorously assign the stereochemistry of the newly created stereocenters, they were assigned based on literature precedent.<sup>40,50</sup> Incorporation of the selenide followed by TPAP-mediated oxidation and *syn* elimination provided the allyl epoxide **116**. Unfortunately, we were again unable to effect global desilylation under a range of conditions (e.g. TASF or HF•pyr). Fortunately, the ordering of the final events could be altered (global deprotection followed by *syn* elimination using TMSOOTMS for selenide oxidation) to reveal the proposed structure for amphidinolide B<sub>2</sub> (**3**). It should be noted that the use of TMSOOTMS has not been previously reported for selenide oxidation / elimination. H<sub>2</sub>O<sub>2</sub> was ineffective in this transformation – likely due to unwanted Baeyer-Villiger-type oxidation of the C<sub>20</sub> ketone. To our surprise, the spectral data did not match the literature values for amphidinolide B<sub>2</sub>. We had presumed that the incorrect epoxide had been utilized. Consequently, we repeated the analogous endgame, but this product **114** also did not match the natural product. It became clear that the assignment of amphidinolide B<sub>2</sub> was incorrect. Comparison of the synthesized material with the

literature data revealed a large chemical shift difference for H<sub>14</sub> [**Isolation data**: 5.93 (bs), **Synthetic 3**: 6.06 (bs), **Synthetic 114**: 6.08 (bs)] and H<sub>19a,b</sub> [**Isolation data**: 3.09 (dd, *J* = 2.3, 8.8 Hz, 1H) and 2.69 (dd, *J* = 8.6, 17.7 Hz, 1H), **Synthetic 3**: 3.05 (m) and 2.48 (dd, *J* = 8.0, 17.0 Hz), **Synthetic 114**: 2.90 (dd, *J* = 9.9, 17.1 Hz) and 2.45 (m)]. Careful inspection of the structure elucidation paper<sup>2c</sup> revealed that while amphidinolide B<sub>1</sub> was assigned by crystallographic analysis, amphidinolide B<sub>2</sub> was assigned based on analogy and comparison of the NMR spectra. We hypothesize that the actual structure of amphidinolide B<sub>2</sub> likely contains the opposite stereochemistry at C<sub>16</sub> (e.g. **117**) – thereby maintaining a *syn* relationship between the two alcohols at C<sub>16</sub> and C<sub>18</sub>.

The successful completion of amphidinolide B<sub>1</sub> is shown in Scheme 20. Starting from the macrocycle **109**, CBS reduction provided the allylic alcohol **118** in 74% yield (3.5:1 dr). Titanium-mediated epoxidation of the alkene was high yielding, but unselective (1:1.5 dr). Incorporation of the aryl selenide using previously described conditions followed by global deprotection and selenide oxidation / *syn* elimination yielded amphidinolide B<sub>1</sub> (**2**). Comparison of the synthetic material with literature values showed excellent agreement (<sup>1</sup>H NMR, <sup>13</sup>C NMR, [α]<sub>D</sub>). For analogue studies, we also carried the epimeric epoxide series onto 8,9-*epi*-amphidinolide B<sub>1</sub> (**121**).

To assess the cytotoxic effects of the proposed structure of amphidinolide B<sub>2</sub> on human solid and blood cancer cells, cell viability assays were conducted using nine cancer cell line panel.<sup>50</sup> Compound **3** differentially reduced cell viabilities at 0.1 μM in human DU145 prostate cancer, MDA-MB-435 breast cancer, Ly3 lymphoma, K562 CML, MOLT-4 ALL, Reh ALL, U266 myeloma, KG1a AML and HL60 AML cells (Table 2). To further understand these anti-tumor activities of amphidinolide B<sub>2</sub>, we determined IC<sub>50</sub> values = 36.4 ± 2.9 nM, 94.5 ± 8.0 nM, 3.3 ± 0.9 nM and 7.4 ± 0.6 nM against DU145, MDA-MB-435, KG1a and HL60 AML cancer cells, respectively (Table 3). Next, compared the potency of compound **3** to C<sub>8,9</sub> epimer **114** and C<sub>18</sub> epimer **121** in DU145 prostate cancer cells, compound **3** exhibited over 12-fold increase in biological activity (Figure 3). These findings suggest that the stereochemistry of the epoxide plays an important role in eliciting potent anticancer effects.

## Conclusion

In summary, the first total synthesis of amphidinolide B<sub>1</sub> and the proposed structure for amphidinolide B<sub>2</sub> has been achieved. In our initial approach to this family, we utilized a chelation-controlled aldol reaction to provide excellent stereoselectivity at C<sub>18</sub>. Unfortunately, late stage removal of the PMB group proved not feasible in our hands. Consequently, a revised approach utilizing a dipole-minimized aldol provided access to a stereoselective aldol product. The stereoselectivity in this key aldol process could be controlled by variation of the temperature. Other highlights of the synthetic route include two non-metal catalyzed methods to construct the C<sub>13</sub>-C<sub>15</sub> diene, a spontaneous HWE macrocyclization strategy and a novel late stage epoxidation / elimination strategy to incorporate the sensitive C<sub>6</sub>-C<sub>9</sub> allylic epoxide moiety.

The proposed structure for amphidinolide B<sub>2</sub> displays potent and stereoselective anti-tumor activities against human solid and blood tumor cells at low nanomolar concentrations that include highly aggressive and metastatic prostate and breast cancer cells. In contrast, C<sub>8,9</sub>-epimer and C<sub>18</sub> epimer exhibit an over 12-fold decrease in anti-tumor activity in comparison. The stereochemistry of the epoxide plays a key role in the anticancer effects.



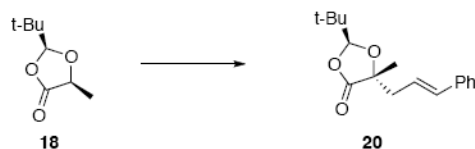
## EXPERIMENTAL SECTION

### General

Infrared spectra were recorded neat unless otherwise indicated and are reported in  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR spectra were recorded in deuterated solvents and are reported in ppm relative to tetramethylsilane and referenced internally to the residually protonated solvent.  $^{13}\text{C}$  NMR spectra were recorded in deuterated solvents and are reported in ppm relative to tetramethylsilane and referenced internally to the residually protonated solvent. HRMS data was collected using a TOF Mass Spectrometer.

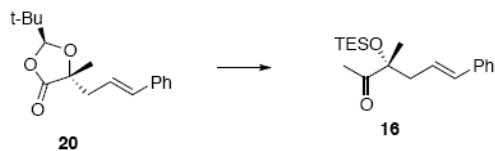
Routine monitoring of reactions was performed using EM Science DC-Alufolien silica gel, aluminum-backed TLC plates. Flash chromatography was performed with the indicated eluents on EM Science Gedurian 230-400 mesh silica gel.

Air and/or moisture sensitive reactions were performed under usual inert atmosphere conditions. Reactions requiring anhydrous conditions were performed under a blanket of argon, in glassware dried in an oven at  $120^\circ\text{C}$  or by flame, then cooled under argon. Dry THF and DCM were obtained via a solvent purification system. All other solvents and commercially available reagents were either purified via literature procedures or used without further purification.



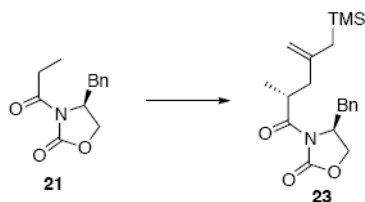
### Lactone **20**

To a solution of diisopropyl amine (1.67 g, 2.3 mL, 16.5 mmol) in THF (7.6 mL) at  $-78^\circ\text{C}$  added *n*-BuLi (6.6 mL, 16.5 mmol, 2.5 M in hexanes) dropwise. After 10 min, the white slurry was warmed to  $-10^\circ\text{C}$  for 30 min. Then, the solution was cooled back to  $-78^\circ\text{C}$  and another 58 mL THF was added slowly to the above solution. Next, a solution of Seebach lactone **18**<sup>51</sup> (2.37 g, 15.0 mmol) in THF (15 mL) was added dropwise to the above solution. After 20 min, a solution of cinnamyl bromide **19** (4.43 g, 3.33 mL, 22.5 mmol) in THF (10 mL) was added dropwise. After 30 min, the reaction was warmed slowly to  $-10^\circ\text{C}$  over 2 h. After 5 min, the reaction was quenched with sat. aq.  $\text{NH}_4\text{Cl}$  (30 mL) and warmed to r.t. After 10 min, the organic layer was separated and the aqueous layer was extracted with  $\text{Et}_2\text{O}$  ( $3 \times 30$  mL). The dried ( $\text{MgSO}_4$ ) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 2-10% EtOAc / hexanes, to give **20** (3.74 g, 13.7 mmol, 91%) as a white solid:  $[\alpha]_{\text{D}}^{23} +45.5^\circ$  (c 1.21,  $\text{CHCl}_3$ ); IR (thin film) 3027, 2963, 1796, 1484, 1173, 1138, 970, 692  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.28-7.42 (m, 5H), 6.58 (d,  $J = 15.6$  Hz, 1H), 6.23 (dt,  $J = 15.6, 6.0$  Hz, 1H), 5.24 (s, 1H), 2.72 (dd,  $J = 6.0, 10.8$  Hz, 1H), 2.62 (dd,  $J = 6.0, 10.8$  Hz, 1H), 1.51 (s, 3H), 0.98 (s, 9H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  175.5, 137.1, 135.3, 128.8, 127.9, 126.5, 122.4, 108.9, 80.2, 40.3, 34.8, 23.5, 23.1; HRMS (FAB+) calcd. for  $\text{C}_{17}\text{H}_{23}\text{O}_3$  (M+H) 275.1647, found 275.1650.



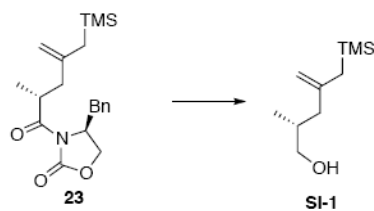
## Methyl ketone 16

To a solution of lactone acetal **20** (1.37 g, 5.0 mmol) in THF (100 mL) at  $-78^{\circ}\text{C}$  was added MeLi (4.64 mL, 5.6 mmol, 1.2 M in Et<sub>2</sub>O) *via* syringe pump. After 15 min, the resulted solution was warmed to r.t. After additional 10 min, the solvent was concentrated *in vacuo*, diluted with Et<sub>2</sub>O (50 mL), filtrated through a plug of Celite<sup>®</sup> and concentrated again *in vacuo*. The yellow oil was purified by chromatography over silica gel, eluting with 10-30% EtOAc / hexanes, to give a ketone intermediate (0.78 g, 3.85 mmol, 77%) as a colorless oil. To a solution of the above intermediate (340 mg, 1.66 mmol) in THF (8.3 mL) at  $-78^{\circ}\text{C}$  was added 2,6-lutidine (0.27 g, 0.29 mL, 2.49 mmol). After 5 min, TESOTf (0.53 g, 0.45 mL, 1.99 mmol) was added. After 30 min, the reaction was warmed to r.t. After 5 min, the reaction was quenched with sat. aq. NH<sub>4</sub>Cl (10 mL). After 10 min, the organic layer was separated and the aqueous layer was extracted with Et<sub>2</sub>O (3 × 15 mL). The dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 2-6% EtOAc / hexanes, to give **16** (448 mg, 1.41 mmol, 88%) as a colorless oil:  $[\alpha]_{\text{D}}^{23} +0.7^{\circ}$  (c 0.70, CHCl<sub>3</sub>); IR (thin film) 3027, 2955, 2916, 2876, 1718, 1457, 1415, 1350, 1239, 1166, 1131, 1016, 742 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 7.20-7.33 (m, 5H), 6.38 (d, *J* = 15.9 Hz, 1H), 6.09-6.20 (m, 1H), 2.40-2.63 (m, 2H), 2.21 (s, 3H), 1.38 (s, 3H), 1.01 (t, *J* = 7.5 Hz, 9H), 0.68 (q, *J* = 7.5 Hz, 6H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 214.2, 137.8, 133.6, 128.9, 127.6, 126.5, 125.1, 83.0, 45.2, 26.2, 25.4, 7.6, 7.1; HRMS (FAB+) calcd. for C<sub>19</sub>H<sub>31</sub>O<sub>2</sub>Si (M+H) 319.2093, found 319.2094.



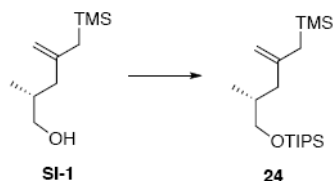
## Allylsilane 23

To a solution of NaHMDS (5.6 mL, 5.6 mmol, 1.0 M in THF) at  $-78^{\circ}\text{C}$  was added a solution of imide **21** (1.09 g, 4.67 mmol) in THF (4.6 mL). After 20 min, a solution of allyl iodide **22**<sup>52</sup> (3.6 g, 14 mmol) in THF (3 mL) was added *via* cannula. After 10 min, the reaction was warmed slowly to 10 °C over 4 h and quenched with sat. aq. NH<sub>4</sub>Cl (25 mL). After 10 min at r.t., the organic layer was separated and the aqueous layer was extracted with Et<sub>2</sub>O (3 × 20 mL). The dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 4-15% EtOAc / hexanes, to give **23** (1.46 g, 4.06 mmol, 87%) as a colorless oil:  $[\alpha]_{\text{D}}^{23} +30.6^{\circ}$  (c 0.66, CHCl<sub>3</sub>); IR (thin film) 2954, 1780, 1699, 1632, 1454, 1385, 1349, 1246, 1207, 1101, 851, 701 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 7.20-7.35 (m, 5H), 4.66-4.69 (m, 1H), 4.69 (s, 1H), 4.64 (s, 1H), 4.14-4.19 (m, 2H), 4.06 (q, *J* = 6.9 Hz, 1H), 3.26 (dd, *J* = 3.3, 13.2 Hz, 1H), 2.71 (dd, *J* = 3.9, 13.2 Hz, 1H), 2.52 (dd, *J* = 7.5, 14.4 Hz, 1H), 2.04 (dd, *J* = 7.5, 14.4 Hz, 1H), 1.59 (d, *J* = 3.6 Hz, 2H), 1.17 (d, *J* = 6.9 Hz), 0.04 (s, 9H); <sup>13</sup>C NMR (75 MHz, CDCl<sub>3</sub>) δ 177.4, 153.5, 145.1, 135.8, 129.9, 129.3, 127.7, 109.7, 66.3, 55.7, 42.6, 38.4, 36.2, 26.8, 17.4, -1.0; HRMS (FAB +) calcd. for C<sub>20</sub>H<sub>30</sub>NO<sub>3</sub>Si (M+H) 360.1995, found 360.1989.

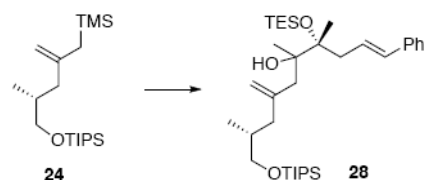


### Allylsilane 24

To a solution of **23** (1.88 g, 5.23 mmol) in THF (35 mL) at 0°C was added sequentially MeOH (0.20 g, 0.25 mL, 6.28 mmol) followed by LiBH<sub>4</sub> (3.14 mL, 6.28 mmol, 2.0 M in THF). After 2 h at 0°C, the reaction was warmed to r.t. After 2 h, the reaction was quenched with sat. aq. sodium tartrate (25 mL). After stirring for 20 min, the organic layer was separated and the aqueous layer was extracted with Et<sub>2</sub>O (3 × 25 mL). The dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 15-25% Et<sub>2</sub>O / pentane, to give free alcohol **SI-1** (0.96 g, 5.18 mmol, 99%) as a colorless oil: [α]<sub>D</sub><sup>23</sup> (+) 9.4° (c 0.84, CHCl<sub>3</sub>); IR (thin film) 3337 (br), 3072, 2954, 2916, 1631, 1455, 1419, 1248, 1036, 849 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 5.60 (d, *J* = 15.6 Hz, 2H), 3.44-3.52 (m, 2H), 2.03-2.10 (m, 1H), 1.77-1.89 (m, 2H), 1.54 (s, 2H), 1.41 (t, OH), 0.91 (d, *J* = 6.3 Hz, 3H), 0.04 (s, 9H); <sup>13</sup>C NMR (75 MHz, CDCl<sub>3</sub>) δ 146.6, 109.2, 68.7, 43.1, 34.2, 26.7, 17.2, -0.9; HRMS (FAB+) calcd. for C<sub>10</sub>H<sub>22</sub>OSi (M) 186.1440, found 186.1447.

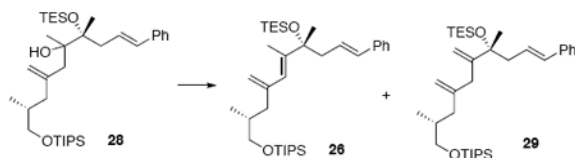


To a solution of alcohol intermediate **SI-1** (308 mg, 1.65 mmol) in CH<sub>2</sub>Cl<sub>2</sub> at -78°C was added sequentially Et<sub>3</sub>N (0.25 g, 0.34 mL, 2.48 mmol) and TIPSOTf (607 mg, 0.53 mL, 1.98 mmol). After 20 min, the reaction was warmed to r.t. After 5 min, the reaction was quenched with sat. aq. NH<sub>4</sub>Cl (25 mL). After 5 min, the organic layer was separated and the aqueous layer was extracted with Et<sub>2</sub>O (3 × 20 mL). The dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 1% EtOAc / hexanes, to give **24** (560 mg, 1.64 mmol, 99%) as a colorless oil: [α]<sub>D</sub><sup>23</sup> -4.9° (c 0.98, CHCl<sub>3</sub>); IR (thin film) 3072, 2944, 2866, 1631, 1463, 1387, 1248, 1103, 1068, 878, 849, 796, 681 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 4.57-4.58 (m, 1H), 4.54 (s, 1H), 3.47-3.51 (m, 2H), 2.18 (dd, *J* = 5.4, 13.8, 1H), 1.78-1.82 (m, 1H), 1.63-1.71 (m, 1H), 1.51 (s, 2H), 1.04-1.08 (m, 21H), 0.87 (d, *J* = 6.6 Hz, 3H), 0.20 (s, 9H); <sup>13</sup>C NMR (75 MHz, CDCl<sub>3</sub>) δ 146.6, 108.8, 68.9, 42.7, 34.6, 26.7, 18.5, 17.0, 12.4, -0.9; HRMS (FAB+) calcd. for C<sub>19</sub>H<sub>42</sub>OSi<sub>2</sub> (M<sup>+</sup>) 342.2774, found 342.2772.



### Tertiary alcohol **28**

To a solution of allylsilane **24** (214 mg, 0.62 mmol) and ketone **16** (96 mg, 0.3 mmol) in  $\text{CH}_2\text{Cl}_2$  (3.0 mL) at  $-78^\circ\text{C}$  was added freshly distilled  $\text{TiCl}_4$  (117.6 mg,  $70\ \mu\text{L}$ , 0.62 mmol) *via* micro-syringe dropwise. After 15 min, the dark red solution was quenched with sat. aq.  $\text{K}_2\text{CO}_3$  (5 mL) and warmed to r.t. immediately. After 20 min, the organic layer was separated and the aqueous layer was extracted with  $\text{Et}_2\text{O}$  ( $3 \times 20$  mL). The dried ( $\text{MgSO}_4$ ) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting carefully with 0.5-2%  $\text{EtOAc}$  / hexanes, to give **28** (382 mg, 0.19 mmol, 65%) as a colorless oil of a mixture of isomers (d.r. = 6:1). The major isomer:  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  7.24-7.39 (m, 5H), 6.35-6.44 (m, 2H), 4.93 (s, 1H), 4.84 (s, 1H), 3.57-3.61 (m, 1H), 3.43-3.48 (m, 1H), 2.55-2.60 (m, 2H), 2.35-2.40 (m, 1H), 2.31 (dd,  $J = 5.7, 10.8$ , 1H), 2.16 (d,  $J = 9.9$  Hz, 1H), 2.03 (dd,  $J = 5.7, 10.8$  Hz, 1H), 1.85-1.88 (m, 1H), 1.33 (s, 3H), 1.20 (s, 3H), 1.08-1.10 (m, 21H), 0.99 (t,  $J = 6.0$  Hz, 9H), 0.94 (d,  $J = 5.1$  Hz, 3 H), 0.70 (q,  $J = 6.0$  Hz, 6H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  146.1, 138.0, 132.5, 128.9, 127.9, 127.4, 126.4, 115.4, 81.9, 77.7, 68.6, 43.3, 42.2, 42.1, 34.8, 23.1, 21.3, 18.5, 17.5, 12.4, 7.7, 7.4; HRMS (FAB+) calcd. for  $\text{C}_{35}\text{H}_{64}\text{O}_3\text{Si}_2$  ( $\text{M}^+$ ) 588.4394, found 588.4382.

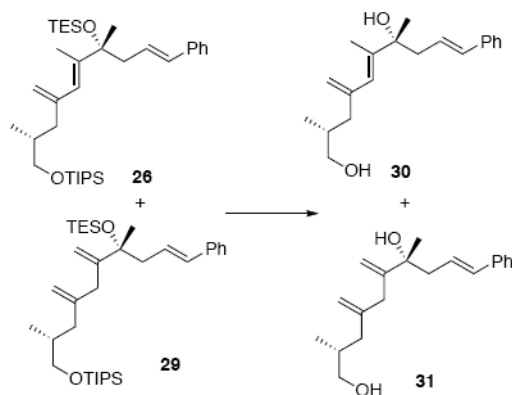


### Dienes **26** and **29**

To a solution of **28** (118 mg, 0.20 mmol) in  $\text{PhMe}$  (5.0 mL) at  $-78^\circ\text{C}$  was added sequentially pyridine (79.0 mg, 0.08 mL, 1.0 mmol) and  $\text{SOCl}_2$  (71.4 mg,  $44\ \mu\text{L}$ , 0.60 mmol) *via* micro-syringe. After 30 min, the reaction was quenched with sat. aq.  $\text{NaHCO}_3$  (10 mL) and warmed to r.t. After 20 min, the organic layer was separated and the aqueous layer was extracted with  $\text{Et}_2\text{O}$  ( $3 \times 20$  mL). The dried ( $\text{MgSO}_4$ ) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting carefully with 0.5-1%  $\text{EtOAc}$  / hexanes, to give mixture of **26** and **29** (114 mg, 0.20 mmol, 99%, 2.2:1 ratio) was separable by HPLC as colorless oil. Conjugate diene **26**:  $[\alpha]_D^{23} -43.2^\circ$  (c 0.1,  $\text{CHCl}_3$ ); IR (thin film) 2954, 2866, 1640, 1459, 1156, 1119, 1013, 882, 741  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  7.20-7.34 (m, 5H), 6.35 (d,  $J = 12.0$  Hz, 1H), 6.18 (dt,  $J = 12.0, 5.4$  Hz, 1H), 5.89 (s, 1H), 5.01 (s, 1H), 4.82 (s, 1H), 3.44 (d,  $J = 4.2$  Hz, 2H), 2.48-2.50 (m, 2H), 2.35 (dd,  $J = 3.6, 9.9$  Hz, 1H), 1.84 (d,  $J = 0.9$  Hz, 3H), 1.82 (dd,  $J = 3.6, 9.9$  Hz, 1H), 1.66-1.72 (m, 1H), 1.46 (s, 3H), 1.07-1.09 (m, 21H), 1.00 (t,  $J = 5.7$  Hz, 9H), 0.78 (d,  $J = 5.6$  Hz, 3H), 0.64 (q,  $J = 5.7$  Hz, 6H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  145.7, 142.8, 138.3, 131.9, 128.8, 127.4, 127.2, 126.3, 125.5, 114.5, 78.7, 68.6, 46.3, 42.6, 34.9, 27.2, 18.5, 16.7, 15.0, 12.4, 7.6, 7.2; HRMS (FAB+) calcd. for  $\text{C}_{35}\text{H}_{62}\text{O}_2\text{Si}_2$  ( $\text{M}^+$ ) 570.4288, found 570.4277.

### Unconjugated diene **29**

$[\alpha]_D^{23} -1.3^\circ$  (c 1.74,  $\text{CHCl}_3$ ); IR (thin film) 3026, 2942, 2865, 1643, 1495, 1462, 1381, 1241, 1097, 1012, 882  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  7.22-7.36 (m, 5H), 6.38 (d,  $J = 12.0$  Hz, 1H), 6.16-6.20 (m, 1H), 5.16 (s, 1H), 4.92 (s, 1H), 4.89 (s, 1H), 4.88 (s, 1H), 3.55-3.59 (m, 1H), 3.44-3.47 (m, 1H), 2.84 (s, 2H), 2.47-2.50 (m, 2H), 2.25 (dd,  $J = 3.6, 9.9$  Hz, 1H), 1.74-1.85 (m, 2H), 1.43 (s, 3H), 1.08-1.10 (m, 21H), 1.00 (t,  $J = 6.0$  Hz, 9H), 0.92 (d,  $J = 4.8$  Hz, 3H), 0.64 (q,  $J = 6.0$  Hz, 6H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  152.0, 146.7, 138.3, 132.2, 128.9, 127.5, 127.2, 126.4, 113.9, 111.1, 78.3, 68.8, 46.4, 39.8, 38.8, 34.6, 27.5, 18.5, 17.2, 12.4, 7.6, 7.3.

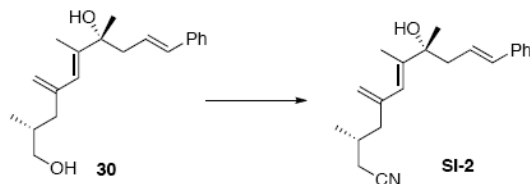


### Diols 30 and 31

To a mixture of **26** and **29** (75 mg, 0.13 mmol) in THF (0.1 mL) at 0°C was added TBAF (0.6 mL, 1.0 M in THF). After 10 min, the reaction was warmed to r.t. After 1 h, the reaction was quenched with sat. aq. NH<sub>4</sub>Cl (3 mL). After 10 min the mixture was extracted with Et<sub>2</sub>O (3 × 10 mL). The dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 20% EtOAc / hexanes, to give diol **30** (20 mg, 0.069 mmol, 61%) as a white foam: [ $\alpha$ ]<sub>D</sub><sup>23</sup> -4.9° (c 0.98, CHCl<sub>3</sub>); IR (thin film) 3373 (br), 3026, 2955, 2925, 2870, 1722, 1627, 1448, 1373, 1032, 966, 897, 741, 692 cm<sup>-1</sup>; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  7.23-7.38 (m, 5H), 6.46 (d, *J* = 15.6 Hz, 1H), 6.12-6.20 (m, 1H), 5.97 (s, 1H), 5.07 (s, 1H), 4.86 (s, 1H), 3.28-3.40 (m, 2H), 2.66 (dd, *J* = 7.2, 14.0 Hz, 1H), 2.46 (dd, *J* = 8.0, 14.0 Hz, 1H), 2.26 (dd, *J* = 5.6, 13.6 Hz, 1H), 1.89 (s, 3H), 1.84-1.88 (m, 1H), 1.61-1.66 (m, 1H), 1.42 (s, 3H), 0.85 (d, *J* = 6.8 Hz, 3H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  145.0, 142.9, 137.7, 133.8, 129.0, 127.8, 126.5, 125.9, 125.1, 115.2, 76.0, 68.5, 44.4, 42.5, 34.9, 28.1, 16.6, 15.4; HRMS (ES<sup>+</sup>) calcd. for C<sub>20</sub>H<sub>28</sub>O<sub>2</sub>Na (M+Na) 323.1987, found 323.1996.

### Diol 31: is colorless oil

[ $\alpha$ ]<sub>D</sub><sup>23</sup> +7.6° (c 1.21, CHCl<sub>3</sub>); IR (thin film) 3373, 3081, 3026, 2957, 2926, 2870, 1724, 1644, 1496, 1449, 1373, 1112, 1034, 967, 900, 739, 692 cm<sup>-1</sup>; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  7.23-7.39 (m, 5H), 6.49 (d, *J* = 15.6 Hz, 1H), 6.16-6.23 (m, 1H), 5.23 (s, 1H), 4.96 (s, 3H), 3.48-3.52 (m, 2H), 2.85-2.96 (m, 2H), 2.62-2.66 (m, 1H), 2.48-2.52 (m, 1H), 2.18-2.24 (m, 1H), 1.86-1.93 (m, 2H), 1.40 (s, 3H), 0.94 (d, *J* = 6.0 Hz, 3H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  151.9, 146.9, 137.7, 134.3, 128.9, 127.7, 126.6, 125.7, 114.3, 111.8, 75.7, 68.6, 45.0, 40.1, 39.2, 34.3, 28.2, 17.1; HRMS (ES<sup>+</sup>) calcd. for C<sub>20</sub>H<sub>28</sub>O<sub>2</sub>Na (M+Na) 323.1987, found 323.1989.

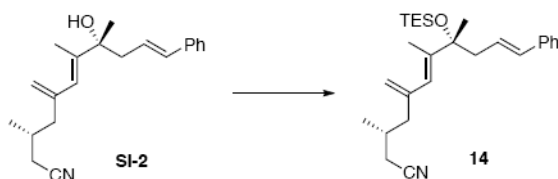


### Nitrile 14

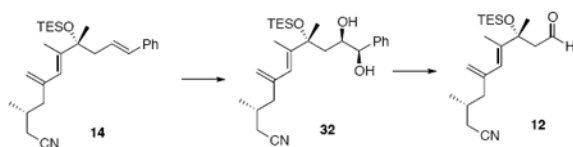
To a solution of **30** (98 mg, 0.33 mmol) in Et<sub>2</sub>O (1.6 mL) at 0°C was added sequentially PPh<sub>3</sub> (342 mg, 1.3 mmol) and DEAD (0.24 mL, 1.3 mmol, 40% w/w in PhMe). After 15 min, acetone cyanohydrin (70.0 mg, 74.5  $\mu$ L, 0.82 mmol) was added dropwise. After 5 min, the reaction was warmed to r.t. After 6 h, the reaction was concentrated *in vacuo* and



purified by chromatography over silica gel, eluting with 10% EtOAc / hexanes, to give a corresponding nitrile intermediate (80 mg, 0.26 mmol, 81%) as a colorless oil:  $[\alpha]_D^{23} +7.8^\circ$  (c 0.99, CHCl<sub>3</sub>); IR (neat) 3479 (br), 2962, 2927, 2246, 1733, 1496, 1456, 1420, 1381, 1105, 968, 902, 743, 694 cm<sup>-1</sup>; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  7.26-7.37 (m, 5H), 6.47 (d,  $J = 16.0$  Hz, 1H), 6.12-6.18 (m, 1H), 5.95 (s, 1H), 5.12 (s, 1H), 4.92 (s, 1H), 2.66 (dd,  $J = 7.2, 14.0$  Hz, 1H), 2.48 (dd,  $J = 7.2, 14.0$  Hz, 1H), 2.05-2.20 (m, 4H), 1.88 (s, 3H), 1.76-1.88 (m, 1H), 1.75 (br, 1H), 1.43 (s, 3H), 0.97 (d,  $J = 6.6$  Hz, 3H); <sup>13</sup>C NMR (75 MHz, CDCl<sub>3</sub>)  $\delta$  143.8, 143.5, 137.5, 134.0, 129.0, 127.9, 126.5, 125.5, 124.3, 119.1, 116.4, 76.0, 44.8, 44.5, 29.3, 28.1, 24.2, 19.5, 15.5; HRMS (FAB+) calcd. for C<sub>21</sub>H<sub>28</sub>NO (M+1) 310.2171, found 310.2144.



To a solution of the above intermediate (80 mg, 0.26 mmol) in CH<sub>2</sub>Cl<sub>2</sub> (1.0 mL) at  $-78^\circ\text{C}$  was added 2,6-lutidine (111.0 mg, 0.12 mL, 1.04 mmol) and followed by TESOTf (136.9 mg, 0.12 mL, 0.52 mmol). After 30 min, the reaction was warmed to r.t. and quenched with sat. aq. NH<sub>4</sub>Cl (3 mL). After 5 min, the mixture was extracted with Et<sub>2</sub>O (3  $\times$  10 mL). The dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 1% EtOAc / hexanes, to give nitrile **14** (80 mg, 0.19 mmol, 72%) as a colorless oil:  $[\alpha]_D^{23} -37.6^\circ$  (c 0.98, CHCl<sub>3</sub>); IR (neat) 2957, 2933, 2876, 2240, 1733, 1496, 1457, 1420, 1381, 1160, 1122, 1016, 967, 902, 742, 693 cm<sup>-1</sup>; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  7.21-7.33 (m, 5H), 6.33 (d,  $J = 11.7$  Hz, 1H), 6.15-6.19 (m, 1H), 5.87 (s, 1H), 5.07 (s, 1H), 4.87 (s, 1H), 2.50 (d,  $J = 5.4$  Hz, 2H), 2.15 (dd,  $J = 5.4, 9.9$  Hz, 1H), 2.00-2.06 (m, 3H), 1.81 (s, 3H), 1.72-1.79 (m, 1H), 1.47 (s, 3H), 1.02 (t,  $J = 5.7$  Hz, 9H), 0.85 (d,  $J = 5.1$  Hz, 3H), 0.67 (q,  $J = 5.1$  Hz, 6H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  143.9, 143.7, 138.1, 131.9, 129.0, 127.4, 127.3, 126.3, 124.6, 119.0, 116.0, 78.8, 46.0, 44.9, 29.3, 27.6, 24.1, 19.4, 15.1, 7.64, 7.26; HRMS (FAB+) calcd. for C<sub>27</sub>H<sub>42</sub>OSiN (M+1) 424.3036, found 424.3044.

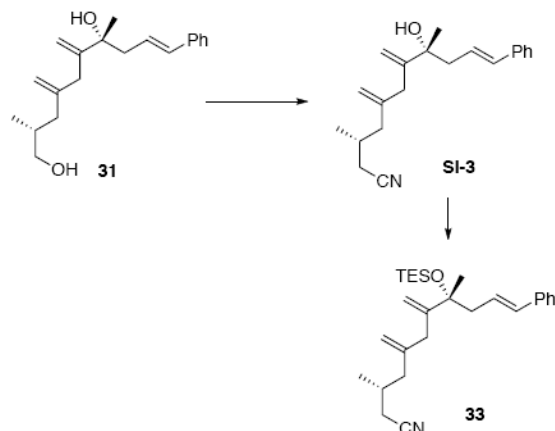


### Aldehyde 12

To a solution of **14** (75 mg, 0.18 mmol) in *t*-BuOH / H<sub>2</sub>O (3 mL, 1:1) was added MeSO<sub>2</sub>NH<sub>2</sub> (25.6 mg, 0.27 mmol) and AD mix  $\beta^{*53}$  (250 mg). After 16 h, the reaction was quenched with sat. aq. Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> (3 mL). After 20 min, the mixture was extracted with EtOAc (3  $\times$  10 mL). The dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 20% EtOAc / hexanes, to give a mixture of diol isomers (73 mg, d.r. = 6:1, 0.16 mmol, 89%) as a colorless oil. The diol substrate was applied to the next step without further purification.

A solution of the mixture described above in THF/Et<sub>2</sub>O (2.8 mL, 1:1) was added NaIO<sub>4</sub> (304 mg, 1.42 mmol) and H<sub>2</sub>O (1.4 mL). After 2 h, the reaction was quenched with sat. aq. NaCl (3 mL) and the mixture was extracted with Et<sub>2</sub>O (3  $\times$  10 mL). The dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* to give aldehyde **12** (54 mg, 0.15 mmol, 96%) as colorless oil:  $[\alpha]_D^{23} -12.6^\circ$  (c 1.22, CHCl<sub>3</sub>); IR (neat) 3081, 2957, 2917, 2876, 2246, 1722, 1628,

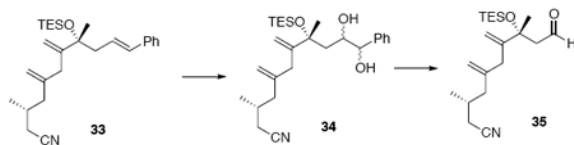
1457, 1417, 1381, 1240, 1163, 1126, 1046, 1017, 904, 802, 743  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  9.66 (t,  $J=3.2$  Hz, 1H), 5.99 (s, 1H), 5.10 (s, 1H), 4.89 (s, 1H), 2.61 (dd,  $J=3.2$ , 14.8 Hz, 1H), 2.47 (dd,  $J=2.8$ , 14.8 Hz, 1H), 2.32 (dd,  $J=5.2$ , 16.8 Hz, 1H), 2.15-2.25 (m, 2H), 2.08 (dd,  $J=7.2$ , 13.6 Hz, 1H), 1.83-1.92 (m, 1H), 1.80 (s, 3H), 1.47 (s, 3H), 1.04 (d,  $J=6.4$  Hz, 3H), 0.96 (t,  $J=8.0$  Hz, 9H), 0.63 (q,  $J=8.0$  Hz, 6H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  203.2, 143.2, 142.7, 125.2, 118.9, 116.8, 54.5, 44.8, 30.1, 29.6, 28.3, 24.3, 19.8, 15.2, 7.5, 7.2; HRMS (FAB+) calcd. for  $\text{C}_{20}\text{H}_{36}\text{O}_2\text{SiN}$  ( $M+1$ ) 350.2515, found 350.2508.



### Nitrile 33

To a solution of **31** (30 mg, 0.10 mmol) in  $\text{Et}_2\text{O}$  (0.5 mL, 0.2 M) at  $0^\circ\text{C}$  was added sequentially  $\text{PPh}_3$  (104 mg, 0.4 mmol) and DEAD (72  $\mu\text{L}$ , 0.4 mmol, 40% solution in PhMe). After 15 min, acetone cyanohydrin (21.2 mg, 23.0  $\mu\text{L}$ , 0.25 mmol) was added dropwise. After 5 min, the reaction was warmed to r.t. After 6 h, the reaction was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 10% EtOAc / hexanes, to give a corresponding nitrile intermediate (25 mg, 0.08 mmol, 81%) as a colorless oil.

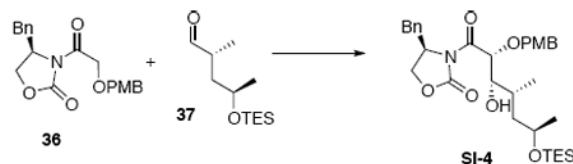
To a solution of the above nitrile (25 mg, 0.08 mmol) in  $\text{CH}_2\text{Cl}_2$  (0.32 mL, 0.25 M) at  $-78^\circ\text{C}$  added sequentially 2,6-lutidine (34.3 mg, 37  $\mu\text{L}$ , 0.32 mmol) and TESOTf (42.1 mg, 36  $\mu\text{L}$ , 0.16 mmol). After 30 min, the reaction was warmed to r.t. and quenched with sat. aq.  $\text{NH}_4\text{Cl}$  (3 mL). After 5 min, the mixture was extracted with  $\text{Et}_2\text{O}$  ( $3 \times 10$  mL). The dried ( $\text{MgSO}_4$ ) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 1% EtOAc / hexanes, to give **33** (26 mg, 62  $\mu\text{mol}$ , 77%) as a colorless oil:  $[\alpha]_{\text{D}}^{23} -13.6^\circ$  (c 0.28,  $\text{CHCl}_3$ ); IR (neat) 2957, 2933, 2911, 2875, 2247, 1238, 1157, 1123, 1063, 1005, 967, 905, 742, 693  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  7.17-7.26 (m, 5H), 6.35 (d,  $J=15.9$  Hz, 1H), 6.08-6.19 (m, 1H), 5.14 (s, 1H), 4.93 (s, 2H), 4.71 (s, 1H), 2.75-2.85 (m, 2H), 2.46 (dd,  $J=0.6$ , 6.9 Hz, 2H), 2.24-2.32 (m, 1H), 1.97-2.17 (m, 4H), 1.38 (s, 3H), 0.95-1.04 (m, 12H), 0.58-0.68 (m, 6H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  151.7, 144.9, 138.1, 132.3, 128.9, 127.4, 127.1, 126.4, 119.2, 115.8, 111.1, 78.2, 46.4, 42.3, 38.2, 28.9, 27.7, 24.3, 20.0, 7.6, 7.3.



## Aldehyde 35

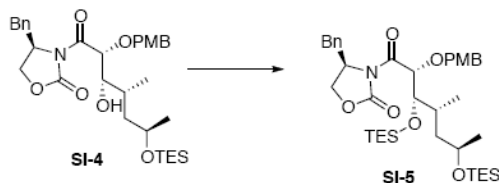
To a solution of **33** (26 mg, 62  $\mu$ mol) in *t*-BuOH / H<sub>2</sub>O (1 mL, 1:1) was added MeSO<sub>2</sub>NH<sub>2</sub> (8.8 mg, 93  $\mu$ mol) and AD mix  $\beta^{*53}$  (87 mg). After 16 h, the reaction was quenched with sat. aq. Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> (3 mL). After 20 min, the mixture was extracted with EtOAc (3  $\times$  10 mL). The dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 20% EtOAc / hexanes, to give a mixture of the diol isomers (25.5 mg, d.r. = 1.3:1, 56  $\mu$ mol, 90%) as a colorless oil. The diol substrate was applied to the next step without further purification.

A solution of the mixture described above in THF/Et<sub>2</sub>O (1.24 mL, 1:1) was added NaIO<sub>4</sub> (120 mg, 0.56 mmol) and H<sub>2</sub>O (0.62 mL). After 2 h, the reaction was quenched with sat. aq. NaCl (3 mL) and the mixture was extracted with Et<sub>2</sub>O (3  $\times$  10 mL). The dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* to give aldehyde **35** (18.5 mg, 0.053 mmol, 95%) as colorless oil:  $[\alpha]_D^{23}$  -11.4° (c 1.57, CHCl<sub>3</sub>); IR (neat) 2958, 2915, 2876, 2737, 2246, 1722, 1645, 1457, 1417, 1375, 1239, 1165, 1123, 1045, 1005, 909, 743, 726 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>)  $\delta$  9.66 (t, *J* = 3.0 Hz, 1H), 5.28 (s, 1H), 4.95 (s, 1H), 4.94 (s, 1H), 4.90 (s, 1H), 2.76 (s, 2H), 2.20-2.62 (m, 5H), 2.02-2.06 (m, 2H), 1.46 (s, 3H), 1.08 (d, *J* = 6.3 Hz, 3H), 0.96 (t, *J* = 7.8 Hz, 9H), 0.63 (q, *J* = 7.8 Hz, 6H); <sup>13</sup>C NMR (75 MHz, CDCl<sub>3</sub>)  $\delta$  203.3, 150.5, 144.3, 119.0, 116.2, 112.6, 54.5, 42.1, 38.4, 28.9, 28.5, 24.3, 24.0, 19.9, 7.5, 7.2.

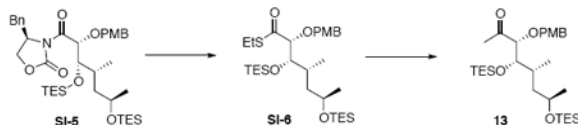


## Methyl ketone 13

To a solution of imide **36**<sup>22</sup> (107 mg, 0.3 mmol) in PhMe (0.7 mL) at -50°C was sequentially added Et<sub>3</sub>N (34.4 mg, 48.2  $\mu$ L, 0.34 mmol) and Bu<sub>2</sub>BOTf (86.0 mg, 80.0  $\mu$ L, 0.32 mmol). After 1.5 h, a solution of aldehyde **37**<sup>8</sup> (46 mg, 0.20 mmol) in PhMe (0.25 mL) was transferred dropwise into the reaction *via* cannula. After 40 min, the reaction was warmed to -30°C within 30 min. After 1 h, the reaction was quenched with aq. phosphate buffer solution (0.5 mL, pH 7), MeOH (0.5 mL) and THF (0.5 mL). Next, the mixture was warmed up to r.t. A solution of H<sub>2</sub>O<sub>2</sub> (0.5 mL, 30% H<sub>2</sub>O<sub>2</sub> in H<sub>2</sub>O) in MeOH (0.5 mL) was added dropwise. After 1 h, the reaction mixture was extracted with EtOAc (3  $\times$  15 mL) and the combined organic extract was diluted with an aqueous phosphate buffer solution (20 mL, pH 7). The mixture was concentrated *in vacuo* and extracted again with Et<sub>2</sub>O (3  $\times$  10 mL). The dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 15-20% EtOAc / hexanes, to give an aldol adduct **SI-4** (83 mg, 0.14 mmol, 72%) as a colorless oil:  $[\alpha]_D^{23}$  -3.9° (c 0.83, CHCl<sub>3</sub>); IR (thin film) 3490 (br), 2956, 2875, 1781, 1708, 1612, 1514, 1389, 1248, 1211, 1051, 1012, 744 cm<sup>-1</sup>; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  7.25-7.39 (m, 7H), 6.92 (d, *J* = 8.8 Hz, 2H), 5.36 (d, *J* = 2.0 Hz, 1H), 4.64-4.72 (m, 1H), 4.64 (d, *J* = 10.8 Hz, 1H), 4.49 (d, *J* = 10.8 Hz, 1H), 4.20-4.29 (m, 2H), 3.84-3.90 (m, 1H), 3.82 (s, 3H), 3.61-3.64 (m, 1H), 3.34 (dd, *J* = 2.8, 13.2 Hz, 1H), 2.78 (dd, *J* = 3.6, 13.5 Hz, 1H), 2.31 (d, *J* = 10.0 Hz, 1H), 1.74-1.81 (m, 1H), 1.56-1.62 (m, 1H), 1.40-1.48 (m, 1H), 1.15 (d, *J* = 5.6 Hz, 3H), 1.03 (d, *J* = 6.8 Hz, 3H), 0.99 (t, *J* = 7.6 Hz, 9H), 0.62 (q, *J* = 7.6 Hz, 6H); <sup>13</sup>C NMR (75 MHz, CDCl<sub>3</sub>)  $\delta$  171.6, 160.0, 153.6, 135.6, 130.7, 129.8, 129.6, 129.4, 127.8, 114.3, 78.4, 76.6, 73.0, 67.4, 67.3, 56.2, 55.7, 43.1, 38.2, 34.6, 23.6, 16.2, 7.3, 5.3; HRMS (FAB+) calcd. for C<sub>32</sub>H<sub>48</sub>NO<sub>7</sub>Si (M+1) 586.3200, found 586.3202.

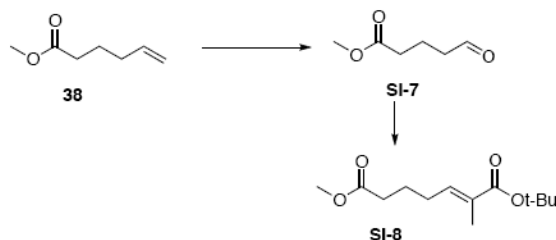


To a solution of the aldol adduct **SI-4** (78 mg, 0.13 mmol) in  $\text{CH}_2\text{Cl}_2$  (0.3 mL) at  $0^\circ\text{C}$  was added sequentially 2,6-lutidine (27.8 mg,  $29.8 \mu\text{L}$ , 0.26 mmol) and TESOTf (68.5 mg,  $60.1 \mu\text{L}$ , 0.26 mmol). After 1 h, the reaction was warmed to r.t. and quenched with sat. aq.  $\text{NH}_4\text{Cl}$  (3 mL). After 5 min, the mixture was extracted with  $\text{Et}_2\text{O}$  ( $3 \times 10 \text{ mL}$ ). The dried ( $\text{MgSO}_4$ ) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 4-6% EtOAc / hexanes, to give the corresponding protected alcohol **SI-5** (84 mg, 0.12 mmol, 90%) as a colorless oil:  $[\alpha]_{\text{D}}^{23} -33.8^\circ$  (c 1.9,  $\text{CHCl}_3$ ); IR (thin film) 2956, 2911, 2875, 1785, 1704, 1612, 1513, 1456, 1381, 1248, 1082, 1011,  $739 \text{ cm}^{-1}$ ;  $^1\text{H NMR}$  (300 MHz,  $\text{CDCl}_3$ )  $\delta$  7.34-7.26 (m, 7H), 6.84 (d,  $J = 8.4 \text{ Hz}$ , 2H), 5.25 (d,  $J = 6.0 \text{ Hz}$ , 1H), 4.64 (d,  $J = 11.7 \text{ Hz}$ , 1H), 4.52 (d,  $J = 11.7 \text{ Hz}$ , 1H), 4.46-4.49 (m, 1H), 4.03-4.12 (m, 3H), 3.73- 3.98 (m, 1H), 3.79-3.81 (m, 1H), 3.74 (s, 3H), 3.11 (dd,  $J = 3.0, 13.2 \text{ Hz}$ , 1H), 2.40 (dd,  $J = 3.0, 13.5 \text{ Hz}$ , 1H), 1.47-1.55 (m, 2H), 1.09 (d,  $J = 6.0 \text{ Hz}$ , 3H), 0.87-0.97 (m, 21H), 0.53-0.63 (m, 12H);  $^{13}\text{C NMR}$  (75 MHz,  $\text{CDCl}_3$ )  $\delta$  172.3, 159.9, 153.3, 135.8, 130.6, 130.3, 129.7, 129.4, 127.8, 114.0, 79.6, 77.8, 73.4, 67.6, 66.8, 56.4, 55.6, 44.7, 37.8, 33.9, 24.1, 15.2, 7.5, 7.4, 5.8, 5.4; HRMS (FAB+) calcd. for  $\text{C}_{38}\text{H}_{60}\text{NO}_7\text{Si}_2$  (M-1) 698.3908, found 698.3890.



To a solution of EtSH (75 mg,  $90.2 \mu\text{L}$ , 1.21 mmol) in THF (9.0 mL) at  $0^\circ\text{C}$  was added *n*-BuLi (0.43 mL, 1.07 mmol, 2.5 M in hexane). After 20 min, a solution of the above intermediate (500 mg, 0.714 mmol) in THF (3.0 mL) was transferred *via* cannula dropwise. After 20 min, the reaction was quenched with sat. aq.  $\text{NH}_4\text{Cl}$  (10 mL). After 5 min, the mixture was extracted with  $\text{Et}_2\text{O}$  ( $3 \times 20 \text{ mL}$ ). The dried ( $\text{MgSO}_4$ ) extract was concentrated *in vacuo* and purified by a plug of silica gel, eluting with 10% EtOAc / Hexanes, to give the corresponding thioester intermediate (375 mg, 0.68 mmol, 95%) as a colorless oil.

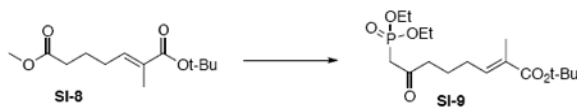
To a suspension of CuI (796 mg, 4.18 mmol) in  $\text{Et}_2\text{O}$  (9.0 mL) at  $0^\circ\text{C}$  was added MeLi (5.2 mL, 8.36 mmol, 1.6 M in  $\text{Et}_2\text{O}$ ). After 15 min, the colorless solution was cooled to  $-50^\circ\text{C}$  and a solution of the above thioester intermediate (375 mg, 0.68 mmol) in  $\text{Et}_2\text{O}$  (2.4 mL) was transferred into the reaction dropwise *via* cannula. After 2 h, the reaction was quenched with sat. aq.  $\text{NH}_4\text{Cl}$  (10 mL) at  $-50^\circ\text{C}$ , warmed to r.t. and extracted with  $\text{Et}_2\text{O}$  ( $3 \times 20 \text{ mL}$ ). The dried ( $\text{MgSO}_4$ ) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 2-4% EtOAc / hexanes, to give methyl ketone **13** (326 mg, 0.60 mmol, 89%) as a colorless oil:  $[\alpha]_{\text{D}}^{23} +31.0^\circ$  (c 0.80,  $\text{CHCl}_3$ ); IR 2956, 2912, 2876, 1716, 1613, 1514, 1457, 1416, 1249, 1172, 1082, 1037, 1007, 820,  $740 \text{ cm}^{-1}$ ;  $^1\text{H NMR}$  (300 MHz,  $\text{CDCl}_3$ )  $\delta$  7.23 (d,  $J = 8.7 \text{ Hz}$ , 2H), 6.86 (d,  $J = 8.7 \text{ Hz}$ , 2H), 4.40 (d,  $J = 11.4 \text{ Hz}$ , 1H), 4.38 (d,  $J = 11.4 \text{ Hz}$ , 1H), 3.81 (s, 3H), 3.69-3.81 (m, 3H), 2.11 (s, 3H), 1.45-1.48 (m, 3H), 1.09 (d,  $J = 6.0 \text{ Hz}$ , 3H), 0.85-0.97 (m, 21H), 0.53-0.61 (m, 12H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  211.5, 159.8, 130.1, 129.9, 114.1, 88.9, 73.1, 67.4, 55.7, 44.9, 33.5, 27.4, 23.9, 14.3, 7.4, 7.3, 5.7, 5.4; HRMS (FAB+) calcd. for  $\text{C}_{29}\text{H}_{55}\text{O}_5\text{Si}_2$  (M+1) 539.3588, found 539.3559.



### Carboxylic acid 11

To a solution of **38** (320 mg, 0.35 mL, 2.50 mmol) in THF/H<sub>2</sub>O (35 mL, 1:1) at r.t. was added K<sub>2</sub>OsO<sub>4</sub>•H<sub>2</sub>O (14 mg, 15 μmol) and NaIO<sub>4</sub> (2.4 g, 11.25 mmol). After 3 h, the reaction was quenched with sat. aq. Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> (5 mL). After 20 min, the mixture was extracted with Et<sub>2</sub>O (3 × 10 mL). The dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* to give an aldehyde intermediate (247 mg, 1.90 mmol, 76%) as a colorless oil. The aldehyde intermediate **SI-7** was used directly in the next step without further purification.

To a solution of the above aldehyde intermediate **SI-7** (247 mg, 1.90 mmol) in CH<sub>2</sub>Cl<sub>2</sub> (5.4 mL) at r.t. was added Wittig reagent Ph<sub>3</sub>P=C(Me)CO<sub>2</sub>t-Bu (725 mg, 2.0 mmol). After 30 min, the reaction was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 5% EtOAc / hexanes, to give Wittig product **SI-8** (377 mg, 1.56 mmol, 82%) as a colorless oil: IR (neat) 2977, 1739, 1704, 1652, 1456, 1436, 1367, 1289, 1252, 1159, 1121, 1083, 852, 743 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 6.59 (dt, J = 1.2, 7.5 Hz, 1H), 3.65 (s, 3H), 2.32 (t, J = 7.5 Hz, 2H), 2.17 (q, J = 7.5 Hz, 2H), 1.71-1.83 (m, 5H), 1.47 (s, 9H); <sup>13</sup>C NMR (75 MHz, CDCl<sub>3</sub>) δ 174.1, 167.8, 139.9, 130.5, 80.5, 51.9, 33.9, 28.5, 28.3, 24.2, 12.8; HRMS (FAB+) calcd. for C<sub>13</sub>H<sub>23</sub>O<sub>4</sub> (M+1) 243.1596, found 243.1598.



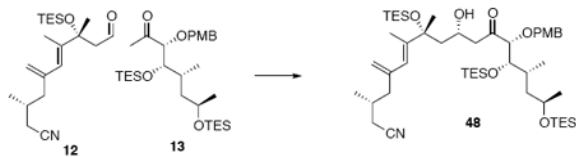
To a solution of methyl diethylphosphonate (318 mg, 0.3 mL, 2.09 mmol) in THF (10 mL) at -78°C was added *n*-BuLi (0.83 mL, 2.09 mmol, 2.5 M in hexane). After 20 min, this resulted solution was transferred dropwise into a solution of the above Wittig product **SI-8** (202 mg, 0.83 mmol) in THF (4 mL) at -78°C *via* cannula. After 30 min, the reaction was quenched with sat. aq. NH<sub>4</sub>Cl (3 mL). The mixture was extracted with EtOAc (3 × 10 mL). The dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 80% EtOAc / Hexanes, to give phosphonate intermediate **SI-9** (254 mg, 0.65 mmol, 78%) as a colorless oil: IR (neat) 2978, 2932, 1701, 1652, 1392, 1366, 1254, 1162, 1024, 965, 794 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 6.58 (dt, J = 1.2, 7.5 Hz, 1H), 4.07-4.17 (m, 4H), 3.09 (s, 1H), 3.01 (s, 1H), 2.63 (t, J = 7.2 Hz, 2H), 2.13 (q, J = 7.5 Hz, 2H), 1.75 (s, 3H), 1.67-1.75 (m, 2H), 1.46 (s, 9H), 1.31 (t, J = 7.2 Hz, 6H); <sup>13</sup>C NMR (75 MHz, CDCl<sub>3</sub>) δ 202.0, 167.8, 140.2, 130.4, 80.5, 63.0, 43.7, 42.0, 28.5, 28.1, 22.7, 16.7, 12.8; HRMS (FAB+) calcd. for C<sub>17</sub>H<sub>32</sub>O<sub>6</sub>P (M+1) 363.1937, found 363.1942.



To a solution of the above phosphonate **SI-9** (102 mg, 0.28 mmol) in CH<sub>2</sub>Cl<sub>2</sub> (1.5 mL) at 0°C was added TFA (1.15 g, 0.75 mL, 9.7 mmol). After 5 min, the reaction was warmed to r.t. After 2 h, the reaction was concentrated *in vacuo* and purified by chromatography over

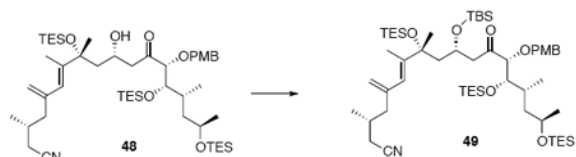


silica gel, eluting with 4% MeOH / CH<sub>2</sub>Cl<sub>2</sub>, to give **11** (84.8 mg, 0.28 mmol, 99%) as a colorless oil: IR (neat) 3418, 2986, 2934, 1772, 1715, 1395, 1209, 1163, 1023, 973, 799, 698 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 6.86 (t, *J* = 7.5 Hz, 1H), 6.07 (br, 1H), 4.12-4.23 (m, 4H), 3.18 (s, 1H), 3.10 (s, 1H), 2.64 (t, *J* = 7.2 Hz, 2H), 2.22 (q, *J* = 7.5 Hz, 2H), 1.82 (s, 3H), 1.71-1.80 (m, 2H), 1.30 (t, *J* = 7.5 Hz, 6H); <sup>13</sup>C NMR (75 MHz, CDCl<sub>3</sub>) δ 202.2, 170.5, 143.5, 128.5, 63.2, 43.6, 41.9, 28.2, 22.5, 16.7, 12.5; HRMS (FAB+) calcd. for C<sub>13</sub>H<sub>24</sub>O<sub>6</sub>P (M+1) 307.1311, found 307.1322.



### Alcohol 48

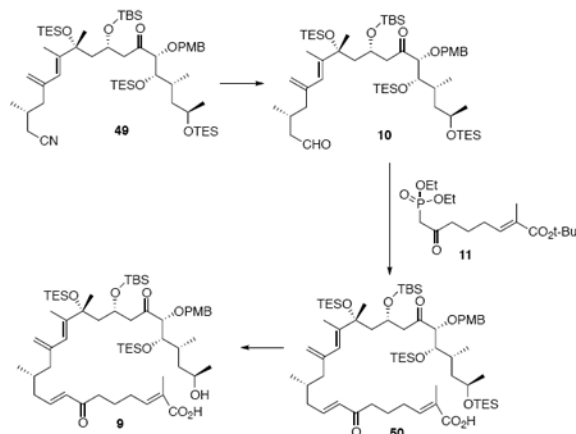
To a solution of **13** (73 mg, 0.14 mmol) in Et<sub>2</sub>O (0.7 mL) at -78°C was added LDA<sup>54</sup> (0.15 mL, 1.0 M in THF). After 20 min, a pre-cooled (-78°C) solution of aldehyde **12** (31.5 mg, 0.09 mmol) in Et<sub>2</sub>O (0.4 mL) was transferred in one portion *via* cannula at -78°C. After 20 min, the reaction was quenched with sat. aq. NH<sub>4</sub>Cl (3 mL) and the mixture was extracted with Et<sub>2</sub>O (3 × 10 mL). The dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 5% EtOAc / hexanes, to give **48** (55 mg, 0.06 mmol, 69%) as a colorless oil: [α]<sub>D</sub><sup>23</sup> +21.3° (c 0.60, CHCl<sub>3</sub>); IR (neat) 3496, 2955, 2911, 2876, 1715, 1614, 1515, 1457, 1418, 1379, 1249, 1086, 1036, 1008, 903, 807, 740 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 7.27 (d, *J* = 8.7 Hz, 2H), 6.85 (d, *J* = 8.7 Hz, 2H), 5.87 (s, 1H), 5.09 (s, 1H), 4.89 (s, 1H), 4.47 (d, *J* = 10.8 Hz, 1H), 4.33-4.36 (m, 2H), 3.80 (s, 3H), 3.76-3.80 (m, 3H), 3.61 (s, 1H), 2.95 (dd, *J* = 7.2, 18.0 Hz, 1H), 2.05-2.40 (m, 6H), 1.88-1.95 (m, 1H), 1.81 (s, 3H), 1.52 (s, 3H), 1.37-1.52 (m, 5H), 1.07 (d, *J* = 6.9 Hz, 3H), 1.05 (d, *J* = 6.0 Hz, 3H), 0.83-0.98 (m, 30H), 0.51-0.67 (m, 18H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 212.1, 159.7, 144.8, 143.2, 130.1, 124.3, 118.9, 116.7, 114.1, 88.5, 79.7, 72.9, 67.3, 65.1, 55.7, 48.4, 47.2, 45.1, 44.9, 33.5, 29.6, 26.7, 24.3, 23.6, 19.8, 15.2, 13.9, 7.5, 7.4, 7.3, 7.0, 5.7, 5.4; HRMS (FAB+) calcd. for C<sub>49</sub>H<sub>90</sub>O<sub>7</sub>Si<sub>3</sub>N (M+1) 888.6025, found 888.6052.



### Silylether 49

To a solution of **48** (55 mg, 60 μmol) in CH<sub>2</sub>Cl<sub>2</sub> (0.15 mL) at r.t. was added Et<sub>3</sub>N (0.15 mL). The solution was then cooled to -78°C. After 5 min, TBSOTf (65.8 mg, 60.4 μL, 0.25 mmol) was added dropwise. After 5 min, the reaction was warmed to r.t. After 20 min, the reaction was quenched with sat. aq. NH<sub>4</sub>Cl (3 mL) and the mixture was extracted with Et<sub>2</sub>O (3 × 10 mL). The dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 3% EtOAc / Hexanes, to give **49** (53 mg, 53 μmol, 88%) as a colorless oil: [α]<sub>D</sub><sup>23</sup> +35.1° (c 0.50, CHCl<sub>3</sub>); IR (neat) 2954, 2928, 2876, 1714, 1615, 1515, 1458, 1381, 1250, 1167, 1125, 1065, 1006, 987, 835, 776, 740 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 7.27 (d, *J* = 8.4 Hz, 2H), 6.85 (d, *J* = 8.7 Hz, 2H), 5.80 (s, 1H), 5.07 (s, 1H), 4.89 (s, 1H), 4.51 (d, *J* = 10.5 Hz, 1H), 4.21-4.25 (m, 2H), 3.81 (s, 3H), 3.64-3.81 (m, 3H), 3.17 (dd, *J* = 9.3, 18.0 Hz, 1H), 2.58 (dd, *J* = 2.7, 17.7 Hz, 1H), 2.38 (dd, *J* = 4.5, 16.8 Hz, 1H), 2.19 (dd, *J* = 6.9, 16.8 Hz, 1H), 2.05-2.10 (m, 2H), 1.86-1.94 (m, 2H),

1.79 (s, 3H), 1.66-1.79 (m, 1H), 1.58-1.62 (m, 1H), 1.40 (s, 3H), 1.28-1.35 (m, 2H), 1.07 (d,  $J = 6.3$  Hz, 3H), 1.05 (d,  $J = 5.4$  Hz, 3H), 0.86-0.97 (m, 30H), 0.78 (s, 9H), 0.50-0.65 (m, 18H), 0.05 (s, 3H), -0.03 (s, 3H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  212.2, 159.5, 143.6, 143.1, 130.3, 129.9, 124.9, 119.0, 116.6, 113.9, 89.1, 77.3, 72.3, 67.2, 66.1, 55.6, 49.7, 46.4, 45.5, 44.7, 33.7, 29.4, 29.0, 26.3, 24.3, 23.5, 19.7, 18.4, 15.4, 12.9, 7.7, 7.4, 7.3, 5.7, 5.3, -3.7, -4.2; HRMS (FAB+) calcd. for  $\text{C}_{55}\text{H}_{104}\text{O}_7\text{Si}_4\text{N}$  ( $M+1$ ) 1002.6890, found 1002.6923.

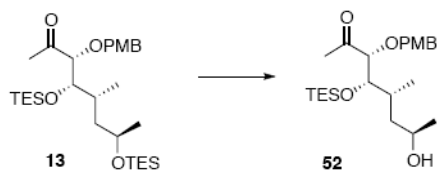


### Acid 9

To a solution of **49** (11 mg, 11  $\mu\text{mol}$ ) in PhMe (0.25 mL) at  $-78^\circ\text{C}$  was added DIBAL-H (13.2  $\mu\text{L}$ , 13.2  $\mu\text{mol}$ , 1.0 M in PhMe) dropwise. After 10 min, another portion of DIBAL-H (6.0  $\mu\text{L}$ , 6.0  $\mu\text{mol}$ , 1.0 M in PhMe) was added. the reaction was quenched sequentially with MeOH (0.5 mL), sat. aq. tartaric acid (0.1 mL) and  $\text{H}_2\text{O}$  (2 mL). Next, the mixture was warmed to r.t. After 1 h, the mixture was extracted with  $\text{Et}_2\text{O}$  ( $3 \times 10$  mL) and the dried ( $\text{MgSO}_4$ ) extract was concentrated *in vacuo* to give the unstable aldehyde **10** as a colorless oil. The aldehyde was applied immediately to the next step without further purification.

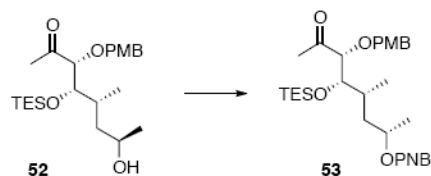
To a solution of **11** (4.0 mg, 0.012 mmol) in THF/ $\text{H}_2\text{O}$  (0.2 mL, 40:1) at r.t. was added  $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$  (7.6 mg, 0.024 mmol). After 30 min, a solution of the above aldehyde intermediate **10** in THF (0.15 mL) was added dropwise *via* cannula. After 16 h, the reaction was quenched with sat. aq.  $\text{NH}_4\text{Cl}$  (2 mL) and the mixture was extracted with  $\text{Et}_2\text{O}$  ( $3 \times 10$  mL). The dried ( $\text{MgSO}_4$ ) extract was concentrated *in vacuo* was applied immediately to the next step without further purification.

To a flask containing crude **50** at  $0^\circ\text{C}$  was added a premixed solution of HOAc/THF/ $\text{H}_2\text{O}$  (4.0 mL, 8:4:1) dropwise. After 2 h, the solution was allowed to warm to  $10^\circ\text{C}$ . After 6 h, the reaction was warmed to rt. After 6 h, the reaction was concentrated in vacuo. Benzene was added to further dry the product **9** (11.3 mg).  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  7.30 (d,  $J = 8.8$  Hz, 2H), 6.84-6.98 (m, 4H), 6.10 (d,  $J = 15.9$  Hz, 2H), 5.83 (s, 1H), 4.99 (s, 1H), 4.83 (s, 1H), 4.52 (d,  $J = 10.5$  Hz, 1H), 4.12-4.27 (m, 2H), 3.81 (s, 3H), 3.68-3.80 (m, 3H), 3.16 (m, 1H), 2.59-2.68 (m, 3H), 2.28-2.38 (m, 1H), 2.21-2.25 (m, 2H), 1.91-2.11 (m, 4H), 1.82 (s, 3H), 1.75 (s, 3H), 1.71-1.82 (m, 4H), 1.64-1.69 (m, 1H), 1.43 (s, 3H), 1.25-1.35 (m, 4H), 1.09 (d,  $J = 4.0$  Hz, 3H), 0.88-1.01 (m, 31H), 0.81 (s, 9H), 0.55-0.68 (m, 18H), 0.09 (s, 3H), 0.01 (s, 3H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  212.5, 201.2, 168.6, 159.6, 147.0, 145.0, 144.0, 142.1, 132.1, 130.1, 129.9, 128.9, 125.7, 115.5, 113.9, 88.5, 77.3, 72.2, 67.2, 66.1, 55.6, 49.6, 47.0, 46.0, 43.9, 40.3, 39.3, 33.3, 32.3, 31.5, 29.1, 28.6, 26.3, 23.3, 23.5, 23.0, 19.6, 18.3, 14.7, 14.5, 12.5, 7.7, 7.4, 7.3, 7.0, 6.2, 5.6, -3.8, -4.1.



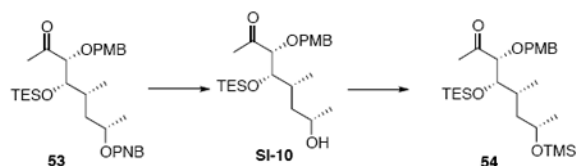
### Alcohol 52

To a flask containing **13** (120 mg, 0.22 mmol) at 0°C was added a premixed solution of HOAc/THF/H<sub>2</sub>O (4.0 mL, 8:8:1) dropwise. After 10 min, the solution was allowed to warm to 5°C. After 2 h, the reaction was quenched with sat. aq. NaHCO<sub>3</sub> (10 mL) dropwise. Next, the mixture was extracted with Et<sub>2</sub>O (3 × 10 mL) and the dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* to give product **52** (90 mg, 0.21 mmol, 95%) as a colorless oil: [ $\alpha$ ]<sub>D</sub><sup>23</sup> (+) 17.7° (c 0.34, CHCl<sub>3</sub>); IR (thin film) 3413, 2958, 2910, 2875, 1712, 1613, 1514, 1457, 1354, 1302, 1249, 1172, 1076, 1055, 1009, 820, 740 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 7.23 (d, J = 8.4 Hz, 2H), 6.86 (d, J = 8.4 Hz, 2H), 4.43 (d, J = 11.4 Hz, 1H), 4.38 (d, J = 11.4 Hz, 1H), 3.81-3.91 (m, 2H), 3.80 (s, 3H), 3.74 (d, J = 6.3 Hz, 1H), 2.40 (br, 1H), 2.14 (s, 3H), 1.49-1.65 (m, 2H), 1.32-1.40 (m, 1H), 1.14 (d, J = 6.0 Hz, 3H), 0.85-0.99 (m, 12H), 0.58 (q, J = 7.8 Hz, 6H); <sup>13</sup>C NMR (400 MHz, CDCl<sub>3</sub>) δ 210.8, 159.8, 130.2, 129.7, 114.2, 88.4, 75.3, 72.9, 66.2, 55.7, 43.5, 33.5, 27.5, 24.2, 15.1, 7.4, 5.6; HRMS (FAB+) calcd. for C<sub>23</sub>H<sub>41</sub>O<sub>5</sub>Si (M+1) 425.2723, found 425.2730.



### Ester 53

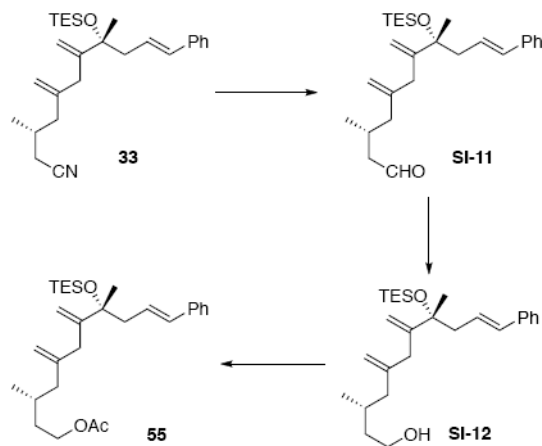
To a solution of **52** (237 mg, 0.56 mmol), *p*-NO<sub>2</sub>-benzoic acid (374 mg, 2.24 mmol) and PPh<sub>3</sub> (587 mg, 2.24 mmol) in THF (3.7 mL) at 0 °C was added DEAD (1.0 mL, 1.04 g, 2.24 mmol, 40% w/w in PhMe) dropwise. After 10 min, the reaction was warmed to r.t. After 2 h, the reaction was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 10-15% EtOAc / Hexanes, to give **53** (46 mg, 0.084mmol, 80%) as a colorless oil: [ $\alpha$ ]<sub>D</sub><sup>23</sup> (+) 38.1° (c 0.48, CHCl<sub>3</sub>); IR (thin film) 2954, 2875, 1719, 1610, 1528, 1514, 1457, 1349, 1275, 1102, 1036, 1013, 823, 720 cm<sup>-1</sup>; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.28 (d, J = 8.8 Hz, 2H), 8.19 (d, J = 8.8 Hz, 2H), 7.26 (d, J = 8.4 Hz, 2H), 6.89 (d, J = 8.4 Hz, 2H), 5.24-5.29 (m, 1H), 4.53 (d, J = 11.2 Hz, 1H), 4.38 (d, J = 11.2 Hz, 1H), 3.80-3.83 (m, 3H), 2.16 (s, 3H), 2.01-2.08 (m, 1H), 1.67-1.69 (m, 1H), 1.55-1.61 (m, 1H), 1.39 (d, J = 6.0 Hz, 3H), 0.93 (t, J = 8.0 Hz, 9H), 0.89 (d, J = 6.8 Hz, 3H), 0.59 (q, J = 8.0 Hz, 6H); <sup>13</sup>C NMR (400 MHz, CDCl<sub>3</sub>) δ 211.3, 164.8, 159.9, 150.8, 136.5, 131.0, 130.3, 129.6, 123.9, 114.2, 87.6, 77.4, 73.1, 71.3, 55.7, 39.9, 33.7, 28.0, 21.4, 14.7, 7.4, 5.5.



Silylether **54**

To a solution of **53** (125 mg, 0.23 mmol) in MeOH (4.7 mL) was added Ba(OH)<sub>2</sub>·8H<sub>2</sub>O (36.1 mg, 0.12 mmol). After 1 h, the reaction was quenched with sat. aq. NH<sub>4</sub>Cl (5 mL). The mixture was extracted with Et<sub>2</sub>O (3 × 10 mL). The dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 10-15% EtOAc / Hexanes, to give an alcohol intermediate **SI-10** (63 mg, 0.15 mmol, 65%) as a colorless oil: [α]<sub>D</sub><sup>23</sup> (+) 38.4° (c 1.87, CHCl<sub>3</sub>); IR (thin film) 3439, 2958, 2933, 2875, 1713, 1613, 1514, 1458, 1376, 1302, 1249, 1079, 1035, 820, 786, 739 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 7.24 (d, J = 8.7 Hz, 2H), 6.87 (d, J = 8.7 Hz, 2H), 4.44 (d, J = 11.4 Hz, 1H), 4.38 (d, J = 11.4 Hz, 1H), 3.75-3.80 (m, 6H), 2.14 (s, 3H), 1.70 (br, 1H), 1.50-1.59 (m, 1H), 1.27-1.35 (m, 2H), 1.16 (d, J = 6.0 Hz, 3H), 0.92 (t, J = 7.8 Hz, 9H), 0.85 (d, J = 6.9 Hz, 3H), 0.58 (q, J = 6.9 Hz, 6H); <sup>13</sup>C NMR (400 MHz, CDCl<sub>3</sub>) δ 211.5, 159.8, 130.2, 129.7, 114.2, 88.3, 73.0, 66.4, 55.7, 43.9, 33.8, 27.7, 24.9, 14.7, 7.4, 5.6; HRMS (FAB+) calcd. for C<sub>23</sub>H<sub>40</sub>O<sub>5</sub>SiNa (M+Na) 447.2543, found 447.2561.

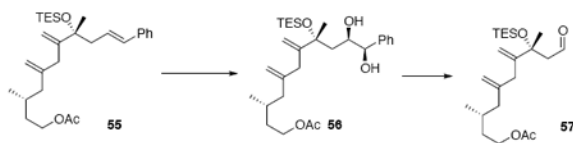
To a solution of the alcohol intermediate **SI-10** (77 mg, 0.18 mmol) in CH<sub>2</sub>Cl<sub>2</sub> (0.9 mL) at -78°C was added 2,6-lutidine (78 mg, 84.8 μL, 0.73 mmol) and TMSOTf (80 mg, 65.2 μL, 0.36 mmol). After 20 min, the reaction was quenched with sat. aq. NH<sub>4</sub>Cl (5 mL) and extracted with Et<sub>2</sub>O (3 × 10 mL). The dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* to give product **54** (80 mg, 0.16 mmol, 90%) as a colorless oil: [α]<sub>D</sub><sup>23</sup> (+) 31.8° (c 2.80, CHCl<sub>3</sub>); IR (thin film) 2955, 2911, 2876, 1715, 1613, 1514, 1458, 1414, 1372, 1352, 1249, 1124, 1088, 1038, 1006, 820, 787, 741 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 7.23 (d, J = 8.4 Hz, 2H), 6.86 (d, J = 8.4 Hz, 2H), 4.42 (d, J = 11.4 Hz, 1H), 4.36 (d, J = 11.4 Hz, 1H), 3.74-3.85 (m, 5H), 3.68 (d, J = 6.9 Hz, 1H), 2.09 (s, 3H), 1.55-1.61 (m, 1H), 1.41-1.50 (m, 1H), 1.25-1.35 (m, 1H), 1.12 (d, J = 6.0 Hz, 3H), 0.92 (t, J = 7.8 Hz, 9H), 0.82 (d, J = 6.6 Hz, 3H), 0.58 (q, J = 7.8 Hz, 6H), 0.07 (s, 9H); <sup>13</sup>C NMR (75 MHz, CDCl<sub>3</sub>) δ 211.0, 159.7, 130.2, 129.7, 114.1, 89.3, 73.1, 66.2, 55.6, 45.2, 32.4, 26.9, 25.3, 12.9, 7.4, 5.7, 0.7; HRMS (ES+) calcd. for C<sub>26</sub>H<sub>48</sub>O<sub>5</sub>NaSi<sub>2</sub> (M+Na) 519.2938, found 519.2914.

Acetate **55**

To a solution of **33** (45 mg, 0.11 mmol) in PhMe (0.53 mL) at -78°C was added DIBAL-H (0.15 mL, 0.15 mmol, 1.0 M in PhMe). After 10 min, the reaction was quenched sequentially with MeOH (0.2 mL), sat. aq. tartaric acid (0.2 mL) and H<sub>2</sub>O (2.0 mL). After stirring 12 h at r.t., the mixture was extracted with Et<sub>2</sub>O (3 × 10 mL). The dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* to give the corresponding crude aldehyde (0.11 mmol).

To a mixed solution of the above aldehyde (0.11 mmol) in  $\text{CH}_2\text{Cl}_2$  (0.5 mL) and EtOH (0.5 mL) at  $0^\circ\text{C}$  was added  $\text{NaBH}_4$  (8.4 mg, 0.22 mmol). After 15 min, the reaction was quenched with a brine solution (5 mL) and extracted with  $\text{Et}_2\text{O}$  ( $3 \times 10$  mL). The dried ( $\text{MgSO}_4$ ) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 6% EtOAc / Hexanes, to give the corresponding alcohol intermediate (38 mg, 0.09 mmol, 85%) as a colorless oil.

To a solution of the above alcohol intermediate (29 mg, 0.07 mmol) in  $\text{CH}_2\text{Cl}_2$  at  $0^\circ\text{C}$  was added sequentially pyridine (21.4 mg, 22.1  $\mu\text{L}$ , 0.27 mmol), DMAP (8.3 mg, 0.07 mmol) and  $\text{Ac}_2\text{O}$  (13.9 mg, 12.8  $\mu\text{L}$ , 0.14 mmol). After 15 min, the reaction was quenched with sat. aq.  $\text{NH}_4\text{Cl}$  (5 mL) and extracted with  $\text{Et}_2\text{O}$  ( $3 \times 10$  mL). The dried ( $\text{MgSO}_4$ ) extract was concentrated *in vacuo* to give product **55** (31 mg, 64  $\mu\text{mol}$ , 94%) as a colorless oil:  $[\alpha]_{\text{D}}^{23}$  (-)  $39.3^\circ$  (c 0.40,  $\text{CHCl}_3$ ); IR (thin film) 3026, 2955, 2913, 2875, 1741, 1496, 1457, 1367, 1236, 1158, 1121, 1053, 1016, 966, 898, 793, 741, 692  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  7.15-7.28 (m, 5H), 6.32 (d,  $J = 15.9$  Hz, 1H), 6.07-6.17 (m, 1H), 5.85 (s, 1H), 4.96 (s, 1H), 4.79 (s, 1H), 3.98-4.07 (m, 2H), 2.41-2.52 (m, 2H), 2.10 (dd,  $J = 5.7, 13.5$  Hz, 1H), 2.00 (s, 3H), 1.85 (dd,  $J = 7.8, 13.2$  Hz, 1H), 1.79 (s, 3H), 1.58-1.67 (m, 2H), 1.43 (s, 3H), 1.28-1.36 (m, 1H), 0.97 (t,  $J = 7.5$  Hz, 9H), 0.75 (d,  $J = 6.6$  Hz, 3H), 0.61 (q,  $J = 7.5$  Hz, 6H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  171.6, 145.3, 143.0, 138.3, 132.0, 128.9, 127.4, 127.3, 126.3, 125.3, 114.9, 78.7, 63.3, 46.4, 46.2, 35.6, 29.0, 27.4, 21.4, 19.6, 15.0, 7.6, 7.2; HRMS (FAB +) calcd. for  $\text{C}_{29}\text{H}_{46}\text{O}_3\text{SiNa}$  (M+Na) 493.3114, found 493.3130.

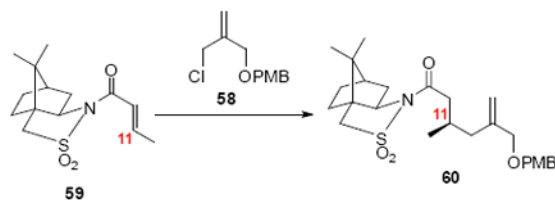


### Compound 69

To a solution of **55** (31 mg, 66  $\mu\text{mol}$ ) in *t*-BuOH (0.55 mL) and  $\text{H}_2\text{O}$  (0.55 mL) at r.t. was added AD mix  $\beta^{*53}$  (92 mg) and  $\text{CH}_3\text{SO}_2\text{NH}_2$  (9.5 mg, 0.10 mmol). After 16 h, the reaction was quenched with 10% aq.  $\text{Na}_2\text{S}_2\text{O}_3$  (2 mL). After 30 min, the mixture was extracted with EtOAc ( $3 \times 10$  mL). The dried ( $\text{MgSO}_4$ ) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 20% EtOAc / Hexanes, to give the corresponding diol (29 mg, 58  $\mu\text{mol}$ , 88%, 6:1 d.r.).

To a solution of the above diol (26 mg, 52  $\mu\text{mol}$ ) in THF/  $\text{Et}_2\text{O}$ /  $\text{H}_2\text{O}$  (1.7 mL, 1:1:1) at r.t. was added  $\text{NaIO}_4$  (110 mg, 0.52 mmol). After 2 h, the reaction was quenched with a brine solution (2 mL) and extracted with  $\text{Et}_2\text{O}$  ( $3 \times 10$  mL). The dried ( $\text{MgSO}_4$ ) extract was concentrated *in vacuo* to give the aldehyde intermediate (20.4 mg, 52  $\mu\text{mol}$ , 99%) as a colorless oil. The aldehyde intermediate was applied to the next step without further purification.  $[\alpha]_{\text{D}}^{23} = -11.6$  (c 1.83,  $\text{CHCl}_3$ ); IR (neat) 2957, 2877, 1741, 1724, 1458, 1368, 1239, 1050, 1017, 743  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  9.66 (t,  $J = 3.0$  Hz, 1H), 6.02 (s, 1H), 5.03 (s, 1H), 4.83 (s, 1H), 4.14-4.04 (m, 2H), 2.65 (dd,  $J = 15.1, 2.9$  Hz, 1H), 2.46 (dd,  $J = 15.1, 3.1$  Hz, 1H), 2.14 (dd,  $J = 13.6, 5.8$  Hz, 1H), 2.04 (s, 3H), 1.92 (dd,  $J = 13.5, 7.8$  Hz, 1H), 1.82 (s, 3H), 1.70-1.60 (m, 2H), 1.48 (s, 3H), 1.45-1.39 (m, 1H), 1.00-0.94 (m, 9H), 0.87 (d,  $J = 6.5$  Hz, 3H), 0.68-0.56 (m, 6H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  203.0, 171.2, 144.3, 141.2, 125.7, 115.1, 62.8, 54.0, 45.8, 35.3, 28.7, 27.9, 20.9, 19.2, 14.7, 7.1, 6.7, 6.6, 5.8; HRMS (EI<sup>+</sup>) calcd. for  $\text{C}_{22}\text{H}_{40}\text{O}_4\text{Si}$  (M<sup>+</sup>) 396.2696, found 396.2678.

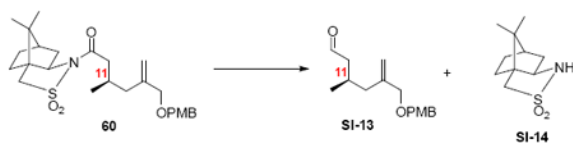




### Sultam 60

Following the similar procedure described by Paquette,<sup>38a</sup> Mg (36.0 g, 1.5 mol) was stirred vigorously at rt in a dry flask under Ar. After 120 h, when black coating formed inside the flask, THF (200 mL) and 1,2-dibromoethane (2.60 g, 1.2 mL, 13.9 mmol) were added sequentially. After 30 min, a solution of allyl chloride **58** (17.0 g, 75.0 mmol) in THF (80 mL) was added slowly to the Mg slurry over 5 h. The resulted mixture was stirred overnight at rt to give 300 mL Grignard reagent (0.12 M, 47%) as gray solution. The concentration of the Grignard reagent was determined by the titration using menthol in the presence of 1,10-phenanthroline.<sup>55</sup>

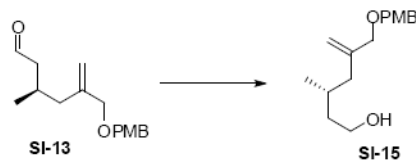
Separately, CuBr•SMe<sub>2</sub> (7.29 g, 35.5 mmol) and LiCl (1.61 g, 37.9 mmol) were dissolved in THF (80 mL) and added to the solution of Grignard reagent (263 mL, 31.5 mmol) at -78°C *via* syringe. TMSCl (3.96 g, 4.5 mL, 36.5 mmol) was then added followed by a solution of known sultam **59**<sup>56</sup> (6.9 g, 24.3 mmol) in THF (60 mL). After another 90 min, the reaction was quenched with NH<sub>4</sub>Cl-NH<sub>4</sub>OH (9:1, pH 9, 60 mL), warmed to rt. The aqueous layer was extracted with EtOAc (3 × 200 mL). The organic phase was washed with sat. aq. NaCl (100 mL). The dried extract (MgSO<sub>4</sub>) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 8-15% EtOAc / Hexanes, to give the product **60** (11.2 g, 34.4 mmol, 97%) as a colorless oil:  $[\alpha]_D^{23} = -68.0$  (*c* 0.51, CHCl<sub>3</sub>); IR (neat) 2959, 2927, 2851, 1693, 1512, 1454, 1328, 1246, 1032 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 7.28 (d, *J* = 8.7 Hz, 2H), 6.88 (d, *J* = 8.7 Hz, 2H), 5.12 (s, 1H), 4.96 (s, 1H), 4.44 (t, *J* = 11.8 Hz, 2H), 3.94 (t, *J* = 11.8 Hz, 2H), 4.00 (dd, *J* = 14.0 Hz, 2H), 3.88 (t, *J* = 6.2 Hz, 1H), 3.82 (s, 3H), 3.46 (dd, *J* = 23.0, 13.8 Hz, 2H), 2.78 (dd, *J* = 16.1, 5.7 Hz, 1H), 2.51 (dd, *J* = 16.1, 7.6 Hz, 1H), 2.30-2.40 (m, 1H), 2.02-2.15 (m, 4H), 1.82-1.96 (m, 3H), 1.28-1.45 (m, 3H), 1.15 (s, 3H), 0.99 (d, *J* = 6.4 Hz, 3H), 0.98 (s, 3H); <sup>13</sup>C NMR (75 MHz, CDCl<sub>3</sub>) δ 171.4, 159.1, 144.1, 130.6, 129.3, 113.7, 113.6, 72.4, 71.7, 65.2, 55.3, 53.0, 48.3, 47.7, 44.7, 42.5, 40.8, 38.6, 32.9, 28.0, 26.5, 20.8, 19.9; HRMS (ES<sup>+</sup>) calcd. for C<sub>26</sub>H<sub>37</sub>NO<sub>5</sub>SNa (M+Na) 498.2290, found 498.2271.



### Aldehyde SI-13

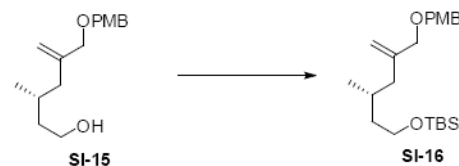
To a stirred solution of sultam **60** (11.0 g, 23.1 mmol) in CH<sub>2</sub>Cl<sub>2</sub> (115 mL) at -78°C was added DIBAL-H (50.8 mL, 50.8 mmol, 1.0 M in CH<sub>2</sub>Cl<sub>2</sub>). After 2 h, the reaction was carefully quenched with methanol (2.0 mL) and poured into aq. sodium potassium tartrate (250 mL, 10% aq.) at rt. The reaction flask was rinsed with an additional portion of CH<sub>2</sub>Cl<sub>2</sub> (150 mL). After 3 h, the aqueous layer was extracted with CH<sub>2</sub>Cl<sub>2</sub> (3 × 150 mL). The dried extract (MgSO<sub>4</sub>) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 10% EtOAc / Hexanes, to give the aldehyde **SI-13** (5.9 g, 22.6 mmol, 98%) as colorless oil. Further elution with 5% MeOH / EtOAc gave recovered auxiliary **SI-14** (4.9 g, 22.4 mmol, 97%). **SI-13**:  $[\alpha]_D^{23} = +5.93$  (*c* 0.91, CHCl<sub>3</sub>); IR (neat) 2956, 2929, 2837, 1723,

1612, 1513, 1247, 1077, 1034  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  9.75 (t,  $J = 1.5$  Hz, 1H), 7.29 (d,  $J = 8.7$  Hz, 2H), 6.90 (d,  $J = 8.7$  Hz, 2H), 5.14 (d,  $J = 1.2$  Hz, 1H), 4.95 (s, 1H), 4.44 (s, 2H), 3.93 (s, 2H), 3.83 (s, 3H), 2.47 (ddd,  $J = 14.0, 4.0$  and  $1.3$  Hz, 1H), 2.17-2.34 (m, 2H), 2.01-2.11 (m, 2H), 0.98 (d,  $J = 6.6$  Hz, 3H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  202.6, 159.2, 143.9, 130.3, 129.3, 114.1, 113.8, 72.4, 71.7, 55.3, 50.6, 41.0, 26.3, 20.1; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{16}\text{H}_{22}\text{O}_3\text{Na}$  ( $\text{M}+\text{Na}$ ) 285.1467, found 285.1494.



### Aldohol SI-15

To a stirred solution of aldehyde **SI-13** (5.6 g, 21.4 mmol) in  $\text{CH}_2\text{Cl}_2$  (110 mL) at  $-78^\circ\text{C}$  was added DIBAL-H (28.3 mL, 28.3 mmol, 1.0 M in  $\text{CH}_2\text{Cl}_2$ ). After 1 h, the reaction was carefully quenched with methanol (2.0 mL) and poured into aq. sodium potassium tartrate (250 mL, 10% aq.) at rt. The reaction flask was rinsed with an additional portion of  $\text{CH}_2\text{Cl}_2$  (150 mL). After 3 h, the aqueous layer was extracted with  $\text{CH}_2\text{Cl}_2$  ( $3 \times 150$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* to give the alcohol **SI-15** (5.6 g, 20.8 mmol, 97%) as a colorless oil:  $[\alpha]_{\text{D}}^{23} = -2.94$  ( $c$  0.51,  $\text{CHCl}_3$ ); IR (neat) 3407, 2926, 2868, 1612, 1513, 1461, 1248, 1059, 1036  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  7.29 (d,  $J = 8.7$  Hz, 2H), 6.90 (d,  $J = 8.7$  Hz, 2H), 5.10 (s, 1H), 4.94 (s, 1H), 4.44 (t,  $J = 12.2$  Hz, 2H), 3.91 (t,  $J = 13.4$  Hz, 2H), 3.82 (s, 3H), 3.61-3.78 (m, 2H), 2.15 (dd,  $J = 13.8, 6.0$  Hz, 1H), 1.89-1.96 (m, 1H), 1.89-1.96 (m, 1H), 1.72-1.86 (m, 1H), 1.57-1.69 (m, 1H), 1.23-1.45 (m, 1H), 0.91 (d,  $J = 6.6$  Hz, 3H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  159.2, 144.6, 130.4, 129.3, 113.8, 113.4, 72.6, 71.6, 61.0, 55.3, 41.3, 39.7, 27.5, 19.7, 18.8; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{16}\text{H}_{24}\text{O}_3\text{Na}$  ( $\text{M}+\text{Na}$ ) 287.1623, found 287.1649.



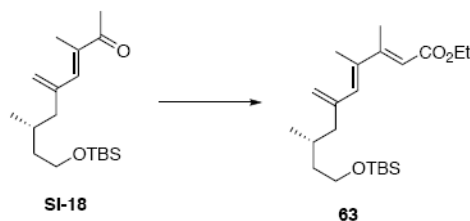
### TBS ether SI-16

To a stirred solution of alcohol **SI-15** (5.5 g, 20.8 mmol) in DMF (50 mL) at rt was sequentially added imidazole (3.4 g, 50.0 mmol) and TBSCl (3.8 g, 25.2 mmol). After 1 h, the reaction was quenched with sat. aq.  $\text{NH}_4\text{Cl}$  (50 mL) and extracted with  $\text{Et}_2\text{O}$  ( $3 \times 150$  mL). The dried ( $\text{MgSO}_4$ ) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 5% EtOAc / Hexanes, to give TBS ether **SI-16** (7.7 g, 20.3 mmol, 97%) as a colorless oil:  $[\alpha]_{\text{D}}^{23} = -3.27$  ( $c$  1.31,  $\text{CHCl}_3$ ); IR (neat) 2954, 2928, 2856, 1513, 1249, 1094, 835  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  7.29 (d,  $J = 8.7$  Hz, 2H), 6.90 (d,  $J = 8.7$  Hz, 2H), 5.11 (s, 1H), 4.93 (s, 1H), 4.44 (s, 2H), 3.92 (s, 2H), 3.83 (s, 3H), 3.63-3.70 (m, 2H), 2.13 (dd,  $J = 13.8, 6.3$  Hz, 1H), 1.88-1.96 (m, 1H), 1.76-1.86 (m, 1H), 1.57-1.69 (m, 1H), 1.28-1.35 (m, 1H), 0.91 (s, 9H), 0.89 (d,  $J = 6.6$  Hz, 3H), 0.06 (s, 6H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  159.1, 144.7, 130.6, 129.3, 113.8, 112.8, 72.6, 71.6, 61.3, 55.3, 41.4, 39.8, 27.5, 26.0, 19.6, 18.3, -5.3; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{22}\text{H}_{38}\text{O}_3\text{NaSi}$  ( $\text{M}+\text{Na}$ ) 401.2488, found 401.2489.



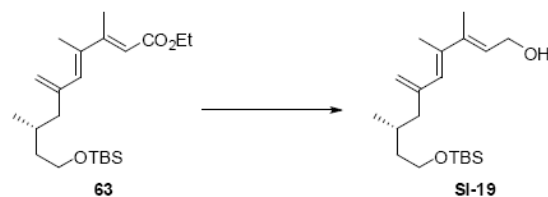
### Methyl ketone SI-18

A solution of aldehyde **61** (4.5 g, 17.5 mmol) and ylide **62**<sup>57</sup> (10.2 g, 30.7 mmol) in toluene (60 mL) was refluxed in a sealed tube (oil bath 112°C). After 16 h, the reaction mixture was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 5% EtOAc / Hexanes (1% Et<sub>3</sub>N added), to give diene **SI-18** (5.0 g, 16.1 mmol, 92%) as a slightly yellow oil:  $[\alpha]_D^{23} = -41.1$  (*c* 0.53, CHCl<sub>3</sub>); IR (neat) 2955, 2928, 2857, 1671, 1255, 1100, 836, 775 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 6.90 (s, 1H), 5.29 (s, 1H), 5.14 (s, 1H), 3.62-3.73 (m, 2H), 2.37 (s, 3H), 2.30 (dd, *J* = 10.2, 4.8 Hz, 1H), 2.05 (dd, *J* = 10.5, 6.3 Hz, 1H), 1.97 (d, *J* = 10.2 Hz, 3H), 1.71-1.78 (m, 1H), 1.59-1.64 (m, 1H), 1.34-1.38 (m, 1H), 0.91 (s, 9H), 0.89 (d, *J* = 6.6 Hz, 3H), 0.07 (s, 6H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 200.3, 143.7, 140.9, 137.8, 118.9, 61.0, 45.1, 39.6, 28.4, 25.9, 25.7, 19.3, 18.3, 13.1, -5.3; HRMS (FAB<sup>+</sup>) calcd. for C<sub>18</sub>H<sub>35</sub>O<sub>2</sub>Si (M+H) 311.2406, found 311.2400.



### Triene ester 63

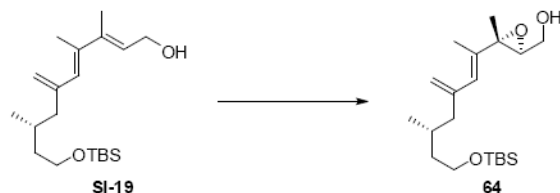
To a stirred slurry of NaH (1.29 g, 32.2 mmol) in DME (50 mL) was added ethyl 2-(diethoxyphosphoryl)acetate (6.48 g, 5.74 mL, 28.9 mmol) at rt. After 1 h, a solution of methyl ketone **SI-18** (5.00 g, 16.1 mmol) in DME (25 mL) was added. The resulted solution was refluxed for 3 h then quenched with H<sub>2</sub>O (15 mL) and extracted with Et<sub>2</sub>O (3 × 150 mL). The dried extract (MgSO<sub>4</sub>) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 2% EtOAc / Hexanes (1% Et<sub>3</sub>N added), to give triene ester **63** (4.42 g, 11.6 mmol, 70%) as a colorless oil:  $[\alpha]_D^{23} = -34.7$  (*c* 1.66, CHCl<sub>3</sub>); IR (neat) 2955, 2928, 2857, 1716, 1610, 1255, 1163, 1098, 836, 775 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 6.24 (s, 1H), 5.92 (s, 1H), 5.13 (s, 1H), 4.93 (s, 1H), 4.19 (q, *J* = 7.1 Hz, 2H), 3.61-3.68 (m, 2H), 2.36 (s, 3H), 2.20 (dd, *J* = 13.3, 5.9 Hz, 1H), 1.93-2.00 (m, 4H), 1.53-1.71 (m, 2H), 1.31 (t, *J* = 7.2 Hz, 3H), 0.89 (s, 9H), 0.87 (d, *J* = 6.9 Hz, 3H), 0.05 (s, 6H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 167.4, 156.4, 144.7, 137.8, 132.4, 116.4, 115.9, 61.2, 59.7, 45.7, 39.7, 28.3, 25.9, 19.5, 18.3, 15.8, 15.5, 14.4, -5.3; HRMS (EI<sup>+</sup>) calcd. for C<sub>22</sub>H<sub>40</sub>O<sub>3</sub>Si (M+H) 380.2747, found 380.2732.



### Allyl alcohol SI-19

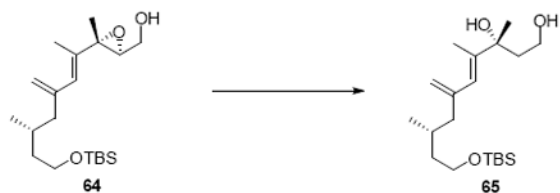
To a stirred solution of triene ester **63** (8.61 g, 22.6 mmol) in THF (200 mL) was added DIBAL-H (46 mL, 46.0 mmol, 1 M in toluene) at -78°C. After 1.5 h, the reaction was quenched with MeOH (1.0 mL) and poured into aq. sodium potassium tartrate (350 mL, 10% aq.) at rt. The reaction flask was rinsed with an additional portion of Et<sub>2</sub>O (50 mL). After 3 h, the aqueous layer was extracted with Et<sub>2</sub>O (3 × 200 mL). The dried extract (MgSO<sub>4</sub>) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting

with 8% EtOAc / Hexanes, to give allyl alcohol **SI-19** (6.20 g, 18.3 mmol, 81%) as a colorless oil:  $[\alpha]_D^{23} = -36.6$  (*c* 1.66, CHCl<sub>3</sub>); IR (neat) 3327, 2954, 2928, 2857, 1471, 1462, 1376, 1255, 1098, 1006, 835, 775 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 5.97 (s, 1H), 5.80 (t, *J* = 6.3 Hz, 1H), 5.08 (s, 1H), 4.87 (s, 1H), 4.34 (d, *J* = 6.4 Hz, 2H), 3.46-3.72 (m, 2H), 2.18 (dd, *J* = 13.6, 6.0 Hz, 1H), 1.99 (d, *J* = 0.8 Hz, 3H), 1.93 (dd, *J* = 13.5, 5.2 Hz, 1H), 1.86 (s, 3H), 1.54-1.73 (m, 2H), 1.28-1.37 (m, 1H), 0.90 (s, 9H), 0.87 (d, *J* = 6.6 Hz, 3H), 0.05 (s, 6H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 145.2, 139.3, 137.6, 128.1, 125.9, 115.4, 61.3, 60.1, 46.0, 39.7, 28.3, 25.9, 19.5, 18.3, 15.6, 14.2, -5.3; HRMS (EI<sup>+</sup>) calcd. for C<sub>20</sub>H<sub>38</sub>O<sub>2</sub>Si (M) 338.2641, found 338.2612.



### Epoxide **64**

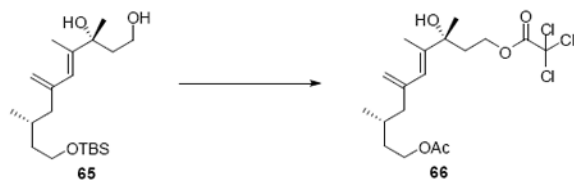
To a stirred solution of (+)-DIPT (41.5 mg, 0.18 mmol) and 4 Å mol sieves (about 200 mg) in CH<sub>2</sub>Cl<sub>2</sub> (4.0 mL) was sequentially added Ti(O-*i*Pr)<sub>4</sub> (34 mg, 34.6 μL, 0.12 mmol) and TBHP (236 μL, 1.30 mmol, 5.0-6.0 M in decane) at -20°C. After 20 min, the reaction mixture was cooled to -78°C and a pre-cooled solution (-78°C) of allyl alcohol **SI-19** (200 mg, 0.59 mmol) in CH<sub>2</sub>Cl<sub>2</sub> (4.0 mL) was added *via* cannula. The resulted solution was warmed up to -50°C. After another 60 min, the reaction was quenched with pH7 phosphate buffer (0.5 mL), filtered over Celite<sup>®</sup>, and extracted with Et<sub>2</sub>O (3 × 20 mL). The dried organic layers (MgSO<sub>4</sub>) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 10% EtOAc / Hexanes, to give epoxide **64** (167 mg, 0.47 mmol, 80%) as colorless oil:  $[\alpha]_D^{23} = -17.3$  (*c* 1.66, CHCl<sub>3</sub>); IR (neat) 3430, 2954, 2927, 2856, 1471, 1463, 1378, 1255, 1097, 836, 775 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 5.89 (s, 1H), 5.03 (s, 1H), 4.86 (s, 1H), 3.86-3.92 (m, 1H), 3.73-3.81 (m, 1H), 3.62-3.71 (m, 2H), 3.02 (dd, *J* = 10.5, 6.3 Hz, 1H), 2.14 (dd, *J* = 13.5, 5.6 Hz, 1H), 1.91 (dd, *J* = 13.5, 8.4 Hz, 1H), 1.84 (d, *J* = 1.1 Hz, 3H), 1.54-1.66 (m, 2H), 1.45 (s, 3H), 1.27-1.34 (m, 1H), 0.91 (s, 9H), 0.83 (d, *J* = 6.4 Hz, 3H), 0.06 (s, 6H); <sup>13</sup>C NMR (75 MHz, CDCl<sub>3</sub>) δ 144.0, 137.5, 126.2, 115.2, 63.7, 61.3, 45.6, 39.8, 28.2, 26.0, 19.3, 18.3, 16.7, 14.8, -5.3; HRMS (CI<sup>+</sup>) calcd. for C<sub>20</sub>H<sub>39</sub>O<sub>3</sub>Si (M+H) 355.2669, found 355.2666.



### Diol **65**

To a stirred solution of epoxide **64** (1.5 g, 4.23 mmol) in THF (30 mL) was added Red-Al (1.5 mL, 9.91 mmol, 65% W/V in toluene) at 0°C. After 1 h, another portion of Red-Al (1.5 mL, 9.91 mmol, 65% W/V in toluene) was added. After another 1.5 h, the reaction was quenched with H<sub>2</sub>O (0.10 mL), and extracted with CH<sub>2</sub>Cl<sub>2</sub> (3 × 150 mL). The dried organic layers (MgSO<sub>4</sub>) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 6-12% EtOAc / Hexanes (1% Et<sub>3</sub>N added), to give diol **65** (1.05 g, 2.96 mmol, 70%) as a colorless oil:  $[\alpha]_D^{23} = -29.4$  (*c* 0.81, CHCl<sub>3</sub>); IR (neat) 3389, 2955, 2928, 2858, 1471, 1462, 1382, 1255, 1097, 836, 775 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 6.10 (s, 1H),

5.04 (d,  $J = 0.9$  Hz, 1H), 4.84 (s, 1H), 3.62-3.77 (m, 4H), 3.04 (s, br, 1H), 2.60 (s, br, 1H), 2.16 (dd,  $J = 13.2, 5.1$  Hz, 1H), 1.88-1.96 (m, 3H), 1.79 (d,  $J = 0.9$  Hz, 3H), 1.55-1.70 (m, 2H), 1.37 (s, 1H), 1.27-1.34 (m, 1H), 0.91 (s, 9H), 0.86 (d,  $J = 6.5$  Hz, 3H), 0.07 (s, 6H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  145.1, 141.7, 125.1, 114.4, 77.1, 61.6, 60.4, 46.1, 40.1, 39.7, 28.6, 28.2, 26.0, 19.6, 18.4, 15.1, -5.2; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{20}\text{H}_{40}\text{O}_3\text{SiNa}$  ( $\text{M}+\text{Na}$ ) 379.2644, found 379.2643



### Ester 66

To a stirred solution of diol **65** (2.10 g, 5.89 mmol) in  $\text{CH}_2\text{Cl}_2$  (50 mL) was sequentially added pyridine (1.37 g, 1.40 mL, 17.7 mmol) and trichloroacetyl chloride (1.29 g, 0.79 mL, 7.09 mmol). After 3 h, the reaction was quenched with sat. aq.  $\text{NH}_4\text{Cl}$  (10 mL) and extracted with ether ( $3 \times 30$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* to give crude ester (3.30 g) as a colorless oil, which was used in the next step without further purification.

To a stirred solution of crude ester (3.30 g) in  $\text{CH}_2\text{Cl}_2$  / EtOH (1:1, 50 mL) was added CSA (2.31 g, 9.88 mmol) at  $0^\circ\text{C}$ . After 1.5 h, the reaction was quenched with sat. aq.  $\text{NaHCO}_3$  (10 mL) and extracted with ether ( $3 \times 40$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* to give crude diol (2.02 g), which was used in the next step without further purification.

To a stirred solution of crude diol (2.02 g) in  $\text{CH}_2\text{Cl}_2$  (50 mL) was sequentially added pyridine (1.53 g, 1.57 mL, 19.5 mmol) and  $\text{Ac}_2\text{O}$  (0.99 g, 0.92 mL, 9.73 mmol). After 1.5 h, the reaction was quenched with sat. aq.  $\text{NH}_4\text{Cl}$  (10 mL) and extracted with ether ( $3 \times 40$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 10% EtOAc / Hexanes, to give **66** (1.90 g, 4.42 mmol, 75% over 3 steps) as a colorless oil:  $[\alpha]_D^{23} = -14.1$  ( $c$  1.16,  $\text{CHCl}_3$ ); IR (neat) 3481, 2962, 2928, 1766, 1739, 1720, 1458, 1368, 1247, 828, 682  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  6.01 (s, 1H), 5.04 (s, 1H), 4.85 (s, 1H), 4.47-4.36 (m, 2H), 4.15-4.06 (m, 2H), 2.12-2.02 (m, 3H), 2.03 (s, 3H), 1.97-1.89 (m, 3H), 1.83 (s, 3H), 1.70-1.60 (m, 2H), 1.50-1.38 (m, 1H), 1.41 (s, 3H), 0.89 (d,  $J = 6.3$  Hz, 3H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  171.2, 161.9, 144.1, 141.4, 124.9, 115.3, 74.6, 66.5, 62.3, 45.6, 37.8, 35.2, 28.7, 28.3, 21.0, 19.4, 14.9; HRMS ( $\text{EI}^+$ ) calcd. for  $\text{C}_{18}\text{H}_{27}\text{O}_5\text{Cl}_3$  ( $\text{M}^+$ ) 428.0924, found 428.0932.

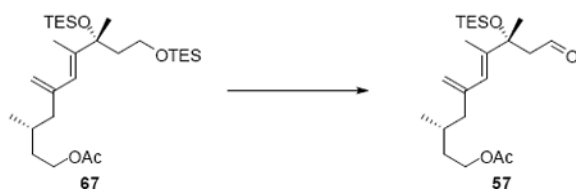


### TES ether 67

To a stirred solution of alcohol **66** (1.90 g, 4.4 mmol) in  $\text{CH}_2\text{Cl}_2$  / EtOH (1:1, 50 mL) was added  $\text{NH}_3 \cdot \text{H}_2\text{O}$  (15 mL) at rt. After 1 h, the reaction was quenched with sat. aq.  $\text{NH}_4\text{Cl}$  (15 mL) and extracted with ether ( $3 \times 40$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* to afford crude diol (1.55 g), which was used in the next step without further purification.



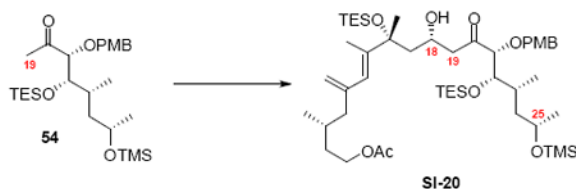
To a stirred solution of crude diol (1.55 g) in  $\text{CH}_2\text{Cl}_2$  /  $\text{Et}_3\text{N}$  (1:1, 30 mL) was added freshly distilled TESOTf (3.52 g, 3.01 mL, 13.1 mmol) at  $-78^\circ\text{C}$ . After 20 min, the reaction was quenched with sat. aq.  $\text{NaHCO}_3$  (10 mL) and extracted with ether ( $3 \times 40$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 2% EtOAc / Hexanes, to give TES ether **67** (2.12 g, 4.09 mmol, 93% over 2 steps) as a colorless oil:  $[\alpha]_{\text{D}}^{23} = -18.4$  (c 1.11,  $\text{CHCl}_3$ ); IR (neat) 2955, 2912, 2876, 1748, 1458, 1238, 1086, 1016, 741  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  5.89 (s, 1H), 5.00 (d,  $J = 1.2$  Hz, 1H), 4.81 (d,  $J = 1.2$  Hz, 1H), 4.18-4.05 (m, 2H), 3.72-3.63 (m, 1H), 3.54-3.41 (m, 1H), 2.15 (dd,  $J = 13.5, 5.4$  Hz, 1H), 2.05 (s, 3H), 1.95-1.89 (m, 2H), 1.87-1.78 (m, 1H), 1.77 (d,  $J = 1.2$  Hz, 3H), 1.71-1.58 (m, 2H), 1.49-1.39 (m, 1H), 1.42 (s, 3H), 1.12-0.91 (m, 18H), 0.87 (d,  $J = 6.6$  Hz, 3H), 0.74-0.50 (m, 12H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  171.1, 144.8, 142.3, 124.3, 114.4, 77.2, 62.3, 59.5, 46.0, 44.4, 35.3, 28.8, 27.8, 21.0, 19.3, 14.6, 7.2, 6.9, 6.8, 6.4, 5.8, 4.4; HRMS ( $\text{EI}^+$ ) calcd. for  $\text{C}_{28}\text{H}_{56}\text{O}_4\text{Si}_2\text{Na}$  ( $\text{M}+\text{Na}$ ) 535.3615, found 535.3637.



### Aldehyde 57

TES ether **67** (2.1 mg, 4.09 mmol) was dissolved in a stirred solution of HOAc / THF /  $\text{H}_2\text{O}$  (34 mL, 8:8:1) at  $0^\circ\text{C}$ . After 1.5 h, the reaction was then quenched with solid  $\text{NaHCO}_3$  and extracted with ether ( $4 \times 50$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* to afford crude alcohol (2.0 g), which was used in the next step without further purification.

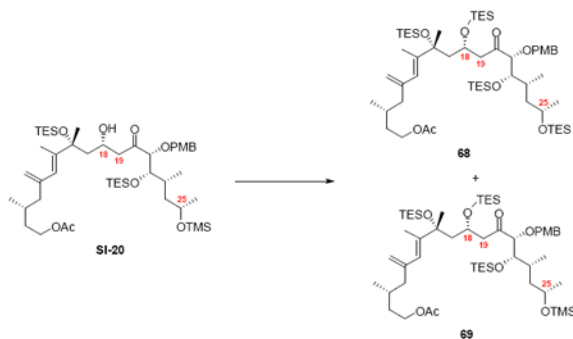
To a stirred solution of crude alcohol (2.0 g) in  $\text{CH}_2\text{Cl}_2$  (20 mL) was added sequentially solid  $\text{NaHCO}_3$  (1.0 g, 11.9 mmol) and DMP (2.16 g, 5.09 mmol) at rt. After 1 h, the reaction was quenched with sat. aq.  $\text{NaHCO}_3$  (15 mL) and extracted with ether ( $3 \times 40$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 5% EtOAc / Hexanes, to give aldehyde **57** (1.36 g, 3.43 mmol, 74% over 2 steps) as a colorless oil.



### Aldol Product SI-20

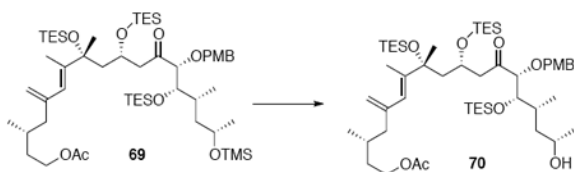
To a solution of methyl ketone **54** (38 mg, 76  $\mu\text{mol}$ ) in  $\text{Et}_2\text{O}$  (0.4 mL) at  $-78^\circ\text{C}$  was added LDA<sup>54</sup> (85.0  $\mu\text{L}$ , 1.0 M in THF). After 20 min, a pre-cooled ( $-78^\circ\text{C}$ ) solution of aldehyde intermediate (20 mg, 50  $\mu\text{mol}$ ) in  $\text{Et}_2\text{O}$  (0.25 mL) was transferred in one portion *via* cannula at  $-78^\circ\text{C}$ . After 20 min, the reaction was quenched with sat. aq.  $\text{NH}_4\text{Cl}$  (3 mL) and extracted with  $\text{Et}_2\text{O}$  ( $3 \times 10$  mL). The dried ( $\text{MgSO}_4$ ) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 5% EtOAc / Hexanes, to give the alcohol intermediate **SI-20** (28 mg, 31  $\mu\text{mol}$ , 62%) as a colorless oil:  $[\alpha]_{\text{D}}^{23}$  (+) 15.7° (c 1.55,  $\text{CHCl}_3$ ); IR (neat) 3515, 2955, 2912, 2876, 1741, 1717, 1615, 1515, 1417, 1368, 1247, 1117, 1037, 1008, 899, 806, 741  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  7.28 (d,  $J = 9.0$  Hz, 2H),

6.84 (d,  $J = 8.7$  Hz, 2H), 5.87 (s, 1H), 5.01 (s, 1H), 4.83 (s, 1H), 4.50 (d,  $J = 11.1$  Hz, 1H), 4.34-4.51 (m, 1H), 4.33 (d,  $J = 11.1$  Hz, 1H), 4.04-4.14 (m, 2H), 3.80 (s, 3H), 3.71-3.78 (m, 3H), 3.03 (dd,  $J = 7.5, 17.4$  Hz, 1H), 2.29 (dd,  $J = 4.5, 17.4$  Hz, 1H), 2.12 (dd,  $J = 5.7, 8.7$  Hz, 1H), 2.03 (s, 3H), 1.83-1.96 (m, 2H), 1.82 (s, 3H), 1.59-1.73 (m, 3H), 1.52 (s, 3H), 1.42-1.49 (m, 4H), 1.11 (d,  $J = 6.0$  Hz, 3H), 0.86-0.98 (m, 21H), 0.82 (d,  $J = 6.6$  Hz, 3H), 0.51-0.67 (m, 12H), 0.06 (s, 9H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  211.7, 171.6, 159.6, 144.6, 143.8, 130.3, 130.1, 125.2, 115.6, 114.0, 88.4, 79.8, 77.6, 72.8, 66.2, 65.1, 63.3, 55.6, 48.5, 46.7, 46.2, 44.8, 35.7, 32.5, 29.1, 26.5, 25.2, 21.4, 19.7, 15.1, 13.3, 7.5, 7.4, 7.0, 5.7, 0.7; HRMS (ES+) calcd. for  $\text{C}_{48}\text{H}_{88}\text{O}_9\text{Si}_3\text{Na}$  (M+Na) 915.5634, found 915.5564.



### TES Ethers 68 and 69

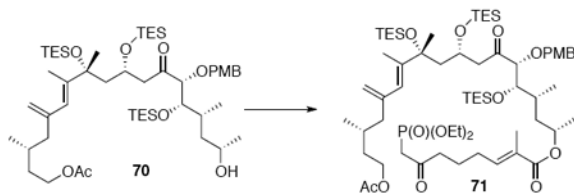
To a solution of the above alcohol intermediate (40 mg, 45  $\mu\text{mol}$ ) in  $\text{CH}_2\text{Cl}_2$  (0.15 mL) and  $\text{Et}_3\text{N}$  (0.15 mL) at  $-78^\circ\text{C}$  was added TESOTf (32.0 mg, 28.3  $\mu\text{L}$ , 0.12 mmol). After 20 min, the reaction was quenched with sat. aq.  $\text{NH}_4\text{Cl}$  (3 mL). The mixture was extracted with  $\text{Et}_2\text{O}$  ( $3 \times 10$  mL) and the dried ( $\text{MgSO}_4$ ) extract was concentrated *in vacuo* to give **69** (36 mg, 36  $\mu\text{mol}$ , 82%) as a colorless oil:  $[\alpha]_{\text{D}}^{23}$  (+)  $18.6^\circ$  (c 1.58,  $\text{CHCl}_3$ ); IR (neat) 2955, 2926, 2876, 2855, 1742, 1716, 1615, 1515, 1458, 1366, 1249, 1127, 1084, 1006, 899, 835, 776, 741  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.33 (d,  $J = 8.4$  Hz, 2H), 6.88 (d,  $J = 8.4$  Hz, 2H), 5.84 (s, 1H), 5.04 (s, 1H), 4.89 (s, 1H), 4.59 (d,  $J = 10.8$  Hz, 1H), 4.29-4.35 (m, 1H), 4.27 (d,  $J = 10.8$  Hz, 1H), 4.10-4.17 (m, 2H), 3.84 (s, 4H), 3.76-3.78 (m, 1H), 3.71 (d,  $J = 7.2$  Hz, 1H), 3.19 (dd,  $J = 8.4, 17.6$  Hz, 1H), 2.54 (dd,  $J = 3.3, 17.6$  Hz, 1H), 2.11-2.15 (m, 1H), 2.06 (s, 3H), 1.86-1.98 (m, 2H), 1.85 (s, 3H), 1.63-1.77 (m, 4H), 1.52-1.56 (m, 1H), 1.45 (s, 3H), 1.30-1.38 (m, 2H), 1.13 (d,  $J = 6.4$  Hz, 3H), 0.83-0.98 (m, 30H), 0.86 (d,  $J = 6.4$  Hz, 3H), 0.52-0.64 (m, 18H), 0.15 (s, 9H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  211.3, 171.2, 159.1, 144.4, 142.6, 130.1, 129.7, 125.1, 115.0, 113.5, 88.2, 77.4, 76.4, 72.0, 65.9, 63.0, 55.3, 50.0, 46.5, 46.0, 44.0, 35.3, 32.3, 29.7, 28.7, 28.0, 24.7, 21.0, 19.3, 14.9, 13.3, 7.3, 7.1, 7.0, 6.8, 6.6, 6.4, 5.3, 5.1, 0.4; HRMS (ES+) calcd. for  $\text{C}_{54}\text{H}_{102}\text{O}_9\text{Si}_4\text{Na}$  (M+Na) 1029.6499, found 1029.6470.



### Alcohol 70

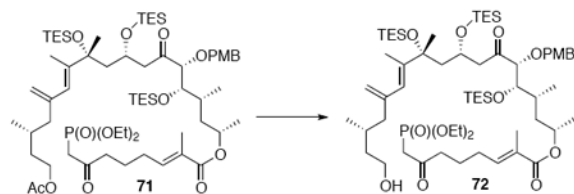
To a flask with **69** (180 mg, 0.18 mmol) at  $0^\circ\text{C}$  was added a freshly prepared stock solution of  $\text{HOAc}/\text{THF}/\text{H}_2\text{O}$  (3.0 mL, 8:8:1) dropwise. After 40 min, the reaction was quenched with sat. aq.  $\text{NaHCO}_3$  (20 mL) carefully and extracted with  $\text{Et}_2\text{O}$  ( $3 \times 10$  mL). The dried ( $\text{MgSO}_4$ ) extract was concentrated *in vacuo* and purified by chromatography over silica gel,

eluting with 5% EtOAc / Hexanes, to give **70** (102 mg, 0.11 mmol, 61%) as a colorless oil:  $[\alpha]_D^{23}$  (+) 23.7° (c 0.60, CHCl<sub>3</sub>); IR (neat) 3546, 2955, 2926, 2876, 2855, 1742, 1716, 1615, 1515, 1458, 1366, 1249, 1127, 1084, 1006, 899, 835, 776, 741 cm<sup>-1</sup>; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 7.33 (d, J = 8.4 Hz, 2H), 6.89 (d, J = 8.4 Hz, 2H), 5.87 (s, 1H), 5.02 (s, 1H), 4.86 (s, 1H), 4.55 (d, J = 10.8 Hz, 1H), 4.23-4.29 (m, 1H), 4.23 (d, J = 10.8 Hz, 1H), 4.12-4.17 (m, 2H), 3.85 (s, 4H), 3.75-3.85 (m, 3H), 3.18 (dd, J = 9.2, 17.6 Hz, 1H), 2.54 (dd, J = 2.8, 17.6 Hz, 1H), 2.13 (dd, J = 5.6, 13.6 Hz, 1H), 2.06 (s, 3H), 1.86-1.94 (m, 2H), 1.83 (s, 3H), 1.63-1.80 (m, 4H), 1.52-1.56 (m, 1H), 1.45 (s, 3H), 1.38-1.45 (m, 2H), 1.19 (d, J = 6.0 Hz, 3H), 0.88-1.01 (m, 33H), 0.55-0.68 (m, 18H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 211.3, 171.2, 159.1, 144.9, 141.7, 130.0, 129.8, 125.5, 114.9, 113.5, 88.5, 77.4, 77.2, 76.4, 71.8, 65.8, 63.2, 55.3, 49.5, 46.2, 45.8, 44.1, 35.4, 33.2, 29.7, 28.7, 28.5, 24.5, 21.0, 19.3, 14.9, 13.6, 7.3, 7.0, 6.95, 6.87, 5.2, 5.1; HRMS (ES+) calcd. for C<sub>51</sub>H<sub>94</sub>O<sub>9</sub>Si<sub>3</sub>Na (M+Na) 957.6103, found 957.6157.



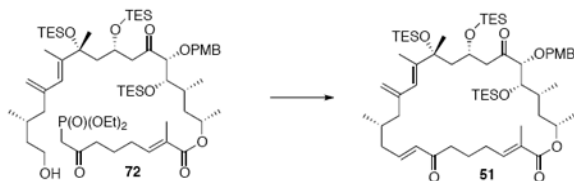
### Ketophosphonate **71**

To a solution of phosphonate acid **11** (74 mg, 0.24 mmol) in PhMe (0.5 mL) at r.t. was added triethylamine (26.2 mg, 36.0 μL, 0.24 mmol) and 2,4,6-trichlorobenzoyl chloride (56 mg, 36.0 μL, 0.24 mmol). After 6 h, solvent of the reaction was removed *in vacuo*. A solution of the alcohol **70** (60 mg, 64 μmol) in PhMe (0.5 mL) was transferred into the above flask *via* cannula and DMAP (29.6 mg, 0.24 mmol) was sequentially added. After 16 h, the reaction was purified by chromatography over silica gel, eluting with 70% EtOAc / Hexanes, to give **71** (50 mg, 41 μmol, 64%) as a colorless oil:  $[\alpha]_D^{23}$  (+) 25.3° (c 1.50, CHCl<sub>3</sub>); IR (neat) 2954, 2933, 2876, 1739, 1712, 1613, 1515, 1461, 1366, 1251, 1165, 1124, 1026, 968, 901, 835, 770, 741 cm<sup>-1</sup>; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 7.31 (d, J = 8.8 Hz, 2H), 6.88 (d, J = 8.8 Hz, 2H), 6.69 (t, J = 7.2 Hz, 1H), 5.85 (s, 1H), 5.03 (br, 2H), 4.88 (s, 1H), 4.62 (d, J = 10.8 Hz, 1H), 4.25-4.31 (m, 1H), 4.25 (d, J = 10.8 Hz, 1H), 4.05-4.21 (m, 6H), 3.84 (s, 3H), 3.81-3.83 (m, 1H), 3.72 (d, J = 6.0 Hz, 1H), 3.16 (dd, J = 8.8, 17.6 Hz, 1H), 3.12 (s, 1H), 3.07 (s, 1H), 2.67 (t, J = 7.2 Hz, 2H), 2.60 (dd, J = 2.8, 17.6 Hz, 1H), 2.16 (dd, J = 7.6, 14.8 Hz, 2H), 2.08-2.12 (m, 1H), 2.06 (s, 3H), 1.83-1.94 (m, 4H), 1.83 (s, 3H), 1.81 (s, 3H), 1.61-1.77 (m, 5H), 1.52-1.55 (m, 1H), 1.43 (s, 3H), 1.40-1.43 (m, 1H), 1.36 (t, J = 6.8 Hz, 6H), 1.22 (d, J = 6.0 Hz, 3H), 0.90-1.00 (m, 30H), 0.86 (d, J = 6.4 Hz, 3H), 0.54-0.66 (m, 18H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 211.7, 201.5, 201.4, 171.2, 167.7, 159.2, 144.5, 142.3, 140.6, 129.9, 129.7, 129.0, 125.2, 115.0, 113.6, 87.4, 76.0, 72.0, 68.9, 66.0, 63.1, 62.6, 62.5, 55.3, 49.9, 46.8, 45.9, 43.4, 43.1, 41.8, 39.3, 35.3, 33.0, 28.7, 28.2, 27.7, 22.3, 21.0, 20.8, 19.3, 16.4, 16.3, 14.9, 14.1, 12.5, 7.3, 7.0, 6.9, 6.8, 5.2, 5.1; HRMS (ES+) calcd. for C<sub>64</sub>H<sub>115</sub>O<sub>14</sub>PSi<sub>3</sub>Na (M+Na) 1245.7230, found 1245.7181.



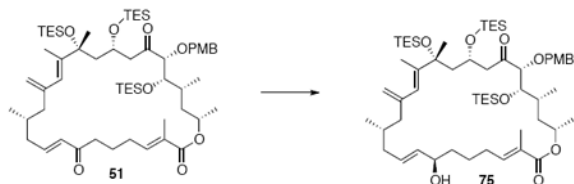
## Alcohol 72

To a flask containing **71** (50.0 mg, 41  $\mu\text{mol}$ ) at r.t. was added a premixed solution of  $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$  (1.5 mL, 0.1 M in MeOH). After 10 min, the mixture was purified by chromatography over silica gel, eluting with 50% EtOAc / Hexanes, to give **72** (42 mg, 36  $\mu\text{mol}$ , 88%) as a colorless oil:  $[\alpha]_D^{23}$  (+) 19.8° (c 0.78,  $\text{CHCl}_3$ ); IR (neat) 3444, 2954, 2929, 2876, 1713, 1614, 1515, 1458, 1379, 1251, 1165, 1125, 1059, 1024, 970, 900, 835, 809, 741  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.33 (d,  $J = 8.8$  Hz, 2H), 6.89 (d,  $J = 8.8$  Hz, 2H), 6.69 (t,  $J = 7.6$  Hz, 1H), 5.85 (s, 1H), 5.03-5.06 (m, 2H), 4.85 (s, 1H), 4.62 (d,  $J = 10.4$  Hz, 1H), 4.12-4.27 (m, 7H), 3.84 (s, 3H), 3.81 (dd,  $J = 3.2, 6.8$  Hz, 1H) 3.70-3.76 (m, 3H), 3.19 (dd,  $J = 9.2, 17.2$  Hz, 1H), 3.13 (s, 1H), 3.07 (s, 1H), 2.68 (t,  $J = 7.2$  Hz, 2H), 2.60 (dd,  $J = 2.8, 17.6$  Hz, 1H), 2.18 (q,  $J = 7.6$  Hz, 2H), 2.10 (dd,  $J = 5.2, 18.4$  Hz, 1H), 1.83-1.91 (m, 3H), 1.83 (s, 3H), 1.81 (s, 3H), 1.51-1.81 (m, 7H), 1.43 (s, 3H), 1.38-1.43 (m, 1H), 1.36 (t,  $J = 7.2$  Hz, 6H), 1.23 (d,  $J = 6.0$  Hz, 3H), 0.87-1.00 (m, 33H), 0.54-0.66 (m, 18H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  212.3, 201.5, 201.4, 167.7, 159.2, 144.9, 141.7, 140.7, 130.0, 129.7, 129.0, 125.6, 114.9, 113.5, 87.6, 77.5, 75.9, 72.0, 68.9, 66.2, 62.6, 62.5, 61.0, 55.3, 49.5, 46.6, 46.2, 43.4, 43.1, 41.8, 40.1, 39.5, 32.9, 29.7, 28.4, 28.3, 27.7, 22.3, 20.8, 19.2, 16.4, 16.3, 15.1, 14.1, 13.9, 12.5, 7.3, 7.0, 6.9, 6.8, 5.2, 5.1; HRMS (ES+) calcd. for  $\text{C}_{62}\text{H}_{113}\text{O}_{13}\text{PSi}_3\text{Na}$  (M+Na) 1203.7124, found 1203.7054.



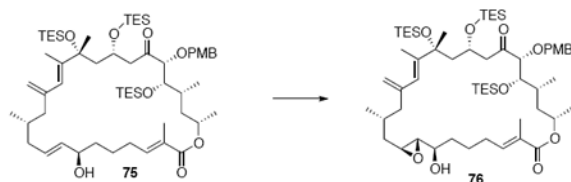
## Macrolactone 51

To a solution of **72** (42 mg, 36  $\mu\text{mol}$ ) in  $\text{CH}_2\text{Cl}_2$  (1.2 mL) at r.t. was added TPAP (15 mg, 43  $\mu\text{mol}$ ). After 1 h, THF (3.3 mL),  $\text{H}_2\text{O}$  (82.8  $\mu\text{L}$ ) and  $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$  (43 mg, 0.13 mmol) were sequentially added to the reaction. After 3 h, the reaction was directly purified by chromatography over silica gel, eluting with 5% EtOAc / Hexanes, to give **51** (30.6 mg, 30  $\mu\text{mol}$ , 85%) as a colorless oil:  $[\alpha]_D^{23}$  (+) 1.6° (c 0.45,  $\text{CHCl}_3$ ); IR (neat) 2954, 2925, 2875, 2854, 1710, 1673, 1614, 1515, 1461, 1377, 1251, 1171, 1120, 1068, 1018, 985, 835, 808, 742  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.33 (d,  $J = 8.6$  Hz, 2H), 6.94-7.01 (m, 1H), 6.88 (d,  $J = 8.6$  Hz, 2H), 6.71 (t,  $J = 7.6$  Hz, 1H), 6.09 (d,  $J = 16.0$  Hz, 1H), 5.77 (s, 1H), 5.05 (s, 1H), 4.96-5.04 (m, 1H), 4.87 (s, 1H), 4.53 (d,  $J = 10.8$  Hz, 1H), 4.21-4.27 (m, 1H), 4.21 (d,  $J = 10.8$  Hz, 1H), 3.84 (s, 3H), 3.67-3.74 (m, 2H), 3.15 (dd,  $J = 9.2, 17.6$  Hz, 1H), 2.56-2.67 (m, 3H), 2.08-2.27 (m, 3H), 1.90 (s, 3H), 1.78 (s, 3H), 1.47-1.78 (m, 9H), 1.43 (s, 3H), 1.26-1.42 (m, 2H), 1.25 (d,  $J = 6.0$  Hz, 3H), 0.90-1.00 (m, 30H), 0.83 (d,  $J = 6.4$  Hz, 3H), 0.54-0.66 (m, 18H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  209.8, 200.8, 167.6, 159.2, 147.0, 144.5, 142.7, 140.8, 132.3, 130.0, 129.5, 129.2, 125.3, 115.5, 113.6, 87.9, 71.7, 68.9, 65.4, 55.3, 49.2, 47.1, 45.8, 41.8, 40.6, 37.4, 32.0, 31.5, 31.4, 27.4, 22.9, 21.0, 19.5, 15.2, 14.2, 12.5, 7.3, 7.0, 6.9, 6.8, 5.2, 5.1; HRMS (ES+) calcd. for  $\text{C}_{58}\text{H}_{100}\text{O}_9\text{Si}_3\text{Na}$  (M+Na) 1047.6573, found 1047.6494.



### Allylic alcohol **75**

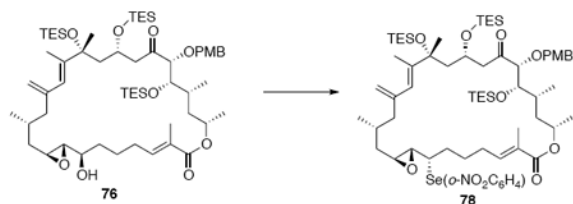
To a solution of (S)-2-methyl-CBS-oxazaborolidine (10.1  $\mu\text{L}$ , 10  $\mu\text{mol}$ , 1.0 M in PhMe) in  $\text{CH}_2\text{Cl}_2$  (0.3 mL) at r.t. was added catechol borane (0.20 mL, 0.20 mmol, 1.0 M  $\text{CH}_2\text{Cl}_2$ ). After 10 min, the resulted solution was cooled to  $-20^\circ\text{C}$ . A solution of macrolactone **51** (26 mg, 25  $\mu\text{mol}$ ) in  $\text{CH}_2\text{Cl}_2$  (0.65 mL) was added into the above solution dropwise *via* cannula. After 2 h, the reaction was quenched with MeOH (2.0 mL) and concentrated *in vacuo*. The resultant mixture was purified by preparative TLC, eluting with 25% EtOAc/Hexane, to give **75** (14 mg, 14  $\mu\text{mol}$ , 56%) as a colorless oil:  $[\alpha]_{\text{D}}^{23}$  (+)  $7.6^\circ$  (c 0.88,  $\text{CHCl}_3$ ); IR (neat) 3459, 2954, 2917, 2875, 2849, 1709, 1614, 1515, 1461, 1377, 1251, 1173, 1125, 1070, 1018, 835, 776,  $743\text{ cm}^{-1}$ ;  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.33 (d,  $J = 8.6$  Hz, 2H), 6.89 (d,  $J = 8.6$  Hz, 2H), 6.72 (t,  $J = 7.6$  Hz, 1H), 5.79 (s, 1H), 5.68-5.72 (m, 1H), 5.49 (dd,  $J = 6.8$ , 15.2 Hz, 1H), 5.05 (s, 1H), 4.97-5.04 (m, 1H), 4.87 (s, 1H), 4.57 (d,  $J = 10.8$  Hz, 1H), 4.28-4.32 (m, 1H), 4.22 (d,  $J = 10.8$  Hz, 1H), 4.13-4.17 (m, 1H), 3.85 (s, 3H), 3.65-3.73 (m, 2H), 3.16 (dd,  $J = 9.2$ , 18.0 Hz, 1H), 2.53 (dd,  $J = 3.2$ , 18.0 Hz, 1H), 2.21-2.24 (m, 4H), 1.98-2.04 (m, 4H), 1.88 (s, 3H), 1.82 (s, 3H), 1.75-1.84 (m, 2H), 1.53-1.70 (m, 7H), 1.44 (s, 3H), 1.30-1.36 (m, 1H), 1.24 (d,  $J = 5.6$  Hz, 3H), 0.89-1.00 (m, 30H), 0.82 (d,  $J = 6.0$  Hz, 3H), 0.54-0.66 (m, 18H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  210.6, 167.8, 159.2, 145.1, 142.6, 141.7, 134.5, 130.4, 129.9, 129.8, 128.5, 125.6, 115.1, 113.5, 88.1, 77.2, 76.6, 72.4, 71.7, 68.6, 65.5, 55.3, 53.5, 49.5, 46.4, 44.9, 41.1, 39.4, 36.6, 32.2, 31.4, 28.6, 27.5, 23.7, 21.1, 19.8, 15.0, 12.6, 11.9, 7.3, 7.0, 6.9, 6.8, 5.2, 5.1; HRMS (ES+) calcd. for  $\text{C}_{58}\text{H}_{102}\text{O}_9\text{Si}_3\text{Na}$  (M+Na) 1049.6729, found 1049.6678.



### Hydroxyl epoxide **76**

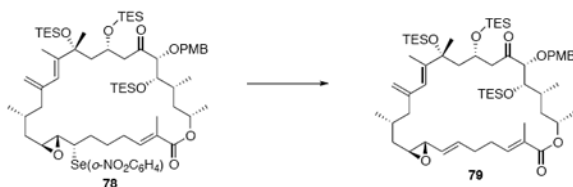
To a solution of (+)-DIPT (0.11 mL, 89  $\mu\text{mol}$ , 0.8 M in  $\text{CH}_2\text{Cl}_2$ ) was added  $\text{CH}_2\text{Cl}_2$  (0.30 mL) and 4 Å MS (30 mg). The resulted mixture was cooled to  $-20^\circ\text{C}$  and  $\text{Ti}(\text{O}^i\text{Pr})_4$  (21.6 mg, 20.0  $\mu\text{L}$ , 76  $\mu\text{mol}$ ) was added. After 30 min, TBHP (14.2  $\mu\text{L}$ , 76  $\mu\text{mol}$ , 5.5 M in decane) was added dropwise. After another 30 min, a solution of alcohol **75** (13 mg, 13  $\mu\text{mol}$ ) in  $\text{CH}_2\text{Cl}_2$  (0.30 mL) was added dropwise *via* cannula and the reaction was allowed to warm to  $0^\circ\text{C}$ . After 16 h, the reaction was cooled back to  $-20^\circ\text{C}$  and a brine solution of NaOH (0.5 mL, 1.0 M) was added. After 5 min, the reaction was diluted with brine (0.5 mL) and  $\text{CH}_2\text{Cl}_2$  (0.5 mL) and warmed up to r.t. Next, the mixture was extracted with  $\text{CH}_2\text{Cl}_2$  ( $3 \times 15$  mL) and the dried ( $\text{MgSO}_4$ ) extract concentrated *in vacuo*. The crude mixture was purified by preparative TLC, eluting with 25% EtOAc/Hexane, to give vinyl epoxide **76** (7.0 mg, 7.0  $\mu\text{mol}$ , 54%) as a colorless oil:  $[\alpha]_{\text{D}}^{23}$  (+)  $12.2^\circ$  (c 0.36,  $\text{CHCl}_3$ ); IR (neat) 3467, 3017, 2954, 2917, 2875, 2849, 2107, 1709, 1515, 1462, 1378, 1251, 1173, 1125, 1070, 1018, 835, 756,  $667\text{ cm}^{-1}$ ;  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.33 (d,  $J = 8.8$  Hz, 2H), 6.90 (d,  $J = 8.8$  Hz, 2H), 6.77 (t,  $J = 7.6$  Hz, 1H), 5.80 (s, 1H), 5.06 (s, 1H), 4.95-5.00 (m, 1H), 4.87 (s, 1H), 4.60 (d,  $J = 10.8$  Hz, 1H), 4.22-4.30 (m, 1H), 4.21 (d,  $J = 10.8$  Hz, 1H), 3.85 (s, 3H), 3.75-3.84 (m, 1H), 3.67-3.74 (m, 2H), 3.22 (dd,  $J = 9.2$ , 18.0 Hz, 1H), 3.05-3.10 (m, 1H), 2.78-2.81 (m, 1H), 2.54 (dd,  $J = 3.2$ , 18.0 Hz, 1H), 2.38 (br, 1H), 2.21-2.30 (m, 4H), 1.89-1.92 (m, 1H), 1.89 (s, 3H), 1.84 (s, 3H), 1.75-1.86 (m, 3H), 1.53-1.70 (m, 7H), 1.45 (s, 3H), 1.30-1.36 (m, 1H), 1.26 (d,  $J = 5.6$  Hz, 3H), 0.91-1.01 (m, 30H), 0.56-0.67 (m, 18H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  210.8, 167.8, 159.2, 144.7, 142.4, 141.2, 129.9, 129.8, 128.9, 125.6, 115.4, 113.6, 88.1, 77.1, 71.8, 68.7, 68.2, 65.4, 61.3, 55.3, 54.2, 49.8, 46.5, 45.4, 41.8, 39.5, 33.3, 31.1, 30.8, 28.5, 27.7, 24.1, 21.1, 20.1, 15.1, 12.5, 11.8, 7.3, 7.0,

6.9, 5.3, 5.1; HRMS (ES<sup>+</sup>) calcd. for C<sub>58</sub>H<sub>102</sub>O<sub>10</sub>Si<sub>3</sub>Na (M+Na) 1065.6679, found 1065.6774.



### Selenide 78

To a solution of vinyl epoxide **76** (5.0 mg, 5  $\mu$ mol) in THF (0.15 mL) at r.t. was added **77** (33 mg, 0.15 mmol) and PBu<sub>3</sub> (29 mg, 36.2  $\mu$ L, 0.15 mmol). After 1 h, the reaction mixture was directly purified by preparative TLC, eluting with 25% EtOAc/Hexane, to give selenide **78** (3.0 mg, 2.5  $\mu$ mol, 50%) as a colorless oil:  $[\alpha]_D^{23}$  (-) 9.9° (c 0.22, CHCl<sub>3</sub>); IR (neat) 2956, 2932, 2874, 1701, 1515, 1457, 1250, 1074, 1007, 806, 730 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>)  $\delta$  8.22 (d = 6.9 Hz, 1H), 7.84 (d, J = 7.8 Hz, 1H), 7.48-7.54 (m, 1H), 7.48-7.55 (m, 3H), 6.87 (d, J = 8.4 Hz, 2H), 6.69 (t, J = 7.6 Hz, 1H), 5.84 (s, 1H), 5.05 (s, 1H), 4.96-5.00 (m, 1H), 4.87 (s, 1H), 4.56 (d, J = 10.5 Hz, 1H), 4.25-4.30 (m, 1H), 4.21 (d, J = 10.5 Hz, 1H), 3.84 (s, 3H), 3.70 (s, 2H), 3.26 (dd, J = 9.6, 17.4 Hz, 1H), 3.20 (d, J = 8.1, 14.4 Hz, 1H), 2.99-3.04 (m, 1H), 2.96 (dd, J = 8.1, 15.0 Hz, 1H), 2.57 (dd, J = 2.8, 17.4 Hz, 1H), 2.21-2.30 (m, 4H), 1.89-1.92 (m, 1H), 1.84 (s, 3H), 1.79 (s, 3H), 1.45-1.78 (m, 10H), 1.42 (s, 3H), 1.30-1.36 (m, 1H), 1.25 (d, J = 5.6 Hz, 3H), 0.91-1.01 (m, 30H), 0.56-0.67 (m, 18H); <sup>13</sup>C NMR (75 MHz, CDCl<sub>3</sub>)  $\delta$  210.9, 167.5, 159.1, 147.7, 144.5, 142.4, 140.3, 133.4, 131.3, 129.9, 129.7, 129.2, 126.1, 126.0, 125.5, 115.4, 113.5, 88.5, 77.2, 71.7, 68.9, 65.6, 62.1, 59.6, 55.3, 49.6, 45.9, 45.7, 44.8, 41.1, 39.6, 31.7, 31.6, 30.9, 28.3, 26.2, 21.0, 19.9, 15.2, 12.6, 12.1, 7.3, 7.0, 6.9, 5.3, 5.1; HRMS (ES<sup>+</sup>) calcd. for C<sub>64</sub>H<sub>106</sub>NO<sub>11</sub>Si<sub>3</sub>Se (M+1) 1228.6239, found 1228.6216.

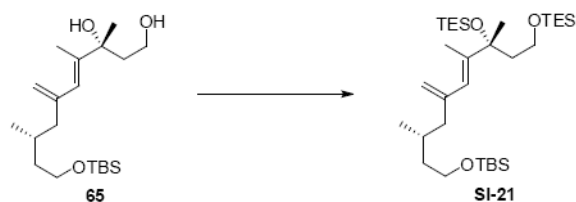


### Allyl epoxide 79

To a solution of selenide **78** (5.7 mg, 5.0  $\mu$ mol) in CH<sub>2</sub>Cl<sub>2</sub> (0.25 mL) at r.t. was sequentially added triethylamine (19 mg, 26.0  $\mu$ L, 0.18 mmol), TPAP (16 mg, 45  $\mu$ mol) and NMO (35 mg, 0.3 mmol). After 30 min, the reaction mixture was purified directly by preparative TLC, eluting with 25% EtOAc/Hexanes, to give vinyl epoxide **79** (2.5 mg, 2.4  $\mu$ mol, 48%) as a colorless oil:  $[\alpha]_D^{23}$  -1.3° (c 0.15, CHCl<sub>3</sub>); IR (neat) 3467, 3017, 2954, 2917, 2875, 2849, 2107, 1709, 1515, 1462, 1378, 1251, 1173, 1125, 1070, 1018, 835, 756, 667 cm<sup>-1</sup>; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  7.34 (d, J = 8.4 Hz, 2H), 6.89 (d, J = 8.4 Hz, 2H), 6.73 (t, J = 7.6 Hz, 1H), 5.85-5.92 (m, 1H), 5.78 (s, 1H), 5.27 (dd, J = 8.0, 15.2 Hz, 1H), 5.01-5.04 (m, 2H), 4.85 (s, 1H), 4.57 (d, J = 10.4 Hz, 1H), 4.28-4.32 (m, 1H), 4.21 (d, J = 10.4 Hz, 1H), 3.85 (s, 3H), 3.70-3.74 (m, 2H), 3.25 (dd, J = 9.6, 17.2 Hz, 1H), 3.09 (dd, J = 2.0, 6.4 Hz, 1H), 2.90-2.94 (m, 1H), 2.54 (dd, J = 2.8, 17.2 Hz, 1H), 2.06-2.28 (m, 4H), 1.94 (d, J = 2.4, 10.8 Hz, 1H), 1.86 (s, 3H), 1.80-1.86 (m, 3H), 1.79 (s, 3H), 1.53-1.70 (m, 7H), 1.46 (s, 3H), 1.30-1.36 (m, 1H), 1.25 (d, J = 6.0 Hz, 3H), 0.90-1.01 (m, 27H), 0.86 (d, J = 6.0 Hz, 3H), 0.54-0.68 (m, 18H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  211.0, 167.6, 159.1, 144.6, 142.4,



140.5, 134.3, 130.1, 129.8, 129.5, 128.7, 125.2, 115.3, 113.5, 88.4, 76.4, 71.7, 68.9, 65.7, 59.6, 58.5, 55.3, 49.4, 46.1, 45.6, 40.6, 40.2, 32.1, 30.9, 30.5, 29.7, 28.0, 27.8, 20.4, 19.8, 15.2, 13.0, 12.5, 7.3, 7.0, 6.9, 6.8, 5.2, 5.1; HRMS (ES<sup>+</sup>) calcd. for C<sub>58</sub>H<sub>100</sub>O<sub>9</sub>Si<sub>3</sub>Na (M<sup>+</sup>+Na) 1047.6573, found 1047.6664.



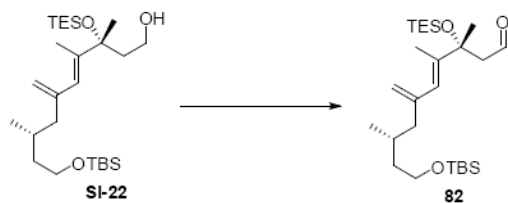
### TES ether SI-21

To a stirred solution of diol **65** (470 mg, 1.32 mmol) in DCM / TEA (6 mL, 1:1) was added freshly distilled TESOTf (1.05 g, 0.89 mL, 3.96 mmol) at -78°C. After 30 min, the reaction was quenched with sat. aq. NaHCO<sub>3</sub> (1 mL) and extracted with ether (3 × 20 mL). The dried extract (MgSO<sub>4</sub>) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 2-5% EtOAc / Hexanes, to give **SI-21** (732 mg, 1.25 mmol, 95%) as a colorless oil: [α]<sub>D</sub><sup>23</sup> = -21.3° (*c* 1.37, CHCl<sub>3</sub>); IR (neat) 2954, 2929, 2876, 1460, 1254, 1093, 1007, 835, 741 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 5.88 (s, 1H), 4.99 (s, 1H), 4.80 (s, 1H), 3.61-3.71 (m, 3H), 3.47 (dt, *J* = 15.6, 5.4 Hz, 1H), 2.15 (dd, *J* = 13.5, 5.4 Hz, 1H), 1.80-1.99 (m, 5H), 1.77 (d, *J* = 0.9 Hz, 3H), 1.54-1.66 (m, 1H), 0.88-1.00 (m, 27H), 0.84 (d, *J* = 6.3 Hz, 3H), 0.55-0.66 (m, 12H), 0.063 (s, 6H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 145.2, 142.0, 124.6, 114.1, 77.2, 61.7, 59.3, 46.2, 44.5, 40.0, 28.7, 26, 19.6, 18.4, 14.7, 7.2, 7.0, 6.9, 6.8, 4.4, -5.3; HRMS (EI<sup>+</sup>) calcd. for C<sub>32</sub>H<sub>68</sub>O<sub>3</sub>Si<sub>3</sub> (M<sup>+</sup>) 584.4476, found 584.4500.



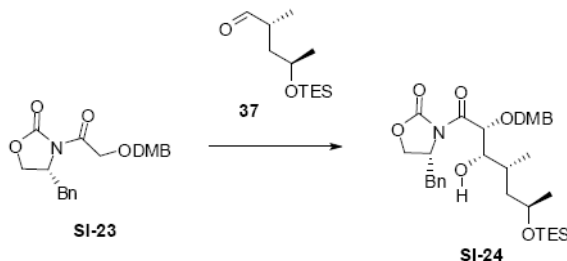
### Alcohol SI-22

TES ether **SI-21** (300 mg, 0.51 mmol) was dissolved in a stirred solution of HOAc / THF / H<sub>2</sub>O (8 mL, 8:8:1) at 0°C. After 1.5 h, the reaction was then quenched with solid NaHCO<sub>3</sub> and extracted with ether (3 × 20 mL). The dried extract (MgSO<sub>4</sub>) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 10% EtOAc / Hexanes, to give alcohol **SI-22** (241 mg, 0.51 mmol, 99%) as a colorless oil: [α]<sub>D</sub><sup>23</sup> = -15.5° (*c* 0.64, CHCl<sub>3</sub>); IR (neat) 3437, 2954, 2928, 2876, 1461, 1254, 1099, 1008, 835 cm<sup>-1</sup>; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 6.02 (s, 1H), 5.04 (s, 1H), 4.85 (s, 1H), 3.63-3.73 (m, 4H), 2.79 (t, *J* = 5.6 Hz, 1H), 2.17 (dd, *J* = 13.6, 5.6 Hz, 1H), 1.88-1.97 (m, 3H), 1.74-1.83 (m, 1H), 1.79 (d, *J* = 1.2 Hz, 3H), 1.59-1.68 (m, 1H), 1.47 (s, 3H), 1.28-1.40 (m, 1H), 0.99-1.03 (t, *J* = 7.6 Hz, 9H), 0.92 (s, 9H), 0.88 (d, *J* = 6.4 Hz, 3H), 0.69 (q, *J* = 7.2 Hz, 6H), 0.078 (s, 6H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 145.0, 141.4, 125.6, 114.6, 80.0, 61.6, 60.1, 46.1, 42.8, 39.9, 29.7, 28.6, 27.6, 26.0, 19.5, 18.4, 14.9, 7.2, 6.9, 6.8, -5.3; HRMS (EI<sup>+</sup>) calcd. for C<sub>26</sub>H<sub>54</sub>O<sub>3</sub>Si<sub>2</sub> (M<sup>+</sup>) 470.3611, found 470.3604.



### Aldehyde 82

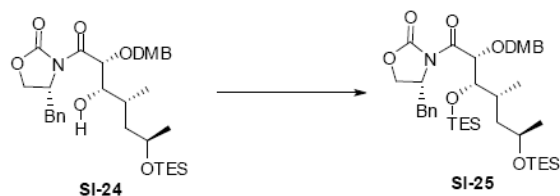
To a stirred solution of alcohol **SI-22** (1.29 g, 2.73 mmol) in DCM (40 mL, 1:1) was sequentially added DMP (2.17 g, 5.12 mmol) and  $\text{NaHCO}_3$  (1.68 g, 20.0 mmol) at rt. After 30 min, the reaction was quenched with sat. aq.  $\text{NaHCO}_3$  (10 mL) and extracted with ether ( $3 \times 40$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 5% EtOAc / Hexanes, to give aldehyde **82** (1.17 g, 2.49 mmol, 91%) as a colorless oil:  $[\alpha]_{\text{D}}^{23} = -12.5^\circ$  ( $c$  0.56,  $\text{CHCl}_3$ ); IR (neat) 2955, 2929, 2877, 1725, 1255, 1099, 1007, 836, 726  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  9.69 (t,  $J = 3.3$  Hz, 1H), 6.03 (s, 1H), 5.03 (s, 1H), 4.83 (s, 1H), 3.61-3.68 (m, 2H), 2.64 (dd,  $J = 15.0, 3.0$  Hz, 1H), 2.45 (dd,  $J = 15.0, 3.0$  Hz, 1H), 2.15 (dd,  $J = 13.5, 6.0$  Hz, 1H), 1.85-1.92 (m, 1H), 1.83 (d,  $J = 1.2$  Hz, 3H), 1.54-1.64 (m, 1H), 1.49 (s, 3H), 1.25-1.35 (m, 2H), 0.95-1.00 (t,  $J = 7.7$  Hz, 9H), 0.91 (s, 9H), 0.85 (d,  $J = 6.5$  Hz, 3H), 0.65 (q,  $J = 7.8$  Hz, 6H), 0.061 (s, 6H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  203.1, 144.7, 141.0, 126.0, 114.9, 76.9, 61.5, 54.2, 46.0, 39.9, 28.5, 27.8, 26.0, 19.5, 18.3, 14.7, 7.1, 6.7, -5.3; HRMS ( $\text{EI}^+$ ) calcd. for  $\text{C}_{26}\text{H}_{52}\text{O}_3\text{Si}_2$  ( $\text{M}^+$ ) 468.3455, found 468.3448



### Aldol adduct SI-24

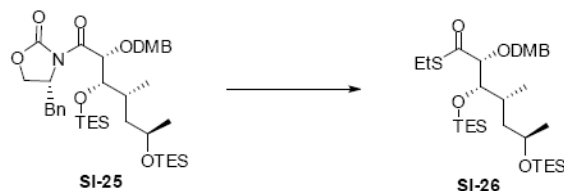
To a stirred solution of **SI-23** (1.60 g, 0.15 mmol) in  $\text{CH}_2\text{Cl}_2$  (11.2 mL) at  $-60^\circ\text{C}$  was sequentially added  $\text{Et}_3\text{N}$  (0.44 g, 0.60 mL, 4.33 mmol) and  $\text{Bu}_2\text{BOTf}$  (1.19 g, 1.08 mL, 4.33 mmol). After 3 h, the resulted solution was warmed up  $0^\circ\text{C}$  for 30 min and then cooled back to  $-60^\circ\text{C}$ . A solution of aldehyde **37**<sup>8</sup> (1.12 g, 4.86 mmol) in DCM (4.8 mL) was transferred to the reaction mixture via *cannula*. After 2 h, the reaction was allowed to warm up to  $0^\circ\text{C}$ . After another 20 min, the reaction was quenched by adding pH 7 phosphate buffer (20 mL) followed by MeOH (15 mL) and 30%  $\text{H}_2\text{O}_2$  (4 mL). After 1 h, the reaction mixture was extracted with EtOAc ( $4 \times 35$  mL). The dried ( $\text{MgSO}_4$ ) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 15-20% EtOAc / Hexanes, to give **SI-24** (1.58 g, 2.57 mmol, 62%) as a colorless oil:  $[\alpha]_{\text{D}}^{23} = -9.2^\circ$  ( $c$  0.77,  $\text{CHCl}_3$ ); IR (neat) 3493, 2957, 2876, 1781, 1709, 1593, 1517, 1455, 1390, 1265, 1240, 1159, 1052, 1028, 746  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (400 MHz)  $\delta$  7.23-7.38 (m, 5H), 6.83-7.03 (m, 3H), 5.36 (d,  $J = 2.0$  Hz, 1H), 4.63-4.71 (m, 2H), 4.51 (d,  $J = 10.8$  Hz, 1H), 4.21-4.29 (m, 2H), 3.93 (s, 3H), 3.84-3.90 (m, 1H), 3.88 (s, 3H), 3.62-3.66 (m, 1H), 3.32 (dd,  $J = 13.6, 3.6$  Hz, 1H), 2.77 (dd,  $J = 13.6, 10.0$  Hz, 1H), 2.32 (d,  $J = 10.0$  Hz, 1H), 1.78-1.80 (m, 1H), 1.58-1.64 (m, 1H), 1.15 (d,  $J = 6.0$  Hz, 3H), 1.03 (d,  $J = 6.8$  Hz, 3H), 0.98 (t,  $J = 8.0$  Hz, 9H), 0.62 (q,  $J = 8.0$  Hz, 6H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  177.2, 153.2, 149.1, 149.0, 135.2, 129.5, 129.4, 129.0,

127.4, 121.4, 112.1, 110.9, 78.1, 76.1, 66.9, 55.9, 55.7, 42.8, 37.7, 34.1, 23.2, 15.7, 6.9, 4.9;  
HRMS (ES<sup>+</sup>) calcd. for C<sub>33</sub>H<sub>49</sub>NO<sub>8</sub>SiNa (M+Na) 638.3125, found 638.3155.



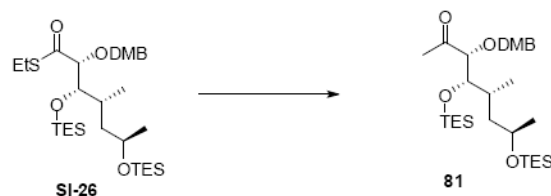
### TES ether SI-25

To a stirred solution of adol adduct **SI-24** (500 mg, 0.81 mmol) in DCM (3.32 mL) at 0°C was sequentially added 2,6-lutidine (184 mg, 0.20 mL, 1.72 mmol) and TESOTf (287 mg, 0.25 mL, 1.09 mmol). After 1 h, the reaction was quenched with sat. aq. NH<sub>4</sub>Cl (10 mL) and extract with Et<sub>2</sub>O (3 × 30 mL). The dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 15% EtOAc / Hexanes, to give **SI-25** (570 mg, 0.78 mmol, 96%) as a colorless oil: [α]<sub>D</sub><sup>23</sup> = -40.7° (*c* 0.42, CHCl<sub>3</sub>); IR (neat) 2955, 2911, 2876, 1784, 1702, 1517, 1456, 1239, 1084, 740 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz) δ 7.17-7.32 (m, H), 6.80-7.00 (m, 3H), 5.28 (d, *J* = 6.0 Hz, 1H), 4.71 (d, *J* = 11.7 Hz, 1H), 4.54 (d, *J* = 11.7 Hz, 2H), 4.47-4.49 (m, 1H), 4.00-4.12 (m, 3H), 3.90 (s, 3H), 3.84 (s, 3H), 3.78-3.82 (m, 1H), 3.14 (dd, *J* = 3.0, 13.2 Hz, 1H), 2.40 (dd, *J* = 10.5, 13.5 Hz, 1H), 1.42-1.56 (m, 3H), 1.11 (d, *J* = 5.7 Hz, 3H), 0.89-0.97 (m, 21H), 0.55-0.63 (m, 12H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 171.9, 152.9, 148.7, 148.8, 135.3, 130.3, 129.3, 129.0, 127.3, 121.1, 111.9, 110.7, 73.4, 67.2, 66.4, 56.0, 55.9, 55.8, 44.4, 37.4, 33.5, 23.7, 14.8, 7.1, 6.9, 5.4, 5.3, 5.2, 5.0; HRMS (ES<sup>+</sup>) calcd. for C<sub>39</sub>H<sub>63</sub>NO<sub>8</sub>Si<sub>2</sub>Na (M+Na) 752.3990, found 752.3992.



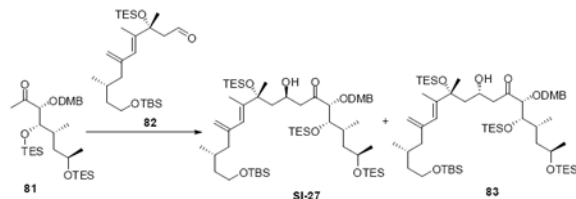
### Thiol ester SI-26

To a stirred solution of EtSH (90 mg, 0.107 mL, 1.45 mmol) in THF (12.6 mL) at 0°C was added *n*-BuLi (0.51 mL, 1.27 mmol, 2.5 M in Hexanes). After 1 h, a solution of **SI-25** (610 mg, 0.83 mmol) in THF (2.7 mL) was added dropwise via *cannula*. After another 1 h, the reaction was quenched with sat. aq. NH<sub>4</sub>Cl (10 mL) and extract with Et<sub>2</sub>O (3 × 30 mL). The dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 5-8% EtOAc / Hexanes, to give **SI-26** (470 mg, 0.76 mmol, 92%) as a colorless oil: [α]<sub>D</sub><sup>23</sup> = +42.0° (*c* 0.39, CHCl<sub>3</sub>); IR (neat) 2955, 2911, 2876, 1683, 1517, 1458, 1419, 1378, 1266, 1240, 1161, 1079, 1032, 811, 740 cm<sup>-1</sup>; <sup>1</sup>H NMR (400 MHz) δ 7.04 (dd, *J* = 1.6 Hz, 1H), 6.94 (dd, *J* = 1.6, 8.0 Hz, 1H), 6.86 (d, *J* = 8.4 Hz, 1H), 4.63 (d, *J* = 10.8 Hz, 1H), 4.43 (d, *J* = 10.8 Hz, 1H), 3.94 (s, 3H), 3.92-3.93 (m, 4H), 3.81-3.86 (m, 2H), 2.91 (q, *J* = 7.6 Hz, 2H), 1.45-1.57 (m, 3H), 1.30 (t, *J* = 7.2 Hz, 3H), 1.14 (d, *J* = 6.0 Hz, 3H), 0.90-0.98 (m, 21H), 0.53-0.62 (m, 12H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 202.2, 148.8, 148.6, 129.9, 120.6, 110.6, 110.7, 88.2, 72.9, 66.9, 55.9, 55.8, 44.9, 32.7, 23.4, 22.5, 14.6, 13.6, 7.0, 6.9, 5.3, 5.2, 5.0; HRMS (ES<sup>+</sup>) calcd. for C<sub>31</sub>H<sub>58</sub>O<sub>6</sub>Si<sub>2</sub>SNa (M+Na) 637.3390, found 637.3407.



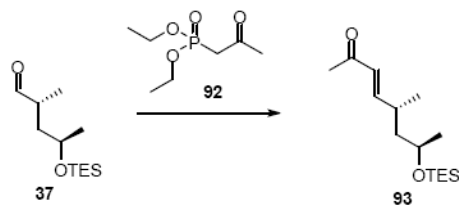
### Methyl ketone **81**

To a stirred slurry of CuI (859 mg, 4.51 mmol) in Et<sub>2</sub>O (8.3 mL) at 0°C was added MeLi (5.6 mL, 9.6 mmol, 1.6 M in Et<sub>2</sub>O). After 15 min, the colorless solution was cooled to -50°C and a solution of **SI-26** (450 mg, 0.75 mmol) in Et<sub>2</sub>O (4.2 mL) was transferred into the reaction mixture dropwise via *cannula*. After 2 h, the reaction was quenched with sat. aq. NH<sub>4</sub>Cl (10 mL) at -50°C, warmed to rt and extracted with Et<sub>2</sub>O (3 × 30 mL). The dried (MgSO<sub>4</sub>) extract was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 2-4% EtOAc / Hexanes, to give **81** (296 mg, 0.52 mmol, 71%) as a colorless oil: [α]<sub>D</sub><sup>23</sup> = +22.6 (*c* 0.23, CHCl<sub>3</sub>); IR (neat) 2955, 2911, 2876, 1716, 1517, 1457, 1267, 1240, 1082, 1031, 1007, 741 cm<sup>-1</sup>; <sup>1</sup>H NMR (400 MHz) δ 6.82-6.90 (m, 3H), 4.50 (dd, *J* = 11.4, 15.0 Hz, 2H), 3.90 (s, 6H), 3.80-3.85 (m, 2H), 3.76 (d, *J* = 6.3 Hz, 1H), 2.13 (s, 3H), 1.50-1.52 (m, 3H), 1.13 (d, *J* = 6.0 Hz, 3H), 0.88-1.00 (m, 21H), 0.57-0.64 (m, 12H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 210.6, 148.8, 129.9, 120.7, 111.4, 110.8, 88.5, 72.9, 67.0, 55.9, 55.8, 44.5, 33.1, 27.0, 23.5, 14.0, 7.0, 6.9, 5.3, 5.0; HRMS (ES<sup>+</sup>) calcd. for C<sub>30</sub>H<sub>56</sub>O<sub>6</sub>Si<sub>2</sub>Na (M+Na) 591.3513, found 591.3527.



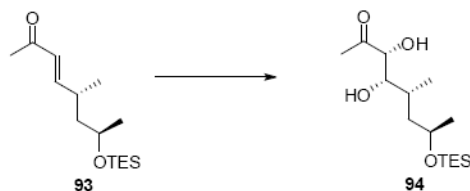
### Aldol adduct **83**

To a stirred solution of methyl ketone **81** (30 mg, 0.0527 mmol) in Et<sub>2</sub>O (0.5 mL) at -78°C was added LDA<sup>54</sup> (64 μL, 0.064 mmol, 1 M in THF). After 15 min, a pre-cooled (-78°C) solution of aldehyde **82** (50 mg, 0.105 mmol) in THF (0.5 mL) was added via *cannula* in one portion. After another 0.5 h, the reaction was quenched with sat. aq. NH<sub>4</sub>Cl (2 mL) at -78°C, warmed up to rt and extracted with ether (3 × 10 mL). The dried extract (MgSO<sub>4</sub>) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 6-8% EtOAc / Hexanes, to sequentially give aldol adduct **SI-27** (10 mg, 0.0096 mmol, 18%) and **83** (39 mg, 0.0375 mmol, 71%) and as colorless oils. **83**: [α]<sub>D</sub><sup>23</sup> = +9.1° (*c* 0.58, CHCl<sub>3</sub>); IR (neat) 3503, 2955, 2934, 2876, 1715, 1517, 1463, 1265, 1240, 1095, 1007, 741 cm<sup>-1</sup>; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 6.83-6.97 (m, 3H), 5.90 (s, 1H), 5.05 (s, 1H), 4.85 (s, 1H), 4.53 (d, *J* = 11.2 Hz, 1H), 4.44-4.50 (m, 1H), 4.39 (d, *J* = 10.8 Hz, 1H), 3.91 (s, 6H), 3.76-3.83 (m, 3H), 3.66-3.70 (m, 2H), 3.05 (dd, *J* = 17.6, 6.8 Hz, 1H), 2.38 (dd, *J* = 17.6, 5.6 Hz, 1H), 2.19 (dd, *J* = 13.5, 4.8 Hz, 1H), 1.80-1.91 (m, 1H), 1.84 (s, 3H), 1.48-1.68 (m, 4H), 1.57 (s, 3H), 1.20-1.42 (m, 4H), 1.10 (d, *J* = 6.0 Hz, 3H), 0.86-1.00 (m, 42H), 0.57-0.66 (m, 18H), 0.08 (s, 6H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 211.0, 148.8, 148.6, 144.6, 142.9, 130.1, 125.2, 120.7, 114.9, 111.5, 110.7, 88.3, 79.5, 72.6, 66.9, 64.8, 61.4, 55.9, 55.8, 48.0, 46.7, 46.0, 44.8, 39.9, 33.1, 28.4, 23.3, 19.5, 14.7, 13.5, 7.1, 7.0, 6.9, 6.5, 5.3, 5.0, -5.2; HRMS (ES<sup>+</sup>) calcd. for C<sub>56</sub>H<sub>107</sub>O<sub>9</sub>Si<sub>4</sub> (M+H) 1035.6992, found 1035.7047.



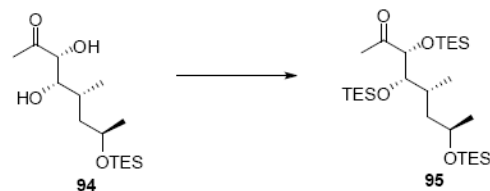
### Enone **93**

To a stirred slurry of NaH (36 mg, 0.90 mmol, 60% W / W in mineral oil) in DME (2 mL) was added phosphonate **92** (138 mg, 0.83 mmol) at rt. After 1 h, a solution of aldehyde **37** (160 mg, 0.69 mmol) in DME (2 mL) was added via *cannula*. After another 6 h, the reaction was quenched with sat. aq. NH<sub>4</sub>Cl (2 mL) and extracted with Et<sub>2</sub>O (4 × 10 mL). The dried extract (MgSO<sub>4</sub>) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 5% EtOAc / Hexanes, to give enone **93** (142 mg, 0.52 mmol, 76%) as a colorless oil:  $[\alpha]_D^{23} = -46.0^\circ$  (*c* 1.47, CHCl<sub>3</sub>); IR (neat) 2958, 2877, 1700, 1678, 1627, 1458, 1360, 1252, 1139, 1055, 984, 745 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 6.76 (dd, *J* = 15.9, 7.8 Hz, 1H), 6.09 (d, *J* = 15.9 Hz, 1H), 3.86-3.79 (m, 1H), 2.58-2.53 (m, 1H), 2.26 (s, 3H), 1.41-1.55 (m, 2H), 1.18 (d, *J* = 6.0 Hz, 3H), 1.09 (d, *J* = 6.9 Hz, 3H), 0.97 (t, *J* = 7.8 Hz, 9H), 0.64 (q, *J* = 7.5 Hz, 6H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 198.8, 153.5, 129.6, 66.4, 46.3, 33.4, 27.0, 24.3, 20.3, 6.9, 5.2, 5.0; HRMS (EI<sup>+</sup>) calcd. for C<sub>15</sub>H<sub>30</sub>O<sub>2</sub>Si (M<sup>+</sup>) 270.2015, found 270.2008.



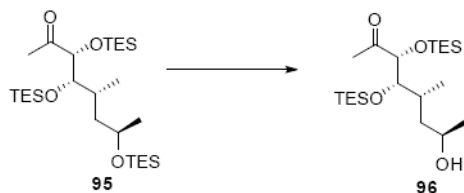
### Diol **94**

To a stirred solution of enone **93** (142 mg, 0.52 mmol) in *t*BuOH/H<sub>2</sub>O (5 mL, 1:1) at 0°C was sequentially added AD-mix-α (0.735 g), NaHCO<sub>3</sub> (132 mg, 1.57 mmol), MeSO<sub>2</sub>NH<sub>2</sub> (50.6 mg, 0.53 mmol), and K<sub>2</sub>OsO<sub>2</sub>(OH)<sub>4</sub> (1.9 mg, 0.005 mmol). After 8 h, the reaction was quenched with sat. aq. Na<sub>2</sub>SO<sub>3</sub> (8 mL) and extracted with EtOAc (4 × 10 mL). The dried extract (MgSO<sub>4</sub>) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 15-40% EtOAc / Hexanes, to give diol **94** (122 mg, 0.40 mmol, 77%) as a colorless oil:  $[\alpha]_D^{23} = -29.2^\circ$  (*c* 1.5, CHCl<sub>3</sub>); IR (neat) 3456, 2957, 2877, 1717, 1380, 1238, 1132, 1048, 1011, 744 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 4.28 (d, *J* = 3.6 Hz, 1H), 4.04-3.99 (m, 1H), 3.72-3.78 (m, 1H & OH), 2.41 (d, *J* = 10.4 Hz, 1H), 2.30 (s, 3H), 1.89-1.96 (m, 1H), 1.71-1.77 (m, 1H), 1.40-1.47 (m, 1H), 1.22 (d, *J* = 6.0 Hz, 3H), 1.10 (d, *J* = 6.8 Hz, 3H), 1.00 (t, *J* = 7.8 Hz, 9H), 0.68 (q, *J* = 7.9 Hz, 6H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 208.9, 77.7, 75.2, 66.9, 42.8, 34.0, 25.3, 23.1, 16.4, 6.9, 4.9; HRMS (ES<sup>+</sup>) calcd. for C<sub>15</sub>H<sub>32</sub>O<sub>4</sub>SiNa (M+Na) 327.1968, found 327.1950.



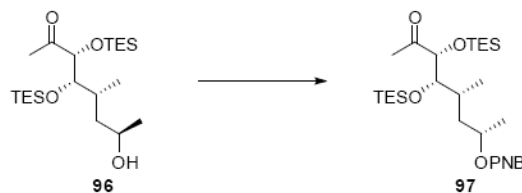
### TES ether **95**

To a stirred solution of diol **94** (800 mg, 2.63 mmol) in  $\text{CH}_2\text{Cl}_2$  (10 mL) at  $-78^\circ\text{C}$  was sequentially added 2,6-lutidine (1.41 g, 1.53 mL, 13.1 mmol) and TESOTf (1.74 g, 1.49 mL, 6.58 mmol). After 30 min, the reaction was quenched with sat. aq.  $\text{NH}_4\text{Cl}$  (10 mL) and extracted with  $\text{Et}_2\text{O}$  ( $4 \times 25$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 10% EtOAc / Hexanes, to give TES ether **95** (1.29 g, 2.42 mmol, 92%) as a colorless oil:  $[\alpha]_{\text{D}}^{23} = -0.83^\circ$  ( $c$  1.2,  $\text{CHCl}_3$ ); IR (neat) 2957, 2878, 1716, 1458, 1238, 1005  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  4.07 (d,  $J = 6.0$  Hz, 1H), 3.78-3.85 (m, 1H), 3.70 (dd,  $J = 5.9, 2.6$  Hz, 1H), 2.20 (s, 3H), 1.60-1.64 (m, 1H), 1.45-1.51 (m, 2H), 1.13 (d,  $J = 6.0$  Hz, 3H), 0.94-1.00 (m, 27H), 0.83 (d,  $J = 6.6$  Hz, 3H), 0.55-0.70 (m, 18H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  210.0, 81.5, 78.6, 67.1, 45.4, 32.2, 27.3, 23.1, 14.0, 7.0, 6.84, 6.79, 5.2, 4.9, 4.8; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{27}\text{H}_{60}\text{O}_4\text{Si}_3\text{Na}$  ( $\text{M} + \text{Na}$ ) 555.3697, found 555.3683.



### Alcohol **96**

TES ether **95** (5.60 g, 10.5 mmol) was dissolved in a stirred solution of HOAc / THF /  $\text{H}_2\text{O}$  (107 mL, 8:8:1) at  $0^\circ\text{C}$ . After 12 h, the reaction was quenched with solid  $\text{NaHCO}_3$ , filtered over Celite<sup>®</sup> and extracted with ether ( $4 \times 100$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 10% EtOAc / Hexanes, to give alcohol **96** (3.90 g, 9.31 mmol, 89%) as a colorless oil:  $[\alpha]_{\text{D}}^{23} = -30.5$  ( $c$  1.45,  $\text{CHCl}_3$ ); IR (neat) 3446, 2958, 2878, 1716, 1458, 1239, 1005, 739  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  4.18 (d,  $J = 5.6$  Hz, 1H), 3.86-3.88 (m, 2H), 2.24 (s, 3H), 1.80-1.90 (m, 1H), 1.41-1.55 (m, 2H), 1.20 (d,  $J = 6.0$  Hz, 3H), 0.97-1.05 (m, 18H), 0.87 (d,  $J = 6.8$  Hz, 3H), 0.61-0.73 (m, 12H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  209.3, 81.4, 76.4, 65.6, 43.7, 31.6, 27.8, 23.6, 15.4, 7.0, 6.8, 5.2, 4.8, 4.7; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{21}\text{H}_{46}\text{O}_4\text{Si}_2\text{Na}$  ( $\text{M} + \text{Na}$ ) 441.2832, found 441.2836



### PNB ester **97**

To a stirred solution of alcohol **96** (600 mg, 1.43 mmol) in THF (15 mL) at  $0^\circ\text{C}$  was sequentially added  $\text{PPh}_3$  (1.50 g, 5.72 mmol), 4-nitrobenzoic acid (0.96 g, 5.74 mmol), and DEAD (0.99 g, 0.90 mL, 5.70 mmol). After 1 h, the reaction mixture was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 1-3% EtOAc / Hexanes, to give ester **97** (670 mg, 1.18 mmol, 82%) as a colorless oil:  $[\alpha]_{\text{D}}^{23} = +13.6^\circ$  ( $c$  1.08,  $\text{CHCl}_3$ ); IR (neat) 2956, 2878, 1723, 1530, 1319, 1275, 1014, 721  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  8.31 (d,  $J = 9.0$  Hz, 2H), 8.23 (d,  $J = 9.0$  Hz, 2H), 5.26 (m, 1H), 4.17 (d,  $J = 4.8$  Hz, 1H), 3.69 (t,  $J = 4.8$  Hz, 1H), 2.18 (s, 3H), 2.02-2.12 (m, 1H), 1.76 (m, 1H), 1.45-1.49 (m, 1H), 1.38 (d,  $J = 6.1$  Hz, 3H), 0.93-1.02 (m, 18H), 0.90 (d,  $J = 6.6$  Hz, 3H),

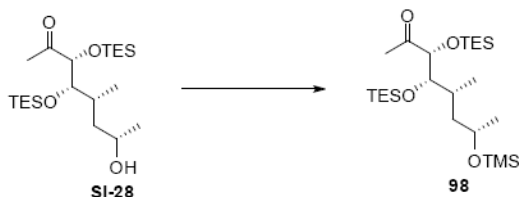


0.56-0.70 (m, 12H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  209.3, 164.3, 150.4, 136.1, 130.7, 123.4, 81.5, 78.2, 70.8, 40.2, 32.4, 27.9, 20.9, 14.8, 7.0, 6.8, 5.1, 4.8; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{28}\text{H}_{49}\text{NO}_7\text{Si}_2\text{Na}$  ( $\text{M}+\text{Na}$ ) 590.2945, found 590.2926.



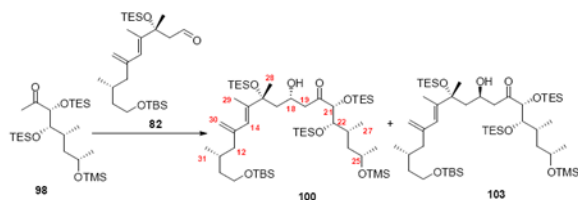
### Alcohol SI-28

To a stirred solution of ester **97** (700 mg, 1.23 mmol) in MeOH (20 mL) at  $0^\circ\text{C}$  was added  $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$  (390 mg, 1.24 mmol). After 4 h, the reaction was quenched with sat. aq.  $\text{NH}_4\text{Cl}$  (10 mL) and extracted with EtOAc ( $4 \times 20$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 15% EtOAc / Hexanes, to give alcohol **SI-28** (369 mg, 0.88 mmol, 72%) as a colorless oil:  $[\alpha]_{\text{D}}^{23} = -7.6^\circ$  ( $c$  1.2,  $\text{CHCl}_3$ ); IR (neat) 3434, 2957, 2878, 1716, 1459, 1415, 1239, 1005, 739  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  4.17 (d,  $J = 5.4$  Hz, 1H), 3.81 (m, 1H), 3.69 (dd,  $J = 5.4, 3.9$  Hz, 1H), 2.22 (s, 3H), 1.83 (m, 1H), 1.61-1.69 (m, 1H), 1.24-1.30 (m, 1H), 1.20 (d,  $J = 6.0$  Hz, 3H), 0.94-1.04 (m, 18H), 0.87 (d,  $J = 6.6$  Hz, 3H), 0.58-0.71 (m, 12H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  210.1, 81.5, 78.1, 66.2, 43.8, 32.9, 27.6, 24.4, 15.2, 7.0, 6.8, 5.2, 4.8; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{21}\text{H}_{47}\text{O}_4\text{Si}_2$  ( $\text{M}+\text{H}$ ) 419.3013, found 419.2993.



### TMS ether 98

To a stirred solution of alcohol **SI-28** (1.90 g, 4.54 mmol) in  $\text{CH}_2\text{Cl}_2$  (25 mL) at  $-78^\circ\text{C}$  was sequentially added 2,6-lutidine (1.45 g, 1.58 mL, 13.5 mmol) and TMSOTf (1.51 g, 1.23 mL, 6.81 mmol). After 30 min, the reaction was quenched with sat. aq.  $\text{NH}_4\text{Cl}$  (10 mL) and extracted with  $\text{Et}_2\text{O}$  ( $4 \times 20$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 10% EtOAc / Hexanes, to give TMS ether **98** (2.12 g, 4.32 mmol, 95%) as a colorless oil:  $[\alpha]_{\text{D}}^{23} = +14.4^\circ$  ( $c$  2.2,  $\text{CHCl}_3$ ); IR (neat) 2957, 2878, 1716, 1459, 1415, 1124, 1006, 841, 741  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  4.03 (d,  $J = 6.3$  Hz, 1H), 3.79-3.85 (m, 1H), 3.71 (dd,  $J = 6.3, 2.4$  Hz, 1H), 2.19 (s, 3H), 1.73-1.79 (m, 1H), 1.45-1.54 (m, 1H), 1.23-1.32 (m, 1H), 1.16 (d,  $J = 6.0$  Hz, 3H), 0.95-1.03 (m, 18H), 0.83 (d,  $J = 6.6$  Hz, 3H), 0.58-0.70 (m, 12H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  210.2, 81.8, 78.6, 65.9, 45.3, 31.3, 26.8, 24.7, 13.2, 7.0, 6.8, 5.3, 4.8, 0.3; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{24}\text{H}_{54}\text{O}_4\text{Si}_3\text{Na}$  ( $\text{M}+\text{Na}$ ) 513.3224, found 513.3204.

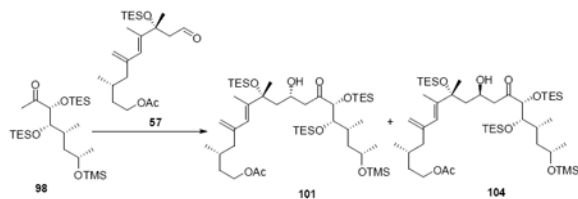


### Aldol adducts 100&103

To a stirred solution of methyl ketone **98** (312 mg, 0.64 mmol) in THF (5 mL) at  $-78^{\circ}\text{C}$  was added LDA<sup>2</sup> (0.765 mL, 1 M in THF). After 15 min, TMEDA (133 mg, 0.172 mL, 1.14 mmol) was added. After 5 min, the reaction was warmed up to  $-40^{\circ}\text{C}$ , followed by the addition of a pre-cooled ( $-40^{\circ}\text{C}$ ) solution of aldehyde **82** (200 mg, 0.43 mmol) in THF (5 mL) via *cannula* in one portion. After another 0.5 h, the reaction was quenched with sat. aq.  $\text{NH}_4\text{Cl}$  (10 mL)  $-78^{\circ}\text{C}$ , warmed up to rt and extracted with ether ( $4 \times 20$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 1-1.5% EtOAc / Hexanes, to give aldol adduct **100** (142 mg, 0.15 mmol, 35%) and **103** (114 mg, 0.12 mmol, 28%) as colorless oil. **100**:  $[\alpha]_{\text{D}}^{23} = -12.0^{\circ}$  ( $c$  1.3,  $\text{CHCl}_3$ ); IR (neat) 3511, 2955, 2929, 2877, 1715, 1460, 1413, 1250, 1092, 1006, 838, 742  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  5.89 (s, 1H), 5.02 (s, 1H), 4.83 (s, 1H), 4.33 (m, 1H), 4.10 (d,  $J = 5.7$  Hz, 1H), 3.82 (m, 1H), 3.74 (s, 1H), 3.64-3.72 (m, 3H), 2.96 (dd,  $J = 17.7, 6.2$  Hz, 1H), 2.60 (dd,  $J = 18.1, 6.4$  Hz, 1H), 2.18 (dd,  $J = 12.8, 4.0$  Hz, 1H), 1.81-1.90 (m, 2H), 1.84 (s, 3H), 1.47-1.67 (m, 4H), 1.56 (s, 3H), 1.22-1.38 (m, 3H), 1.15 (d,  $J = 6.0$  Hz, 3H), 0.92-1.03 (m, 36H), 0.87 (d,  $J = 6.4$  Hz, 3H), 0.80 (d,  $J = 6.7$  Hz, 3H), 0.58-0.70 (m, 18H), 0.10 (s, 9H), 0.06 (s, 6H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  210.7, 144.7, 125.1, 114.7, 81.1, 79.4, 78.4, 65.9, 65.1, 61.5, 48.2, 47.2, 46.0, 45.0, 39.9, 31.1, 28.5, 26.2, 26.0, 24.7, 19.5, 18.3, 14.7, 13.8, 7.2, 7.1, 6.9, 6.6, 5.3, 4.9, 0.4, -5.2; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{50}\text{H}_{106}\text{O}_7\text{Si}_5\text{Na}$  (M+Na) 981.6683, found 981.6646.

### MTPA esters

To a solution of **100** (5 mg, 0.005 mmol) in  $\text{CH}_2\text{Cl}_2$  (0.5 mL) was sequentially added DMAP (6.4 mg, 0.052 mmol) and (*R*) or (*S*)-(+)- $\alpha$ -methoxy- $\alpha$ -trifluoromethylphenylacetyl chloride (6.6 mg,  $4.9 \mu\text{L}$ , 0.026 mmol). After 10 min, the solution was evaporated and the residue was loaded directly onto silica gel and purified by chromatography, eluting with 2 - 10% EtOAc / Hexanes, to give product (*S*)- or (*R*)- MTPA esters (52-61%) as colorless oils.  $^1\text{H}$  NMR Difference in ppm [(*S*)-Mosher Ester - (*R*)-Mosher ester,  $\text{CDCl}_3$ ,  $\text{CDCl}_3$ , 300 MHz NMR]  $\text{H}_{19} = 2.847 - 2.834 = +0.013$ ,  $\text{H}_{21} = 3.996 - 3.961 = +0.035$ ,  $\text{H}_{22} = 3.686 - 3.678 = +0.008$ ,  $\text{H}_{25} = 3.848 - 3.818 = +0.030$ ,  $\text{H}_{31}' = 0.881 - 0.876 = +0.005$ ,  $\text{H}_{29} = 1.888 - 1.895 = -0.007$ ,  $\text{H}_{14} = 5.723 - 5.824 = -0.101$ ,  $\text{H}_{28} = 4.905 - 4.925 = -0.020$ ,  $\text{H}_{12} = 2.319 - 2.334 = -0.015$ ,  $\text{H}_{27} = 1.130 - 1.137 = -0.007$ .



### Aldol adducts 101 & 104

**Method A ( $-100^{\circ}\text{C}$  Conditions)**—To a stirred solution of methyl ketone **98** (574 mg, 1.17 mmol) in THF (6 mL) at  $-78^{\circ}\text{C}$  was added LDA<sup>2</sup> (1.38 mL, 1 M in THF). After 15 min, TMEDA (400 mg, 0.310 mL, 3.44 mmol) was added. After 5 min, the reaction was cooled

to  $-100^{\circ}\text{C}$ , followed by the addition of a pre-cooled ( $-100^{\circ}\text{C}$ ) solution of aldehyde **57** (310 mg, 0.78 mmol) in THF (6 mL) via *cannula* in one portion. After another 0.5 h, the reaction was quenched with 1 M AcOH in THF (1.5 mL) at  $-100^{\circ}\text{C}$ . The reaction mixture was then warmed up to rt, diluted with sat. aq.  $\text{NH}_4\text{Cl}$  (10 mL) and extracted with ether ( $4 \times 25$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 50%  $\text{CH}_2\text{Cl}_2$  / Hexanes -2% EtOAc / Hexanes, to give aldol adduct **104** (405 mg, 0.45 mmol, 58%) and **101** (50 mg, 0.056 mmol, 7%) as colorless oils.

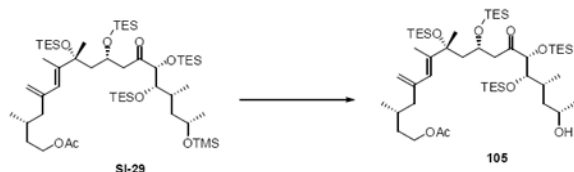
**Method B ( $-40^{\circ}\text{C}$  Conditions)**—To a stirred solution of methyl ketone **98** (37.2 mg, 0.0758 mmol) in THF (0.4 mL) at  $-78^{\circ}\text{C}$  was added  $\text{LDA}^2$  (90  $\mu\text{L}$ , 0.09 mmol, 1 M in THF). After 15 min, TMEDA (15.5 mg, 20  $\mu\text{L}$ , 0.133 mmol) was added. After 5 min, the reaction was warmed up to  $-40^{\circ}\text{C}$ , followed by the addition of a pre-cooled ( $-40^{\circ}\text{C}$ ) solution of aldehyde **57** (20 mg, 0.0504 mmol) in THF (0.4 mL) via *cannula* in one portion. After another 0.5 h, the reaction was quenched with sat. aq.  $\text{NH}_4\text{Cl}$  (2 mL) and extracted with ether ( $4 \times 5$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 50%  $\text{CH}_2\text{Cl}_2$  / Hexanes -2% EtOAc / Hexanes, to give aldol adduct **101** (16.1 mg, 0.0181 mmol, 36%) and **104** (13.4 mg, 0.0151 mmol, 30%) as colorless oils. **101**:  $[\alpha]_{\text{D}}^{23} = -9.42^{\circ}$  ( $c$  1.21,  $\text{CHCl}_3$ ); IR (neat) 3516, 2956, 2913, 2877, 1743, 1719, 1458, 1414, 1370, 1249, 1116, 1088, 1008, 841, 742  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  5.89 (s, 1H), 5.02 (s, 1H), 4.83 (s, 1H), 4.38-4.27 (m, 1H), 4.06-4.10 (m, 3H), 3.86-3.75 (m, 1H), 3.72-3.68 (m, 1H), 3.66 (s, 1H, OH), 2.96 (dd,  $J = 17.9, 6.2$  Hz, 1H), 2.59 (dd,  $J = 18.0, 6.1$  Hz, 1H), 2.15 (dd,  $J = 13.2, 5.7$  Hz, 1H), 2.04 (s, 3H), 1.94-1.76 (m, 4H), 1.81 (s, 3H), 1.70-1.63 (m, 2H), 1.54 (s, 3H), 1.48-1.38 (m, 2H), 1.27-1.22 (m, 1H), 1.13 (d,  $J = 5.9$  Hz, 3H), 1.02-0.93 (m, 27H), 0.89 (d,  $J = 6.3$  Hz, 3H), 0.79 (d,  $J = 6.6$  Hz, 3H), 0.59-0.69 (m, 18H), 0.09 (s, 9H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  210.8, 171.1, 144.3, 143.3, 124.8, 115.0, 81.0, 79.3, 78.4, 65.9, 65.0, 62.9, 48.2, 47.2, 45.8, 45.0, 35.3, 31.0, 28.7, 26.3, 24.6, 21.0, 19.3, 14.7, 13.8, 7.1, 7.0, 6.8, 6.6, 5.2, 4.9, 0.3; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{46}\text{H}_{94}\text{O}_8\text{Si}_4\text{Na}$  ( $\text{M}+\text{Na}$ ) 909.5924, found 909.5895. **104**:  $[\alpha]_{\text{D}}^{23} = +1.76^{\circ}$  ( $c$  1.25,  $\text{CHCl}_3$ ); IR (neat) 3511, 2956, 2913, 2877, 1743, 1718, 1458, 1369, 1249, 1119, 1088, 1011, 841, 742  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  6.06 (s, 1H), 5.03 (s, 1H), 4.88 (s, 1H), 4.17-4.06 (m, 4H), 3.88 (s, 1H, OH), 3.88-3.81 (m, 1H), 3.73-3.69 (m, 1H), 2.66-2.78 (m, 2H), 2.17 (dd,  $J = 13.5, 6.0$  Hz, 1H), 2.05 (s, 3H), 1.97-1.93 (m, 1H), 1.85-1.78 (m, 1H), 1.82 (s, 3H), 1.74-1.70 (m, 1H), 1.62-1.14 (m, 4H), 1.44 (s, 3H), 1.28-1.20 (m, 2H), 1.14 (d,  $J = 5.8$  Hz, 3H), 1.02-0.94 (m, 27H), 0.91 (d,  $J = 6.2$  Hz, 3H), 0.78 (d,  $J = 6.6$  Hz, 3H), 0.72-0.57 (m, 18H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  210.5, 171.1, 144.5, 140.8, 125.4, 114.8, 81.3, 80.7, 78.4, 66.0, 65.7, 63.0, 47.1, 45.9, 45.0, 35.2, 31.0, 29.7, 28.7, 28.2, 24.6, 21.0, 19.4, 14.9, 13.6, 7.1, 7.0, 6.9, 6.8, 6.6, 5.2, 4.8, 0.3; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{46}\text{H}_{94}\text{O}_8\text{Si}_4\text{Na}$  ( $\text{M}+\text{Na}$ ) 909.5924, found 909.5948.



### TES ether SI-29

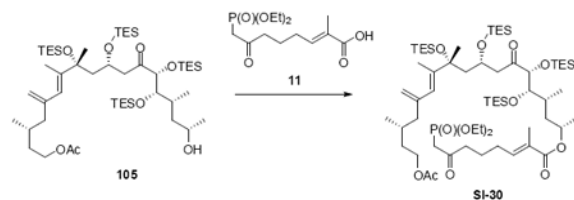
To a stirred solution of aldol adduct **101** (295 mg, 0.332 mmol) in  $\text{CH}_2\text{Cl}_2$  (10 mL) at rt was sequentially added DMAP (608 mg, 4.98 mmol) and  $\text{TESCl}$  (375 mg, 0.418 mL, 2.49 mmol). After 3 h, the reaction mixture was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 2% EtOAc / Hexanes, to give TES ether **SI-29** (290 mg, 0.289 mmol, 87%) as a colorless oil:  $[\alpha]_{\text{D}}^{23} = -31.4^{\circ}$  ( $c$  0.85,  $\text{CHCl}_3$ ); IR (neat) 2955, 2913, 2877, 1745, 1718, 1459, 1368, 1249, 1127, 1086, 1007, 841, 742  $\text{cm}^{-1}$ ;  $^1\text{H}$

NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  5.78 (s, 1H), 5.03 (s, 1H), 4.92 (s, 1H), 4.20-4.08 (m, 3H), 4.04 (d,  $J = 5.7$  Hz, 1H), 3.84-3.81 (m, 1H), 3.72-3.68 (m, 1H), 2.86 (dd,  $J = 18.0, 5.8$  Hz, 1H), 2.72 (dd,  $J = 17.4, 7.2$  Hz, 1H), 2.17 (dd,  $J = 13.8, 6.0$  Hz, 1H), 2.05 (s, 3H), 1.93-1.64 (m, 5H), 1.84 (s, 3H), 1.54-1.39 (m, 3H), 1.45 (s, 3H), 1.27-1.21 (m, 1H), 1.14 (d,  $J = 6.0$  Hz, 3H), 1.03-0.87 (m, 39H), 0.78 (d,  $J = 6.7$  Hz, 3H), 0.71-0.55 (m, 24H), 0.11 (s, 9H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  208.6, 171.1, 144.3, 143.0, 125.0, 115.1, 81.0, 78.3, 77.7, 66.1, 65.7, 63.0, 49.8, 48.5, 46.0, 44.9, 35.4, 31.0, 28.6, 27.9, 24.6, 21.0, 19.2, 14.5, 14.2, 7.2, 7.0, 6.9, 6.8, 5.2, 4.9, 0.4; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{52}\text{H}_{108}\text{O}_8\text{Si}_5\text{Na}$  ( $\text{M}+\text{Na}$ ) 1023.6788, found 1023.6785.



### Alcohol 105

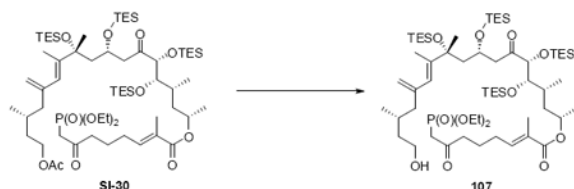
To a stirred solution of TMS ether **SI-29** (290 mg, 0.289 mmol) in THF /  $\text{H}_2\text{O}$  (6.52 mL, 8:1) at  $-20^\circ\text{C}$  was added HOAc ( $4 \times 1.45$  mL) in 4 portions every 60 min. After 5 h, the reaction was quenched with solid  $\text{NaHCO}_3$ , filtered over Celite<sup>®</sup> and extracted with ether ( $4 \times 15$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 5-10% EtOAc / Hexanes, to give alcohol **105** (220 mg, 0.237 mmol, 82%) as a colorless oil:  $[\alpha]_{\text{D}}^{23} = -31.6^\circ$  ( $c$  1.01,  $\text{CHCl}_3$ ); IR (neat) 3510, 2956, 2912, 2877, 1744, 1720, 1458, 1414, 1368, 1239, 1062, 1006, 741  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  5.78 (s, 1H), 5.02 (s, 1H), 4.90 (s, 1H), 4.22-4.08 (m, 4H), 3.81-3.77 (m, 1H), 3.69-3.66 (m, 1H), 2.94 (dd,  $J = 18.3, 6.1$  Hz, 1H), 2.78 (dd,  $J = 18.3, 5.7$  Hz, 1H), 2.15 (dd,  $J = 13.1, 5.7$  Hz, 1H), 2.04 (s, 3H), 1.93-1.60 (m, 6H), 1.83 (s, 3H), 1.45-1.34 (m, 2H), 1.44 (s, 3H), 1.30-1.20 (m, 1H), 1.17 (d,  $J = 6.0$  Hz, 3H), 1.04-0.87 (m, 39H), 0.82 (d,  $J = 6.0$  Hz, 3H), 0.72-0.56 (m, 24H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  208.8, 171.2, 144.4, 142.6, 125.2, 115.1, 81.4, 78.1, 77.7, 66.2, 65.4, 63.1, 49.7, 49.0, 45.9, 44.2, 35.3, 32.5, 28.6, 28.0, 24.3, 21.0, 19.2, 15.5, 14.6, 7.2, 7.0, 6.8, 5.3, 5.2, 4.8; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{49}\text{H}_{100}\text{O}_8\text{Si}_4\text{Na}$  ( $\text{M}+\text{Na}$ ) 951.6393, found 951.6398.



### Phosphonate SI-30

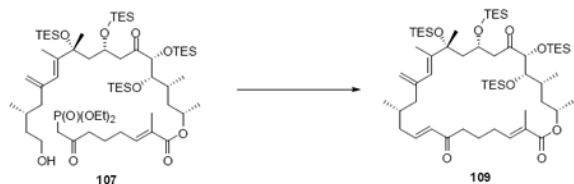
To a stirred solution of acid **11** (450 mg, 1.47 mmol) in PhMe (3.2 mL) at rt was sequentially added  $\text{Et}_3\text{N}$  (149 mg, 0.204 mL, 1.47 mmol) and 2, 4, 6-trichlorobenzoyl chloride (346 mg, 0.222 mL, 1.47 mmol). After 12 h, the resulted solution was concentrated *in vacuo*. DMAP (180 mg, 1.47 mmol) was added, followed by the addition of a solution of alcohol **105** (240 mg, 0.258 mmol) in PhMe (5.7 mL). After another 19 h, the reaction was quenched with sat. aq.  $\text{NH}_4\text{Cl}$  (8 mL) and extracted with EtOAc ( $4 \times 50$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 20-60% EtOAc / Hexanes, to give phosphonate **SI-30** (235 mg, 0.193 mmol, 78%) as a colorless oil:  $[\alpha]_{\text{D}}^{23} = -23.6^\circ$  ( $c$  0.83,  $\text{CHCl}_3$ ); IR (neat) 2955, 2912, 2877, 1734, 1716, 1458, 1369, 1241, 1056, 1019, 970, 741  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  6.69 (t,

$J = 6.3$  Hz, 1H), 5.79 (s, 1H), 5.10-5.00 (m, 1H), 5.03 (s, 1H), 4.92 (s, 1H), 4.22-4.08 (m, 8H), 3.72 (dd,  $J = 5.1, 3.6$  Hz, 1H), 3.13 (d,  $J = 27.8$  Hz, 2H), 2.90 (dd,  $J = 18.0, 5.9$  Hz, 1H), 2.77 (dd,  $J = 17.8, 6.0$  Hz, 1H), 2.68 (t,  $J = 7.2$  Hz, 2H), 2.18-2.07 (m, 3H), 2.06 (s, 3H), 1.94-1.68 (m, 9H), 1.842 (s, 3H), 1.82 (s, 3H), 1.46 (s, 3H), 1.43-1.39 (m, 2H), 1.36 (t,  $J = 7.0$  Hz, 6H), 1.25 (d,  $J = 6.0$  Hz, 3H), 1.03-0.92 (m, 36H), 0.90 (d,  $J = 6.4$  Hz, 3H), 0.80 (d,  $J = 6.7$  Hz, 3H), 0.70-0.55 (m, 24H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  208.4, 201.3, 171.1, 167.6, 144.3, 142.7, 140.5, 127.9, 125.1, 115.1, 80.9, 77.8, 77.6, 68.8, 65.6, 63.0, 62.9, 62.8, 48.7, 49.0, 45.9, 43.4, 41.7, 40.6, 35.3, 31.4, 28.6, 28.0, 27.7, 22.3, 21.0, 20.7, 19.2, 16.3, 16.2, 14.7, 14.5, 12.4, 7.2, 7.0, 6.9, 6.8, 5.3, 5.2, 4.9; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{62}\text{H}_{121}\text{O}_{13}\text{Si}_4\text{PNa}$  ( $\text{M}+\text{Na}$ ) 1239.7520, found 1239.7458.



### Alcohol 107

To a stirred solution of ester **SI-30** (230 mg, 0.189 mmol) in MeOH (10 mL) at rt was added  $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$  (66.4 mg, 0.189 mmol). After 1 h, the reaction mixture was purified directly by chromatography over silica gel, eluting with 20-60% EtOAc / Hexanes, to give alcohol **107** (204 mg, 0.168 mmol, 89%) as a colorless oil:  $[\alpha]_{\text{D}}^{23} = -27.0^\circ$  ( $c$  0.80,  $\text{CHCl}_3$ ); IR (neat) 3434, 2955, 2877, 1716, 1458, 1376, 1242, 1019, 742  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ ):  $\delta$  6.68 (t,  $J = 6.8$  Hz, 1H), 5.78 (s, 1H), 5.11-5.00 (m, 1H), 5.00 (s, 1H), 4.86 (s, 1H), 4.19-4.05 (m, 6H), 3.73-3.66 (m, 3H), 3.07 (d,  $J = 27.8$  Hz, 2H), 2.93 (dd,  $J = 18.0, 6.1$  Hz, 1H), 2.78 (dd,  $J = 18.3, 5.7$  Hz, 1H), 2.65 (t,  $J = 7.1$  Hz, 2H), 2.22-2.11 (m, 3H), 1.92-1.59 (m, 8H), 1.81 (s, 6H), 1.43 (s, 3H), 1.42-1.39 (m, 3H), 1.33 (t,  $J = 7.0$  Hz, 6H), 1.23 (d,  $J = 6.3$  Hz, 3H), 1.02-0.85 (m, 39H), 0.78 (d,  $J = 6.5$  Hz, 3H), 0.69-0.52 (m, 24H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  209.0, 201.4, 167.6, 144.8, 142.3, 140.5, 129.0, 125.5, 114.9, 80.8, 77.8, 77.7, 68.8, 65.6, 62.6, 62.5, 61.0, 49.5, 49.0, 46.2, 43.3, 41.6, 40.6, 40.0, 31.4, 28.3, 28.1, 27.7, 22.3, 20.7, 19.3, 16.3, 16.2, 14.7 (2C), 12.4, 7.2, 7.0, 6.9, 6.8, 5.2, 5.1, 4.9; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{60}\text{H}_{119}\text{O}_{12}\text{Si}_4\text{PNa}$  ( $\text{M}+\text{Na}$ ) 1197.7414, found 1197.7422.



### Macrocycle 109

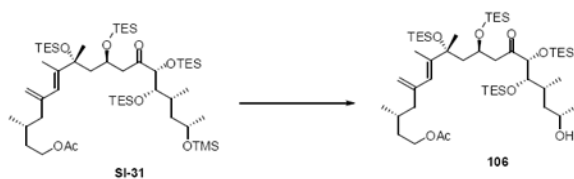
To a stirred solution of alcohol **107** (125 mg, 0.106 mmol) in  $\text{CH}_2\text{Cl}_2$  (4 mL) at rt was added TPAP (45 mg, 0.127 mmol). After 0.5 h, the reaction mixture was diluted with THF (6.5 mL) /  $\text{H}_2\text{O}$  (16  $\mu\text{L}$ ) and  $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$  ( $3 \times 74$  mg, 0.636 mmol) was added in 3 portions every 30 min. After another 2 h, the reaction mixture was purified directly by chromatography over silica gel, eluting with 5% EtOAc / Hexanes, to give macrocycle **109** (54 mg, 0.053 mmol, 50% over 2 steps) as colorless crystals:  $[\alpha]_{\text{D}}^{23} = -27.0^\circ$  ( $c$  0.40,  $\text{CHCl}_3$ ); IR (neat) 2955, 2925, 2876, 1727, 1708, 1675, 1458, 1417, 1260, 1127, 1064, 1009, 741  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.15-7.03 (m, 1H), 6.73 (t,  $J = 6.9$  Hz, 1H), 6.19 (d,  $J = 16.3$  Hz, 1H), 5.78 (s, 1H), 5.00 (s, 1H), 5.05-4.97 (m, 1H), 4.82 (s, 1H), 4.18-4.09 (m, 1H), 4.11 (d,  $J = 5.1$  Hz, 1H), 3.62-3.58 (m, 1H), 3.00-2.93 (m, 2H), 2.85-2.70 (m, 1H),

2.62-2.50 (m, 1H), 2.37-2.21 (m, 3H), 2.15-2.00 (m, 2H), 1.91-1.63 (m, 7H), 1.80 (s, 6H), 1.45-1.35 (m, 2H), 1.41 (s, 3H), 1.25 (d,  $J = 6.1$  Hz, 3H), 1.08-0.83 (m, 39H), 0.75-0.47 (m, 27H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  206.2, 201.0, 167.6, 147.2, 144.7, 141.8, 140.6, 132.4, 129.2, 125.8, 115.4, 80.5, 79.6, 77.9, 68.3, 64.9, 49.7, 48.6, 46.7, 43.2, 41.1, 37.5, 31.0, 29.2, 28.9, 27.8, 22.6, 21.0, 18.8, 15.6, 13.3, 12.5, 7.3, 7.1, 7.0, 5.2, 4.8; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{56}\text{H}_{106}\text{O}_8\text{Si}_4\text{Na}$  ( $\text{M}+\text{Na}$ ) 1041.6863, found 1041.6812.



### TES ether SI-31

To a stirred solution of aldol adduct **104** (440 mg, 0.496 mmol) in  $\text{CH}_2\text{Cl}_2$  (20 mL) at rt was sequentially added DMAP (910 mg, 7.44 mmol) and TESCl (557 mg, 0.620 mL, 3.72 mmol). After 3 h, the reaction mixture was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 2% EtOAc / Hexanes, to give TES ether **SI-31** (445 mg, 0.444 mmol, 90%) as a colorless oil:  $[\alpha]_{\text{D}}^{23} = -20.0^\circ$  ( $c$  0.24,  $\text{CHCl}_3$ ); IR (neat) 2955, 2912, 2877, 1744, 1717, 1458, 1249, 1127, 1069, 1008, 840, 742  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  5.81 (s, 1H), 5.00 (s, 1H), 4.85 (s, 1H), 4.43-4.30 (m, 1H), 4.16-4.03 (m, 3H), 3.88-3.78 (m, 1H), 3.69-3.72 (m, 1H), 2.88 (dd,  $J = 17.4, 4.8$  Hz, 1H), 2.73 (dd,  $J = 17.4, 7.2$  Hz, 1H), 2.13 (dd,  $J = 13.8, 6.0$  Hz, 1H), 2.04 (s, 3H), 1.82-1.94 (m, 3H), 1.79 (s, 3H), 1.64-1.75 (m, 3H), 1.46 (s, 3H), 1.39-1.51 (m, 2H), 1.20-1.28 (m, 1H), 1.14 (d,  $J = 6.0$  Hz, 3H), 0.84-1.03 (m, 39H), 0.77 (d,  $J = 6.6$  Hz, 3H), 0.56-0.71 (m, 24H), 0.11 (s, 9H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  208.4, 171.1, 144.3, 143.8, 124.3, 114.8, 81.1, 78.4, 77.3, 66.1 (2C), 62.9, 50.3, 48.7, 45.9, 45.2, 35.2, 30.7, 28.7, 26.9, 24.7, 21.0, 19.3, 14.8, 13.8, 7.2, 7.0, 6.9, 6.7, 5.4, 5.3, 5.0, 0.3; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{52}\text{H}_{108}\text{O}_8\text{Si}_5\text{Na}$  ( $\text{M}+\text{Na}$ ) 1023.6788, found 1023.6737.

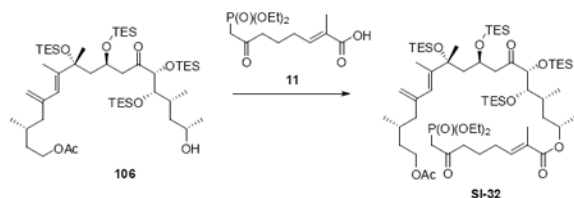


### Alcohol 106

To a stirred solution of TMS ether **SI-31** (432 mg, 0.43 mmol) in THF /  $\text{H}_2\text{O}$  (9 mL, 8:1) at  $-20^\circ\text{C}$  was added HOAc (8 mL). After 5 h, the reaction was quenched with solid  $\text{NaHCO}_3$ , filtered over Celite<sup>®</sup> and extracted with ether ( $4 \times 20$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 5-10-20% EtOAc / Hexanes, to give alcohol **106** (338 mg, 0.36 mmol, 85%) as a colorless oil:  $[\alpha]_{\text{D}}^{23} = -20.8^\circ$  ( $c$  1.01,  $\text{CHCl}_3$ ); IR (neat) 3503, 2955, 2912, 2877, 1744, 1720, 1458, 1414, 1367, 1239, 1007, 741  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  5.85 (s, 1H), 5.02 (s, 1H), 4.86 (s, 1H), 4.50-4.40 (m, 1H), 4.18-4.03 (m, 3H), 3.85-3.77 (m, 1H), 3.67 (t,  $J = 5.0$  Hz, 1H), 2.74-2.86 (m, 2H), 2.19 (br, OH), 2.14 (dd,  $J = 13.6, 6.3$  Hz, 1H), 2.06 (s, 3H), 1.89-1.96 (m, 2H), 1.80 (s, 3H), 1.66-1.85 (m, 5H), 1.45 (s, 3H), 1.39-1.42 (m, 1H), 1.19 (d,  $J = 6.0$  Hz, 3H), 1.10-1.22 (m, 1H), 0.95-1.05 (m, 36H), 0.90 (d,  $J = 6.4$  Hz, 3H), 0.85 (d,  $J = 6.4$  Hz, 3H), 0.59-0.72 (m, 24H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  208.4, 171.2, 144.3, 143.5, 124.4, 115.0, 82.1, 78.5, 77.3, 66.0, 65.9, 63.0, 50.0, 48.0, 45.9, 44.4, 35.2, 32.3,

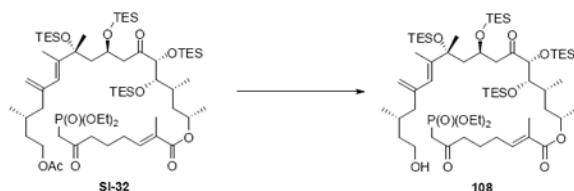


28.7, 27.3, 24.2, 21.0, 19.3, 15.4, 15.0, 7.3, 7.1, 7.0, 6.9, 6.8, 5.3, 5.2, 4.9; HRMS (ES<sup>+</sup>) calcd. for C<sub>49</sub>H<sub>100</sub>O<sub>8</sub>Si<sub>4</sub>Na (M+Na) 951.6393, found 951.6418.



### Phosphonate SI-32

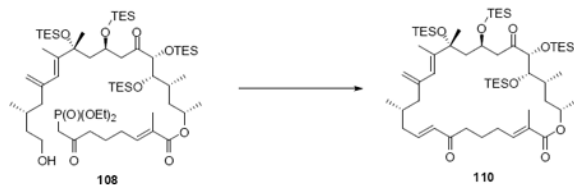
To a stirred solution of acid **11** (837 mg, 2.73 mmol) in PhMe (6 mL) at rt was sequentially added Et<sub>3</sub>N (276 mg, 0.379 mL, 2.73 mmol) and 2, 4, 6-trichlorobenzoyl chloride (641 mg, 0.411 mL, 2.73 mmol). After 12 h, the resulted solution was concentrated *in vacuo*. DMAP (333 mg, 2.73 mmol) was added, followed by the addition of a solution of alcohol **106** (445 mg, 0.479 mmol) in PhMe (10.5 mL). After another 19 h, the reaction was quenched with sat. aq. NH<sub>4</sub>Cl (15 mL) and extracted with EtOAc (4 × 50 mL). The dried extract (MgSO<sub>4</sub>) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 20-60% EtOAc / Hexanes, to give phosphonate **SI-32** (450 mg, 0.100 mmol, 77%) as a colorless oil: [α]<sub>D</sub><sup>23</sup> = -20.3° (*c* 1.23, CHCl<sub>3</sub>); IR (neat) 2955, 2913, 2877, 1740, 1716, 1458, 1368, 1243, 1056, 1019, 968, 742 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>) δ 6.69 (t, *J* = 6.4 Hz, 1H), 5.82 (s, 1H), 5.10-5.02 (m, 1H), 5.01 (s, 1H), 4.84 (s, 1H), 4.42-4.32 (m, 1H), 4.21-4.02 (m, 7H), 3.76-3.68 (m, 1H), 3.12 (d, *J* = 22.8 Hz, 2H), 2.85 (dd, *J* = 17.4, 4.1 Hz, 1H), 2.65-2.76 (m, 3H), 2.12-2.22 (m, 2H), 2.10-2.04 (m, 1H), 2.05 (s, 3H), 1.58-1.93 (m, 10H), 1.82 (s, 3H), 1.79 (s, 3H), 1.45 (s, 3H), 1.43-1.39 (m, 1H), 1.35 (t, *J* = 7.1 Hz, 6H), 1.24 (d, *J* = 5.9 Hz, 3H), 0.87-1.03 (m, 39H), 0.79 (d, *J* = 6.6 Hz, 3H), 0.55-0.68 (m, 24H); <sup>13</sup>C NMR (75 MHz, CDCl<sub>3</sub>) δ 208.3, 201.4, 171.1, 167.6, 144.3, 143.7, 140.5, 129.0, 124.4, 114.9, 81.1, 77.9, 77.34, 68.8, 66.2, 62.9, 62.6, 62.5, 50.3, 49.0, 45.9, 43.3, 41.6, 40.8, 35.2, 31.1, 28.7, 27.7, 26.9, 22.3, 21.0, 20.7, 19.3, 16.3, 16.2, 14.8, 14.3, 12.4, 7.2, 7.1, 7.0, 6.9, 6.7, 5.3, 5.2, 5.0; HRMS (ES<sup>+</sup>) calcd. for C<sub>62</sub>H<sub>121</sub>O<sub>13</sub>Si<sub>4</sub>PNa (M+Na) 1239.7520, found 1239.7563.



### Alcohol 108

To a stirred solution of ester **SI-32** (170 mg, 0.140 mmol) in MeOH (0.5 mL) at rt was added a saturated solution of Ba(OH)<sub>2</sub>·8H<sub>2</sub>O in MeOH (6.0 mL). After 20 min, the reaction mixture was purified directly by chromatography over silica gel, eluting with 20-60% EtOAc / Hexanes, to give alcohol **108** (150 mg, 0.127 mmol, 91%) as a colorless oil: [α]<sub>D</sub><sup>23</sup> = -20.3° (*c* 0.60, CHCl<sub>3</sub>); IR (neat) 3440, 2955, 2877, 1716, 1458, 1242, 1019, 969, 742 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>): δ 6.69 (t, *J* = 6.2 Hz, 1H), 5.82 (s, 1H), 5.10-5.03 (m, 1H), 5.00 (s, 1H), 4.83 (s, 1H), 4.42-4.31 (m, 1H), 4.20-4.08 (m, 5H), 3.63-3.74 (m, 3H), 3.12 (d, *J* = 22.8 Hz, 2H), 2.78-2.72 (m, 2H), 2.66 (t, *J* = 7.1 Hz, 2H), 2.04-2.19 (m, 3H), 1.89-1.61 (m, 10H), 1.81 (s, 3H), 1.78 (s, 3H), 1.44 (s, 3H), 1.43-1.38 (m, 1H), 1.35 (t, *J* = 7.1 Hz, 6H), 1.24 (d, *J* = 5.9 Hz, 3H), 1.03-0.92 (m, 36H), 0.87 (d, *J* = 6.4 Hz, 3H), 0.79 (d, *J* = 6.6 Hz, 3H), 0.55-0.71 (m, 24H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 208.5, 201.5, 167.7, 144.6, 143.5, 140.6, 129.0, 124.7, 114.7, 81.2, 78.0, 68.8, 66.1, 62.6, 62.5, 61.1, 50.3, 49.1,

46.1, 43.5, 43.4, 41.8, 40.9, 39.8, 31.1, 28.5, 27.8, 27.1, 22.3, 20.8, 19.5, 16.4, 16.3, 14.9, 14.2, 12.4, 7.3, 7.1, 7.0, 6.9, 6.8, 5.3, 5.2, 5.0; HRMS (ES<sup>+</sup>) calcd. for C<sub>60</sub>H<sub>119</sub>O<sub>12</sub>Si<sub>4</sub>PNa (M+Na) 1197.7414, found 1197.7423.



### Macrocycle 110

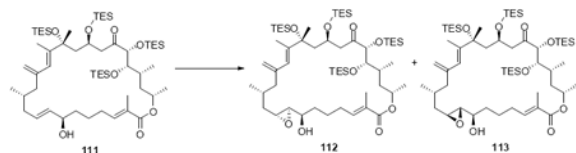
To a stirred solution of alcohol **108** (170 mg, 0.144 mmol) in CH<sub>2</sub>Cl<sub>2</sub> (4 mL) at rt was added TPAP (61 mg, 0.173 mmol). After 0.5 h, the reaction mixture was diluted with CH<sub>2</sub>Cl<sub>2</sub> (3 mL) / CH<sub>3</sub>CN (7 mL) and Hunig's base (297 mg, 0.4 mL, 2.29 mmol) was added, followed by the addition of LiCl (20 mg, 0.476 mmol). After 24 h, the reaction mixture was purified directly by chromatography over silica gel, eluting with 5% EtOAc / Hexanes, to give macrocycle **110** (75 mg, 0.073 mmol, 51% over 2 steps) as a colorless oil: [α]<sub>D</sub><sup>23</sup> = -10.0° (c 0.62, CHCl<sub>3</sub>); IR (neat) 2955, 2913, 2876, 1708, 1674, 1457, 1417, 1375, 1240, 1124, 1072, 1008, 742 cm<sup>-1</sup>; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 6.88 (dt, *J* = 16.2, 7.4 Hz, 1H), 6.72 (t, *J* = 8.0 Hz, 1H), 6.10 (d, *J* = 16.0 Hz, 1H), 5.82 (s, 1H), 5.08-4.99 (m, 1H), 5.02 (s, 1H), 4.87 (s, 1H), 4.30-4.22 (m, 1H), 4.01 (d, *J* = 6.4 Hz, 1H), 3.58 (dd, *J* = 6.4, 2.7 Hz, 1H), 2.86 (dd, *J* = 17.4, 8.6 Hz, 1H), 2.77 (dd, *J* = 15.4, 6.0 Hz, 1H), 2.62-2.54 (m, 2H), 2.36-2.19 (m, 4H), 2.14 (dd, *J* = 17.4, 8.6 Hz, 1H), 2.05-1.76 (m, 7H), 1.80 (s, 3H), 1.79 (s, 3H), 1.70-1.60 (m, 1H), 1.57-1.51 (m, 1H), 1.41 (s, 3H), 1.25 (d, *J* = 6.2 Hz, 3H), 1.05-0.93 (m, 36H), 0.84 (d, *J* = 6.6 Hz, 3H), 0.76 (d, *J* = 6.6 Hz, 3H), 0.73-0.58 (m, 24H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 208.1, 201.0, 167.6, 147.3, 147.1, 144.0, 142.8, 140.8, 132.4, 129.3, 124.7, 115.1, 80.6, 77.4 (2C), 68.5, 65.1, 50.6, 49.0, 46.1, 41.7, 40.2, 37.2, 31.3, 30.8, 27.8, 27.4, 23.1, 21.0, 19.7, 15.3, 12.8, 12.5, 7.3, 7.1, 7.0, 6.9, 5.3, 5.2, 4.9; HRMS (ES<sup>+</sup>) calcd. for C<sub>56</sub>H<sub>106</sub>O<sub>8</sub>Si<sub>4</sub>Na (M +Na) 1041.6863, found 1041.6824.



### Allylic alcohol 111

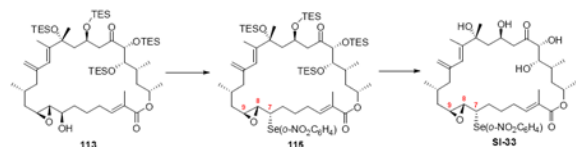
To a stirred solution of macrocycle **110** (107 mg, 0.105 mmol) in CH<sub>2</sub>Cl<sub>2</sub> (5.4 mL) at -20°C was sequentially added (*S*)-CBS (0.42 mL, 0.42 mmol, 1 M in PhMe) and BH<sub>3</sub>•DMS (0.84 mL, 0.84 mmol, 1 M in THF). After 45 min, the reaction was quenched with MeOH (0.3 mL), diluted with aq. NaHCO<sub>3</sub> (5 mL) and extracted with Et<sub>2</sub>O (3 × 8 mL). The dried extract (MgSO<sub>4</sub>) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 3-6% EtOAc / Hexanes, to give allylic alcohol **111** (72 mg, 0.0704 mmol, 67%) as a colorless oil: [α]<sub>D</sub><sup>23</sup> = -16.3° (c 0.30, CHCl<sub>3</sub>); IR (neat) 3431, 2954, 2913, 2876, 1708, 1674, 1458, 1414, 1376, 1241, 1128, 1073, 1009, 742 cm<sup>-1</sup>; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 6.80 (t, *J* = 8.0 Hz, 1H), 5.89 (s, 1H), 5.63-5.52 (m, 1H), 5.45 (dd, *J* = 15.4, 7.5 Hz, 1H), 5.10-5.00 (m, 1H), 4.98 (s, 1H), 4.82 (s, 1H), 4.32-4.20 (m, 1H), 4.19-4.09 (m, 1H), 4.04 (d, *J* = 6.2 Hz, 1H), 3.57 (dd, *J* = 6.2, 2.5 Hz, 1H), 2.87 (dd, *J* = 17.0, 9.0 Hz, 1H), 2.49 (d, *J* = 16.8 Hz, 1H), 2.28-2.20 (m, 2H), 2.13-1.98 (m, 3H), 1.90-1.61 (m, 9H), 1.86 (s, 3H), 1.75 (s, 3H), 1.55-1.46 (m, 2H), 1.39 (s, 3H), 1.26 (d, *J* = 6.0 Hz, 3H), 1.06-0.94 (m, 36H), 0.82

(d,  $J = 6.4$  Hz, 3H), 0.73-0.60 (m, 27H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  208.5, 167.8, 144.6, 142.0, 141.3, 134.6, 130.8, 128.2, 125.4, 114.4, 80.6, 78.0, 72.9, 68.4, 65.2, 50.3, 49.2, 45.4, 41.8, 39.7, 36.8, 31.3, 30.4, 28.8, 28.2, 24.0, 20.9, 19.6, 15.4, 12.5, 12.4, 7.3, 7.1, 7.0, 5.3, 5.2, 4.9; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{56}\text{H}_{108}\text{O}_8\text{Si}_4\text{Na}$  ( $\text{M}+\text{Na}$ ) 1043.7019, found 1043.7052



## Epoxide 113 & 112

To a stirred solution of allylic alcohol **111** (70 mg, 0.0685 mmol) in  $\text{CH}_2\text{Cl}_2$  (6 mL) at  $-20^\circ\text{C}$  was sequentially added  $4\text{\AA}$  MS (50 mg), TBHP (37  $\mu\text{L}$ , 0.206 mmol, 5.5 M in decane) and  $\text{Ti}(\text{O}-i\text{Pr})_4$  (23.3 mg, 24  $\mu\text{L}$ , 0.082 mmol). After 5 h, the reaction was quenched with aq.  $\text{NaHCO}_3$  (3 mL) and extracted with  $\text{Et}_2\text{O}$  ( $3 \times 7$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 6-10%  $\text{EtOAc}$  / Hexanes, to give epoxide **113** (35 mg, 0.0342 mmol, 50%) and epoxide **112** (17 mg, 0.0166 mmol, 24%) as colorless oils. **113**:  $[\alpha]_{\text{D}}^{23} = -29.0^\circ$  ( $c$  0.42,  $\text{CHCl}_3$ ); IR (neat) 3431, 2954, 2923, 2876, 1708, 1647, 1458, 1414, 1377, 1242, 1128, 1073, 1009, 742  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  6.78 (t,  $J = 8.0$  Hz, 1H), 5.88 (s, 1H), 5.05-4.98 (m, 1H), 5.01 (s, 1H), 4.86 (s, 1H), 4.30-4.20 (m, 1H), 4.05 (d,  $J = 6.1$  Hz, 1H), 3.59 (dd,  $J = 6.1$ , 2.0 Hz, 1H), 3.52-3.43 (m, 1H), 3.22-3.15 (m, 1H), 2.91 (dd,  $J = 16.3$ , 9.1 Hz, 1H), 2.70 (dd,  $J = 6.0$ , 2.0 Hz, 1H), 2.44-2.25 (m, 3H), 2.18 (dd,  $J = 13.0$ , 5.6 Hz, 1H), 2.10-1.63 (m, 12H), 1.87 (s, 3H), 1.78 (s, 3H), 1.41 (s, 3H), 1.26 (d,  $J = 6.0$  Hz, 3H), 1.15-1.09 (m, 1H), 1.07-0.89 (m, 36H), 0.80 (d,  $J = 6.4$  Hz, 3H), 0.76-0.59 (m, 27H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  208.4, 167.7, 144.0, 142.1, 141.4, 128.6, 125.0, 114.9, 80.8, 78.2, 77.5, 71.8, 68.3, 65.6, 62.8, 56.4, 50.6, 49.1, 46.6, 42.1, 38.9, 33.1, 30.1, 29.4, 28.8, 28.3, 23.7, 21.0, 19.8, 15.5, 12.5, 12.4, 7.3, 7.1, 7.0, 5.3, 5.2, 5.0; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{56}\text{H}_{108}\text{O}_9\text{Si}_4\text{Na}$  ( $\text{M}+\text{Na}$ ) 1059.6968, found 1059.7009. **112**:  $[\alpha]_{\text{D}} = -26.2$  ( $c$  0.60,  $\text{CHCl}_3$ ); IR (neat) 3482, 2954, 2923, 2876, 1708, 1458, 1414, 1377, 1240, 1128, 1008, 742  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  6.79 (t,  $J = 7.7$  Hz, 1H), 5.87 (s, 1H), 5.05-4.98 (m, 1H), 4.99 (s, 1H), 4.84 (s, 1H), 4.30-4.20 (m, 1H), 4.09 (d,  $J = 5.9$  Hz, 1H), 3.75-3.69 (m, 1H), 3.57 (dd,  $J = 5.6$ , 3.2 Hz, 1H), 2.91-2.78 (m, 3H), 2.68-2.60 (m, 2H), 2.38-2.20 (m, 3H), 2.07 (dd,  $J = 12.9$ , 6.2 Hz, 1H), 1.93-1.62 (m, 10H), 1.85 (s, 3H), 1.76 (s, 3H), 1.50-1.44 (m, 2H), 1.40 (s, 3H), 1.25 (d,  $J = 6.0$  Hz, 3H), 1.05-0.93 (m, 39H), 0.74-0.59 (m, 27H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  208.6, 167.8, 144.1, 142.5, 141.5, 128.4, 124.9, 114.9, 81.0, 78.2, 77.4, 69.0, 68.4, 65.5, 60.7, 54.9, 50.3, 49.2, 46.3, 41.7, 38.4, 33.3, 30.7, 30.3, 29.0, 27.9, 23.7, 21.0, 20.0, 15.3, 13.2, 12.4, 7.3, 7.1, 7.0, 6.9, 5.3, 5.2, 4.9; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{56}\text{H}_{108}\text{O}_9\text{Si}_4\text{Na}$  ( $\text{M}+\text{Na}$ ) 1059.6968, found 1059.7009.



## Selenide 115

To a stirred solution of epoxide **113** (42 mg, 0.0405 mmol) in THF (2 mL) at rt was sequentially added  $o\text{-NO}_2\text{C}_6\text{H}_4\text{SeCN}$  (184 mg, 0.809 mmol) and  $\text{PBu}_3$  (164 mg, 202  $\mu\text{L}$ , 0.809 mmol). After 5 h, the reaction mixture was concentrated *in vacuo* purified by chromatography over silica gel, eluting with Hexanes then with 4%  $\text{EtOAc}$  / Hexanes, to

give crude selenide **115** (30 mg) as yellow oils which was used directly in next step without further purification.

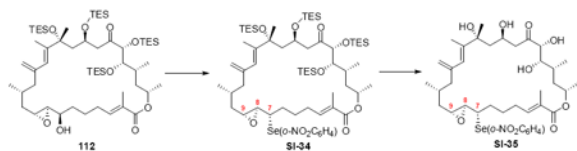
### Polyol SI-33

To a stirred solution of selenide **115** (30 mg) in THF /DMF / H<sub>2</sub>O (10:1:0.02, 1.8 mL / 180  $\mu$ L / 3.6  $\mu$ L) at 0°C was added TAS-F (33.7 mg, 0.123 mmol). The reaction mixture was then warmed up to rt. After 2 h, the reaction mixture was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 10-65% EtOAc / Hexanes, to give polyol **SI-33** (15 mg, 0.0196 mmol, 48% over 2 steps) as a yellow solid:  $[\alpha]_D^{23} = -20.1^\circ$  (*c* 0.12, CHCl<sub>3</sub>); IR (neat) 3447, 2925, 2854, 1701, 1520, 1456, 1334, 1273, 759, 732 cm<sup>-1</sup>; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  8.28 (d, *J* = 8.3 Hz, 1H), 7.66 (d, *J* = 7.8 Hz, 1H), 7.56 (t, *J* = 8.1 Hz, 1H), 7.38 (t, *J* = 8.1 Hz, 1H), 6.81 (t, *J* = 6.4 Hz, 1H), 6.05 (s, 1H), 5.10-5.00 (m, 1H), 5.02 (s, 1H), 4.80 (s, 1H), 4.38 (d, *J* = 3.6 Hz, 1H), 4.18 (s, 1H), 4.17-4.11 (m, 1H), 4.07 (t, *J* = 9.6 Hz, 1H), 3.58 (t, *J* = 8.6 Hz, 1H), 3.18-3.10 (m, 1H), 2.97 (d, *J* = 8.1 Hz, 1H), 2.79 (dd, *J* = 12.8, 10.1 Hz, 1H), 2.37-2.28 (m, 1H), 2.40-2.30 (m, 1H), 2.22-2.04 (m, 3H), 1.94-1.76 (m, 7H), 1.83 (s, 3H), 1.79 (s, 3H), 1.72-1.62 (m, 3H), 1.38 (s, 3H), 1.31 (d, *J* = 6.1 Hz, 3H), 1.25-1.19 (m, 2H), 1.07 (d, *J* = 6.4 Hz, 3H), 0.83 (d, *J* = 6.2 Hz, 3H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  211.1, 167.6, 149.6, 144.4, 141.0 (2C), 133.1, 132.5, 128.9, 128.3, 127.0, 126.0, 125.1, 115.0, 78.3, 77.5, 75.3, 68.7, 68.3, 62.3, 59.3, 46.7, 45.7, 45.5, 43.8, 40.4, 40.0, 32.8, 31.6, 29.1, 29.0, 28.1, 26.1, 21.2, 17.7, 16.2, 15.3, 12.5; HRMS (ES<sup>+</sup>) calcd. for C<sub>38</sub>H<sub>55</sub>NO<sub>10</sub>NaSe (M+Na) 788.2889, found 788.2859.



### Proposed structure of Amphidinolide B<sub>2</sub> (3)

To a stirred solution of selenide **SI-33** (6.0 mg, 0.00784 mmol) in CH<sub>2</sub>Cl<sub>2</sub> (1.2 mL) at rt was sequentially added NaHCO<sub>3</sub> (60 mg, 0.714 mmol) and TMSOOTMS (41.7 mg, 50  $\mu$ L, 0.233 mmol). After 1.5 h, the yellow color vanished and the reaction mixture was purified by preparative TLC, eluting with 60% EtOAc / Hexanes, to give allylic epoxide **3** (3.0 mg, 0.00533 mmol, 68%):  $[\alpha]_D^{23} = -52.3^\circ$  (*c* 0.21, CHCl<sub>3</sub>); IR (neat) 3446, 2923, 2853, 1701, 1457, 1273, 1120 cm<sup>-1</sup>; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  6.74 (t, *J* = 6.4 Hz, 1H), 6.06 (s, 1H), 5.92 (ddd, *J* = 15.0, 8.9, 4.4 Hz, 1H), 5.20 (dd, *J* = 15.5, 8.8 Hz, 1H), 5.11-5.07 (m, 1H), 5.07 (s, 1H), 4.86 (s, 1H), 4.28 (d, *J* = 5.4, 1H), 4.14 (s, OH), 4.14-4.09 (m, 1H), 3.73 (d, *J* = 5.6 Hz, OH), 3.69 (t, *J* = 9.5 Hz, 1H), 3.50 (d, *J* = 6.8 Hz, 1H), 3.23 (dd, *J* = 8.7, 2.2 Hz, 1H), 3.08-3.03 (m, 2H), 2.95 (d, *J* = 9.2 Hz, OH), 2.53-2.45 (m, 1H), 2.45-2.36 (m, 1H), 2.28 (dd, *J* = 13.2, 1.8 Hz, 1H), 2.17-2.12 (m, 3H), 1.97-1.93 (m, 4H), 1.85 (s, 3H), 1.82-1.79 (m, 1H), 1.80 (s, 3H), 1.78-1.75 (m, 1H), 1.64-1.60 (m, 1H), 1.34 (s, 3H), 1.31 (d, *J* = 6.1 Hz, 3H), 1.17-1.12 (m, 1H), 1.03 (d, *J* = 6.7 Hz, 3H), 0.98 (d, *J* = 5.6 Hz, 3H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  212.5, 167.7, 144.7, 141.6, 139.5, 136.3, 128.4, 128.3, 124.9, 114.6, 78.1, 75.6, 69.28, 68.23, 61.45, 59.5, 47.1, 46.4, 44.1, 40.0, 39.4, 33.3, 31.0, 29.3, 28.3, 26.7, 21.2, 17.5, 15.9, 15.2, 12.6; HRMS (ES<sup>+</sup>) calcd. for C<sub>32</sub>H<sub>50</sub>O<sub>8</sub>Na (M+Na) 585.3403, found 585.3390.

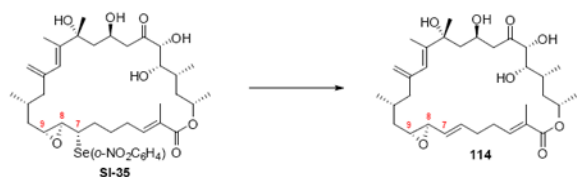


### Selenide SI-34

To a stirred solution of epoxide **112** (12 mg, 0.0116 mmol) in THF (0.7 mL) at rt was sequentially added *o*-NO<sub>2</sub>C<sub>6</sub>H<sub>4</sub>SeCN (53 mg, 0.232 mmol) and PBU<sub>3</sub> (47 mg, 58  $\mu$ L, 0.232 mmol). After 0.5 h, the reaction mixture was concentrated *in vacuo* purified by chromatography over silica gel, eluting with Hexanes then with 4% EtOAc / Hexanes, to give crude selenide **SI-34** (10.6 mg) as a yellow oil which was used directly in next step without further purification.

### Polyol SI-35

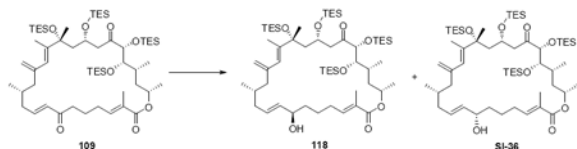
To a stirred solution of selenide **SI-34** (10.6 mg) in THF / DMF / H<sub>2</sub>O (10:1:0.02, 1.0 mL / 100  $\mu$ L / 2.0  $\mu$ L) at 0°C was added TAS-F (12 mg, 0.0434 mmol). The reaction mixture was then warmed up to rt. After 2 h, the reaction mixture was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 10-65% EtOAc / Hexanes, to give polyol **SI-35** (6.2 mg, 0.00811 mmol, 70% over 2 steps) as a yellow oil: [ $\alpha$ ]<sub>D</sub> = -47.0° (*c* 0.30, CHCl<sub>3</sub>); IR (neat) 3446, 2925, 2854, 1701, 1515, 1456, 1332, 1271, 757, 731 cm<sup>-1</sup>; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  8.16 (d, *J* = 8.1 Hz, 1H), 7.70 (d, *J* = 8.0 Hz, 1H), 7.55 (t, *J* = 7.4 Hz, 1H), 7.42 (t, *J* = 7.8 Hz, 1H), 6.85 (t, *J* = 6.3 Hz, 1H), 6.02 (s, 1H), 5.11-5.05 (m, 1H), 5.04 (s, 1H), 4.81 (s, 1H), 4.38 (d, *J* = 3.6 Hz, 1H), 4.32-4.25 (m, 1H), 4.17-4.12 (m, 1H), 3.89 (d, *J* = 4.6 Hz, 1H), 3.72-3.65 (m, 1H), 3.62-3.55 (m, 1H), 3.10-3.05 (m, 2H), 2.84 (dd, *J* = 14.8, 9.2 Hz, 1H), 2.52 (dd, *J* = 14.8, 2.5 Hz, 1H), 2.38 (d, *J* = 9.5 Hz, 1H), 2.40-2.20 (m, 3H), 1.97-1.74 (m, 8H), 1.83 (s, 3H), 1.76 (s, 3H), 1.70-1.60 (m, 3H), 1.36 (s, 3H), 1.33 (d, *J* = 6.1 Hz, 3H), 1.06 (d, *J* = 6.7 Hz, 3H), 0.87 (d, *J* = 6.2 Hz, 3H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  212.0, 167.7, 147.7, 144.6, 141.3, 140.9, 133.7, 132.3, 130.1, 128.6, 126.5, 126.1, 125.6, 115.1, 78.0, 77.0, 75.5, 69.1, 67.7, 60.6, 58.4, 45.7, 45.6, 43.7, 43.1, 40.4, 39.2, 33.8, 30.3, 29.5, 28.9, 28.0, 27.0, 21.2, 19.7, 16.3, 15.2, 12.5; HRMS (ES<sup>+</sup>) calcd. for C<sub>38</sub>H<sub>55</sub>NO<sub>10</sub>NaSe(M+Na) 788.2889, found 788.2897.



### Allylic epoxide 114

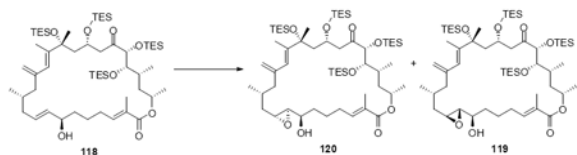
To a stirred solution of selenide **SI-35** (2.5 mg, 0.00327 mmol) in CH<sub>2</sub>Cl<sub>2</sub> (0.5 mL) at rt was sequentially added NaHCO<sub>3</sub> (20 mg, 0.238 mmol) and TMSO-OTMS (19.1 mg, 23  $\mu$ L, 0.107 mmol). After 1.5 h, the yellow color vanished and the reaction mixture was purified by preparative TLC, eluting with 60% EtOAc / Hexanes, to give allylic epoxide **114** (1.2 mg, 0.00213 mmol, 65%): [ $\alpha$ ]<sub>D</sub> = -27.5° (*c* 0.12, CHCl<sub>3</sub>); IR (neat) 3443, 2924, 2852, 1703, 1457, 1379, 1272, 1118 cm<sup>-1</sup>; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>)  $\delta$  6.71-6.63 (m, 1H), 6.08 (s, 1H), 5.88-5.78 (m, 1H), 5.26 (dd, *J* = 15.1, 8.4 Hz, 1H), 5.12-5.05 (m, 1H), 5.05 (s, 1H), 4.84 (s, 1H), 4.29 (dd, *J* = 5.7, 1.5 Hz, 1H), 4.30-4.20 (m, 1H), 3.71 (t, *J* = 7.9 Hz, 1H), 3.66 (d, *J* = 5.7 Hz, 1H), 3.19 (d, *J* = 9.6 Hz, 1H), 3.12 (dd, *J* = 8.6, 2.2 Hz, 1H), 3.01-2.87 (m, 2H), 2.46 (dd, *J* = 14.4, 2.1 Hz, 1H), 2.36-2.20 (m, 5H), 2.00-1.74 (m, 6H), 1.83 (s, 3H), 1.77 (s, 3H), 1.60-1.55 (m, 1H), 1.35 (s, 3H), 1.33-1.28 (m, 1H), 1.30 (d, *J* = 6.1 Hz, 3H),

1.18-1.11 (m, 1H), 1.03 (d,  $J = 6.6$  Hz, 3H), 0.88 (d,  $J = 6.5$  Hz, 3H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  212.9, 167.5, 144.9, 141.6, 140.3, 136.4, 128.7, 128.6, 125.7, 115.0, 78.2, 76.6, 75.9, 68.5, 68.2, 60.2, 60.0, 45.8, 45.1, 43.8, 39.4, 39.3, 33.6, 31.0, 30.3, 28.5, 27.0, 21.2, 20.0, 15.8, 15.2, 12.7; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{32}\text{H}_{50}\text{O}_8\text{Na}$  ( $\text{M}+\text{Na}$ ) 585.3403, found 585.3394.



### Allylic alcohol 118

To a stirred solution of macrocycle **109** (50 mg, 0.049 mmol) in  $\text{CH}_2\text{Cl}_2$  (2.3 mL) at  $-30^\circ\text{C}$  was sequentially added (*S*)-CBS (0.196 mL, 0.196 mmol, 1 M in PhMe) and  $\text{BH}_3\cdot\text{DMS}$  (0.3934 mL, 0.393 mmol, 1 M in THF). After 45 min, the reaction was quenched with MeOH (0.3 mL), diluted with aq.  $\text{NaHCO}_3$  (3 mL) and extracted with  $\text{Et}_2\text{O}$  ( $4 \times 6$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 3-6% EtOAc / Hexanes, to give allylic alcohol **118** (29 mg, 0.028 mmol, 58%) and **SI-36** (8 mg, 0.0078 mmol, 16%) as colorless oils. **118**:  $[\alpha]_{\text{D}}^{23} = -23.6^\circ$  ( $c$  0.25,  $\text{CHCl}_3$ ); IR (neat) 3503, 2954, 2911, 2876, 1707, 1458, 1376, 1240, 1128, 1007, 742  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  6.81 (t,  $J = 6.9$  Hz, 1H), 5.76 (s, 1H), 5.70-5.62 (m, 1H), 5.53 (dd,  $J = 13.2, 6.3$  Hz, 1H), 5.00-4.95 (m, 1H), 4.98 (s, 1H), 4.84 (s, 1H), 4.15-4.04 (m, 3H), 3.58 (dd,  $J = 5.7, 2.4$  Hz, 1H), 2.93 (dd,  $J = 18.4, 6.2$  Hz, 1H), 2.78 (dd,  $J = 18.4, 6.0$  Hz, 1H), 2.28-2.22 (m, 2H), 2.18-2.10 (m, 2H), 2.08-1.99 (m, 1H), 1.89-1.57 (m, 9H), 1.84 (s, 3H), 1.81 (s, 3H), 1.48-1.40 (m, 2H), 1.45 (s, 3H), 1.26 (d,  $J = 6.1$  Hz, 3H), 1.07-0.91 (m, 36H), 0.88 (d,  $J = 6.6$  Hz, 3H), 0.74-0.53 (m, 27H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  207.8, 167.8, 145.5, 142.5 (2C), 134.9, 129.7, 127.9, 125.7, 114.9, 80.6, 79.2, 77.9, 71.9, 68.2, 65.3, 49.6, 49.2, 45.6, 42.2, 39.4, 37.0, 31.8, 29.8, 29.0, 28.1, 23.6, 21.0, 19.9, 14.7, 12.7, 12.4, 7.2, 7.1, 7.0, 6.9, 6.8, 5.3, 5.2, 4.7; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{56}\text{H}_{108}\text{O}_8\text{Si}_4\text{Na}$  ( $\text{M}+\text{Na}$ ) 1043.7019, found 1043.7072. **SI-36**:  $[\alpha]_{\text{D}} = -29.1$  ( $c$  0.80,  $\text{CHCl}_3$ ); IR (neat) 3481, 2954, 2876, 1707, 1458, 1241, 1130, 1008, 742  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  6.74 (t,  $J = 7.4$  Hz, 1H), 5.77 (s, 1H), 5.75-5.70 (m, 1H), 5.55 (dd,  $J = 15.5, 7.0$  Hz, 1H), 5.00-4.96 (m, 1H), 4.99 (s, 1H), 4.83 (s, 1H), 4.22-4.15 (m, 1H), 4.11-4.06 (m, 1H), 4.07 (d,  $J = 5.8$  Hz, 1H), 3.57 (dd,  $J = 5.6, 2.3$  Hz, 1H), 2.96 (dd,  $J = 18.4, 7.4$  Hz, 1H), 2.78 (dd,  $J = 18.3, 4.2$  Hz, 1H), 2.23-2.08 (m, 4H), 1.95-1.52 (m, 11H), 1.834 (s, 3H), 1.80 (s, 3H), 1.48-1.40 (m, 1H), 1.43 (s, 3H), 1.25 (d,  $J = 6.1$  Hz, 3H), 1.06-0.87 (m, 39H), 0.73-0.55 (m, 27H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  207.4, 167.9, 145.3, 142.2, 141.7, 134.2, 130.9, 128.3, 125.9, 114.9, 80.9, 79.0, 77.7, 73.2, 68.4, 65.1, 49.2, 48.8, 45.5, 42.1, 39.8, 36.8, 31.7, 30.1, 28.5, 28.3, 24.5, 21.0, 19.4, 15.0, 13.1, 12.4, 7.3, 7.1, 7.0, 6.9, 6.8, 5.2, 5.1, 4.8; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{56}\text{H}_{108}\text{O}_8\text{Si}_4\text{Na}$  ( $\text{M}+\text{Na}$ ) 1043.7019, found 1043.6984.

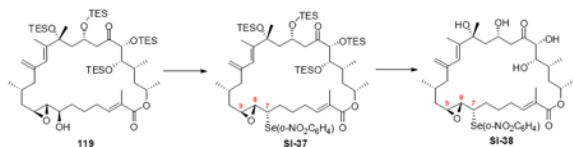


### Epoxide 119 & 120

To a stirred solution of allylic alcohol **118** (29 mg, 0.0284 mmol) in  $\text{CH}_2\text{Cl}_2$  (2.2 mL) at  $-40^\circ\text{C}$  was sequentially added 4Å MS (20 mg), TBHP (15.5  $\mu\text{L}$ , 0.0852 mmol, 5.5 M in



decane) and  $\text{Ti}(\text{O}-i\text{Pr})_4$  (16.1 mg, 16.6  $\mu\text{L}$ , 0.0567 mmol). After 5 h, the reaction was quenched with aq.  $\text{NaHCO}_3$  (3 mL) and extracted with  $\text{Et}_2\text{O}$  ( $4 \times 4$  mL). The dried extract ( $\text{MgSO}_4$ ) was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 6-10%  $\text{EtOAc}$  / Hexanes, to give epoxide **120** (13.6 mg, 0.0131 mmol, 46%) and epoxide **119** (9.1 mg, 0.00867 mmol, 31%) as colorless oils. **120**:  $[\alpha]_D^{23} = -32.3^\circ$  ( $c$  0.73,  $\text{CHCl}_3$ ); IR (neat) 3482, 2954, 2911, 2876, 1706, 1458, 1380, 1239, 1131, 1073, 1009, 742  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  6.83 (t,  $J = 7.0$  Hz, 1H), 5.76 (s, 1H), 5.00-4.92 (m, 1H), 4.98 (s, 1H), 4.83 (s, 1H), 4.20-4.10 (m, 1H), 4.10 (d,  $J = 5.5$  Hz, 1H), 3.58 (dd,  $J = 5.4$ , 1.7 Hz, 1H), 3.60-3.50 (m, 1H), 3.12-3.05 (m, 1H), 2.98-2.92 (m, 2H), 2.90-2.82 (m, 1H), 2.77 (dd,  $J = 5.0$ , 2.0 Hz, 1H), 2.40-2.30 (m, 2H), 2.17 (dd,  $J = 12.7$ , 4.3 Hz, 1H), 2.12-2.00 (m, 1H), 1.91-1.61 (m, 8H), 1.82 (s, 3H), 1.79 (s, 3H), 1.50-1.40 (m, 3H), 1.42 (s, 3H), 1.30-1.20 (m, 1H), 1.26 (d,  $J = 6.0$  Hz, 3H), 1.08-0.87 (m, 39H), 0.75-0.50 (m, 27H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  208.1, 167.8, 144.7, 141.8, 141.7, 128.2, 125.9, 115.0, 80.5, 79.4, 77.9, 70.4, 68.2, 65.1, 60.8, 55.8, 49.8, 48.9, 45.9, 42.9, 39.3, 33.6, 30.2, 29.2, 28.6, 28.5, 24.0, 21.1, 19.5, 15.1, 12.9, 12.4, 7.3, 7.1, 6.9, 5.2, 4.7; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{56}\text{H}_{108}\text{O}_9\text{Si}_4\text{Na}$  ( $\text{M}+\text{Na}$ ) 1059.6968, found 1059.7001. **119**:  $[\alpha]_D^{23} = -25.7$  ( $c$  0.42,  $\text{CHCl}_3$ ); IR (neat) 3482, 2954, 2876, 1708, 1458, 1378, 1240, 1130, 1008, 742  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  6.76 (t,  $J = 6.1$  Hz, 1H), 5.83 (s, 1H), 5.05-4.90 (m, 1H), 5.01 (s, 1H), 4.86 (s, 1H), 4.15-4.10 (m, 1H), 4.08 (d,  $J = 5.8$  Hz, 1H), 3.58 (dd,  $J = 5.5$ , 2.6 Hz, 1H), 3.59-3.49 (m, 1H), 3.11-3.03 (m, 1H), 2.95-2.91 (m, 2H), 2.77 (dd,  $J = 5.5$ , 2.0 Hz, 1H), 2.35-2.20 (m, 3H), 2.02-1.59 (m, 10H), 1.83 (s, 3H), 1.81 (s, 3H), 1.44 (s, 3H), 1.50-1.40 (m, 3H), 1.25 (d,  $J = 6.0$  Hz, 3H), 1.06-0.89 (m, 39H), 0.74-0.52 (m, 27H);  $^{13}\text{C}$  NMR (75 MHz,  $\text{CDCl}_3$ )  $\delta$  207.7, 167.8, 144.8, 142.3, 141.5, 128.4, 125.4, 115.3, 80.8, 78.9, 77.8, 71.5, 68.4, 65.3, 61.8, 55.5, 49.2 (2C), 45.4, 41.7, 38.8, 33.3, 30.4, 29.6, 28.5, 28.3, 23.9, 21.0, 20.0, 15.0, 13.2, 12.5, 7.2, 7.1, 7.0, 6.9, 5.2, 4.8; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{56}\text{H}_{108}\text{O}_9\text{Si}_4\text{Na}$  ( $\text{M}+\text{Na}$ ) 1059.6968, found 1059.6982.



### Selenide SI-37

To a stirred solution of epoxide **119** (8.5 mg, 0.00819 mmol) in THF (0.5 mL) at rt was sequentially added  $o\text{-NO}_2\text{C}_6\text{H}_4\text{SeCN}$  (37 mg, 0.164 mmol) and  $\text{PBU}_3$  (33.2 mg, 41  $\mu\text{L}$ , 0.164 mmol). After 5 h, the reaction mixture was concentrated *in vacuo* purified by chromatography over silica gel, eluting with Hexanes then with 4%  $\text{EtOAc}$  / Hexanes, to give crude selenide **SI-37** (4.5 mg) as a yellow oil which was used directly in next step without further purification.

### Polyol SI-38

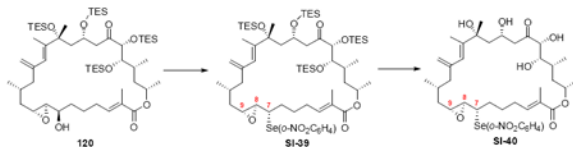
To a stirred solution of selenide **SI-37** (4.5 mg) in THF / DMF /  $\text{H}_2\text{O}$  (10:1:0.02, 0.50 mL / 50  $\mu\text{L}$  / 1  $\mu\text{L}$ ) at  $0^\circ\text{C}$  was added TAS-F (5 mg, 0.0180 mmol). The reaction mixture was then warmed up to rt. After 2 h, the reaction mixture was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 10-65%  $\text{EtOAc}$  / Hexanes, to give polyol **SI-38** (2.0 mg, 0.00261 mmol, 32% over 2 steps) as a yellow oil:  $[\alpha]_D^{23} = -41.7^\circ$  ( $c$  0.12,  $\text{CHCl}_3$ ); IR (neat) 3446, 2924, 2854, 1701, 1519, 1457, 1378, 1334, 1121, 759, 732  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.17 (d,  $J = 8.0$  Hz, 1H), 7.70 (d,  $J = 8.0$  Hz, 1H), 7.55 (t,  $J = 7.4$  Hz, 1H), 7.42 (t,  $J = 7.5$  Hz, 1H), 6.88 (t,  $J = 6.3$  Hz, 1H), 5.87 (s, 1H), 5.15-5.08 (m, 1H), 5.03 (s, 1H), 4.82 (s, 1H), 4.50 (s, 1H), 4.20-4.10 (m, 2H), 3.78-3.69 (m, 1H), 3.20-3.10 (m, 1H), 2.94-2.77 (m, 3H), 2.39-2.33 (m, 1H), 2.30-2.13 (m, 2H), 2.07-1.50 (m,

11H), 1.84 (s, 6H), 1.41 (s, 3H), 1.40-1.28 (m, 5H), 1.07 (d,  $J = 6.5$  Hz, 3H), 0.77 (t,  $J = 6.3$  Hz, 3H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  211.4, 167.7, 149.7, 144.0, 143.0, 141.1, 133.1, 132.6, 128.8, 128.4, 127.1, 125.9, 123.9, 115.2, 77.6, 76.0, 75.3, 68.3, 66.0, 62.1, 59.0, 46.8, 46.1, 45.3, 44.7, 40.3, 40.2, 32.7, 31.9, 29.2, 28.9, 28.0, 26.3, 21.2, 17.8, 15.9, 15.4, 12.5; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{38}\text{H}_{55}\text{NO}_{10}\text{NaSe}(\text{M}+\text{Na})$  788.2889, found 788.2891.



### Amphidinolide B<sub>1</sub> (2)

To a stirred solution of selenide **SI-38** (2.0 mg, 0.00261 mmol) in  $\text{CH}_2\text{Cl}_2$  (0.4 mL) at rt was sequentially added  $\text{NaHCO}_3$  (20 mg, 0.238 mmol) and TMSO-OTMS (16.6 mg, 20  $\mu\text{L}$ , 0.0929 mmol). After 1.5 h, the yellow color vanished and the reaction mixture was purified by preparative TLC, eluting with 60% EtOAc / Hexanes, to give amphidinolide B<sub>1</sub> (**2**) (1.0 mg, 0.00178 mmol, 68%):  $[\alpha]_{\text{D}}^{23} = -63.7^\circ$  ( $c$  0.08,  $\text{CHCl}_3$ ), Literature Value:<sup>2c</sup>  $-62.5^\circ$  ( $c$  0.39,  $\text{CHCl}_3$ );  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  6.78 (t,  $J = 7.8$  Hz, 1H), 5.99 (s, 1H), 5.93 (ddd,  $J = 15.2, 8.5, 4.8$  Hz, 1H), 5.18 (dd,  $J = 15.8, 8.6$  Hz, 1H), 5.06 (m, 1H), 5.05 (s, 1H), 4.84 (s, 1H), 4.34 (dd,  $J = 4.8, 1.4$  Hz, 1H), 4.20 (m, 1H), 3.92 (d,  $J = 3.3$  Hz, 1H), 3.88 (d,  $J = 5.0$  Hz, 1H), 3.73 (ddd,  $J = 10.3, 8.8, 1.5$  Hz, 1H), 3.19 (d,  $J = 10.0$  Hz, 1H), 3.16 (dd,  $J = 8.3, 2.0$  Hz, 1H), 2.94 (ddd,  $J = 8.9, 2.6, 2.2$  Hz, 1H), 2.86 (d,  $J = 7.3$  Hz, 1H), 2.80 (dd,  $J = 15.9, 3.2$  Hz, 1H), 2.43 (m, 1H), 2.38 (m, 1H), 2.25 (m, 1H), 2.20 (m, 1H), 2.17 (m, 1H), 2.16 (s, 1H), 1.98-1.91 (m, 4H), 1.80 (s, 6H), 1.76 (dd,  $J = 14.5, 5.2$  Hz, 1H), 1.64 (m, 1H), 1.49 (ddd,  $J = 13.6, 10.9, 3.0$  Hz, 1H), 1.44 (s, 3H), 1.31 (m, 1H), 1.30 (d,  $J = 6.1$  Hz, 3H), 1.26 (m, 1H), 1.03 (d,  $J = 6.6$  Hz, 3H), 0.90 (d,  $J = 6.4$  Hz, 3H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  212.5, 167.8, 144.5, 143.2, 140.0, 135.5, 128.6, 128.5, 124.4, 114.9, 77.9, 76.1, 75.7, 68.4, 66.7, 60.2, 47.0, 46.0, 45.4, 39.5, 39.4, 33.3, 31.0, 29.4, 28.4, 26.9, 21.1, 18.3, 15.7, 15.2, 12.5; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{32}\text{H}_{50}\text{O}_8\text{Na}$  (M+Na) 585.3403, found 585.3411.



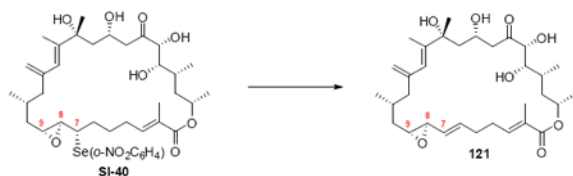
### Selenide SI-39

To a stirred solution of epoxide **120** (14.5 mg, 0.0139 mmol) in THF (0.8 mL) at rt was sequentially added  $o\text{-NO}_2\text{C}_6\text{H}_4\text{SeCN}$  (63 mg, 0.279 mmol) and  $\text{PBU}_3$  (56.7 mg, 70  $\mu\text{L}$ , 0.279 mmol). After 1 h, the reaction mixture was concentrated *in vacuo* purified by chromatography over silica gel, eluting with Hexanes then with 4% EtOAc / Hexanes, to give crude selenide **SI-39** (15.2 mg) as a yellow oil which was used directly in next step without further purification.

### Polyol SI-40

To a stirred solution of selenide **SI-39** (15.2 mg, 0.0122 mmol) in THF / DMF /  $\text{H}_2\text{O}$  (10:1:0.02, 1.6 mL / 0.16 mL / 3.2  $\mu\text{L}$ ) at  $0^\circ\text{C}$  was added TAS-F (16.8 mg, 0.0610 mmol). The reaction mixture was then warmed up to rt. After 2 h, the reaction mixture was concentrated *in vacuo* and purified by chromatography over silica gel, eluting with 10-65% EtOAc / Hexanes, to give polyol **SI-40** (9.1 mg, 0.0119 mmol, 86% over 2 steps) as yellow oils:  $[\alpha]_{\text{D}}^{23} = -51.8^\circ$  ( $c$  0.44,  $\text{CHCl}_3$ ); IR (neat) 3447, 2926, 2855, 1701, 1514, 1456, 1332,

1271, 1037, 902, 756, 731  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.26 (d,  $J = 8.3$  Hz, 1H), 7.73 (d,  $J = 8.0$  Hz, 1H), 7.55 (t,  $J = 7.3$  Hz, 1H), 7.36 (t,  $J = 7.9$  Hz, 1H), 6.81 (t,  $J = 7.0$  Hz, 1H), 5.97 (s, 1H), 5.10-5.03 (m, 1H), 5.03 (s, 1H), 4.83 (s, 1H), 4.47 (s, OH), 4.40-4.32 (m, 1H), 4.14 (dd,  $J = 14.2, 7.2$  Hz, 1H), 3.88-3.78 (m, 1H), 3.42-3.35 (m, 1H), 3.05-2.97 (m, 1H & OH), 2.85 (d,  $J = 4.8$  Hz, 2H), 2.50-2.38 (br, 1H), 2.30-2.20 (m, 2H), 2.07 (s, OH), 2.11-2.02 (m, 1H), 1.96-1.65 (m, 11H), 1.83 (s, 6H), 1.44 (s, 3H), 1.40-1.32 (m, 2H), 1.33 (d,  $J = 5.8$  Hz, 3H), 1.08 (d,  $J = 6.3$  Hz, 3H), 0.90 (d,  $J = 4.4$  Hz, 3H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  211.6, 167.9, 147.6, 144.0, 143.5, 141.2, 133.6, 132.3, 130.6, 128.7, 126.4, 126.0, 124.0, 115.5, 78.0, 76.1, 75.0, 69.5, 66.3, 60.7, 58.7, 46.1, 45.8, 44.8, 43.8, 40.5, 39.5, 33.5, 30.4 (2C), 28.2, 27.7, 27.1, 20.8, 19.6, 16.5, 15.2, 12.5; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{38}\text{H}_{55}\text{NO}_{10}\text{NaSe}$  ( $\text{M}+\text{Na}$ ) 788.2889, found 788.2934.



### Allylic epoxide **121**

To a stirred solution of selenide **SI-40** (2.7 mg, 0.00353 mmol) in  $\text{CH}_2\text{Cl}_2$  (0.5 mL) at rt was sequentially added  $\text{NaHCO}_3$  (30 mg, 0.357 mmol) and TMSO-OTMS (22.5 mg, 27  $\mu\text{L}$ , 0.126 mmol). After 1.5 h, the yellow color vanished and the reaction mixture was purified by preparative TLC, eluting with 60% EtOAc / Hexanes, to give allylic epoxide **121** (1.3 mg, 0.00231 mmol, 65%):  $[\alpha]_{\text{D}}^{23} = +10.0^\circ$  ( $c$  0.13,  $\text{CHCl}_3$ ); IR (neat) 3422, 2923, 2853, 1701, 1457, 1377, 1261, 1103;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  6.72 (t,  $J = 4.9$  Hz, 1H), 6.04 (s, 1H), 5.88-5.80 (m, 1H), 5.28 (dd,  $J = 15.4, 8.4$  Hz, 1H), 5.10-5.05 (m, 1H), 5.06 (s, 1H), 4.84 (s, 1H), 4.35 (dd,  $J = 4.2, 1.5$  Hz, 1H), 4.30-4.20 (m, 1H), 4.13 (s, 1H), 3.79 (t,  $J = 9.8$  Hz, 1H), 3.77 (d,  $J = 4.6$  Hz, 1H), 3.40 (d,  $J = 10.2$  Hz, 1H), 3.09 (dd,  $J = 8.5, 2.1$  Hz, 1H), 2.98-2.93 (m, 2H), 2.76 (dd,  $J = 15.4, 2.4$  Hz, 1H), 2.38-2.23 (m, 5H), 2.35 (s, 1H), 1.98 (m, 1H), 1.95 (m, 1H), 1.88 (m, 1H), 1.85 (m, 1H), 1.84 (s, 6H), 1.78 (dd,  $J = 14.6, 4.7$  Hz, 1H), 1.70 (m, 1H), 1.64 (m, 1H), 1.32 (m, 1H), 1.30 (d,  $J = 6.1$  Hz, 3H), 1.13 (m, 1H), 1.03 (d,  $J = 6.6$  Hz, 3H), 0.83 (d,  $J = 6.4$  Hz, 3H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  212.6, 167.5, 144.6, 143.2, 140.8, 135.9, 128.9, 128.7, 124.3, 114.9, 78.3, 76.1, 75.5, 68.3, 66.8, 60.3, 59.2, 46.5, 46.1, 45.6, 39.6, 33.3, 31.2, 30.5, 29.7, 28.6, 27.1, 21.0, 19.9, 15.7, 15.4, 12.7; HRMS ( $\text{ES}^+$ ) calcd. for  $\text{C}_{32}\text{H}_{50}\text{O}_8\text{Na}$  ( $\text{M}+\text{Na}$ ) 585.3403, found 585.3409.

### Cell viability assays

MTS assays were conducted for cell viability as described by the supplier (Promega).<sup>58</sup> Human DU145 prostate cancer, OCI-LY3 lymphoma, K562 CML, MOLT-4 ALL, Reh ALL, U266 myeloma, KG1a AML, HL60 AML and MDA-MB-435 breast cancer cells were seeded in 96-well plates, incubated overnight at  $37^\circ\text{C}$  in 5% (v/v)  $\text{CO}_2$  and exposed to **3**, **114** or **121** at 0.1 mM or in a dose-dependent manner for 72 h. DMSO was used as the vehicle control. Cell viability was determined by tetrazolium conversion to its formazan dye and absorbance was measured at 490 nm using an automated ELISA plate reader.

### Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

## Acknowledgments

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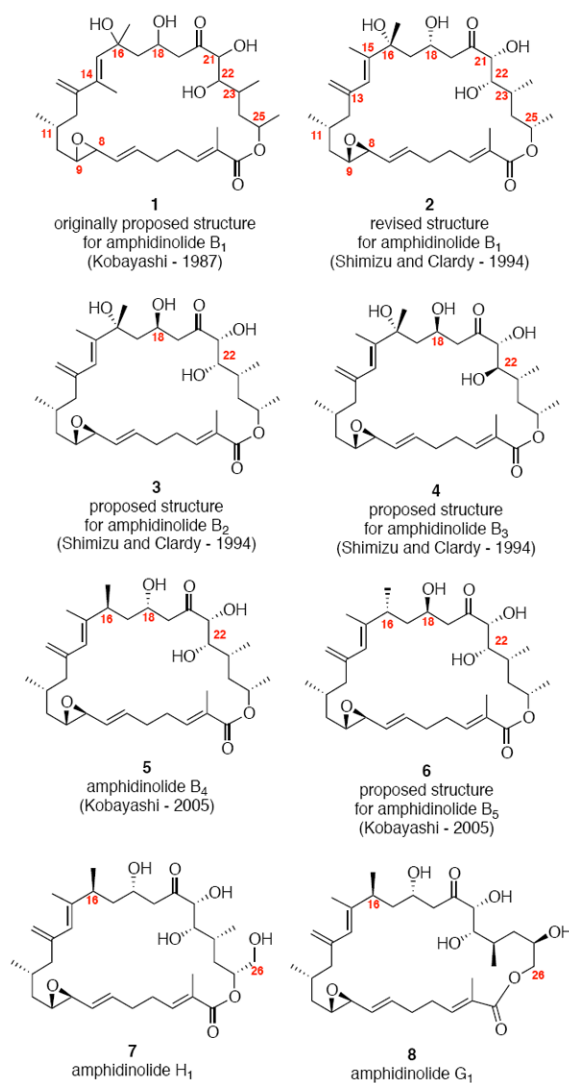


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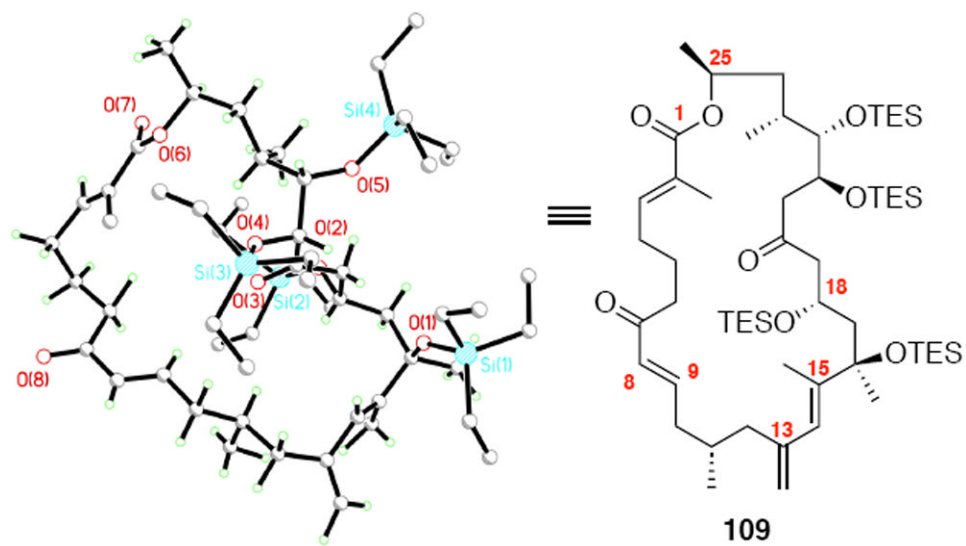


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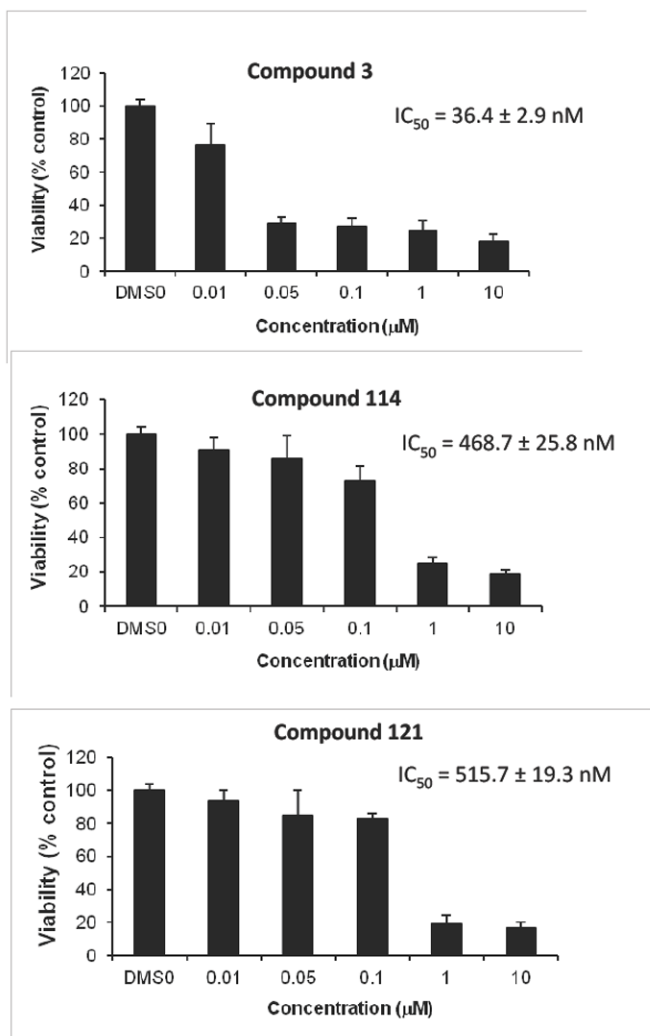
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52. The iodide was prepared from commercially available 2-(chloromethyl)allyl-trimethylsilane [NaI (2.5 equiv), acetone (0.5 M), 16 h, flask covered in aluminum foil, r.t., 99%].  $^1\text{H NMR}$  (300 MHz,  $\text{CDCl}_3$ )  $\delta$  5.16 (s, 1H), 4.70 (s, 1H), 3.88 (s, 2H), 1.72 (s, 2H), 0.04 (s, 9H).
53. AD Mix  $\beta^*$  = (DHQD) $_2$ PHAL (15.2 mg),  $\text{K}_2\text{OsO}_4 \cdot 2\text{H}_2\text{O}$  (2.55 mg),  $\text{K}_2\text{CO}_3$  (293.6 mg),  $\text{K}_3\text{Fe}(\text{CN})_6$  (699.6 mg). Commercially available AD mix  $\beta$  proved to be slow and inefficient.
54. Preparation of LDA Solution: To a solution of diisopropylamine (101.9 mg, 0.14 mL, 1.0 mmol) in THF (0.46 mL) at  $-78^\circ\text{C}$  was added *n*-BuLi (0.4 mL, 1.0 mmol, 2.5 M in THF). After 5 min, the white slurry was warmed to  $-10^\circ\text{C}$  and stirred for an additional 15 min.
55. Titration of Grignard reagent: To a stirred solution of menthol (15.6 mg, 0.1 mmol) and 1,10-phenanthroline (2 mg) in THF (0.5 mL) was added prepared Grignard reagent solution until a burgundy color persists. The concentration was calculated using the formula:  $[\text{RMgX}] = 0.1 \text{ mmol} / \text{volume of added RMgX in mL}$ . *For the references, see:* Lin H-S, Paquette LA. *Synth Comm.* 1994; 24:2503. Watson SC, Eastham JF. *J Organomet Chem.* 1967; 9:165.
56. Vanderwalle M, Van der Eycken J, Oppolzer W, Vullioud C. *Tetrahedron.* 1986; 42:4035.
57. Aitken RA, Atherton JI. *J Chem Soc Perkin Trans.* 1994; 1:1281.
58. Nam S, Williams A, Vultur A, List A, Bhalla K, Smith D, Lee FY, Jove R. *Mol Cancer Ther.* 2007; 6:1400–1405. [PubMed: 17431118]



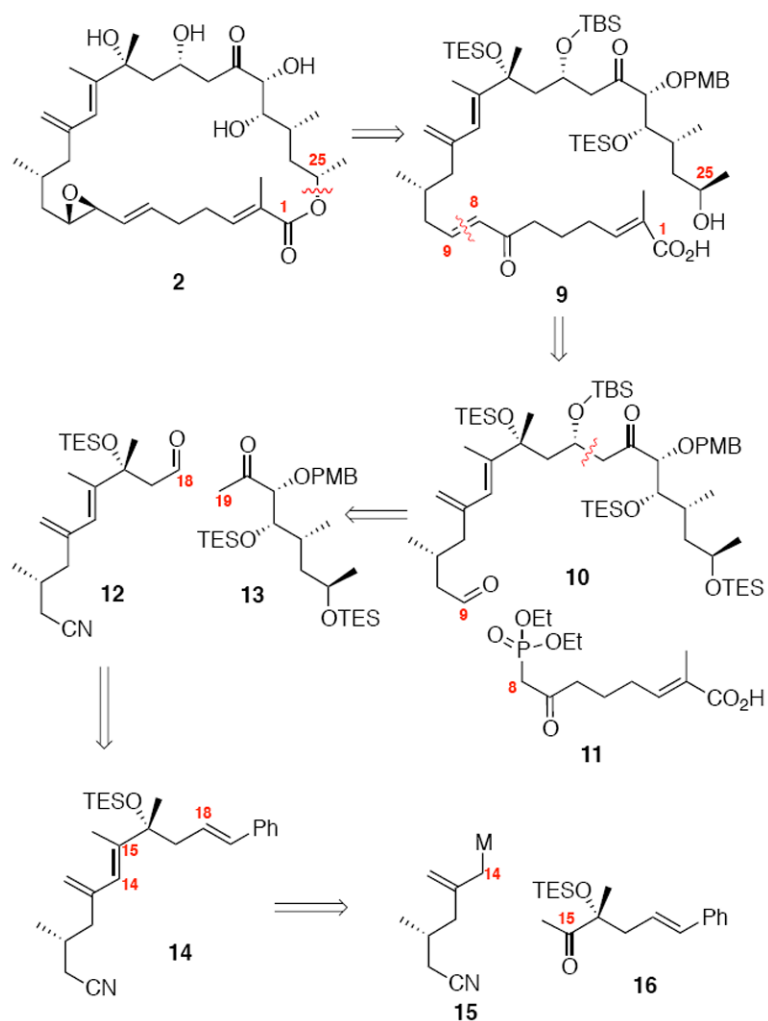
**Figure 1.**  
Amphidinolides B, G and H.



**Figure 2.**  
ORTEP Representation of Macrocycle **109**.

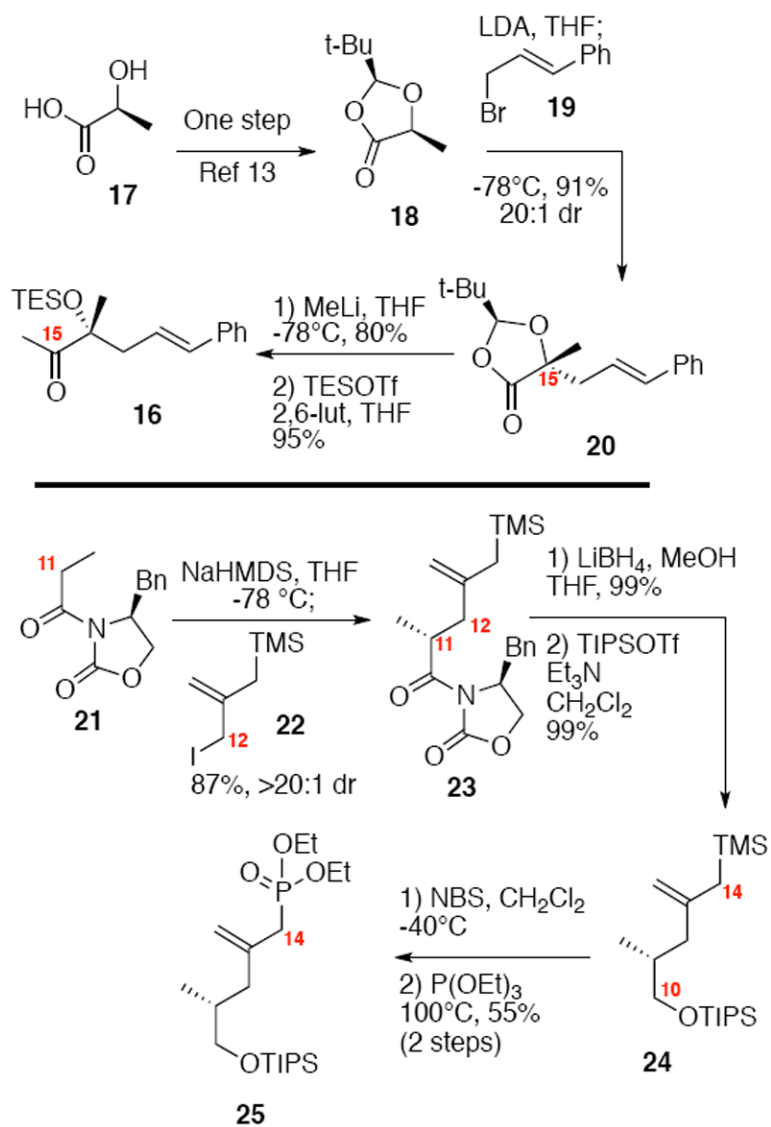


**Figure 3.**  
Comparison of Synthetic Analogues for Biological Activity.

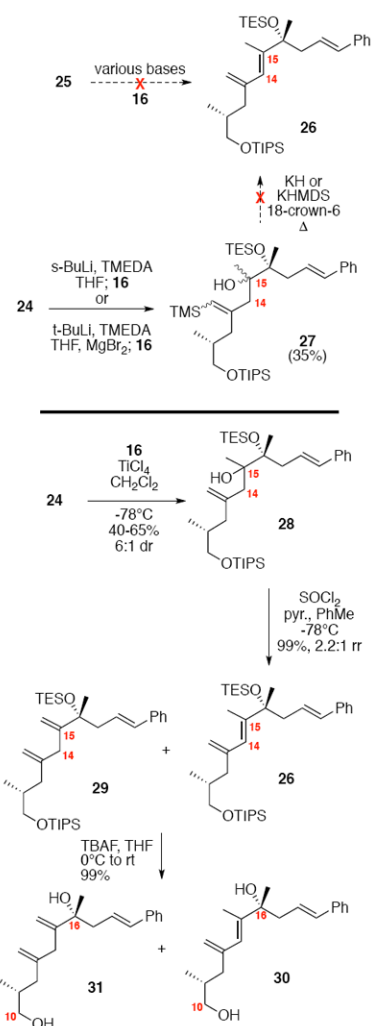


**Scheme 1.**  
Initial Retrosynthetic Analysis of Amphidinolide B<sub>1</sub>.

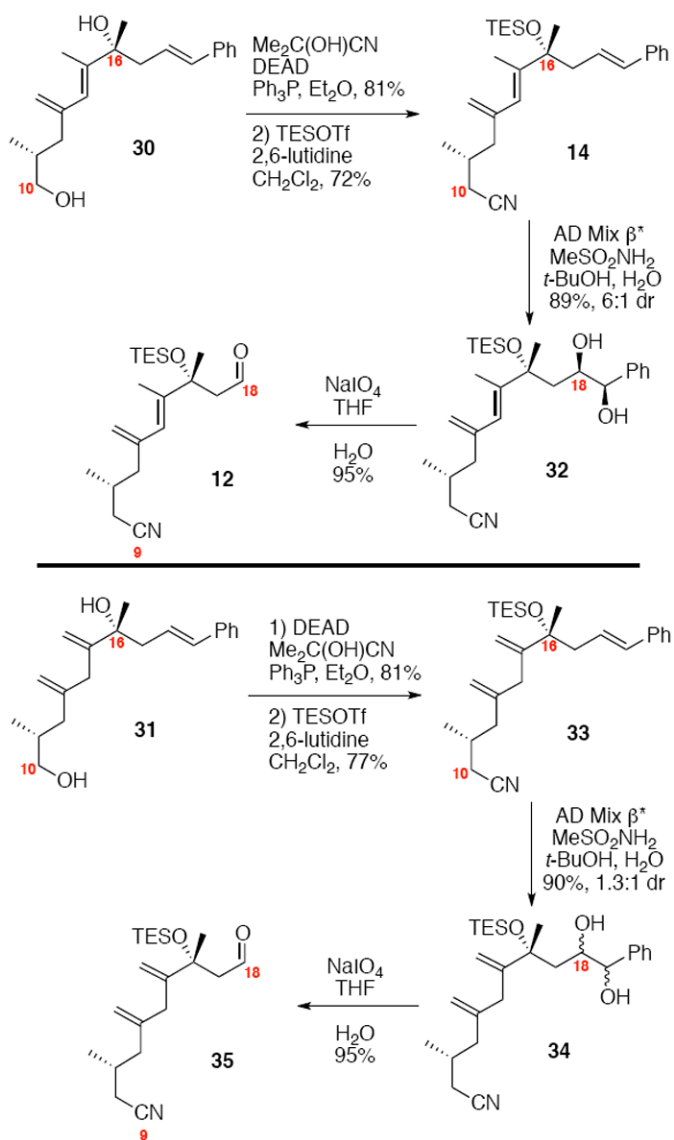




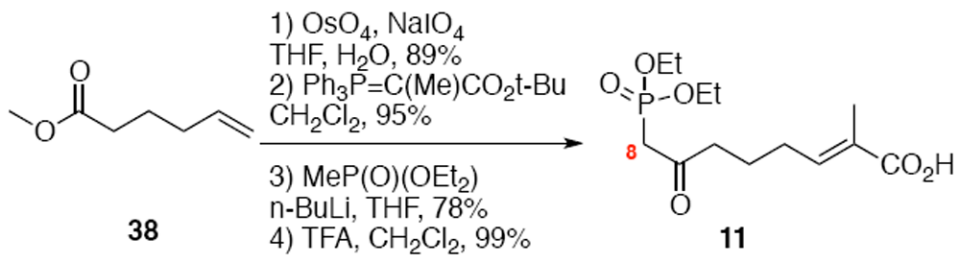
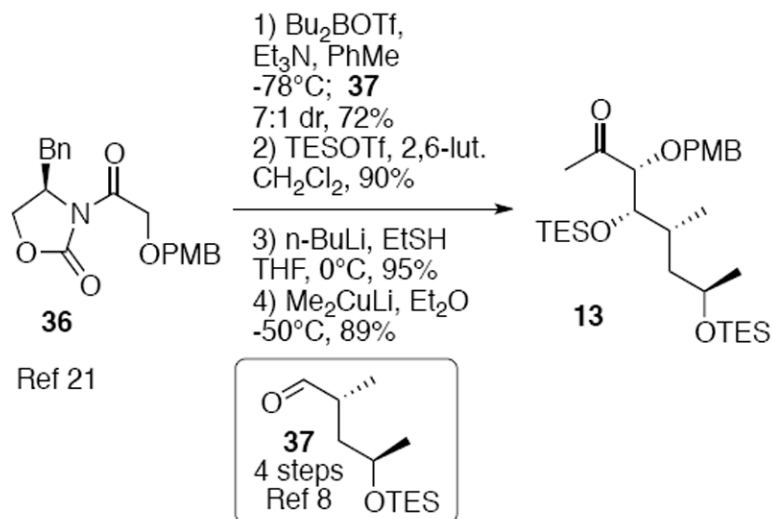
**Scheme 2.**  
Synthesis of Diene Precursors.



**Scheme 3.**  
Synthesis of Diene.

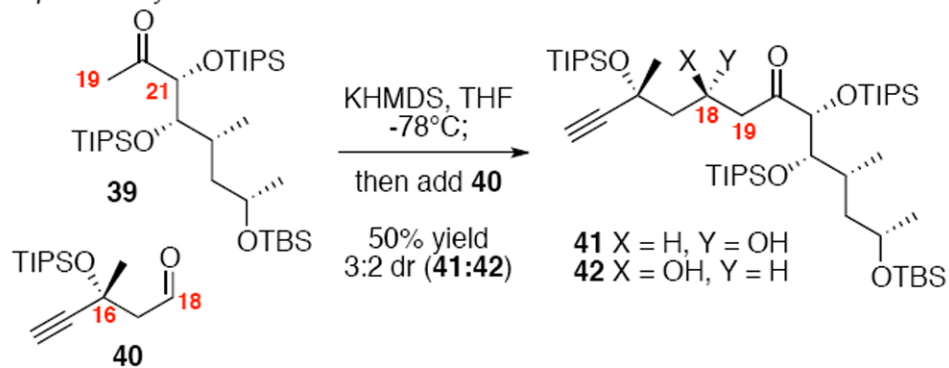


**Scheme 4.**  
 Synthesis of Western Subunit.

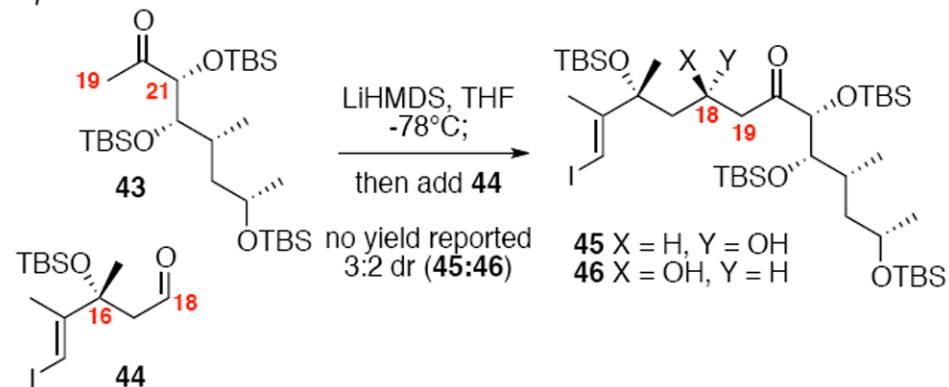


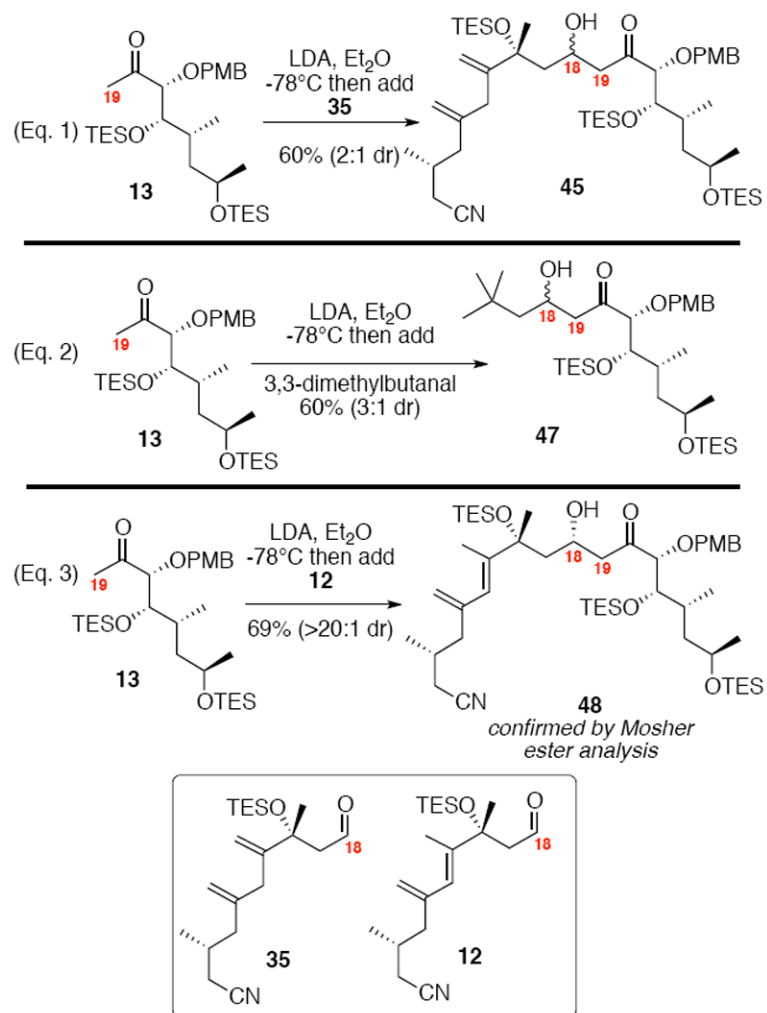
**Scheme 5.**  
 Synthesis of Eastern and Southern Subunits.

## Eq. 1. Kobayashi's Work



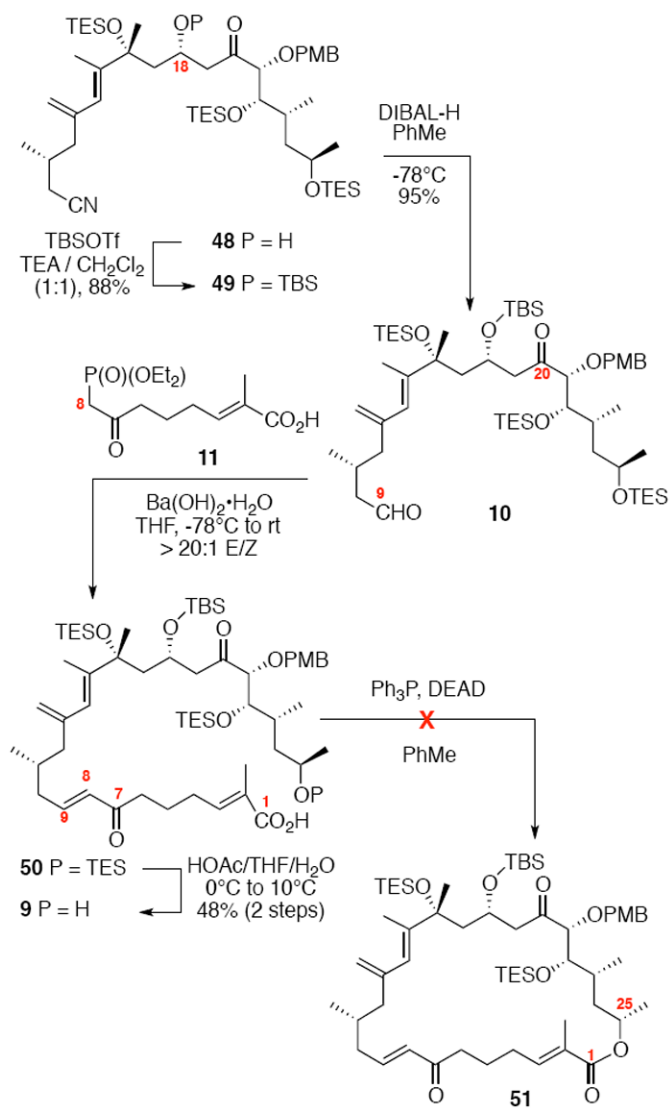
## Eq. 2. Pattenden's Work

**Scheme 6.**Precedent for C<sub>18</sub>-C<sub>19</sub> Aldol Reaction.

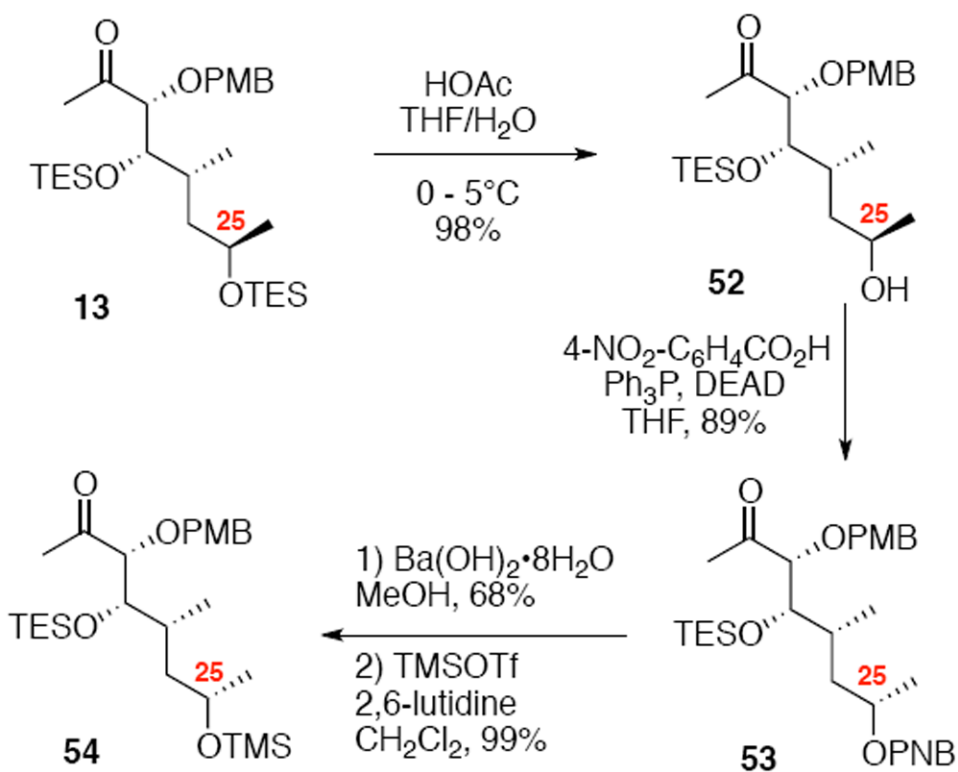


**Scheme 7.**  
Methyl Ketone Aldol Reaction.

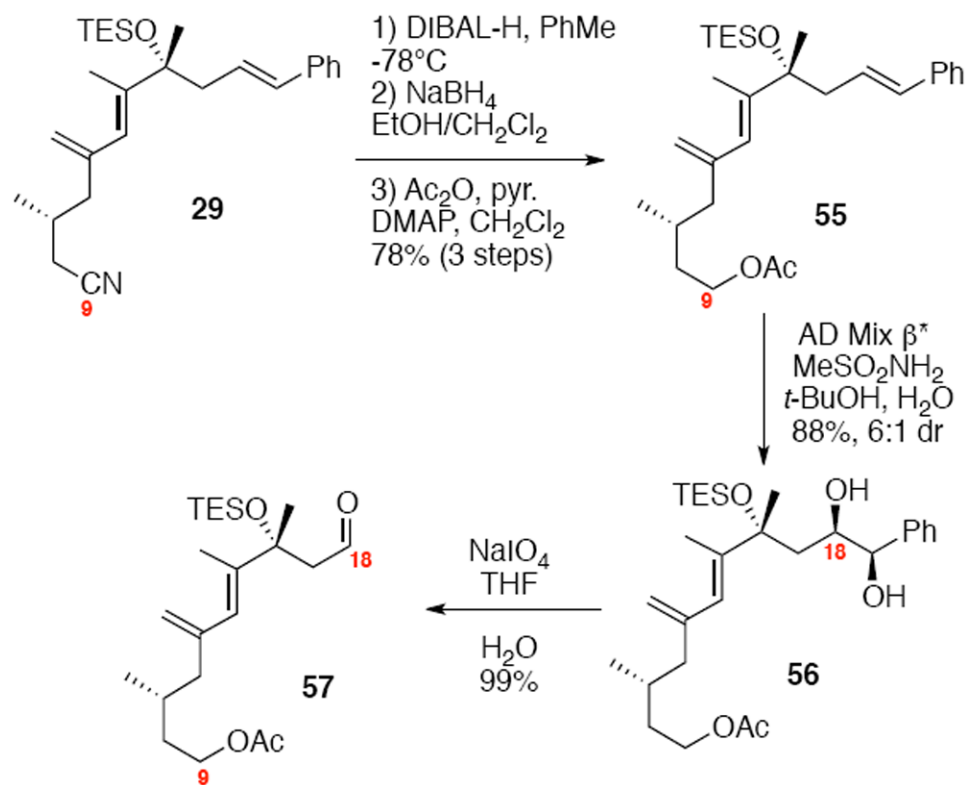




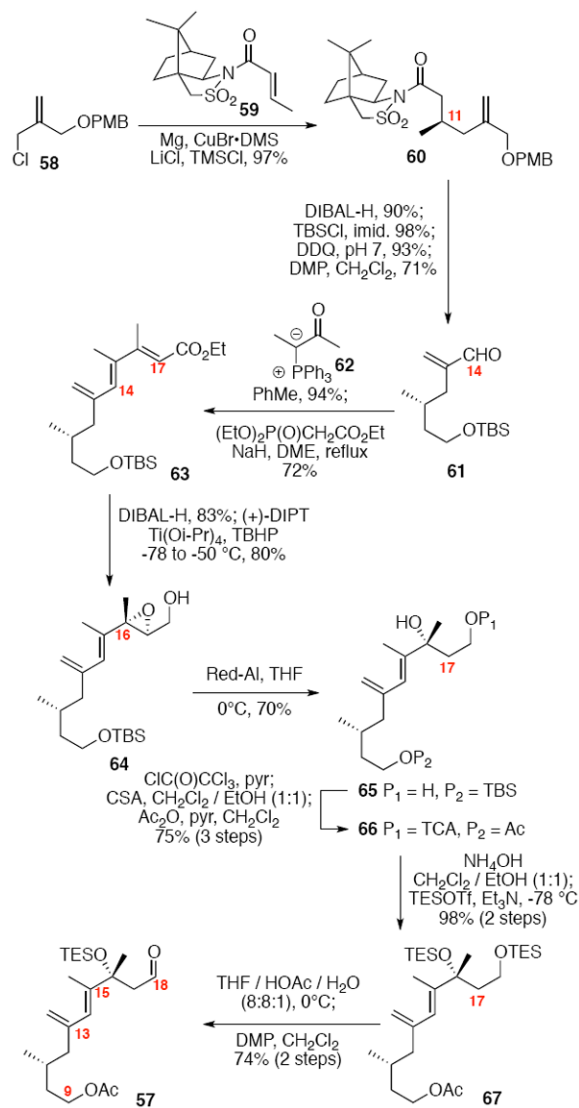
**Scheme 8.**  
Unsuccessful Macrocyclization Strategy.



**Scheme 9.**  
Second Generation Synthesis of Eastern Subunit.

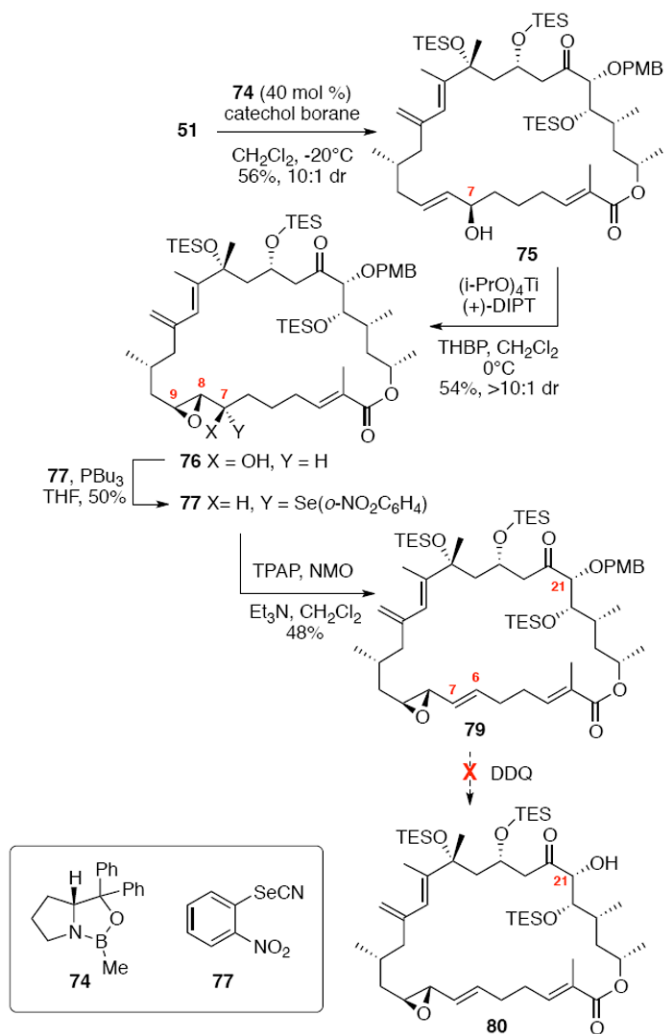


**Scheme 10.**  
Modification of the Western Subunit.



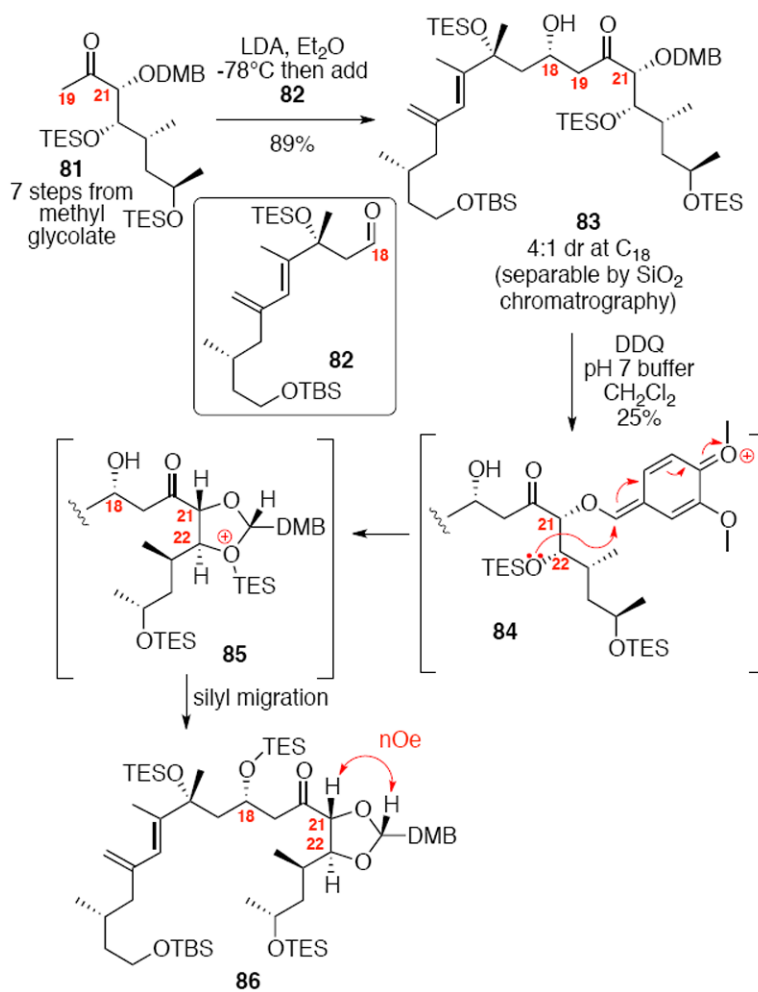
**Scheme 11.**  
 Second Generation Approach to the C<sub>9</sub>-C<sub>18</sub> Western Fragment of Amphidinolide B<sub>1</sub>.



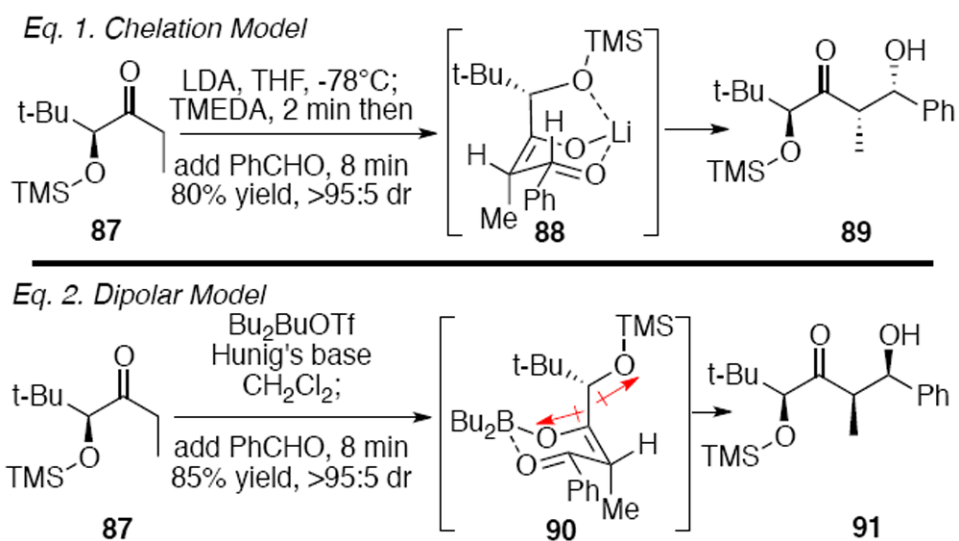


**Scheme 13.**  
Incorporation of the Allylic Epoxide Moiety.

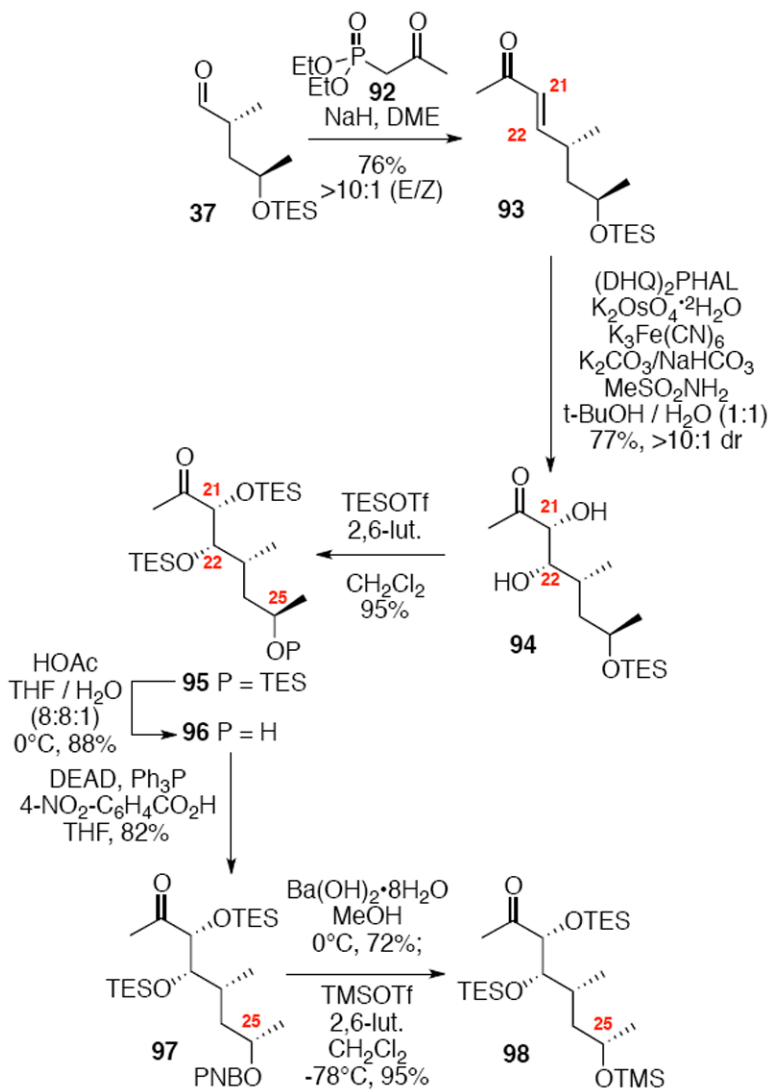




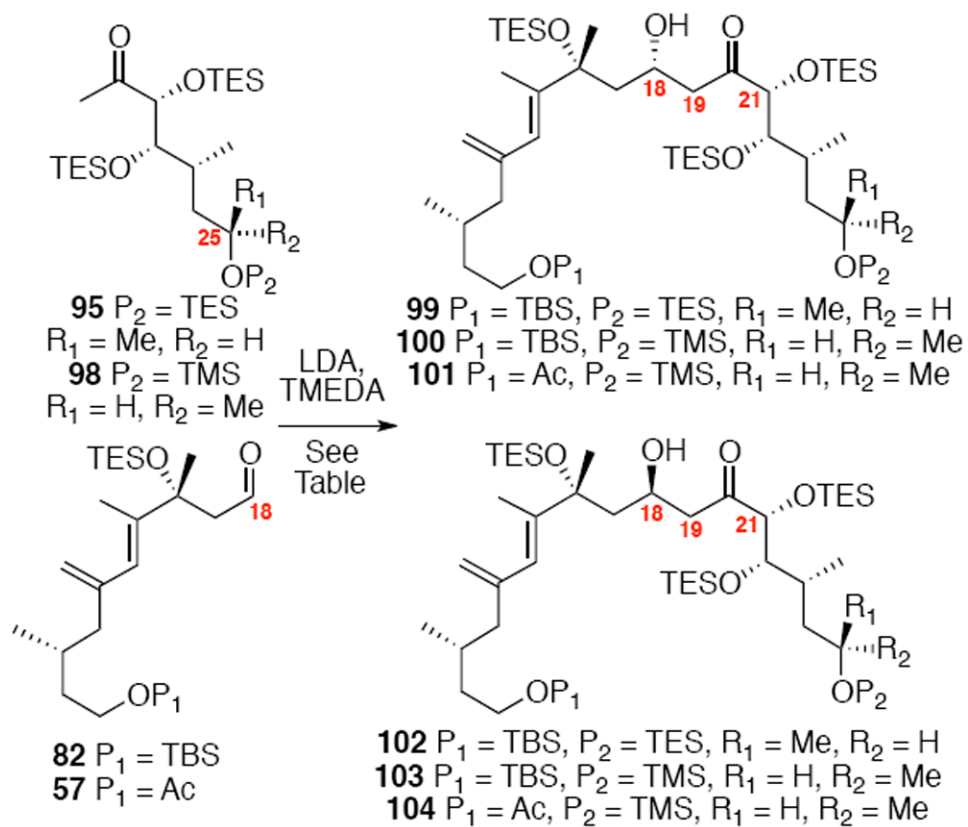
**Scheme 14.**  
C<sub>21</sub> Dimethoxybenzyl Protection Series.



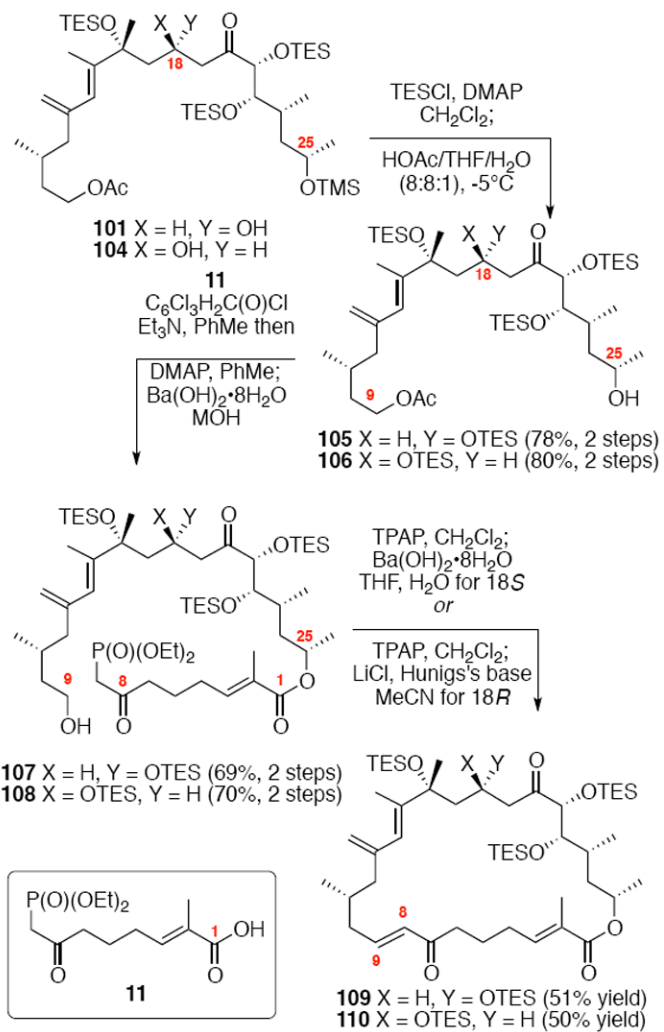
**Scheme 15.**  
Heathcock's Pioneering Stereoselective Aldol Work.



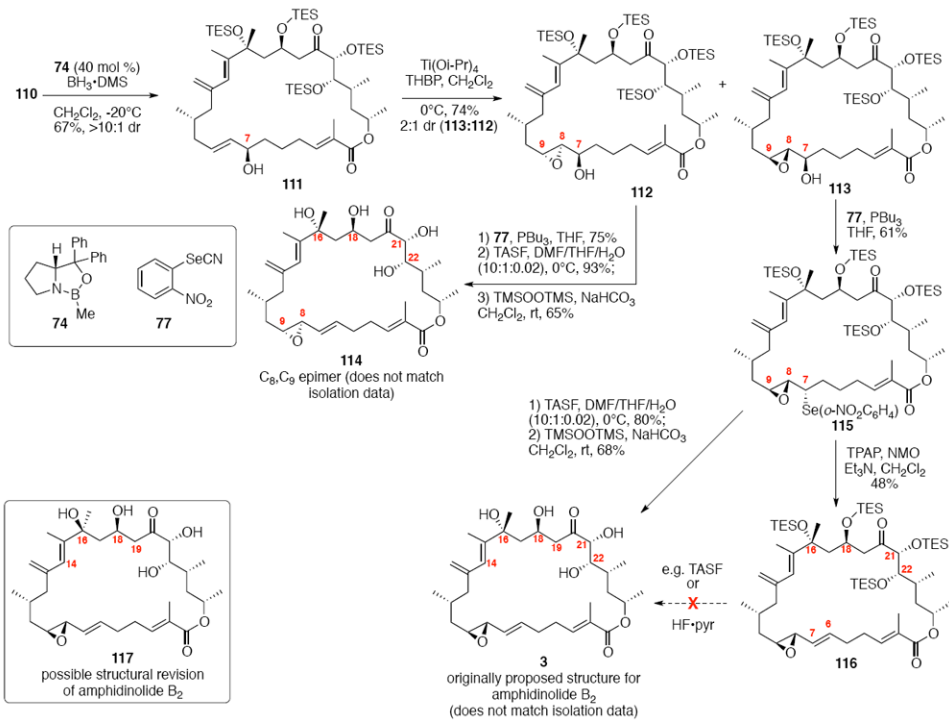
**Scheme 16.**  
Tris-silyl Methyl Ketone Synthesis.



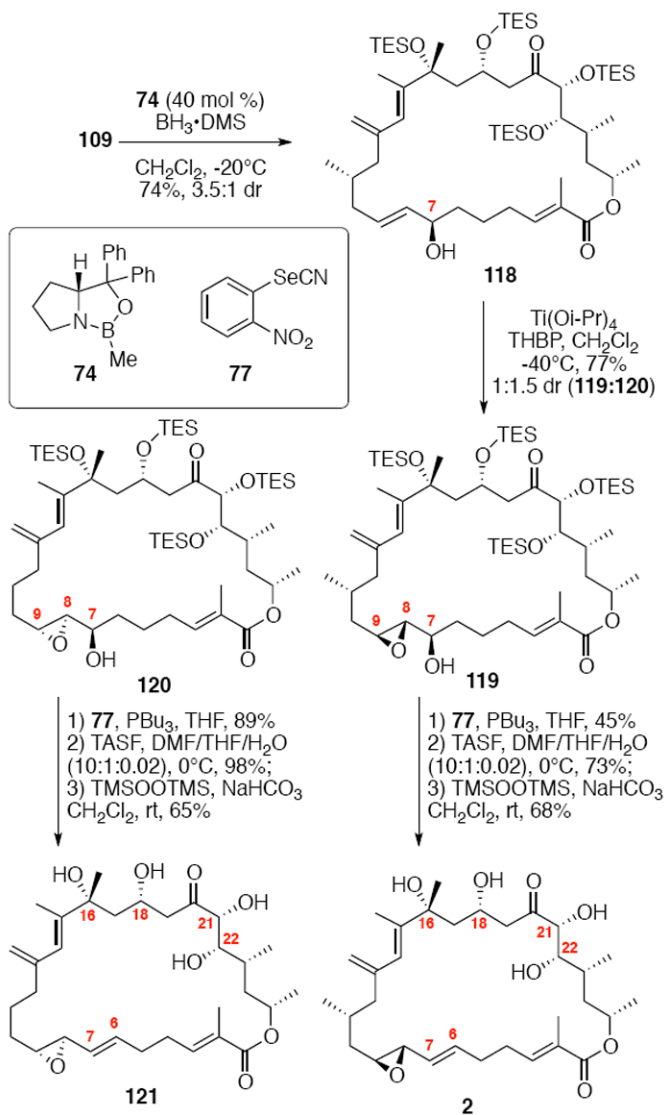
**Scheme 17.**  
Exploration into Aldol Stereoselectivity.



**Scheme 18.**  
Second Generation Macrocycle Formation.



**Scheme 19.**  
Synthesis of Proposed Structure for Amphidinolide B<sub>2</sub>.



**Scheme 20.**  
 Synthesis of Amphidinolide B<sub>1</sub> and 8,9-*epi*-Amphidinolide B<sub>1</sub>.



**Table 1**

Exploration into Aldol Stereoselectivity.

entry	substrates	conditions	Yield [dr]
1	95, 82	THF, -78°C	64% [1.1:1 ( <b>99:102</b> )]
2	95, 82	Et <sub>2</sub> O, -78°C	<10% [1.5:1 ( <b>99:102</b> )]
3	98, 82	THF, -78°C	67% [1:5 ( <b>100:103</b> )]
4	98, 82	THF, -40°C	68% [1.8:1 ( <b>100:103</b> )]
5	98, 57	THF, -100°C	65% [1:8 ( <b>101:104</b> )]
6	98, 57	THF, -40°C	66% [1.2:1 ( <b>101:104</b> )]

**Table 2**

Effects of Proposed structure for Compound **3** on Viabilities of Human Cancer Cells (% control).

DUI145	MDA-MB-435	OCI-LY3	K562	MOLT-4	Reh	U266	KG1a	HL60
31 ± 5	54 ± 10	0	67 ± 6	47 ± 4	82 ± 5	76 ± 5	10 ± 2	0

Cell viability assays were carried out as described in Methods. Human DU145 prostate cancer, MDA-MB-435 breast cancer, OCI-LY3 lymphoma, K562 CML, MOLT-4 ALL, Reh ALL, U266 myeloma, KG1a AML and HL60 AML cells were seeded in 96-well plates (5000/well for DUI145 and MDA-MB-435, 10000/well for OCI-LY3, K562, MOLT-4, Reh, U266, KG1a and HL60), incubated overnight at 37°C in 5% (v/v) CO<sub>2</sub> and exposed to 0.1 μM of compound **3** for 72 h. Absorbance was measured at 490 nm using an automated ELISA plate reader. Each experiment was performed in quadruplicate. Data are mean ± SD.

**Table 3**Determination of IC<sub>50</sub> Values of Compound **3** against Human Cancer Cells (nM).

<b>DU145</b>	<b>HL60</b>	<b>KG1a</b>	<b>MDA-MD-435</b>
36.4 ± 2.9	7.4 ± 0.6	3.3 ± 0.9	94.5 ± 8.0

Cell viability was performed using MTS assays as described in Methods. IC<sub>50</sub> values of compound **3** were determined in human DU145 prostate cancer, MDA-MB-435 breast cancer, KG1a AML and HL60 AML cells. Cells were seeded in 96- well plates (5000/well for DU145 and MDA-MB-435, 10000/well for KG1a and HL60), incubated overnight at 37°C in 5% (v/v) CO<sub>2</sub> and exposed to compound **3** in a dose-dependent manner for 72 h. Absorbance was measured at 490 nm using an automated ELISA plate reader. Each experiment was performed in quadruplicate. Data are mean ± SD.