Natural Product Reports

Electronic supplementary information for

Natural withanolides, an update

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Contents

Note: For structures that have their absolute configurations confirmed by single crystal X-ray analysis, the compounds were drawn with red lines. And cases of erroneous structures and their revisions were drawn with magenta lines.

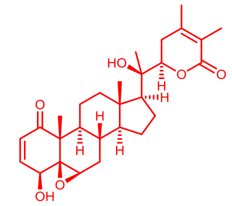
2. Phytochemical investigations

2.2 Withanolides with a δ-lactone or δ-lactol side chain (Type A)

2.2.1 Withanolides with an unmodified skeleton (I)

2.2.1.1 5*β*,6*β*-Epoxides.

2.2.1.1.1 5β,6β-Epoxides with a 17β-side chain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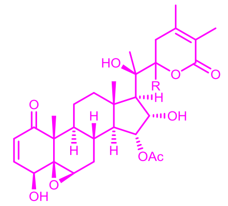
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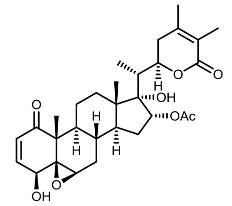
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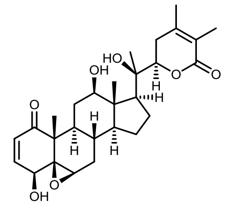
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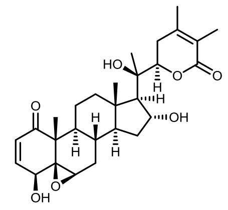
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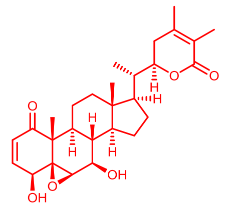
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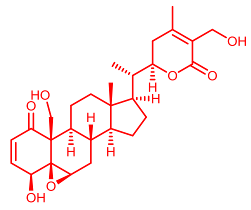
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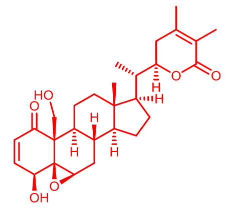
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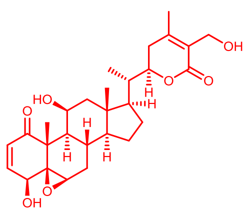
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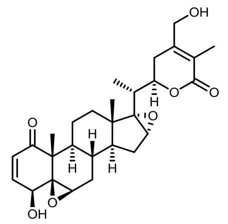
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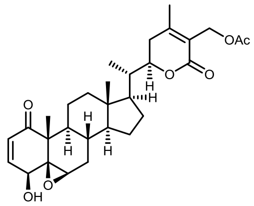
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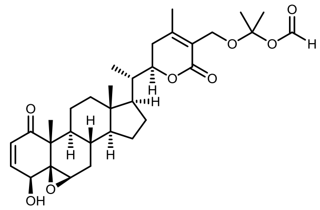
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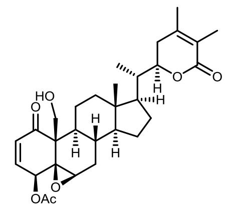
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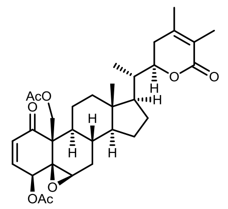
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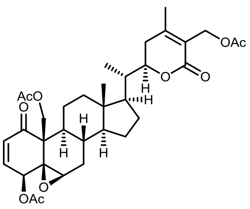
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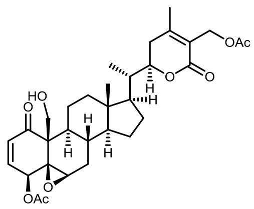
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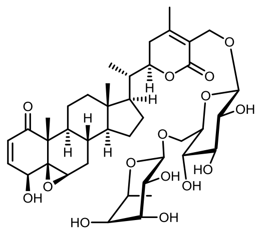
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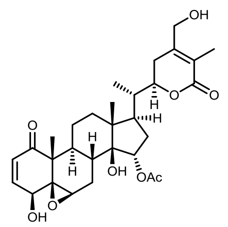
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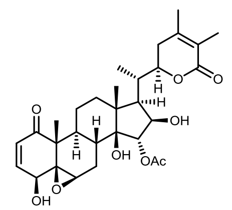
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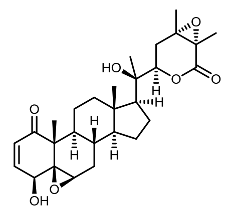
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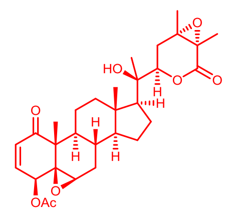
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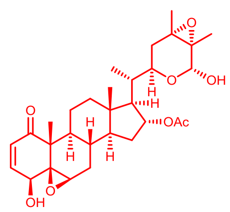
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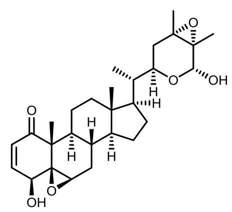
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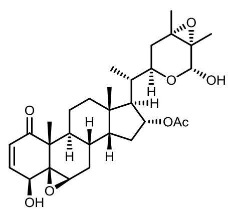
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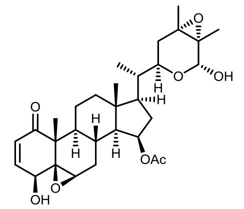
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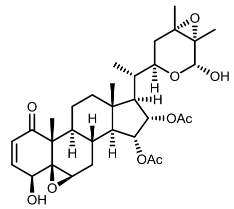
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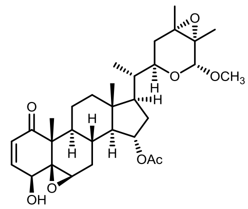
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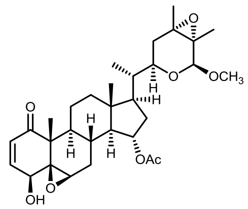
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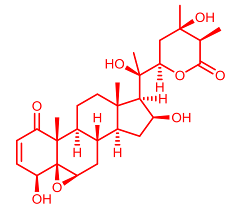
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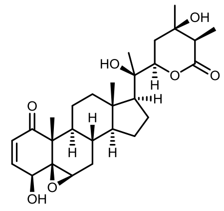
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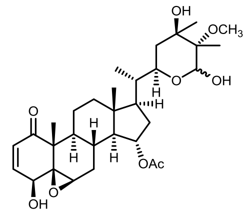
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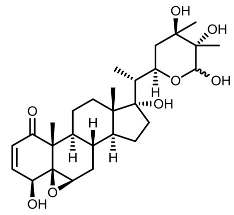
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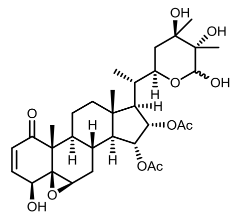
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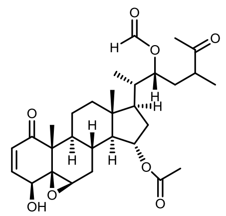
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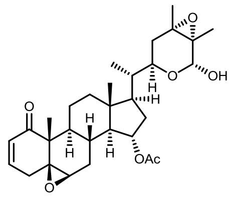
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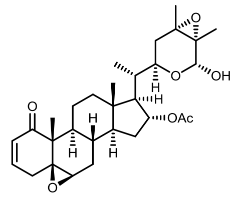
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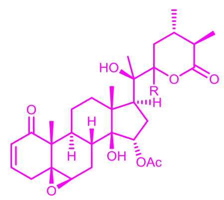
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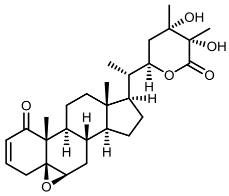
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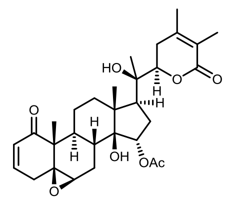
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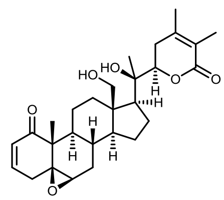
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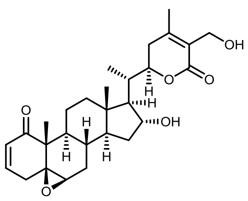
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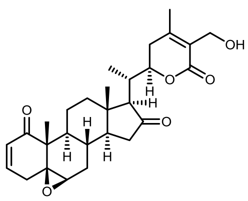
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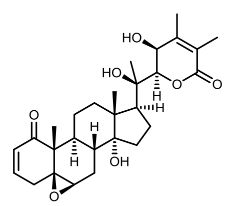
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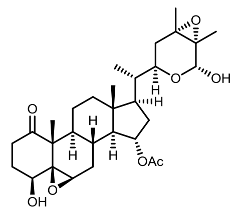
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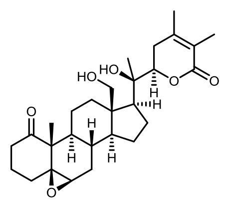
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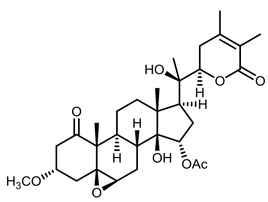
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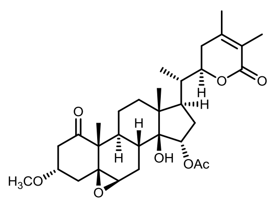
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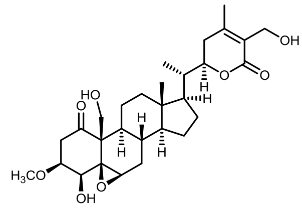
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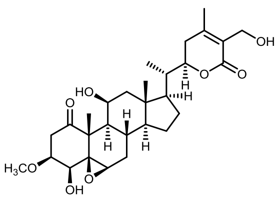

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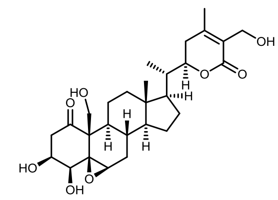

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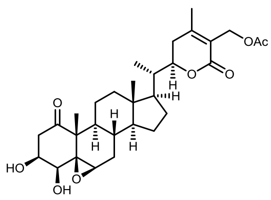

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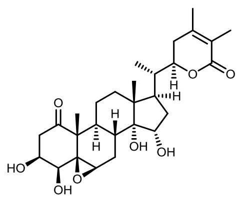

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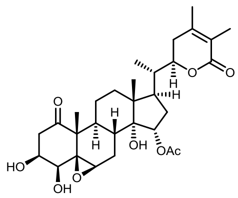

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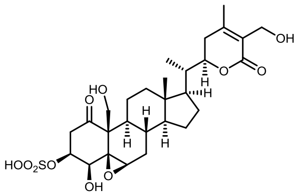

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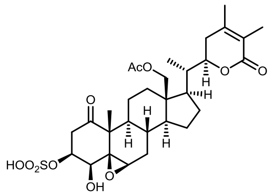

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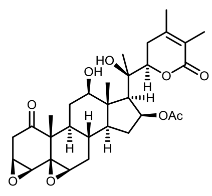

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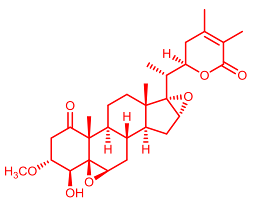

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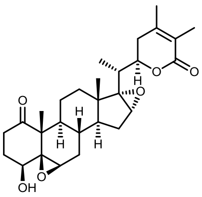

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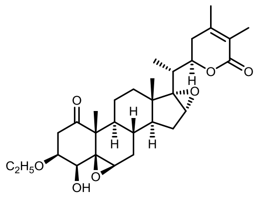

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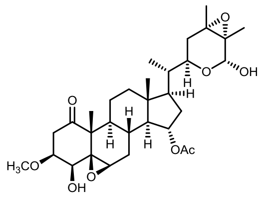

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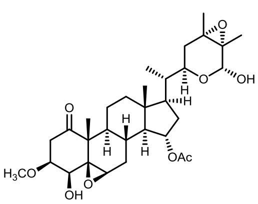

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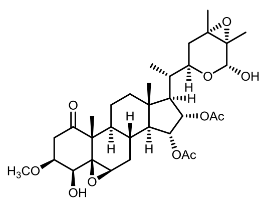

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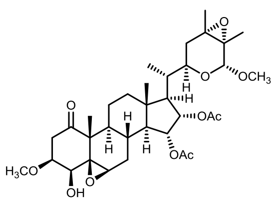

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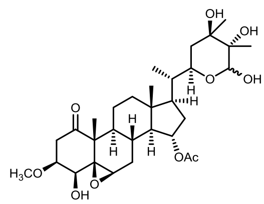

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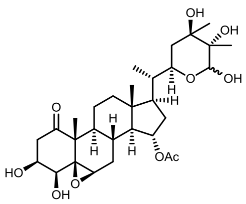

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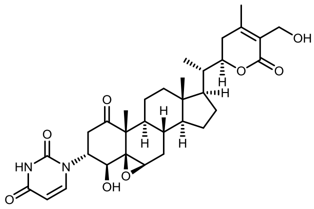

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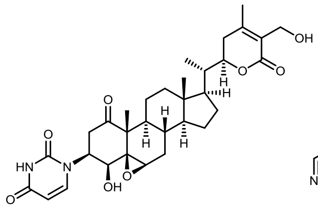

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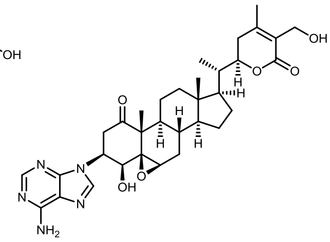

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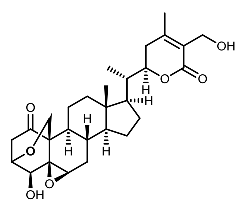

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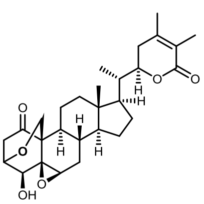

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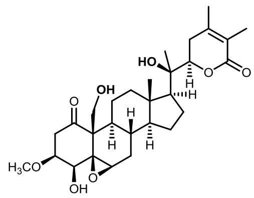

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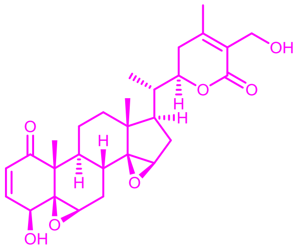

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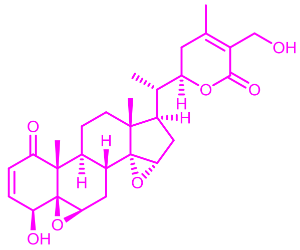

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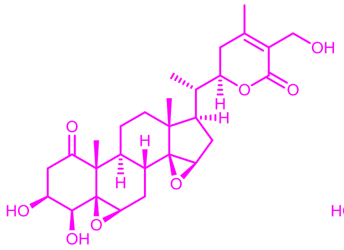

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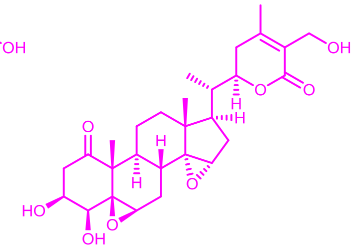

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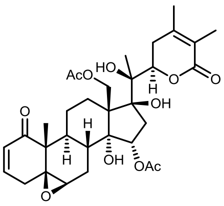
2.2.1.1.2 5β,6β-Epoxides with a 17a-side chain



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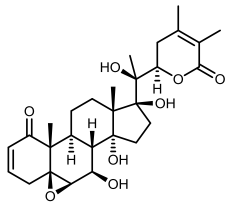

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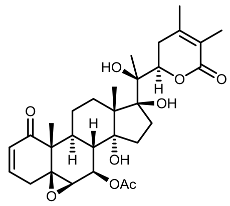

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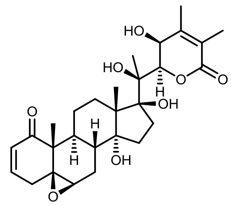

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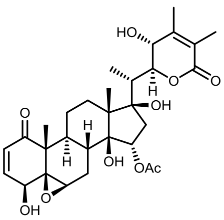

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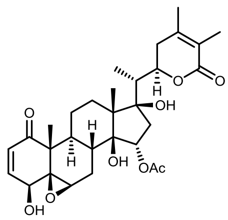

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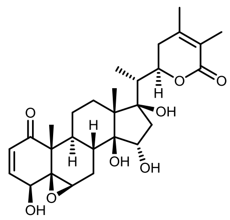

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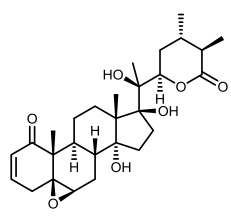

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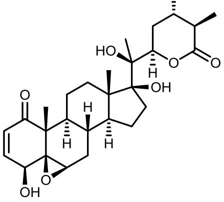

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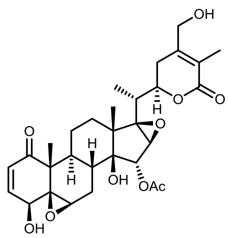

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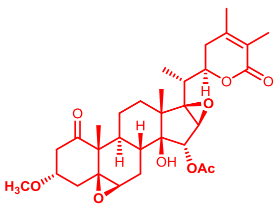

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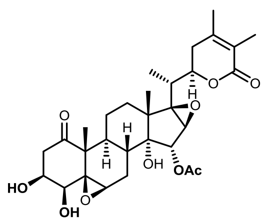

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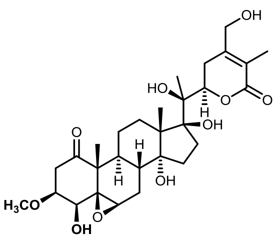

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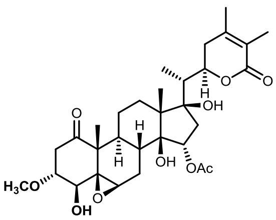

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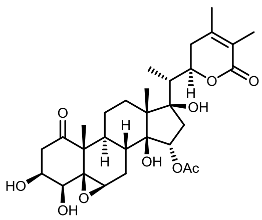

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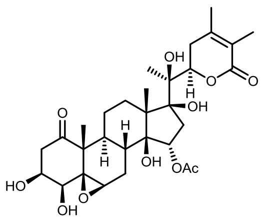

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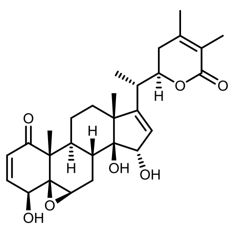
2.2.1.1.3 5β,6β-Epoxides with a 16-ene group



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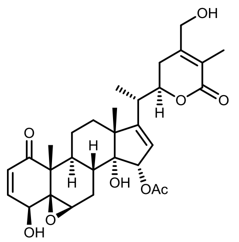

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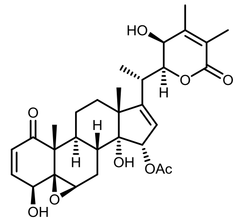

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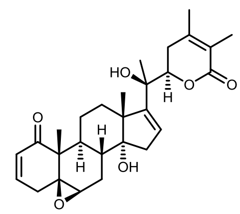

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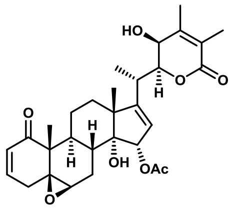

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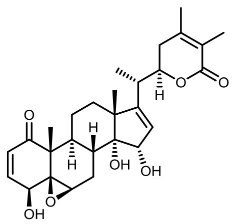

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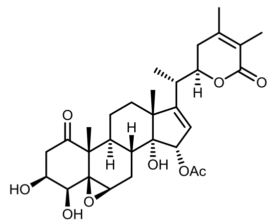

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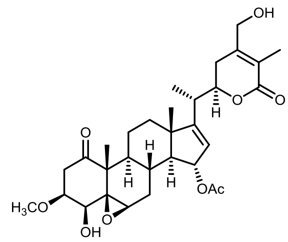

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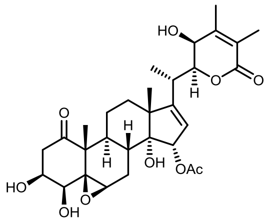

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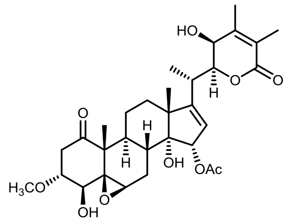

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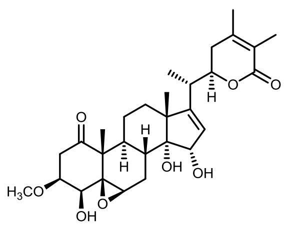

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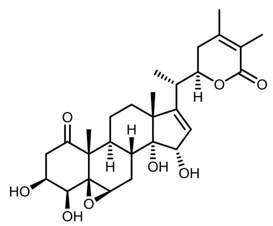

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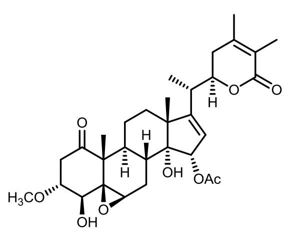

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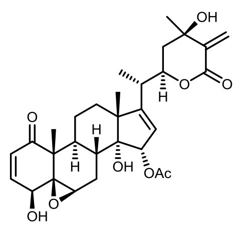

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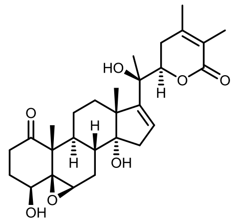

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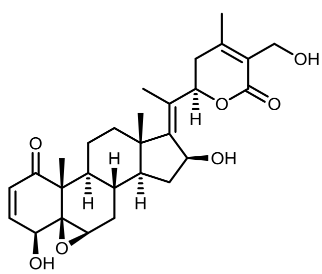
2.2.1.1.4 5β,6β-Epoxides with a 17(20)-ene group



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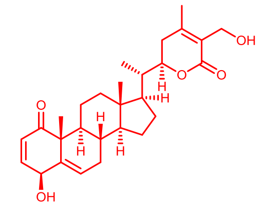
2.2.1.2 5-Ene withanolides

2.2.1.2.1 5-Enes with a 17β-side chain



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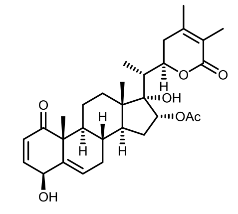

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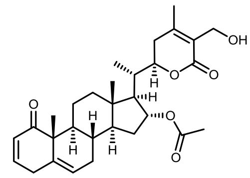

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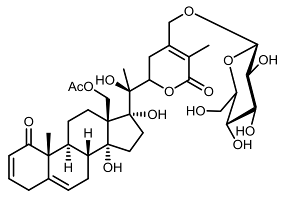

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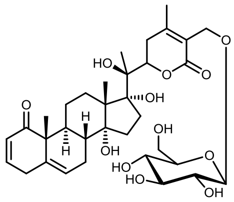

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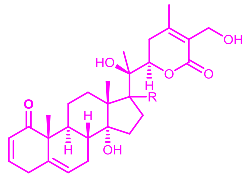
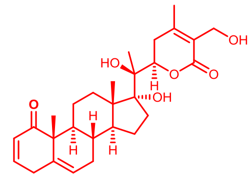


111 R=α-OH
111a R=β-OH



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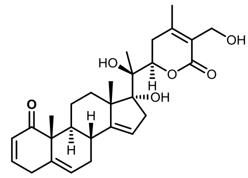

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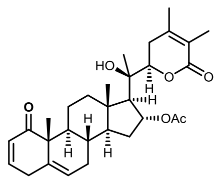

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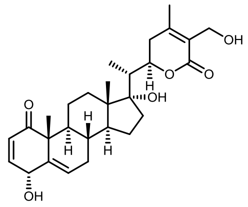

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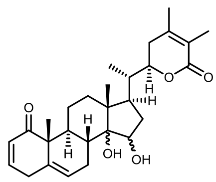

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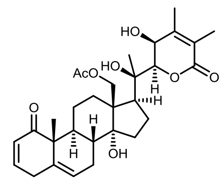

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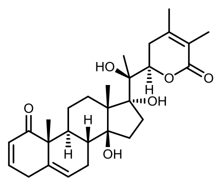

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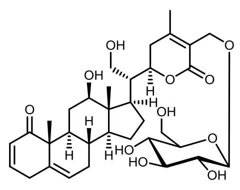

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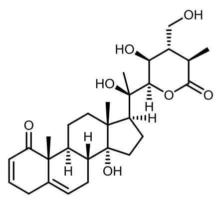

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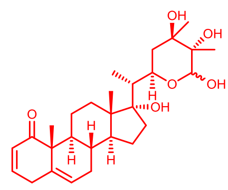

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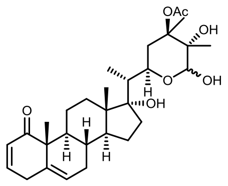

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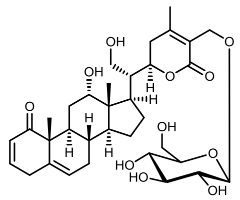

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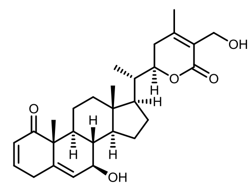

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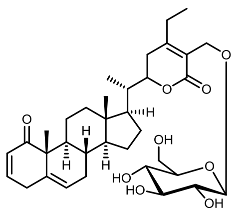

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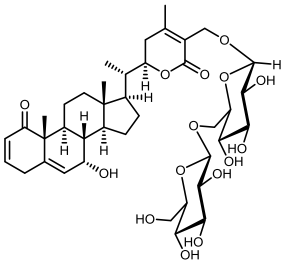

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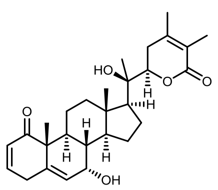

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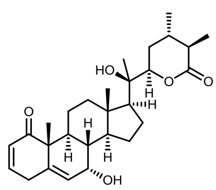

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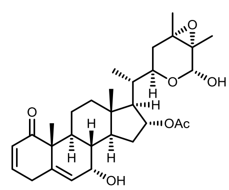

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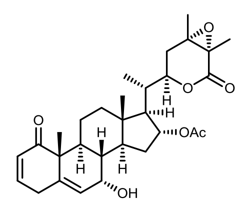

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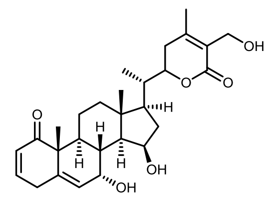

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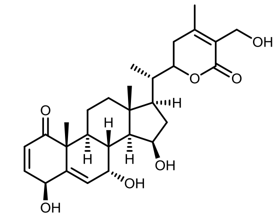

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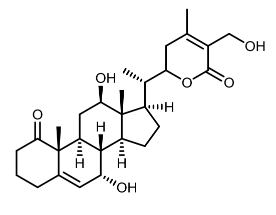

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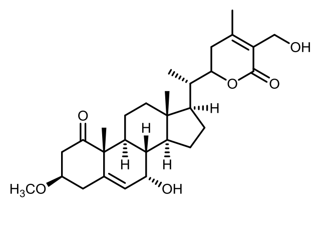

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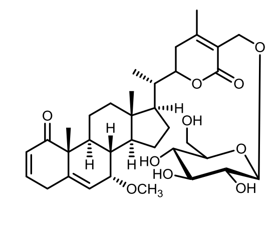

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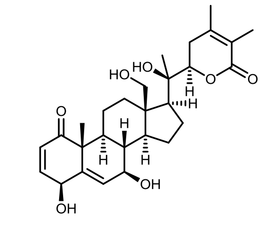

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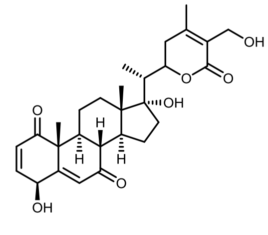

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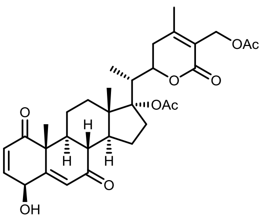

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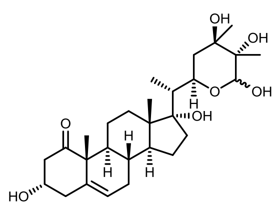

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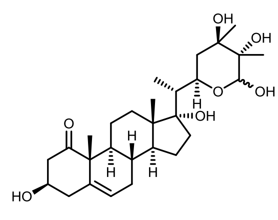

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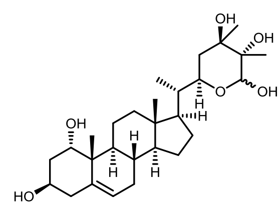

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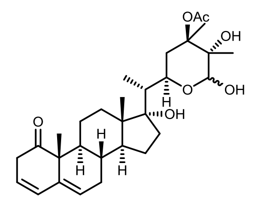

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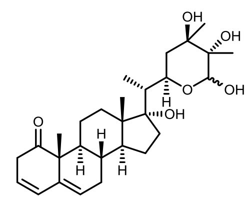

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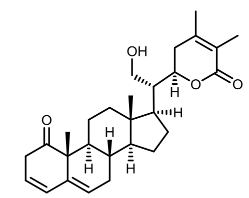

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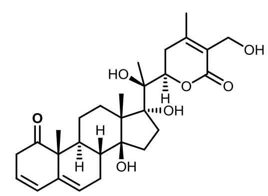

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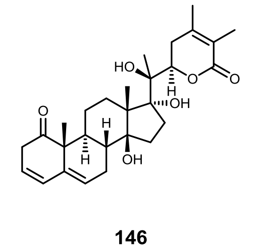

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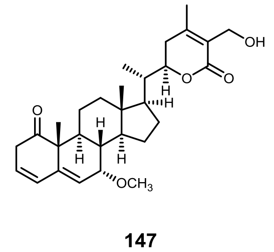

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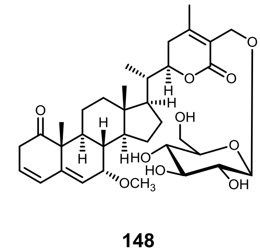

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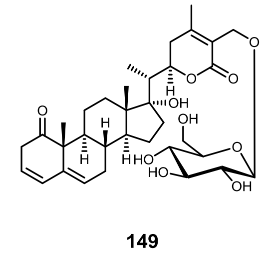

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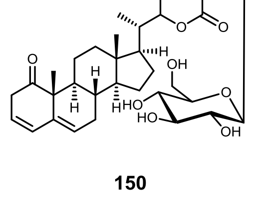

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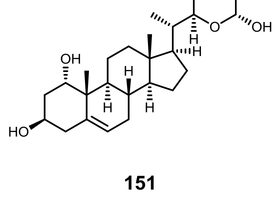

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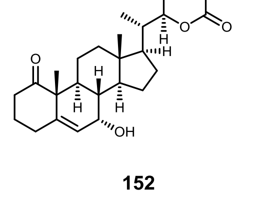

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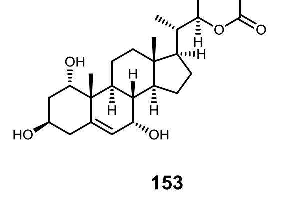

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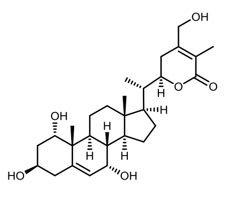

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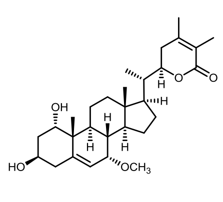

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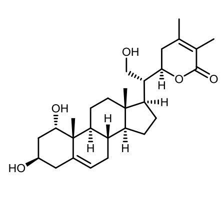

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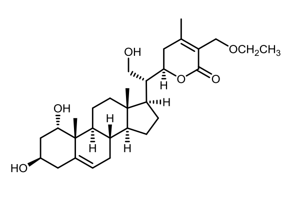

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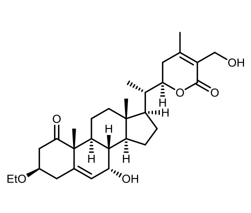

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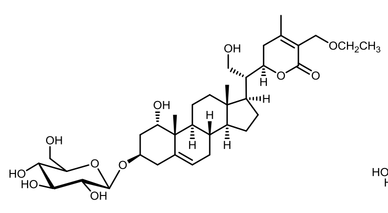

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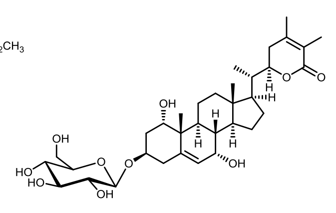

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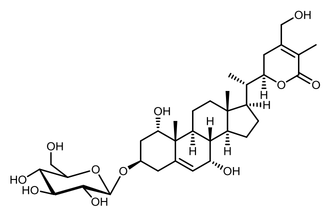

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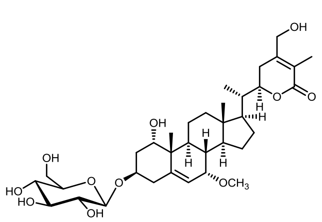

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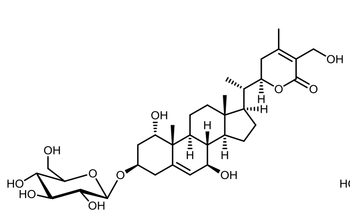

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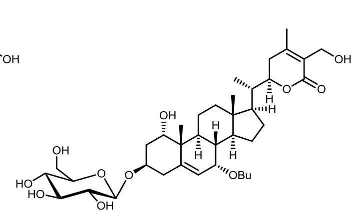

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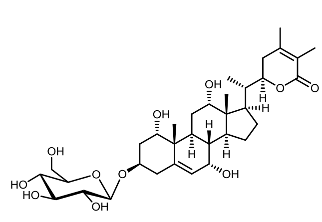

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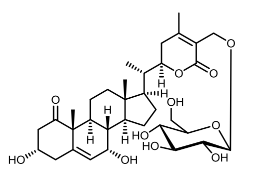

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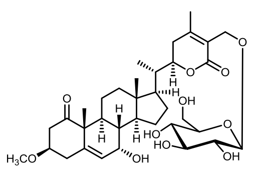

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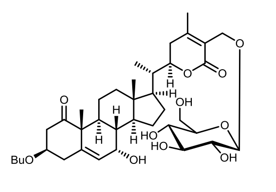

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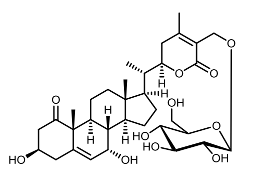

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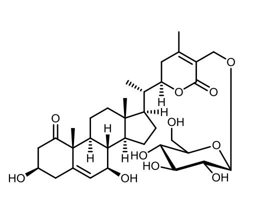

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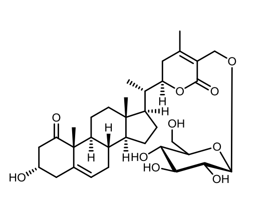

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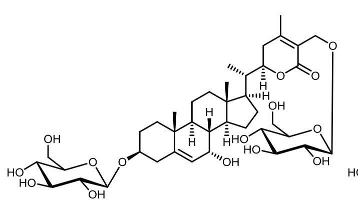

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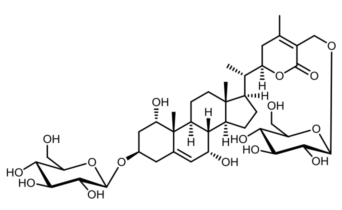

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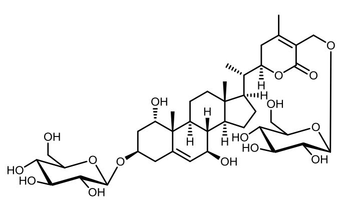

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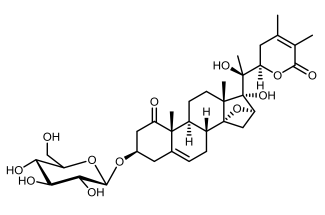

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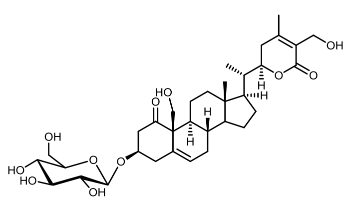

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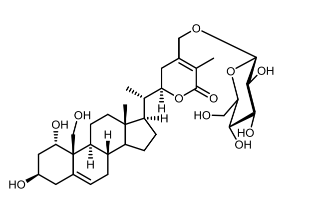

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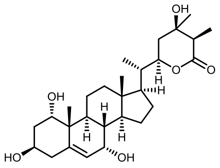

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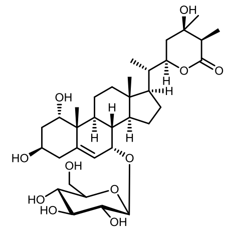

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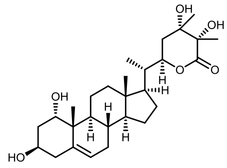

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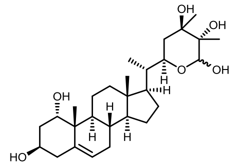

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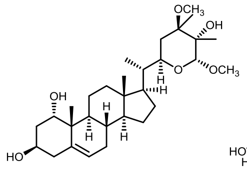

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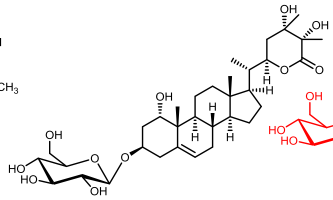

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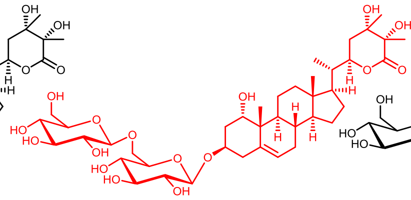

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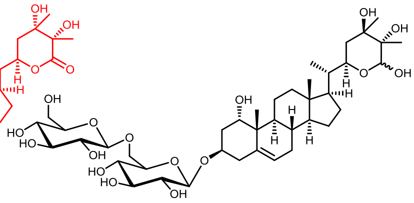

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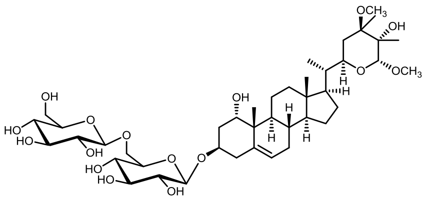

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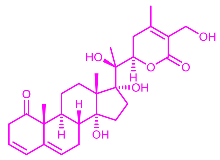

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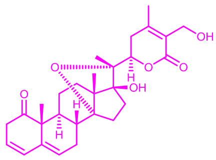

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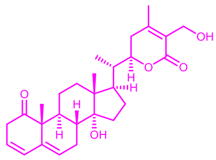

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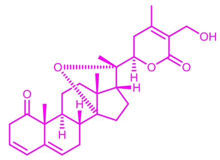

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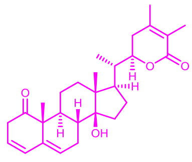

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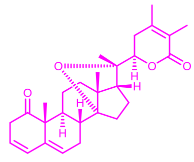

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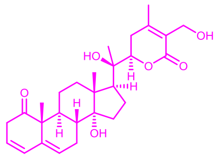

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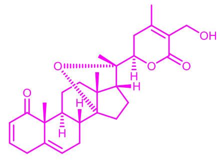

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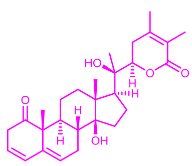

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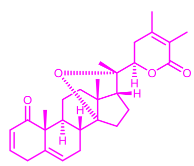

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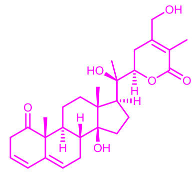

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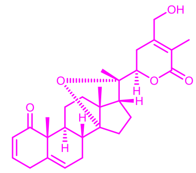

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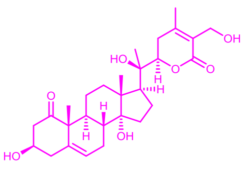

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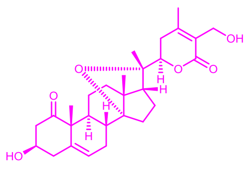

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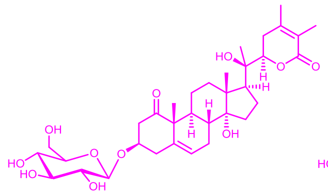

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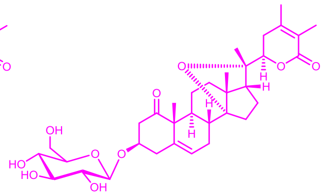

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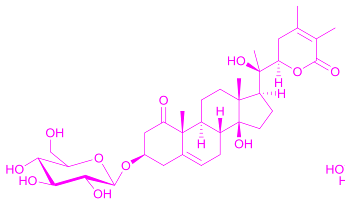

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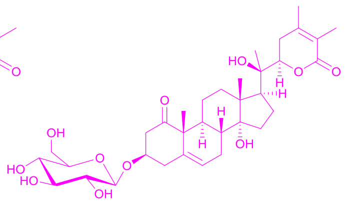

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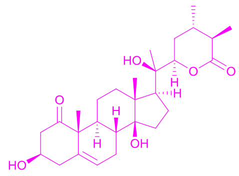

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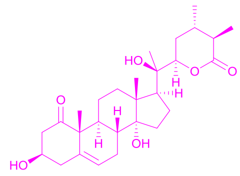

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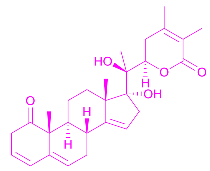

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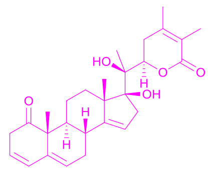

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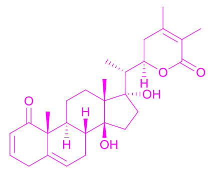

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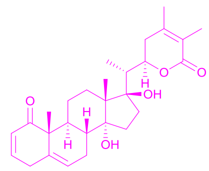

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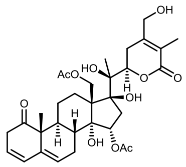
2.2.1.2.2 5-Enes with a 17α-side chain



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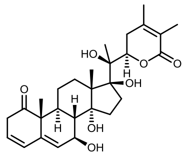

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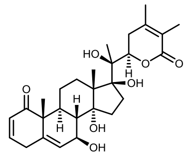

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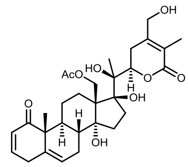

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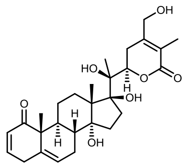

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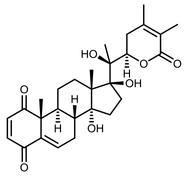

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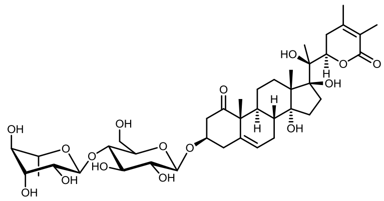

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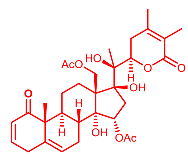

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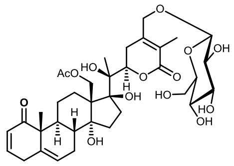

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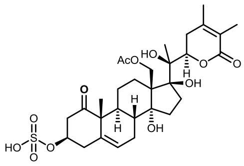

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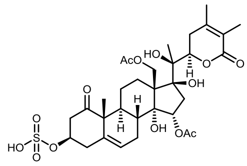

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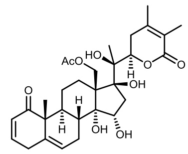

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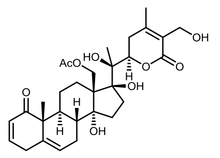

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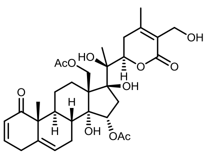

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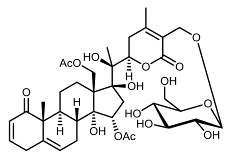

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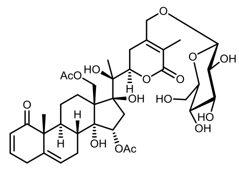

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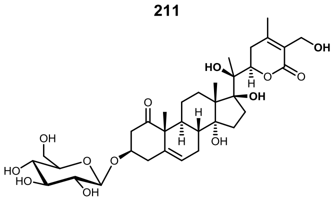

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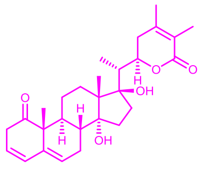

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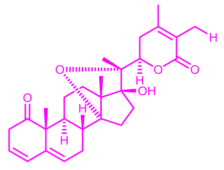

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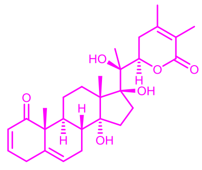

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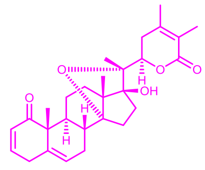

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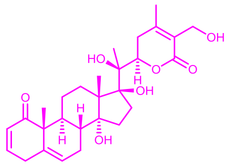

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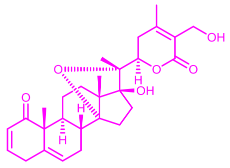

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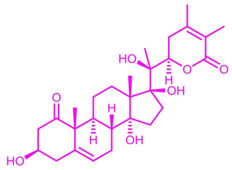

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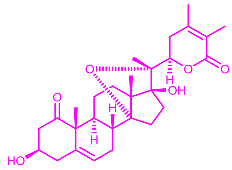

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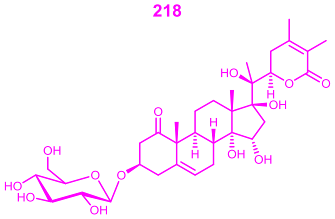

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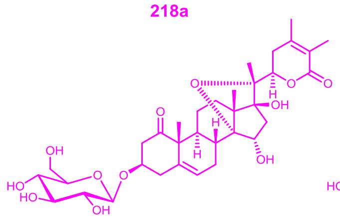

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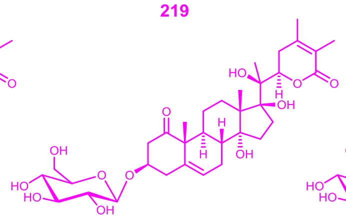

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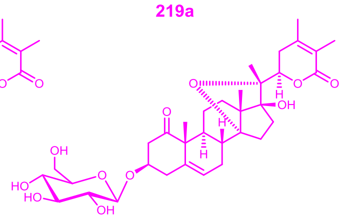

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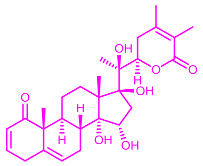

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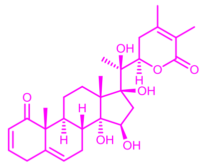

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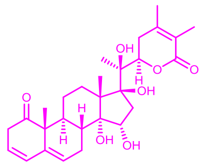

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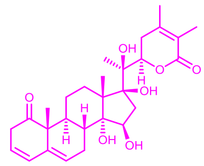

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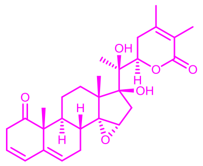

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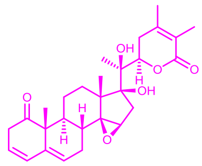

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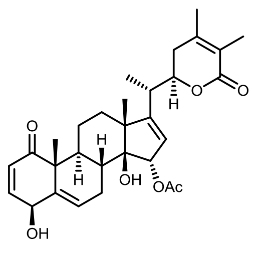
2.2.1.2.3 5-Enes with a 16-ene or 17-ene groups



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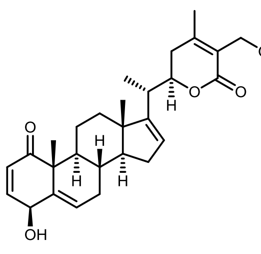

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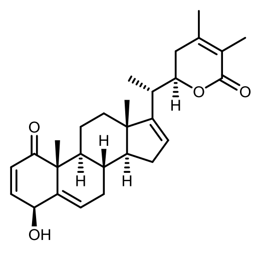

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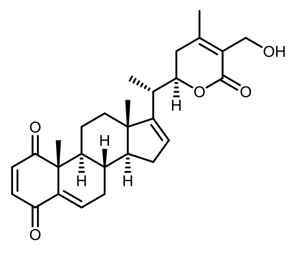

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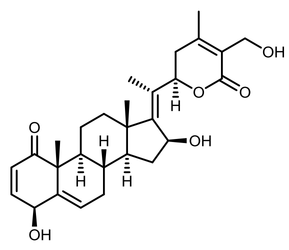

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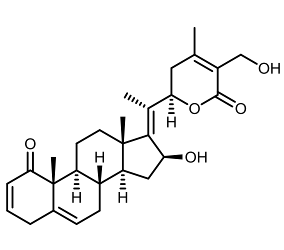

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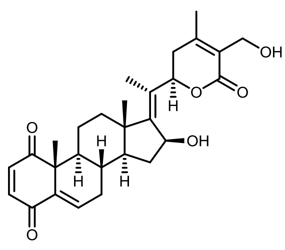

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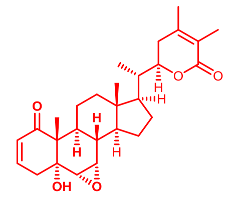
2.2.1.3 6α,7α-Epoxides.



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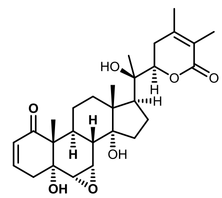

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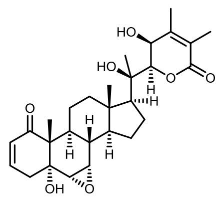

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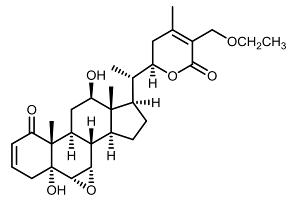

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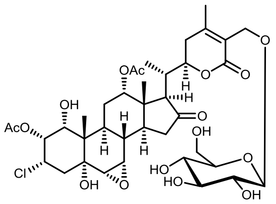

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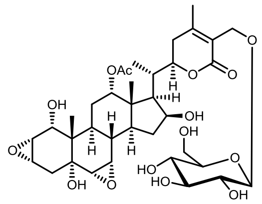

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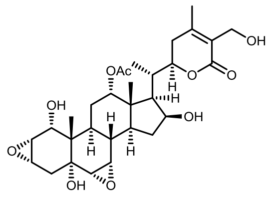

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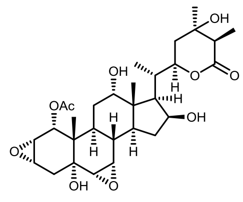

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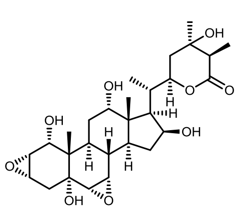

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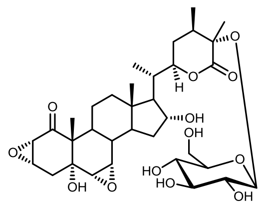

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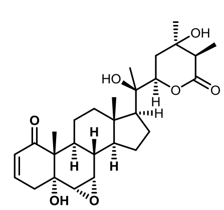

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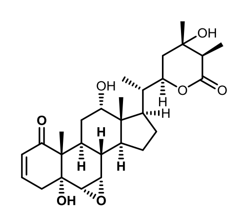

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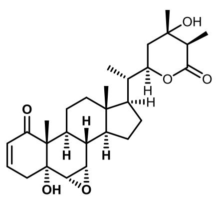

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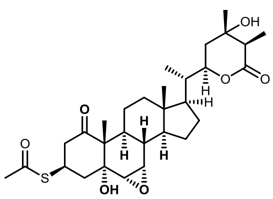

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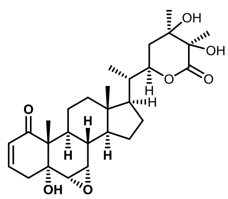

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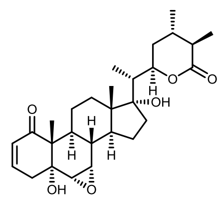

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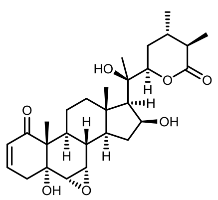

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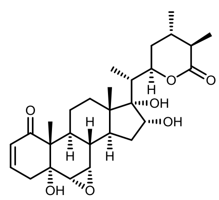

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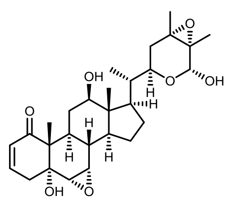

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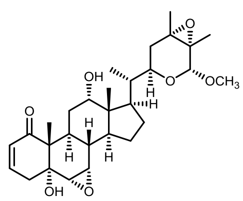

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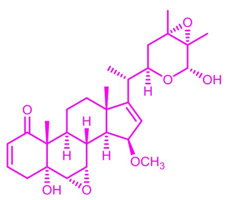

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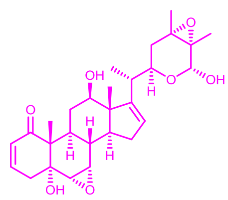

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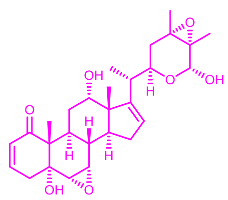

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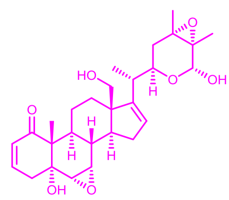

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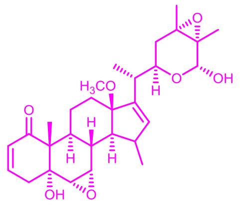

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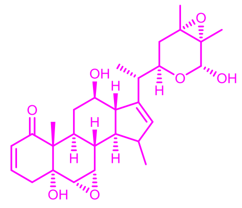

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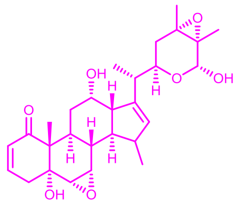

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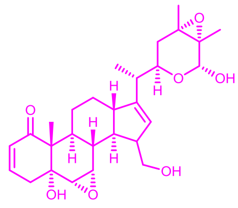

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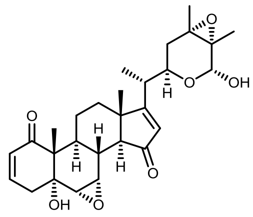

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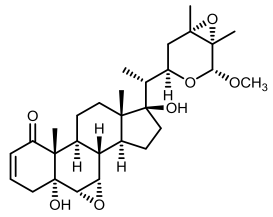

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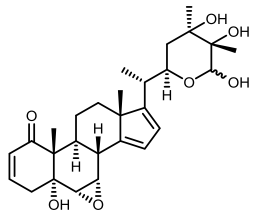

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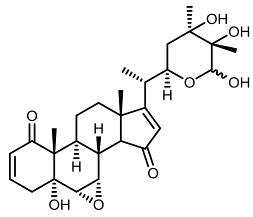

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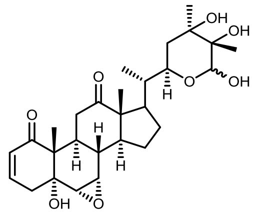

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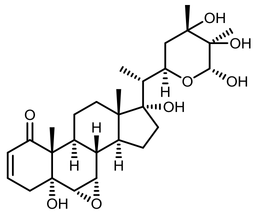

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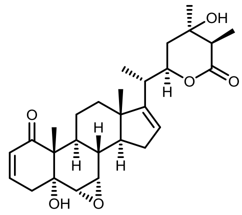

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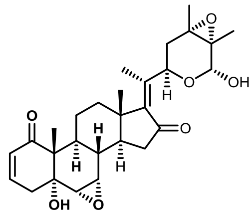

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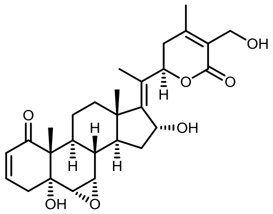

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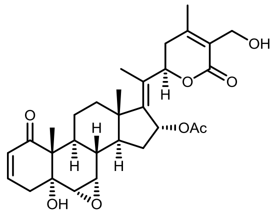

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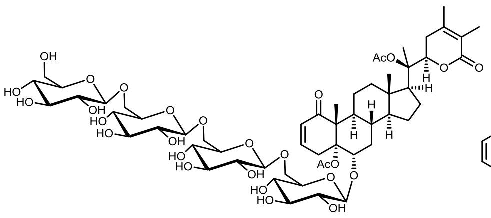
2.2.1.4 Intermediate withanolides

2.2.1.4.1 Intermediate withanolides with a 17β-side chain



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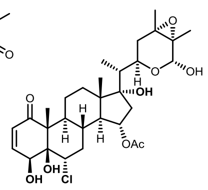

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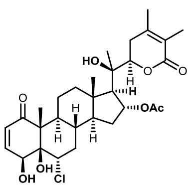

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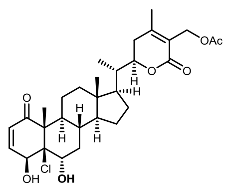

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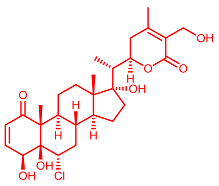

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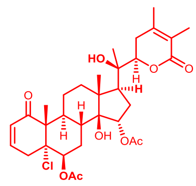

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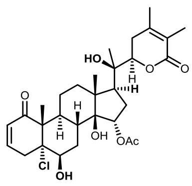

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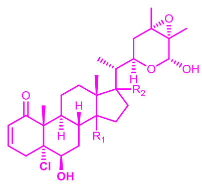
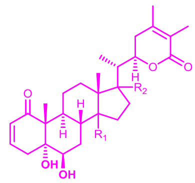
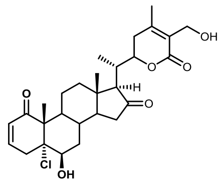


273 R_1=R_2=α-OH
273a R_1=R_2=β-OH



274 R_1=R_2=α-OH
274a R_1=R_2=β-OH



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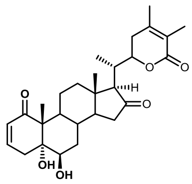

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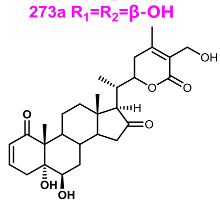

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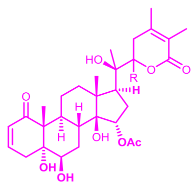
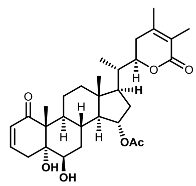


278 R=α-OH
278a R=β-OH



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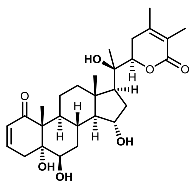

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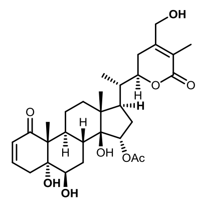

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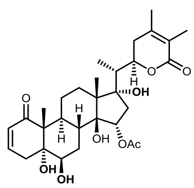

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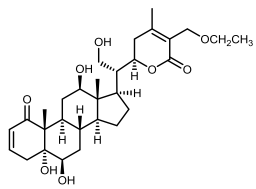

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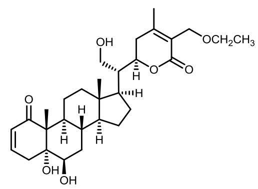

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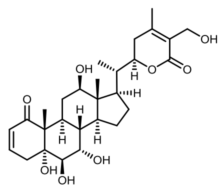

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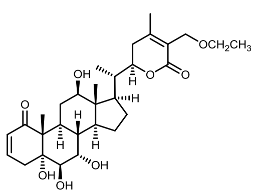

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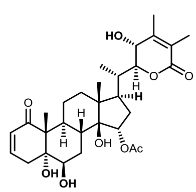

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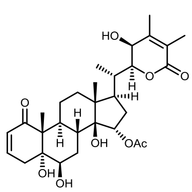

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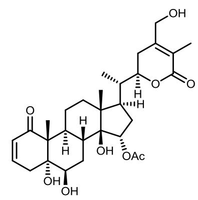

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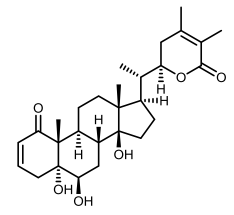

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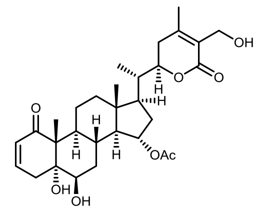

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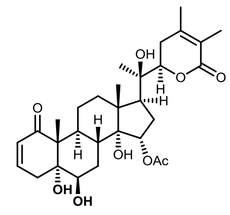

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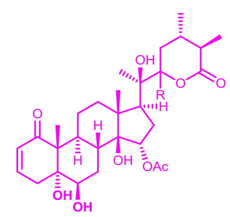
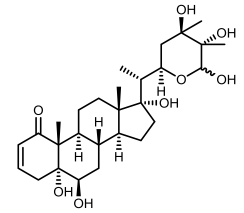


293 R=α-OH
293a R=β-OH



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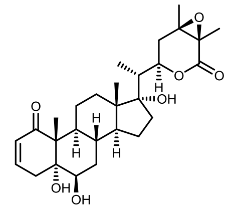

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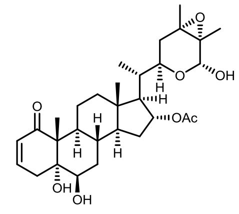

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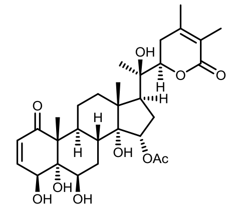

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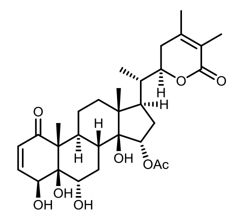

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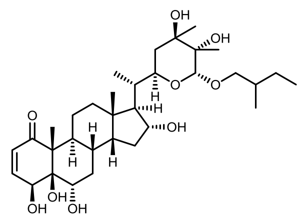

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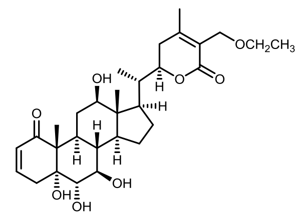

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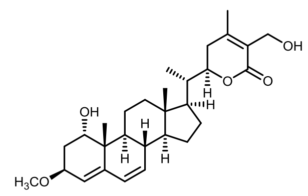

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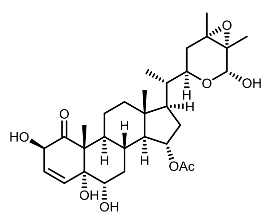

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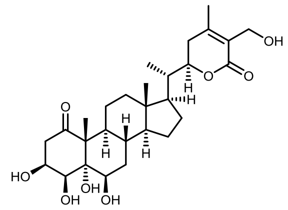

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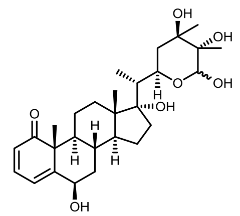

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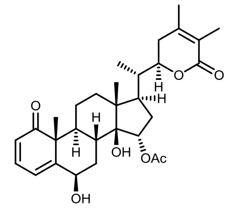

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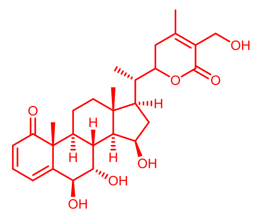

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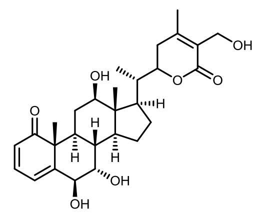

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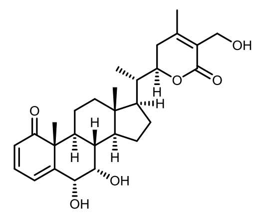

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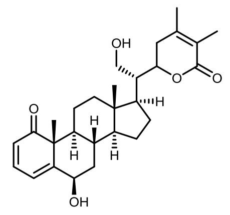

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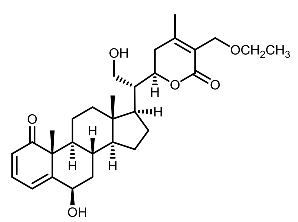

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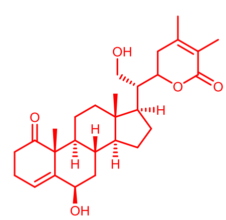

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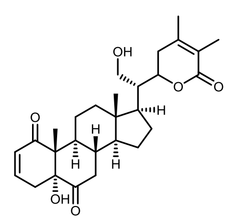

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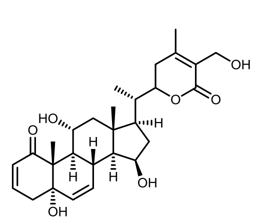

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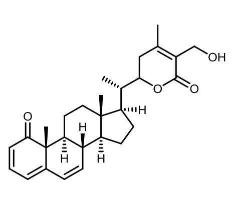

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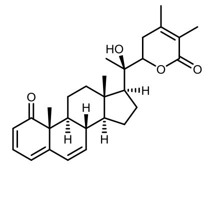

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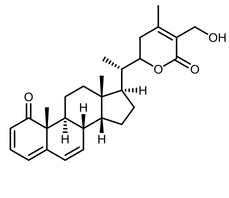

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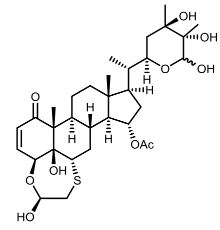

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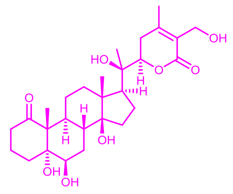

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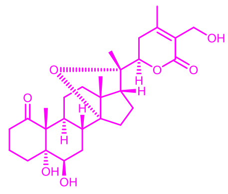

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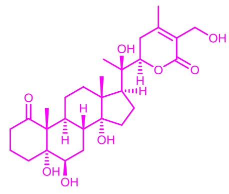

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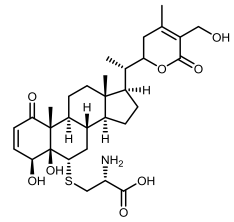

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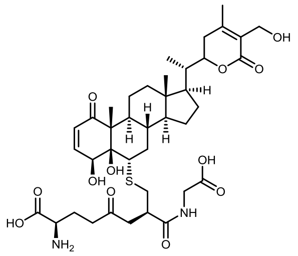

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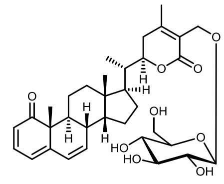

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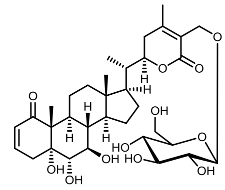

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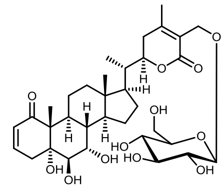

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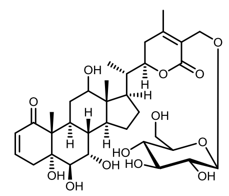

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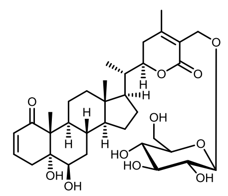

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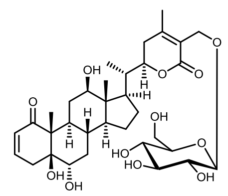

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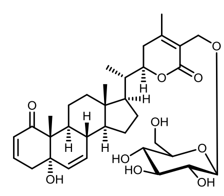

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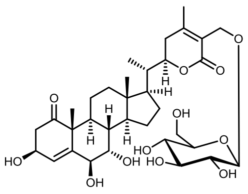

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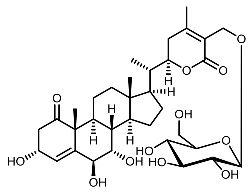

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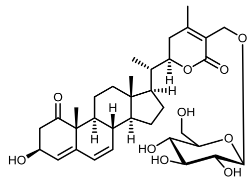

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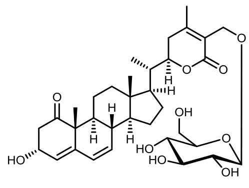

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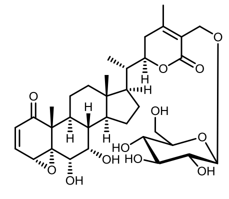

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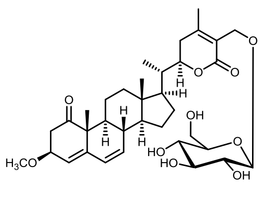

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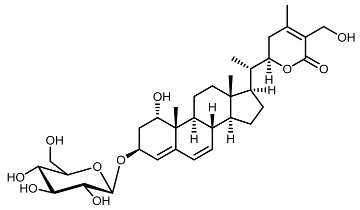

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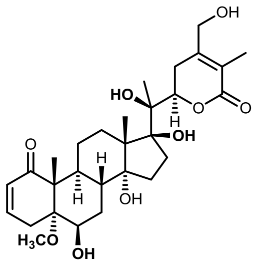
2.2.1.4.2 Intermediate withanolides with a 17α-side chain



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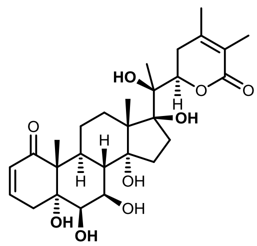

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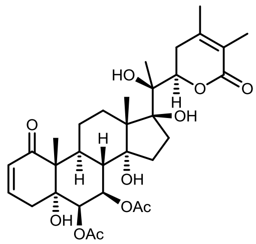

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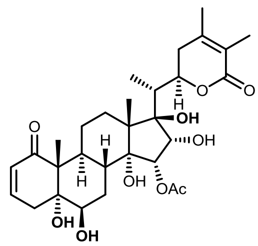

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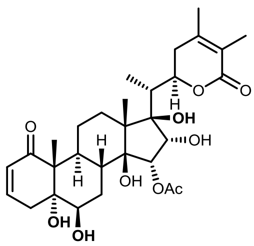

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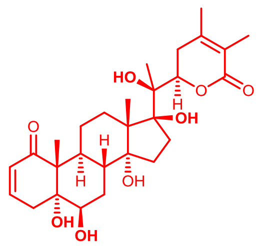

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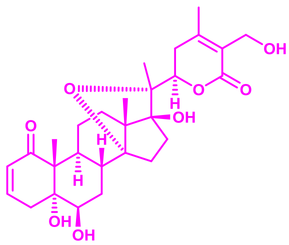
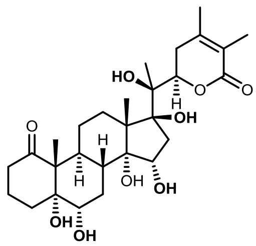
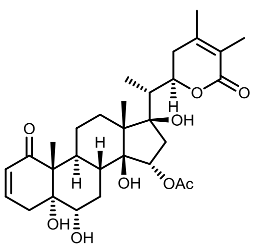


340a



341



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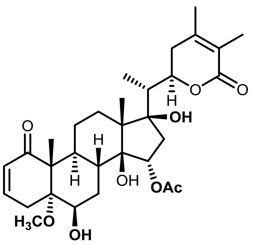

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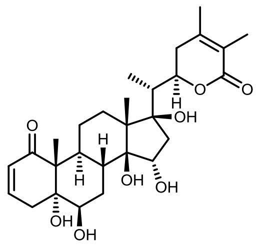

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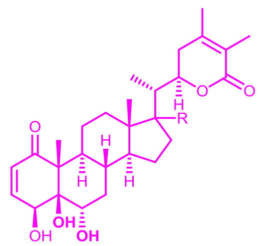
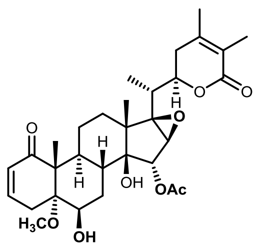


345 R=β-OH
345a R=α-OH



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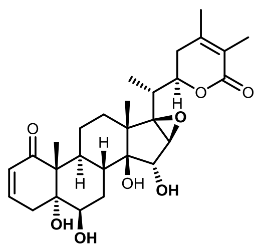

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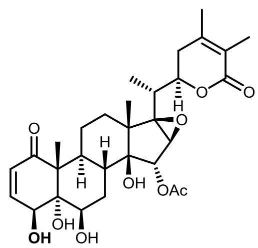
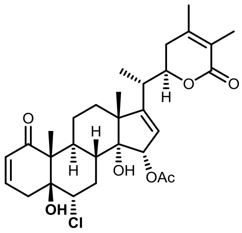


348

2.2.1.4.3 Intermediate withanolides with a 16-ene group



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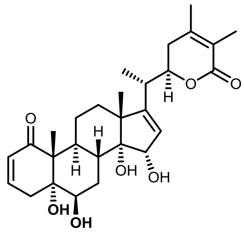

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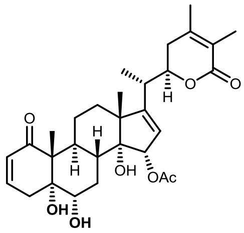
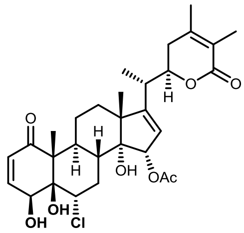
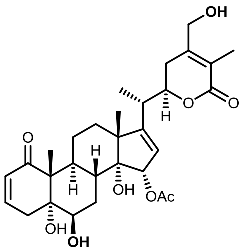


351



352



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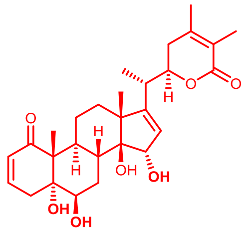

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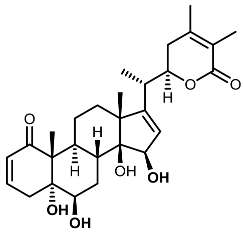

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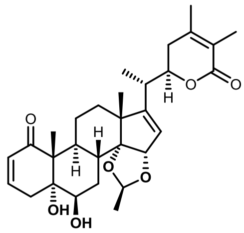
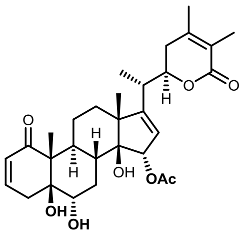


356



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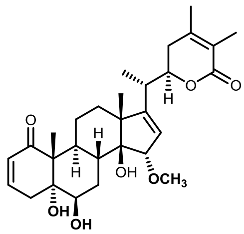

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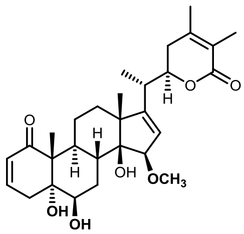

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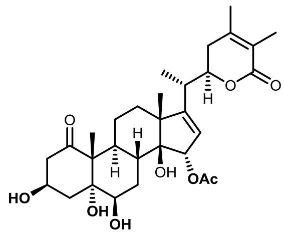

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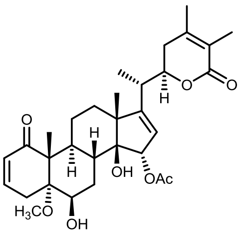

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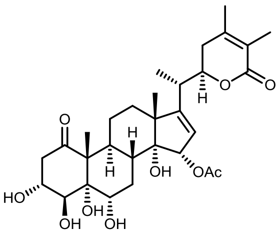

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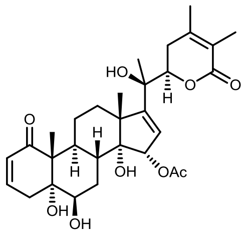

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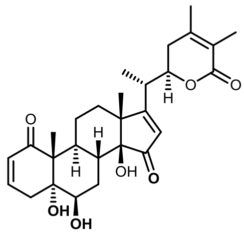
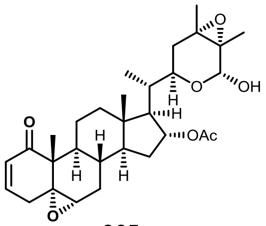


364

2.2.1.4.4 5α,6α-Epoxides



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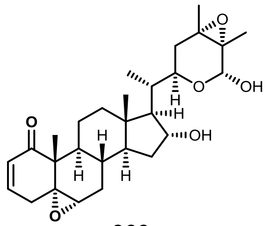

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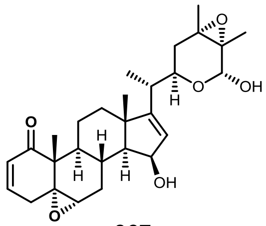
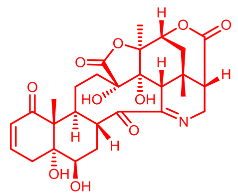


367

2.2.2 Withanolides with a modified skeleton (II)

2.2.2.1 Physalins



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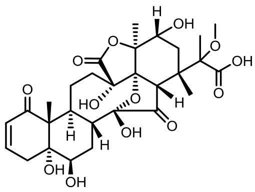

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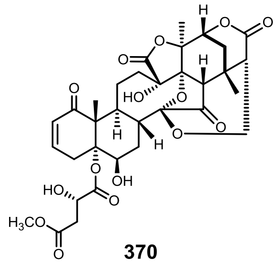

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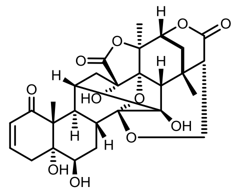

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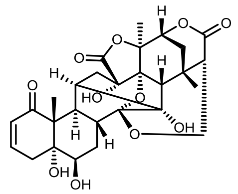

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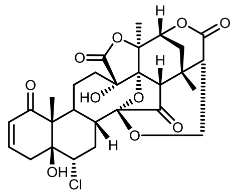
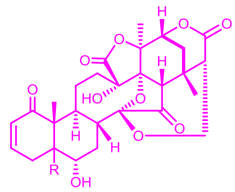
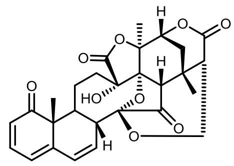


373



374 R=β-OH
374a R=α-OH



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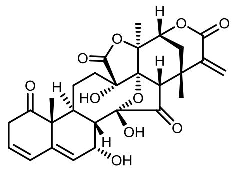

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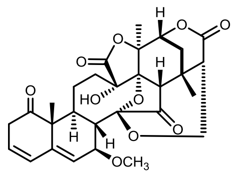

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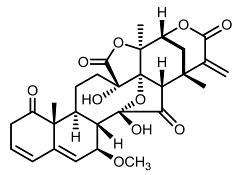

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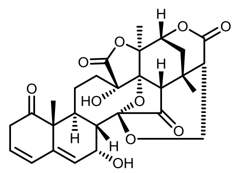

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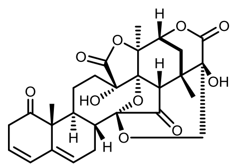

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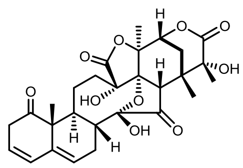

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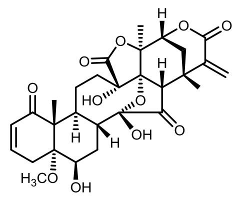

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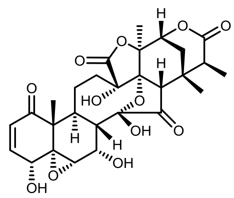

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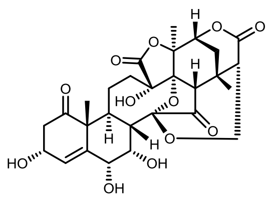

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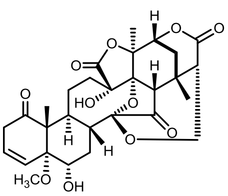

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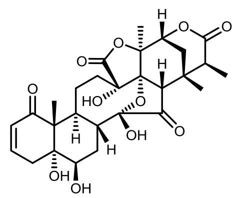

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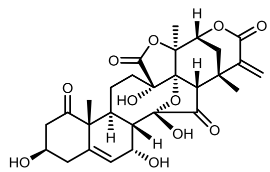
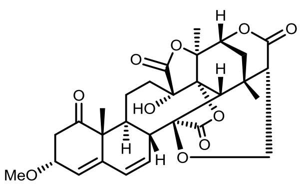
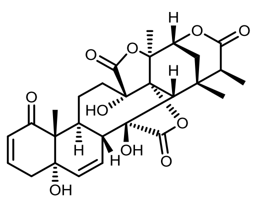


387

2.2.2.2 Neophysalins.



388



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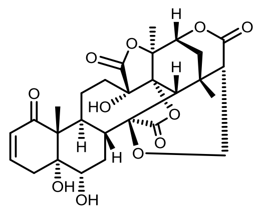
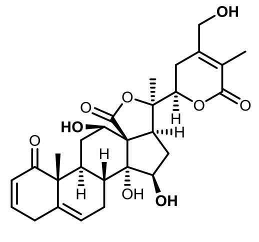


390

2.2.2.3 Withaphysalins.



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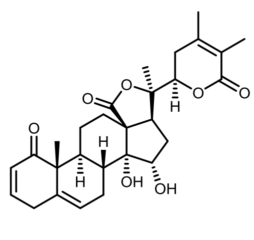

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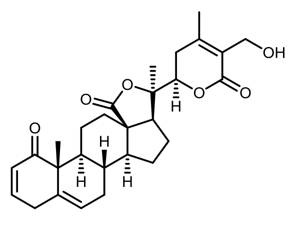

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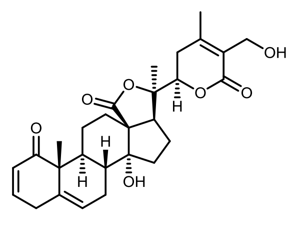

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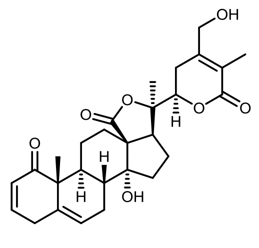

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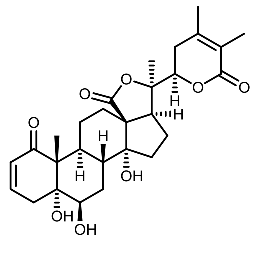

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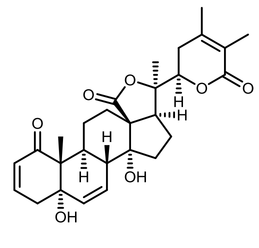

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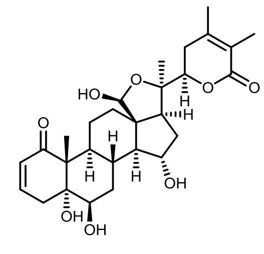

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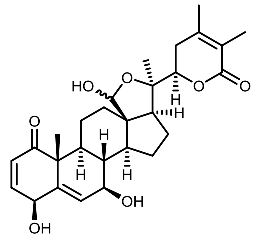

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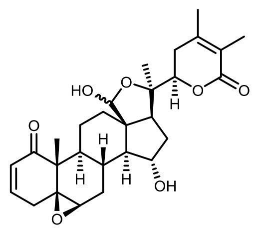

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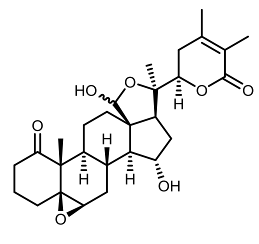

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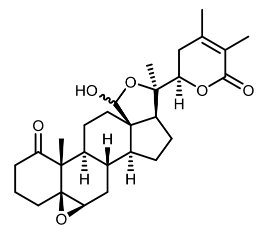

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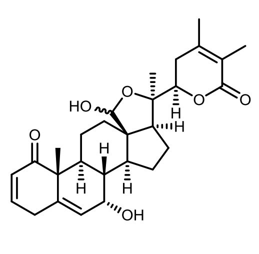

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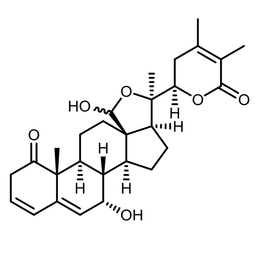

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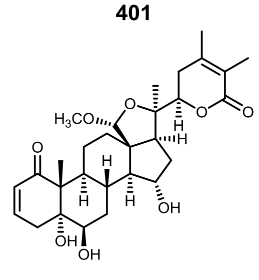

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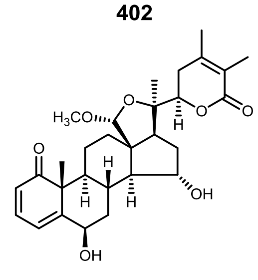

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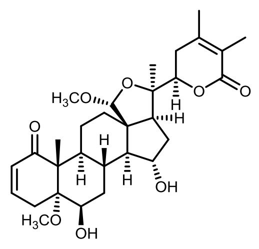

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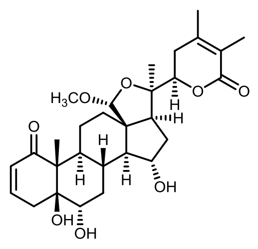

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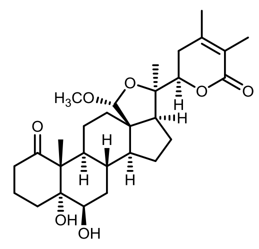

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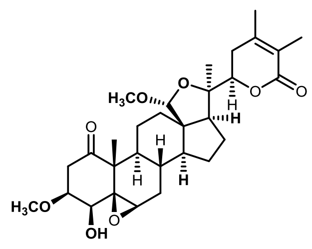

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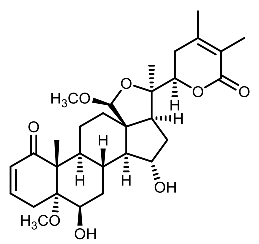

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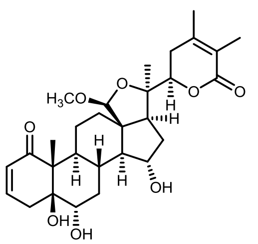

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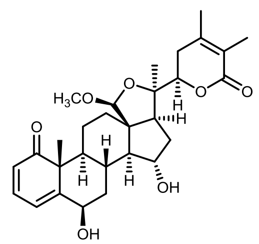

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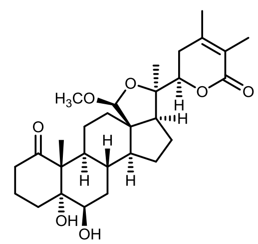
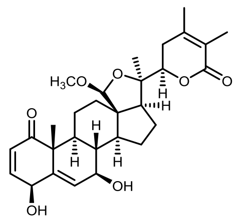


414



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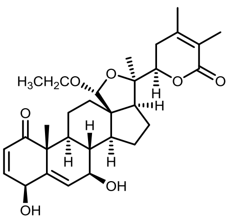

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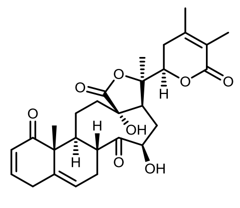

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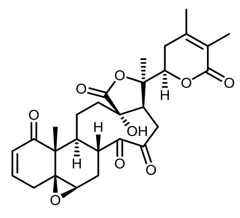

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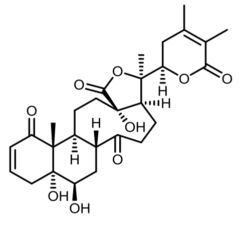

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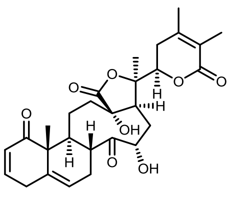

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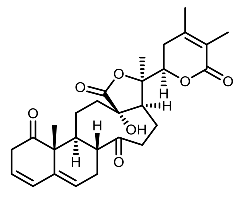

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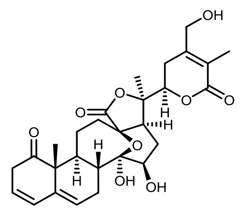

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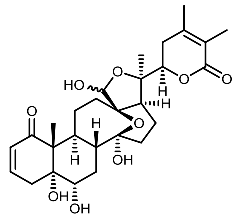

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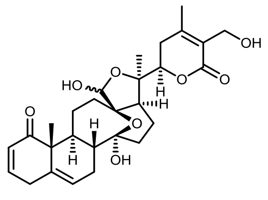

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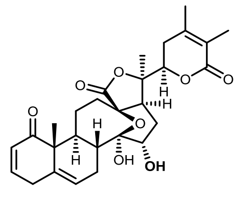

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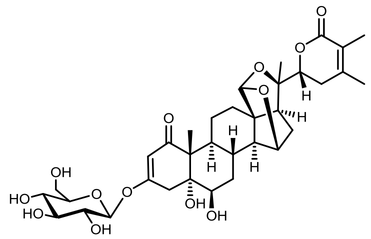
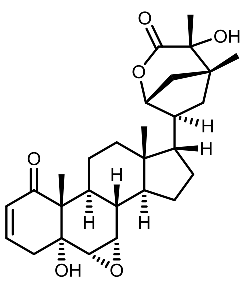


426

2.2.2.4 Acnistins and epiacnistins.



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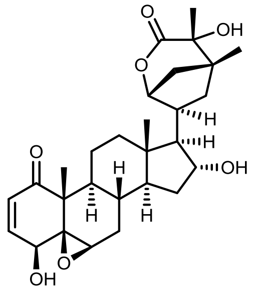

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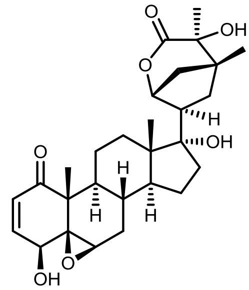

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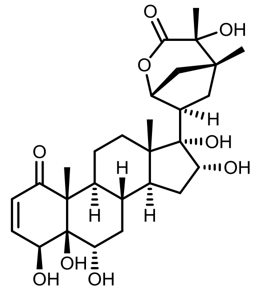

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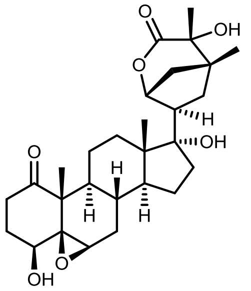

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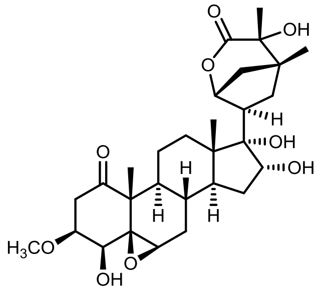

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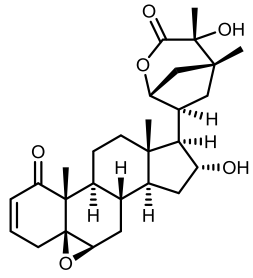

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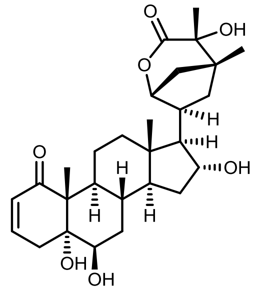

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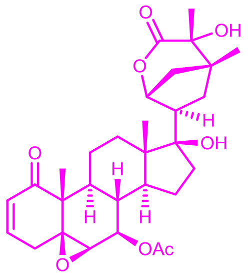

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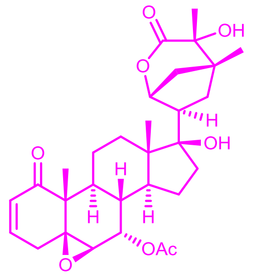

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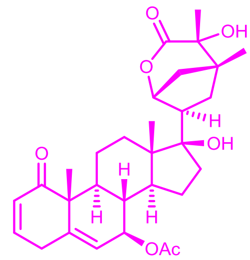

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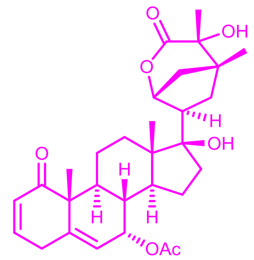
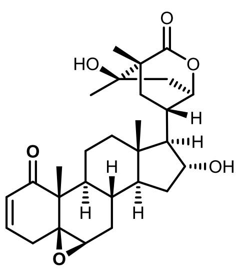


436a

2.2.2.5 Withajardins.



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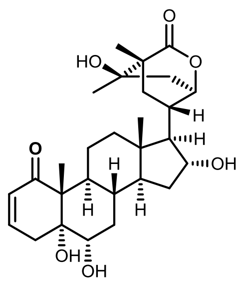

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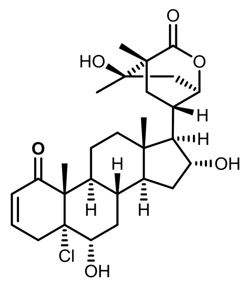

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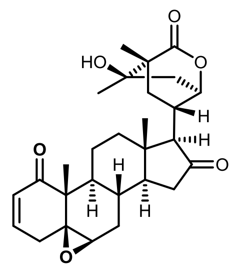

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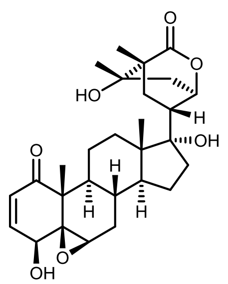

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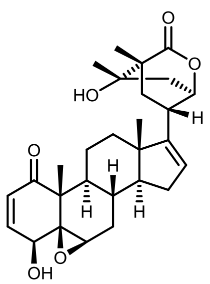

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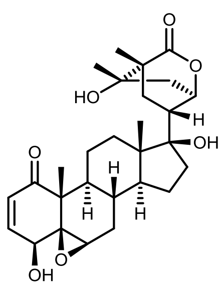

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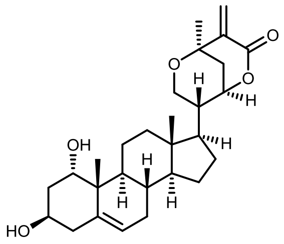
2.2.2.6 Withametelins.



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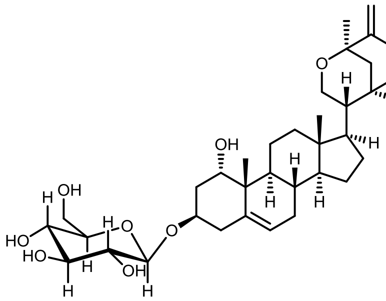

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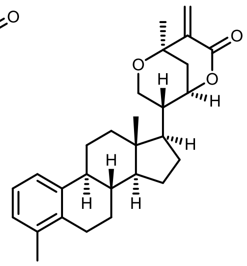

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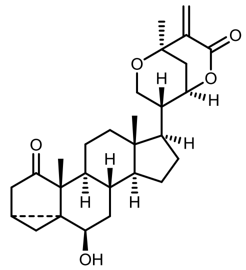

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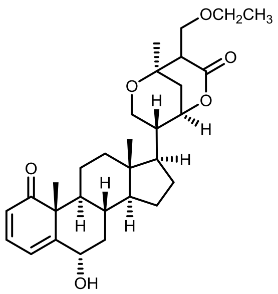

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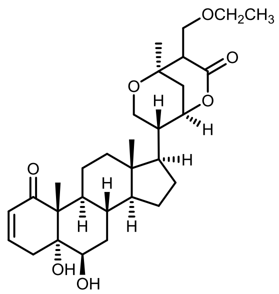

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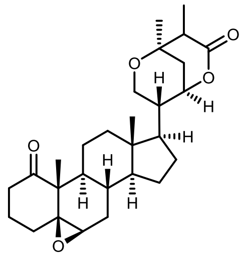

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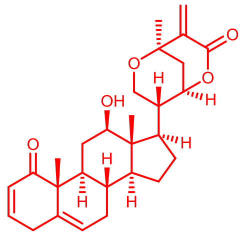

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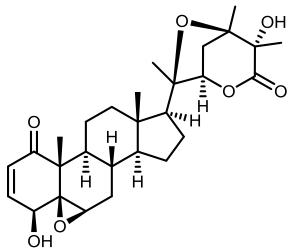
2.2.2.7 20,24-epoxy withanolides



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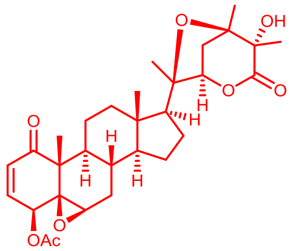

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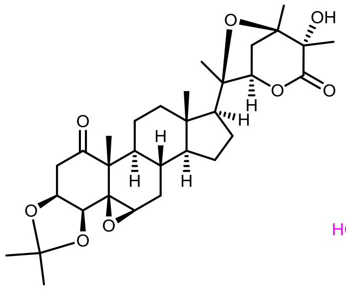

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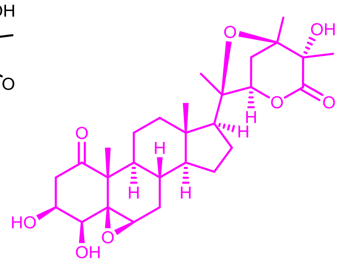

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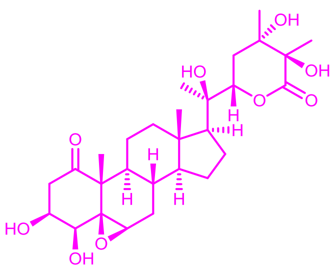
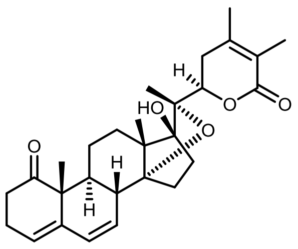


455a

2.2.2.8 14α,20α-Epoxides.



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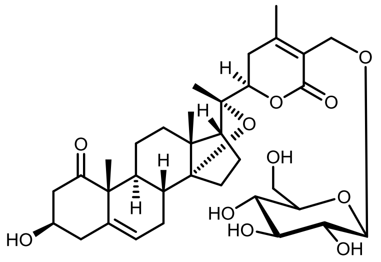
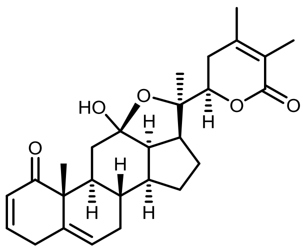


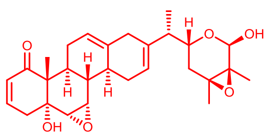
457

2.2.2.9 Subtriflora-δ-lactones.



458

2.2.2.10 six-membered ring D moieties and Ring-D aromatic withanolides.



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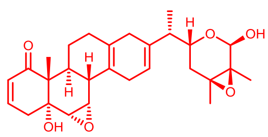

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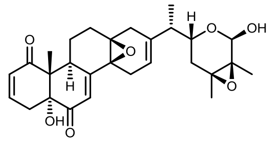

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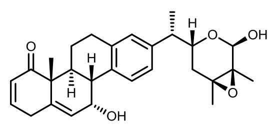

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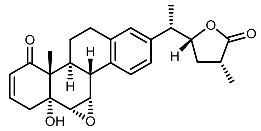

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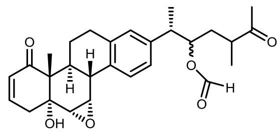

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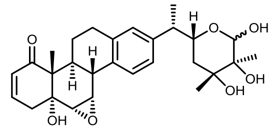

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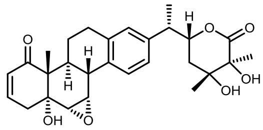

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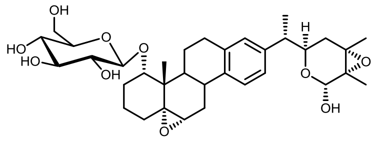

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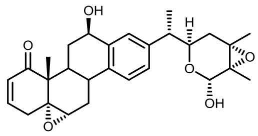

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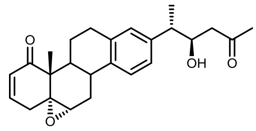

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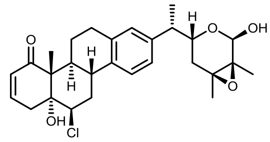

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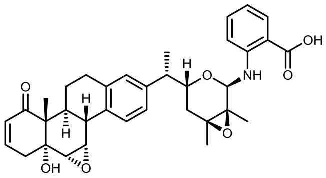

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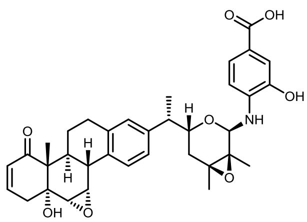

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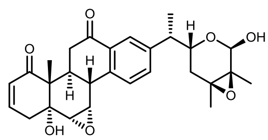

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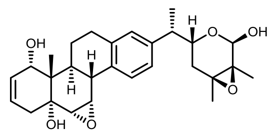

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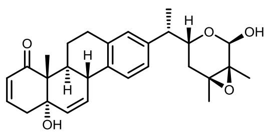

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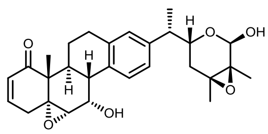

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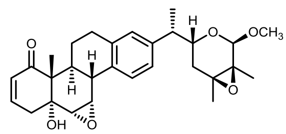

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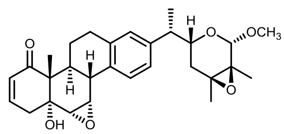

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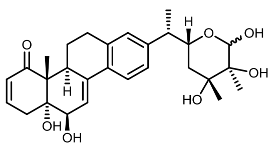

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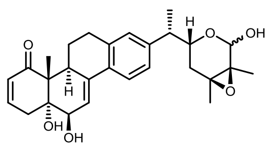

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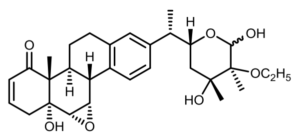

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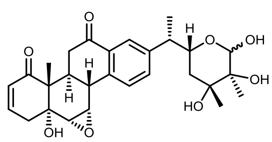
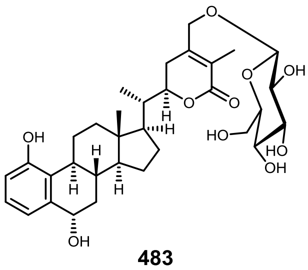


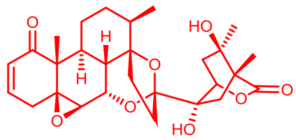
482

2.2.2.11 Ring-A aromatic withanolides



483

2.2.2.12 13,17-seco withanolides



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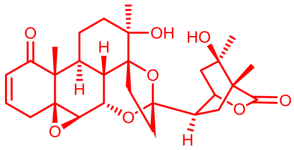

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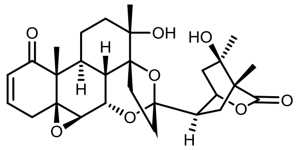

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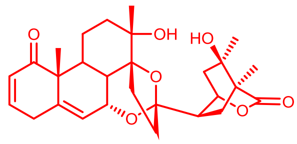

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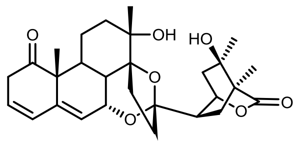

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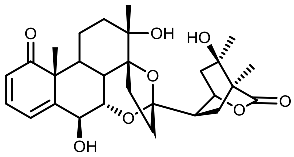

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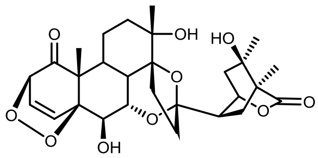

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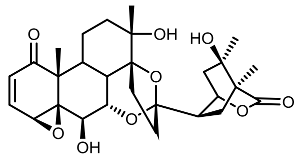

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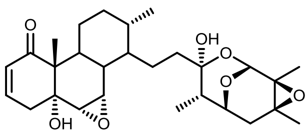

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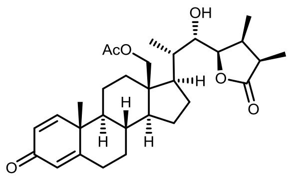
2.3 Withanolides with a g-lactone or g-lactol side chain (Type B)

2.3.1 Ixocarpalactones



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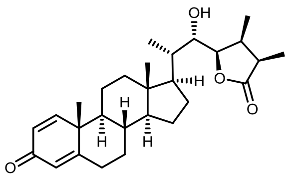

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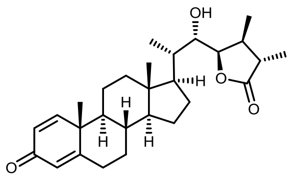

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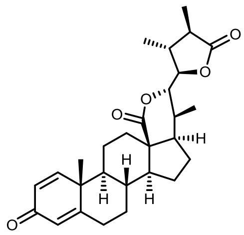

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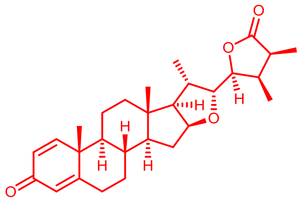

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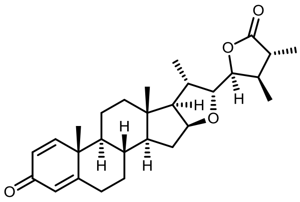

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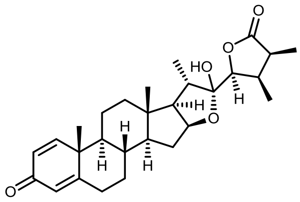

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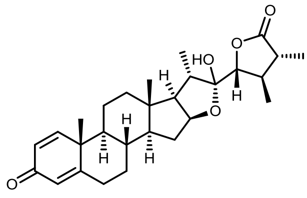

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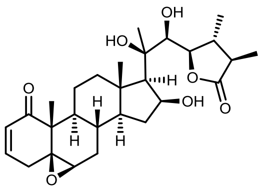

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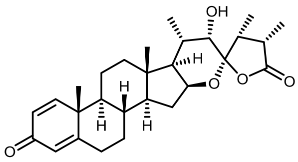

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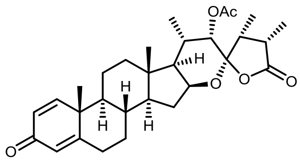

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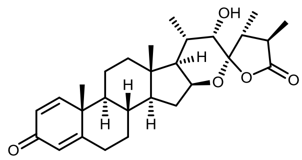

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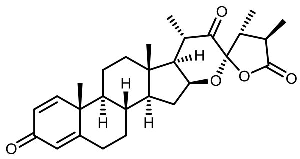

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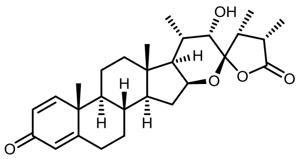

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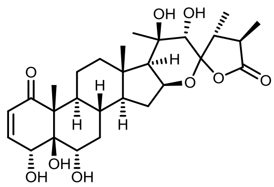

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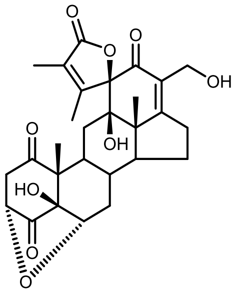
2.3.2 Spiranoid γ-lactones



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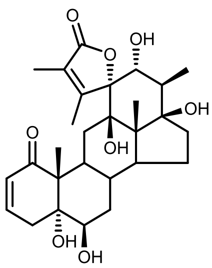

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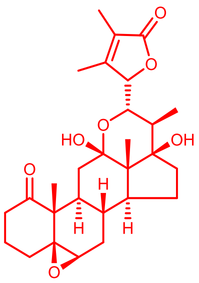
2.3.3 Trechonolides



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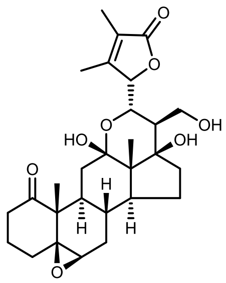

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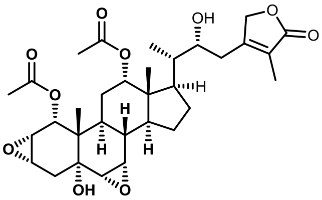
2.3.4 Perulactones



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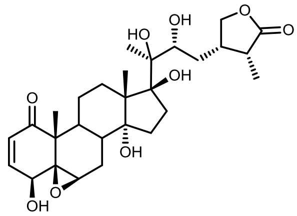

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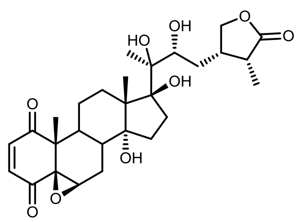

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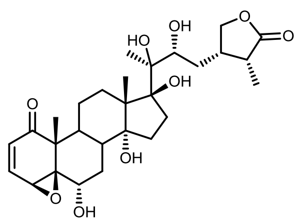

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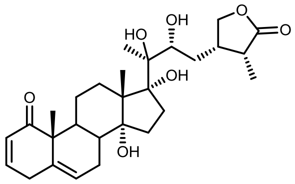

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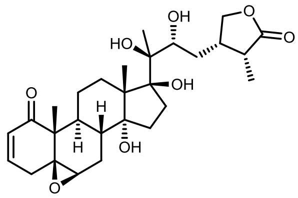

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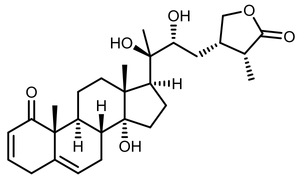

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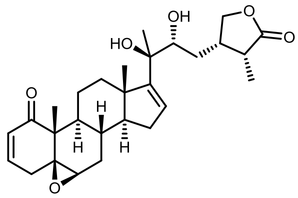

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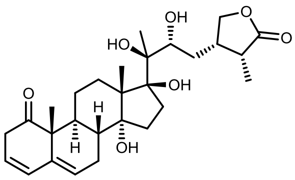

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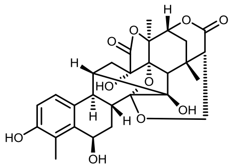
2.4 Other types



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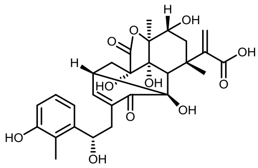

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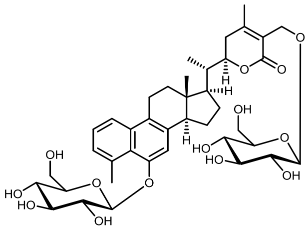

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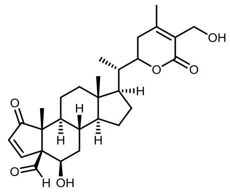

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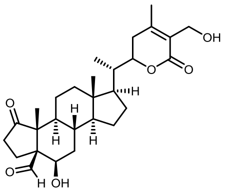

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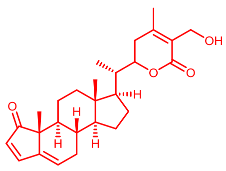

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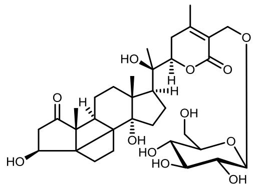

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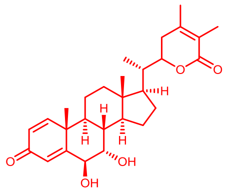

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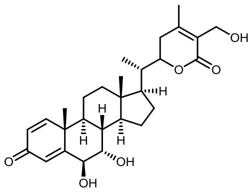

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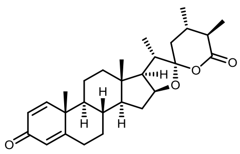

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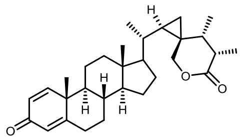

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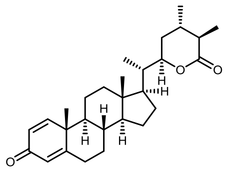

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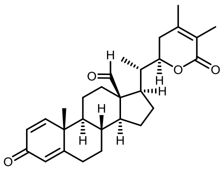

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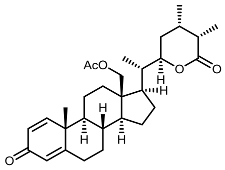

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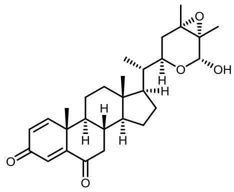

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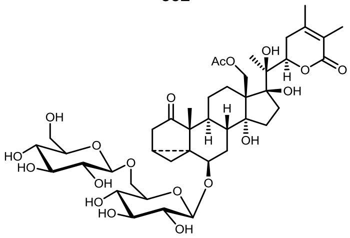

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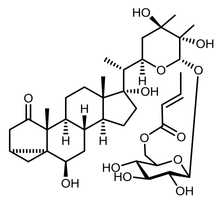

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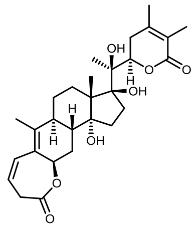

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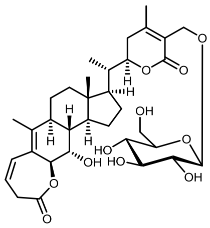

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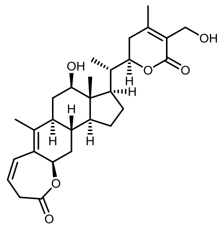

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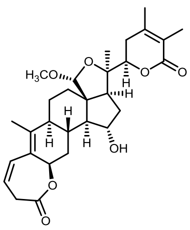

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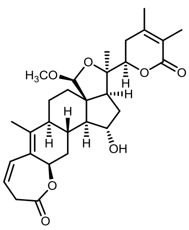

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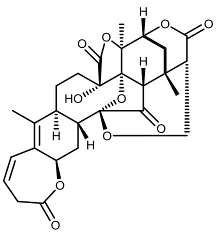

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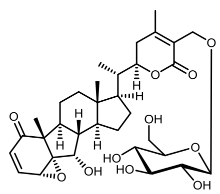

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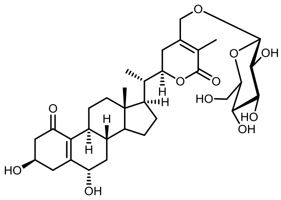
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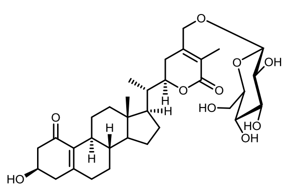
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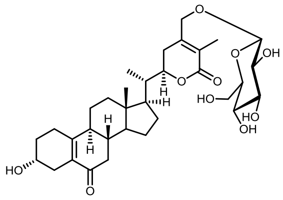
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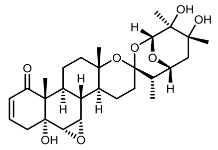
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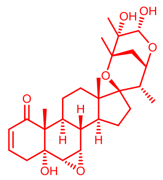
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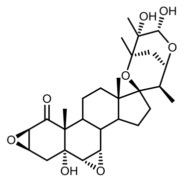
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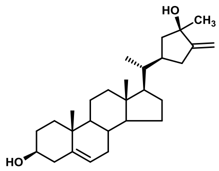
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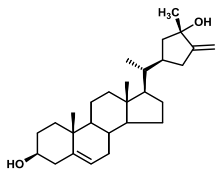
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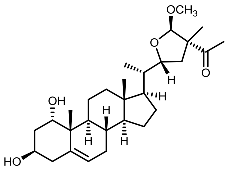
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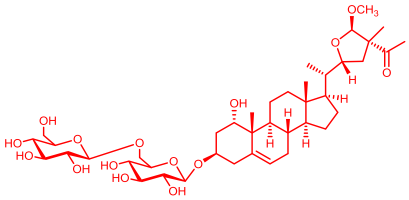
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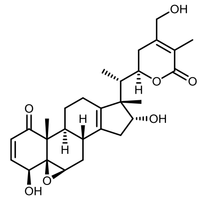
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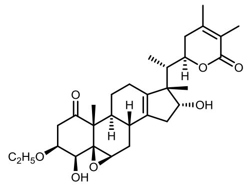
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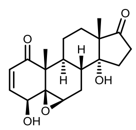
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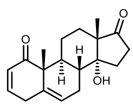
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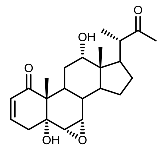
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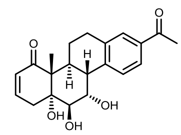
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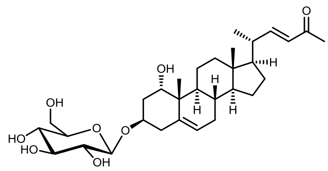
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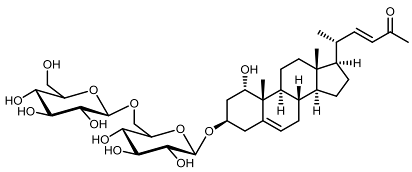
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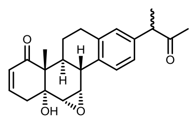

563

3. Biological activities

Table S1 Cytotoxic activity of natural withanolides reported during the covered period.

No.	Names	Cell lines	Activity	References
1	Withanolide D	HL-60	0.3 ± 0.05 μM	37
		HCT-116	0.3 ± 0.05 μM	
		SF-268	0.7 ± 0.2 μM	
		PANC-1	1.7 ± 0.06 μM	
4	(20R,22R)-5β,6β-epoxy-4β,12β,20-trihydroxy-1-oxowith-2-en-24-enolide	K562R	1.54 ± 0.08 μM	36
		DA1-3b/M2	0.93 ± 0.03 μM	
5	rel-(20R,22R)-5β,6β-Epoxy-4β,16α,20-trihydroxy-1-oxowitha-2,24-dienolide	HL-60	2.2 ± 0.6 μM	37
		HCT-116	3.2 ± 0.6 μM	
		SF-268	8.0 ± 1.4 μM	
6	Withalongolide O	B16F10	1.82±0.21 μM	39
		SKMEL-28	0.33±0.06 μM	
		JMAR	3.2±0.62 μM	
		MDA-1986	1.5±0.08 μM	
		MRC-5	1.3±0.11 μM	
7	Withalongolide A	SKMEL-28	5.1 μM	38
		JMAR	5.3 μM	
		MDA-1986	3.3 μM	
8	Withalongolide B	B16F10	0.20 μM	38
		SKMEL-28	3.90 μM	
		JMAR	0.17 μM	
		MDA-1986	1.30 μM	
		MRC-5	0.40 μM	
9	Withalongolide C	B16F10	0.49 μM	38
		SKMEL-28	3.00 μM	
		JMAR	0.77 μM	
		MDA-1986	2.60 μM	
		MRC-5	3.60 μM	
10	28-Hydroxytubocapsanolide A	HCT–116	3.17 ± 0.43 μM	40
		HepG2	3.38 ± 0.53 μM	
		MCF–7	1.86 ± 0.37 μM	
		A375	1.70 ± 0.06 μM	
11	27-O-acetyl-withaferin A	HeLa (48 h)	7.7 ± 0.3 μM	42
		HeLa (72 h)	4.7 ± 0.5 μM	
		A-549 (48 h)	6.7 ± 0.1 μM	
		A-549 (72h)	4.4 ± 0.1 μM	
		MCF-7 (48 h)	5.3 ± 0.1 μM	
		MCF-7 (72 h)	2.0 ± 0.05 μM	

12	5β,6β-Epoxy-4β-hydroxy-27-(1-formyloxy-1-methylethoxy)-1-oxo-witha-2,24-dienolide	HeLa (72 h) MCF-7 (48 h) MCF-7 (72 h)	37.3 ± 2.4 μM 26.9 ± 1.5 μM 18.3 ± 0.9 μM	42
13	Withalongolide B 4-acetae	B16F10 SKMEL-28 JMAR MDA-1986 MRC-5	0.19 μM 0.64 μM 0.12 μM 0.49 μM 0.16 μM	38
14	Withalongolide B 4,19-diacetae	B16F10 SKMEL-28 JMAR MDA-1986 MRC-5	0.13 μM 0.27 μM 0.24 μM 0.11 μM 0.51 μM	38
15	Withalongolide A 4,19,27-triacetae	B16F10 SKMEL-28 JMAR MDA-1986 MRC-5	0.067 μM 0.54 μM 0.16 μM 0.91 μM 0.58 μM	38
16	Withalongolide A 4,27-diacetae	B16F10 SKMEL-28 JMAR MDA-1986 MRC-5	0.098 μM 0.81 μM 0.14 μM 2.2 μM 0.41 μM	38
17	Withalongolide H	JMAR MDA-1986 MRC-5	8.2 μM 8.1 μM 8.7 μM	38
18	Physagulide T	HCT-116 MDA-MB-231	40.18 ± 2.96 μM 68.88 ± 4.56 μM	43
19	Physagulide V	HCT-116 MDA-MB-231	3.80 ± 0.29 μM 5.28 ± 0.67 μM	43
24	Alkekenginin A	HeLa SMMC-7721 HL-60	11.35 ± 1.22 μM 12.90 ± 1.57 μM 13.24 ± 1.83 μM	47
25	Physapubescin B	hepa 1c1c7	Inhibition(% of control) at 10μM 49.65 ± 0.12%	52
26	Physapubescin I	C4-2B CWR22Rvl 786-O A-498 Caki-2 ACHN A375	0.19 ± 0.02 μM 0.31 ± 0.07 μM 0.17 ± 0.03 μM 0.34 ± 0.02 μM 0.55 ± 0.01 μM 0.39 ± 0.03 μM 1.22 ± 0.09 μM	25

		A375-S2	5.30 ± 0.15 μM	
		L02	1.00 ± 0.14 μM	
27	(20S,22R,24S,25S,26R)-15α-acetoxy-5,6β:22,26:24,25-triepoxy-26-methoxy-4β-hydroxyergost-2-en-1-one	786-O	0.54 μM	49
		A-498	0.30 μM	
		Caki-2	0.77 μM	
		ACHN	0.32 μM	
29	Philadelphicalactone C	U-251	10.36 ± 1.0 μM	48
		PC-3	14.11 ± 1.4 μM	
		K-562	8.26 ± 0.80 μM	
		HCT-15	12.54 ± 0.57 μM	
		MCF-7	7.37 ± 0.36 μM	
		SKLU-1	5.40 ± 0.42 μM	
31	(20S,22R,24S,25S,26R/S)-15α-Acetoxy-5,6β:22,26:diepoxy-24-methoxy-4β,25,26-trihydroxyergost-2-en-1-one	786-O	0.39 μM	49
		A-498	1.11 μM	
		Caki-2	1.48 μM	
		ACHN	1.20 μM	
34	Physapubescin G	C4-2B	0.36 ± 0.11 μM	25
		CWR22Rvl	0.38 ± 0.06 μM	
		786-O	0.43 ± 0.09 μM	
		A-498	0.97 ± 0.65 μM	
		Caki-2	0.47 ± 0.03 μM	
		ACHN	0.43 ± 0.05 μM	
		A375	0.77 ± 0.07 μM	
		A375-S2	2.60 ± 0.64 μM	
		L02	0.65 ± 0.10 μM	
35	Physapubescin H	CWR22Rvl	7.92 ± 1.31 μM	25
		786-O	7.75 ± 0.81 μM	
		Caki-2	9.64 ± 1.83 μM	
		A375	8.44 ± 0.91 μM	
37	Withaneomexolide B	MDA-MB-231	1.7 ± 0.2 μM	27
		MCF-7	6.3 ± 1.2 μM	
40	(17S,20R,22R)-5β,6β-epoxy-18,20-dihydroxy-1-oxowitha-2,24-dienolide	A549	4.3 ± 0.1 μM	30
		K562	2.2 ± 0.2 μM	
44	Physapubescin D	hepa 1c1c7	Inhibition(% of control) at 10 μM 13.36 ± 0.07 %	52
45	(17S,20R,22R)-5β,6β-epoxy-18,20-dihydroxy-1-oxowitha-24-enolide	P388	8.03 ± 0.02 μM	54
		Hela	21.75 ± 0.23 μM	
		A549	11.36 ± 0.26 μM	
48	Withalongolide D	B16F10	3.2 μM	38
		SKMEL-28	9.3 μM	
		JMAR	4.7 μM	
		MRC-5	6.5 μM	

49	Withalongolide E	B16F10 MDA-1986 MRC-5	5.6 µM 8.3 µM 7.3 µM	38
51	27-O-acetyl-viscosalactone B	HeLa (48 h) HeLa (72 h) A-549 (48 h) A-549 (72h) MCF-7 (48 h) MCF-7 (72 h)	8.9 ± 0.3 µM 8.3 ± 0.3 µM 18.4 ± 0.7 µM 21.3 ± 1.8 µM 9.2 ± 0.2 µM 7.1 ± 0.4 µM	42
53	Physaminilide E	A375	2.0 ± 1.1 µM	56
54	Withalongolide G	B16F10 SKMEL-28 JMAR MDA-1986 MRC-5	1.3 µM 4.8 µM 2.3 µM 2.0 µM 3.3 µM	38
55	2,3-Dihydro-3β-O-sulfate withacnistin	MIA H460	1.9 ± 1.1 µM 4.1 ± 1.5 µM	57
56	(20R,22R)-16β-Acetoxy-3β,4β;5β,6β-diepoxy-12β,20-dihydroxy-1-oxowith-24-enolide	K562R DA1-3b/M2	30.0 ± 1.5 µM 28.30 ± 0.85 µM	36
57	Tubocaapsanolide MAP	MDA-MB-468	14.56 ± 0.15 µM	58
60	15α-acetoxy-5,6β:22,26:24,25-triepoxy-26α-hydroxy-3β-methoxy 4β-hydroxyergost-1-one	U937	10.32 ± 1.02 µM	59
64	15α-Acetoxy-5,6β:22,26-diepoxy-4β,24β,25α,26(α, β)-tetrahydroxyergost-3β-methoxy-1-one	U937	11.97 ± 0.98 µM	59
72	5β,6β,14β,15β-Diepoxy-4b,27-dihydroxy-1-oxowitha-2,24-dienolide (14β,15β-Epoxywithaferin A)	NCI-H460	GI_{50} 1.5 ± 0.12 µg/mL LC_{50} 8.3 ± 0.21 µg/mL	41, 62
74	15α-Acetoxyphysachenolide C	LNCaP PC-3M	1.2 ± 0.00 µM 1.8 ± 0.10 µM	76
77	23β-Hydroxywithanolide E	22Rv1	0.89 ± 0.10 µM	32
78	Physagulide S	HCT-116 MDA-MB-231	31.16 ± 2.09 µM 56.34 ± 3.45 µM	43
79	Physagulide P	MG-63 HepG-2 MDA-MB-231	3.50 µM 4.22 µM 15.74 µM	65
80	Physaliolide J	A549 SMMC-7721 MCF-7	31.25 ± 0.98 µM 36.76 ± 1.59 µM 35.17 ± 1.69 µM	69

81	24,25-Dihydrowithanolide E	LNCaP 22Rv1	0.29 ± 0.05 μM 0.21 ± 0.02 μM	32
82	17-Epi-philadelphicalactone A	LNCaP ACHN UO-31 HFF (normal)	>2.0 μM 6.9 ± 0.0 μM 7.3 ± 0.4 μM >10.0 μM	44
83	Physagulide R	HCT-116 MDA-MB-231	28.39 ± 1.29 μM 28.57 ± 1.68 μM	43
84	Physangulatin I	C4-2B 22Rv1 786-O	2.12 ± 0.47 μM 1.17 ± 0.24 μM 2.20 ± 0.07 μM	66
88	Physaliolide H	A549 SMMC-7721 MCF-7	58.71 ± 2.58 μM 62.97 ± 1.98 μM 70.15 ± 1.22 μM	69
90	Physagulide U	HCT-116 MDA-MB-231	22.76 ± 1.52 μM 24.44 ± 1.12 μM	43
94	Physaminilide B	A375	3.4 ± 0.9 μM	56
95	Physaliolide K	A549 SMMC-7721 MCF-7	40.25 ± 1.87 μM 45.36 ± 1.36 μM 48.74 ± 0.98 μM	69
98	Physaliolide G	A549 SMMC-7721 MCF-7	63.20 ± 1.77 μM 78.56 ± 2.65 μM 80.14 ± 1.66 μM	69
100	Physaliolide I	A549 SMMC-7721 MCF-7	36.78 ± 4.25 μM 42.01 ± 0.98 μM 38.59 ± 2.01 μM	69
102	3-Methoxy-2,3-dihydrowithangulatin A	A375	9.4 ± 3.3 μM	56
105	5β,6β-epoxy-4β,16β,27-trihydroxy-1-oxo-witha-2,17(20),24-trienolide	HeLa (48 h) HeLa (72 h) MCF-7 (48 h) MCF-7 (72 h)	40.0 ± 2.1 μM 31.1 ± 2.6 μM 27.7 ± 2.0 μM 6.0 ± 0.1 μM	42
108	Obtusifonolide	SW-620	7.3 μM	70
115	(22*R*)-4*α*,17*α*,27-Trihydroxy-1-oxo-witha-2,5,24-trienolide	MCF-7	26.6 μM	74
119	Dinoxin B	MDA-MB453 MDA-MB231 MCF7 MDA-MB468 HS578T T47D Colo205	3.0 ± 0.05 μM 1.0 ± 0.07 μM 0.61 ± 0.05 μM 0.58 ± 0.07 μM 0.44 ± 0.38 μM 0.22 ± 0.06 μM 2.2 ± 0.12 μM	77

		HCT116	1.0 ± 0.07 μM	
		SW48	0.58 ± 0.08 μM	
		RKO	0.36 ± 0.02 μM	
		A549	3.4 ± 0.02 μM	
		A427	0.87 ± 0.03 μM	
		HEPG2	1.5 ± 0.04 μM	
		HUH7	1.5 ± 0.02 μM	
		HEP3B	0.67 ± 0.29 μM	
		IEC6	3.3 ± 0.05 μM	
		NHF177	1.23 ± 0.06 μM	
		HUVEC	0.74 ± 0.09 μM	
		SK-MEL28	2.3 ± 0.05 μM	
		SK-MEL5	1.4 ± 0.03 μM	
		UACC62	0.50 ± 0.03 μM	
		SK-MEL2	0.36 ± 0.05 μM	
		OVCAR3	3.2 ± 0.06 μM	
123	Daturamalakoside B and 12α-Hydroxydaturametelin B	A549 DLD-1 WS1	7.0 ± 1.0 μM 2.0 ± 0.3 μM 1.3 ± 0.2 μM	134
127	Withasilolide A	SK-OV-3 SK-MEL-2 HCT-15	7.9 μM 3.4 μM 5.1 μM	99
128	Withasilolide B	SK-OV-3 SK-MEL-2 HCT-15	8.8 μM 5.9 μM 5.7 μM	99
137	5,6-De-epoxy-5-en-7-one-17-hydroxy withaferin A	MCF-7 WRL-68 PC-3 CACO-2	1.0 ± 0.1 μM 1.0 ± 0.1 μM 3.4 ± 0.1 μM 7.4 ± 0.3 μM	83
144	Baimantuoluoline V	MCF-7 HepG2	36.6 μM 44.0 μM	89
153	Baimantuoluoline K	SGC-7901	29.2 μg/mL	118
156	Baimantuoluoline W	SGC-7901 HepG2	37.7 μM 33.9 μM	89
159	Baimantuoluoside J	SGC-7901 HepG2	40.2 μM 37.5 μM	89
184	Physapubside B	C4-2B	6.31 ± 1.1 μM	25
200	7β-Hydroxy-17-epi-withanolide K	LNCaP 22Rv1	0.94 ± 0.10 μM 0.99 ± 0.08 μM	32
201	7β-Hydroxywithanolide F	LNCaP 22Rv1	0.33 ± 0.04 μM 0.56 ± 0.01 μM	32
205	Wadpressine	RPMI 8226	3.2 ± 0.4 μM	94

209	15α-Acetoxy-2,3-dihydrophysachenolide D 3β-O-sulfate	LNCaP PC-3M NCI-H460 SF-268	0.12 ± 0.02 μM 0.43 ± 0.08 μM 2.5 ± 0.30 μM 2.8 ± 0.20 μM	76
210	15α-Hydroxyphysachenolide D	LNCaP PC-3M	0.19 ± 0.01 μM 0.60 ± 0.11 μM	76
211	27-Hydroxyphysachenolide D	LNCaP	3.7 ± 1.4 μM	76
225	Physaminilide H	A375	7.5 ± 1.2 μM	55
226	(4S,20S,22R)-4,27-Dihydroxy-1-oxo-witha-2,5,16,24-tetraenolide	HeLa A-549 MCF-7	10.8 μM 25.2 μM 13.5 μM	74
227	(4S,20S,22R)-4-Hydroxy-1-oxo-witha-2,5,16,24-tetraenolide	HeLa A-549 MCF-7	11.0 μM 28.4 μM 21.6 μM	74
228	(20S,22R)-27-Hydroxy-1,4-dioxo-witha-2,5,16,24-tetraenolide	HeLa A-549 MCF-7	15.3 μM 35.2 μM 13.9 μM	74
229	(4S,22R)-4,16β,27-Trihydroxy-1-oxo-witha-2,5,17(20),24-tetraenolide	MCF-7	10.3 μM	74
234	Withasilolide D	SK-MEL-2 HCT-15	9.2 μM 9.8 μM	99
235	Baimantuoluoline O	SGC-7901 HepG2	35.5 μM 37.3 μM	89
242	Philadelphicalactone D	U-251 PC-3 K-562 HCT-15 MCF-7 SKLU-1	5.57 ± 1.40 μM 15.39 ± 1.00 μM 69.22 ± 4.30 μM 13.78 ± 1.30 μM 15.04 ± 1.10 μM 24.73 ± 0.16 μM	48
243	Chantriolide D	HCT-116 HepG2 BGC-823 NCI-H1650 A2780	10 μM 10 μM 10 μM 10 μM 4.61 μM	150
244	Dioscorolide A	A549 SK-OV-3 SK-MEL-2 HCT15 HUVEC	20.4 ± 0.7μM 7.1 ± 1.3μM 6.3 ± 0.5μM 26.9 ± 2.1μM 28.8 ± 1.4μM	103
245	Dioscorolide B	A549 SK-OV-3 SK-MEL-2	12.6 ± 1.8μM 25.6 ± 0.4μM 19.7 ± 2.5μM	103

		HCT15 HUVEC	13.5 ± 0.8μM 27.1 ± 0.2μM	
265	Withasilolide F	SK-MEL-2 HCT-15	10.0 μM 7.6 μM	99
269	27-Acetoxy-4β,6α-dihydroxy-5β-chloro-1-oxowitha-2,24-dienolide	NCI-H460	GI_{50} 6.2 ± 0.30 μg/mL LC_{50} 95.6 ± 2.60 μg/mL	41
279	Physangulatin M	22Rv1	11.58 ± 1.35 μM	66
283	Baimantuoluoline P	SGC-7901 MCF-7	30.7 μM 29.9 μM	89
284	Baimantuoluoline Q	SGC-7901 MCF-7 HepG2	29.4 μM 35.8 μM 40.1 μM	89
285	Baimantuoluoline L	MCF-7 HepG2	32.4 μM 27.6 μM	89
286	Baimantuoluoline M	MCF-7	28.7 μM	89
299	Alkekenginin B	HeLa SMMC-7721 HL-60	13.77 ± 1.75 μM 16.25 ± 1.55 μM 15.02 ± 1.63 μM	47
300	Baimantuoluoline N	SGC-7901 MCF-7 HepG2	26.3 μM 27.9 μM 34.8 μM	89
302	Physapubescin C	hepa 1c1c7	Inhibition(% of control) at 10 μM 38.15 ± 0.03%	52
305	Physagulin P_1	A-549 PANC-1	13.47 ± 2.73 μM 20.23 ± 1.38 μM	115
309	Daturanolide C	HCT116 U87-MG NCI-H460 BGC823 HepG2	46.29 μM 16.89 μM 24.56 μM 13.49 μM 19.22 μM	114
310	Baimantuoluoline U	MCF-7	40.6 μM	89
321	Baimantuoluoside H_1	SGC-7901	37.7 μg/mL	118
374	Physalin D1	HeLa SMMC-7721 HL-60	4.65 ± 0.37 μM 5.35 ± 0.44 μM 5.06 ± 0.35 μM	47
400	15-Hydroxy-withaphysalin B	A549 K562	9.2 ± 0.1 μM 10.3 ± 0.1 μM	30

401	(17S, 20R,22R)-5β,6β:18,20-Diepoxy-15α,18-dihydroxy-1-oxowitha-24-enolide (18R and 18S)	A549	19.6 ± 0.3 μM	30
402	(17S,20R,22R)-5β,6β:18,20-Diepoxy-18-hydroxy-1-oxowitha-24-enolide (18R and 18S)	K562	10.6 ± 0.1 μM	30
410	rel-(18R,22R)-5β,6β:18β,20-Diepoxy-3β,18α-dimethoxy-4β-hydroxy-1-oxowith-24-enolide	HL-60 HCT-116 SF-268 PANC-1	3.4 ± 0.6 μM 2.2 ± 0.5 μM 2.7 ± 0.8 μM 4.4 ± 0.4 μM	37
415	18β-O-Methyl-withaphysalin 1	A549 HBL-100 HeLa SW1573 T-47D	3.1 ± 0.6 μM 3.6 ± 0.4 μM 3.2 ± 0.7 μM 3.3 ± 0.6 μM 3.9 ± 1.0 μM	81
416	18α-O-Ethyl-withaphysalin 1	A549 HBL-100 HeLa SW1573 T-47D WiDr	2.8 ± 0.1 μM 3.2 ± 0.3 μM 2.5 ± 0.03 μM 2.4 ± 0.9 μM 4.7 ± 1.0 μM 6.1 ± 1.9 μM	81
422	(22R)-13,14-Epoxy-14,15,28-trihydroxy-1-oxo-13,14-secowitha-3,5,24-trien-18,20:22,26-diolide	P388 A549	17.60 ± 0.11 μM 23.51 ± 0.17 μM	54
428	4β-Hydroxyacnistin I	HCT–116 HepG2 MCF–7 A375	2.13 ± 0.19 μM 4.23 ± 0.50 μM 4.52 ± 0.07 μM 1.36 ± 016 μM	40
429	25-Epi-anomanolide A	HCT–116 HepG2 MCF–7 A375	4.09 ± 0.24 μM 5.96 ± 0.57 μM 7.49 ± 0.88 μM 8.71 ± 0.49 μM	40
430	4β-Hydroxyanomanolide E	HCT–116 HepG2 MCF–7 A375	6.84 ± 0.37 μM 5.52 ± 0.50 μM 8.10 ± 0.90 μM 3.74 ± 0.17 μM	40
432	3β-Methoxy-2,3-dihydroanomanolide C	HCT–116 HepG2 MCF–7 A375	3.17 ± 0.43 μM 3.38 ± 0.53 μM 1.86 ± 0.37 μM 1.70 ± 0.06 μM	40
441	Withajardin J	HCT–116 HepG2 MCF–7	3.19 ± 0.43 μM 6.07 ± 0.76 μM 14.28 ± 1.17 μM	40

		A375	13.12 ± 0.67 μM	
442	Withajardin K	HCT–116 HepG2 MCF–7 A375	8.75 ± 1.40 μM 1.00 ± 0.06 μM 2.60 ± 0.23 μM 1.80 ± 0.41 μM	40
443	17-Epi-withajardin J	HCT–116 HepG2 MCF–7 A375	4.05 ± 0.23 μM 1.14 ± 0.25 μM 5.15 ± 0.06 μM 3.87 ± 0.20 μM	40
445	Daturamalakoside A and withametelin Q	A549 DLD-1 WS1	92.0 ± 2.0 μM 17.0 ± 3.0 μM 22.0 ± 2.0 μM	134
447	Withawrightolide	U87 U251 MDA-1986 MRC-5 MRC-5:U87	1.5 μM 3.6 μM 3.1 μM 5.6 μM 3.8 μM	135
448	Baimantuoluoline R	SGC-7901 HepG2	21.8 μM 42.3 μM	89
449	Baimantuoluoline S	SGC-7901	35.7 μM	89
450	Baimantuoluoline T	HepG2	28.6 μM	89
451	Withametelin L	U87 U251 MDA-1986 MRC-5 MRC-5:U87	0.57 μM 1.3 μM 2.3 μM 4.2 μM 7.4 μM	135
452	Physangulide B	PC-3 SKLU-1	0.43 ± 0.03 μM 0.35 ± 0.01 μM	46
453	4-O-Acetylphysangulide B	PC-3 SKLU-1	0.32 ± 0.02 μM 0.27 ± 0.01 μM	46
470	Salpichrolide V	LNCaP PC-3 T47D	40.23 ± 1.08 μM 54.16 ± 1.03 μM 45.25 ± 1.07 μM	141
484	Physangulidine A	 3T3 H460 HuTu 80 DU145 MCF-7 M-14 HT-29 K562	GI_{50} 4.12 μM 3.59 μM 4.18 μM 3.56 μM 5.26 μM 4.66 μM 2.73 μM 2.73 μM	143

		RWPE-1	2.40 Mm	
485	Physangulidine B		GI_{50}	143
		RWPE-1	6.0 μM	
		DU145	6.8 μM	
486	Physangulidine C		GI_{50}	143
		RWPE-1	6.6 μM	
		DU145	6.0 μM	
498	Sinubrasolide B	P388	9.1 ± 1.4 μM	145
		MOLT-4	4.8 ± 0.9 μM	
		HT-29	4.8 ± 0.7 μM	
500	Sinubrasolide J	P388	18.7 ± 3.1 μM	146
		MOLT-4	17.2 ± 1.5 μM	
		K-562	12.6 ± 3.1 μM	
		HT-29	11.2 ± 1.1 μM	
502	Sinubrasolide E	MOLT-4	9.9 ± 1.8 μM	145
		HT-29	7.5 ± 1.5 μM	
504	Sinubrasolide H	P388	39.8 ± 7.7 μM	146
		MOLT-4	28.6 ± 5.9 μM	
		K-562	29.7 ± 8.6 μM	
		HT-29	24.4 ± 6.2 μM	
506	Sinubrasolide K	P388	18.3 ± 2.6 μM	146
		MOLT-4	13.7 ± 3.3 μM	
		K-562	17.4 ± 3.3 μM	
		HT-29	20.5 ± 3.7 μM	
508	Jaborosalactone 47_1	HBL-100	82 ± 26 μM	147
		HeLa	41 ± 5.7 μM	
		SW1573	72 ± 12 μM	
533	Paraminabeolide A	HepG2	8.0 μM	53
534	Paraminabeolide B	MDA-MB-231	19.3 μM	53
		MCF-7	14.9 μM	
551	Alkesterol A	HeLa	22 μM	156
		SMMC-7721	30 μM	
		HL-60	16 μM	
552	Alkesterol B	HeLa	19 μM	156
		SMMC-7721	36 μM	
		HL-60	21 μM	
553	Withapubesin	786-O	28.9 ± 2.8 μM	132
		CWR22Rvl	22.1 ± 2.34 μM	
		A375	26.6 ± 5.8 μM	
555	28-Hydroxytubocapsenolide A	HCT–116	1.05 ± 0.12 μM	40
		HepG2	12.58 ± 1.67 μM	
		MCF–7	11.15 ± 0.50 μM	

		A375	18.95 ± 0.33 μM	
557	Irinan A	A549 L929 KB-3-1 MCF-7	5.01 ± 5.27 μM 2.29 ± 0.88 μM 4.62 ± 5.76 μM 17.88 ± 7.27 μM	157
558	Irinan B	A549 L929 KB-3-1 MCF-7	3.45 ± 1.91 μM 1.68 ± 1.78 μM 2.40 ± 2.32 μM 13.56 ± 9.18 μM	157
561	Withapubeside C	786-O C4-2B CWR22Rvl A375 A375-S2	9.47 ± 2.15 μM 3.05 ± 1.44 μM 5.32 ± 1.83 μM 8.67 ± 2.36 μM 9.12 ± 3.45 μM	132

Table S2 Anti-inflammatory activity of natural withanolides reported during the covered period.

No.	**Names**	**Anti-inflammatory** **Inhibition of NO production**	**References**
22	Virginol A	TPA-induced ear edema model IC_{50} = 0.27 μM/ear	26
28	Peruvianolide C	1.5 ± 0.1 μM	28
32	Capsisteroid F	Superoxide anion Inhibition 7.9 ± 0.3 % Elastase release Inhibition 11.1 ± 3.0 %	50
38	Peruvianolide D	1.4 ± 0.1 μM	28
55	2,3-Dihydro-3β-O-sulfate withacnistin	1.0 ± 0.1 μM	57
80	Physaliolide J	43.26 ± 1.73 μM	69
84	Physangulatin I	3.51 ± 0.17 μM	66
88	Physaliolide H	58.37 ± 1.56 μM	69
89	Physaliolide M	23.53 ± 1.15 μM	111
95	Physaliolide K	42.18 ± 1.59 μM	69
96	Physaminimin F	90.27 ± 3.27 μM	129
97	Physaliolide L	27.35 ± 1.53 μM	111
98	Physaliolide G	73.26 ± 2.53 μM	69
100	Physaliolide I	52.71 ± 2.41 μM	69
104	Physaperuvin I	14.6 ± 1.2 μM	68
112	Withacoagulin G	1.9 ± 0.1 μM Inhibition of NF-κB 11.8 ± 2.9 μM	73
113	Withacoagulin H	3.1 ± 0.3 μM Inhibition of NF-κB 5.0 ± 1.2 μM	73
121	Cilistol G	Superoxide anion Inhibition 20.9 ± 2.3 %	50

		Elastase release Inhibition 19.2 ± 5.3 %	
122	Capsisteroid A	Superoxide anion Inhibition 21.1 ± 6.8 % Elastase release Inhibition 15.8 ± 3.7 %	50
124	Dmetelin D	11.6 μM	80
125	Daturmetelide P	25.98 ± 1.32 μM	82
126	Dmetelin C	28.6 μM	80
132	Daturmetelide G	13.92 ± 0.89 μM	82
135	Daturmetelide R	25.32 ± 1.84 μM	82
139	Capsisteroid G	Superoxide anion Inhibition 5.4 ± 5.3 % Elastase release Inhibition 14.4 ± 2.3 %	79
140	Capsisteroid H	Superoxide anion Inhibition 14.8 ± 7.0 % Elastase release Inhibition 3.1 ± 5.4 %	79
142	Capsisteroid B	Superoxide anion Inhibition 13.2 ± 2.9 % Elastase release Inhibition 10.3 ± 5.1 %	50
143	Capsisteroid C	Superoxide anion Inhibition 11.2 ± 5.1 % Elastase release Inhibition 11.5 ± 6.1 %	50
145	Withacoagulin I	29.0 ± 0.7 μM Inhibition of NF-κB 8.8 ± 3.1 μM	73
150	Daturmetelide Q	24.52 ± 0.12 μM	82
152	Dmetelin A	17.8 μM	80
161	Daturafoliside A	20.9 μM	87
162	Daturafoliside B	17.7 μM	87
163	Daturafoliside C	59.0 μM	87
165	Daturafoliside T	18.64 ± 1.12 μM	88
166	Daturafoliside F	71.2 μM	87
174	Daturafoliside D	52.8 μM	87
279	Physangulatin M	17.62 ± 1.12 μM	66
280	Physangulatin N	71.69 ± 4.27 μM	66
288	Physaliolide B	77.17 ± 2.15 μM	110
289	Physaliolide A	53.16 ± 1.53 μM	110
290	Physaliolide D	40.25 ± 1.78 μM	110
291	Physaliolide F	75.26 ± 1.46 μM	110
292	Physaliolide O	30.25 ± 1.78 μM	111
294	Capsisteroid D	Superoxide anion Inhibition 7.4 ± 3.8 % Elastase release Inhibition 26.9 ± 6.6 %	50
295	Capsisteroid I	Superoxide anion Inhibition 20.9 ± 2.1 % Elastase release Inhibition 42.9 ± 3.4 %	79
297	Physaliolide N	28.96 ± 1.78 μM	111
301	Dmetelin B	33.3 μM	80
304	Capsisteroid E	Superoxide anion Inhibition 34.0 ± 3.1 % Elastase release Inhibition 15.6 ± 5.5 %	50

306	Daturmetelide C	18.18 ± 0.97 μM	82
330	Daturmetelide T	28.54 ± 2.58 μM	82
331	Daturmetelide U	26.83 ± 2.00 μM	82
332	Daturafoliside M	14.43 ± 1.01 μM	88
333	Daturafoliside R	33.36 ± 2.67 μM	88
340	Physaperuvin G， withanolide S	Inhibition of NF-κB 31.2 ± 3.3 μM	68
341	Physaperuvin J	Inhibition of NF-κB 10.4 ± 3.6 μM	68
343	Physangulatin K	3.53 ± 0.25 μM	66
346	Physangulatin J	6.36 ± 0.39 μM	66
354	Physangulatin A	36.47 ± 2.50 μM	66
355	Physangulatin B	38.23 ± 2.41 μM	66
356	Physangulatin C	11.15 ± 0.92 μM	66
357	Physangulatin D	11.59 ± 0.88 μM	66
358	Physangulatin E	11.36 ± 0.87 μM	66
359	Physangulatin F	18.74 ± 1.33 μM	66
361	Physangulatin H	44.56 ± 3.02 μM	66
362	Physaliolide C	74.27 ± 1.78 μM	110
363	Physaliolide E	66.28 ± 1.59 μM	110
364	Physaliolide P	66.28 ± 1.59 μM	111
369	Physalin X	68.50 ± 1.51 μM	121
370	Physalin VIII	69.81 ±4.44 μM	122
376	Isophysalin A	Average inhibitory rate 83.88 ± 1.19 % at 20 μM	126
380	Physalin VII_1	34.19 ±2.26	122
391	Withaphysalin Z	17.53 ± 1.05 μM	66
393	Withaminima D	3.91 ± 0.49 μM	139
394	Withaminima E	51.48 ± 2.86 μM	139
395	Withaminima F	43.79 ± 5.19 μM	139
398	Physaminimin C	93.54 ± 4.02 μM	129
405	Physaminimin D	64.72 ± 1.96 μM	129
406	Physaminimin E	10.01 ± 0.75 μM	129
407	Physaminimin G	17.41 ± 1.04 μM	128
411	Physaminimin H	36.33± 1.95 μM	128
413	Physaminimin K	21.48 ± 1.67 μM	128
417	Withaminima B	8.68 ± 2.95 μM	139
418	Withaminima C	14.54 ± 7.15 μM	139
420	Minisecolide B	25.34 ± 1.95 μM	130
421	Minisecolide C	20.81 ± 2.11 μM	130
425	Withaphysalin Y	25.91 ± 1.53 μM	66
426	Withapubeside B	27.3 ± 2.8 μM	132

458	Withaminima A	18.46 ± 2.89 μM	139
493	Paraminabeolide C	Reduced the levels of iNOS at the concentration of 10 μM 37.9 ± 9.9%	53
494	Paraminabeolide D	Reduced the levels of iNOS at the concentration of 10 μM 43.4 ± 9.5%	53
500	Sinubrasolide J	Superoxide anion Inhibition at 10 μM 32.1 ± 5.3 % Elastase release Inhibition 10 μM 9.5 ± 5.2 %	146
504	Sinubrasolide H	Superoxide anion Inhibition at 10 μM 14.4 ± 3.1 % Elastase release Inhibition 10 μM 32.4 ± 5.6 %	146
505	Sinubrasolide I	Superoxide anion Inhibition at 10 μM 17.3 ± 5.5 % Elastase release Inhibition 10 μM 12.5 ± 6.1 %	146
506	Sinubrasolide K	Superoxide anion Inhibition at 10 μM 34.3 ± 6.6 % Elastase release Inhibition 10 μM 11.4 ± 3.2 %	146
521	Aromaphysalin A	51.64 μM	151
522	Aromaphysalin B	29.69 ± 1.08 μM	121
528	Daturmetelide A	13.74 ± 1.24 μM	82
529	Daturmetelide B	16.08 ± 0.79 μM	82
532	Sinubrasolide L	Superoxide anion Inhibition at 10 μM 26.3 ± 0.7 % Elastase release Inhibition 10 μM 25.0 ± 1.3 %	146
533	Paraminabeolide A	Reduced the levels of iNOS at the concentration of 10 μM 11.0 ± 7.7%	53
534	Paraminabeolide B	Reduced the levels of iNOS at the concentration of 10 μM 7.3 ± 1.0%	53
535	Peruvianolide B	7.0 ± 0.2 μM	28
539	Daturafoliside K	22.83 ± 1.34 μM	88
541	Physaminimin A	25.54 ± 2.35 μM	129
542	Physaminimin B	8.04 ± 1.54 μM	129
543	Physalin V_1	19.72 ±1.16 μM	122
544	Daturafoliside L	9.37 ± 0.87 μM	88

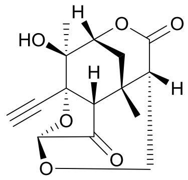
553	Withapubesin	55.3 ± 3.2 μM	132
554	Withapubeside A	72.9 ± 11.5 μM	132
561	Withapubeside C	18.7 ± 3.9 μM	132
562	Withapubeside D	65.8 ± 10.7 μM	132

Table S3 Leishmanicidal, QR induction, antifungal, and peroxisome proliferator-activated receptor transactivational activities of natural withanolides reported during the covered period.

No.	Names	Leishmanicidal activities (IC_{50})	QR induction activities (fold increase from control)	Antifungal activities	Peroxisome Proliferator-Activated Receptor Transactivational Activities (EC_{50})	References
4	(20R,22R)-5β,6β-epoxy-4β,12β,20-trihydroxy-1-oxowith-2-en-24-enolide			*Pneumocystis carinii* IC_{50} 2.0 << 20.0 μM		36
25	Physapubescin B		2.30 ± 0.03			52
42	16-Oxojaborosalactone A			Against *Bacillus cereus*		31
44	Physapubescin D		1.27 ± 0.03			52
118	Withacoagulide C	5.1 μg/mL				96
146	Withacoagulide D	35.0 μg/mL				96
222	14α,15α,17β,20-Tetrahydroxy-1-oxowitha-2,5,24-trienolide	15.9 μg/mL				62,96
223	Withacoagulin C	50.0 μg/mL				62,96,97
236	Plantagiolide I				4.1 ± 0.8 μM	100
237	Plantagiolide J				18.5 ± 3.2 μM	100

302	Physapubescin C	1.86 ± 0.14		52
338	Physagulin P	1.79 ± 0.01		116
339	14-Epi-physagulin P	2.85 ± 0.02		116
349	Physagulin Q	1.51 ± 0.05		116
368	Aminophysalin A	1.09 ± 0.02		120
373	5β-Hydroxy-6α-chloro-5,6-dihydrophysalin B	1.03 ± 0.01		120
433	Acnistin I_1		Against Bacillus cereus	31

6. Chemical synthesis and structural modifications



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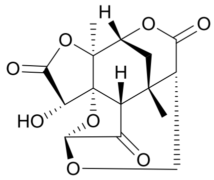

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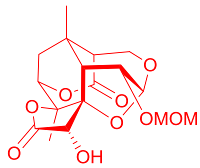

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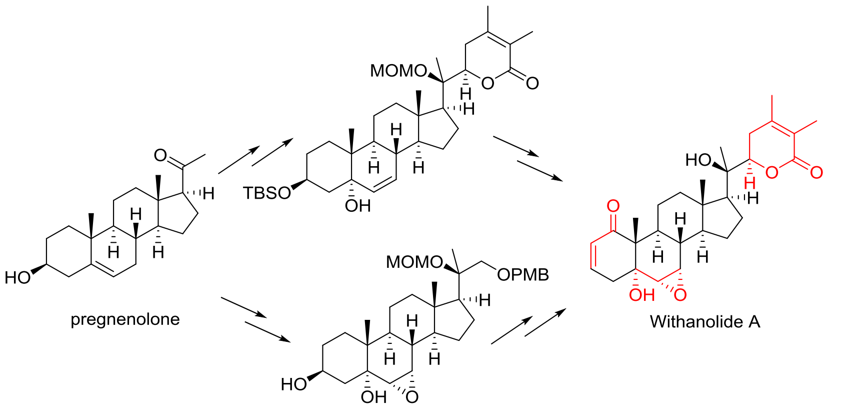
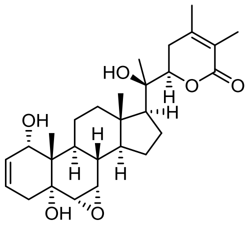


Scheme 1. Key point of the two strategies of the synthesis of withanolide A.[1,2]



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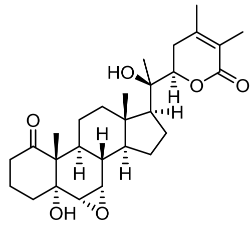

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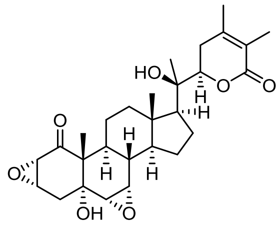

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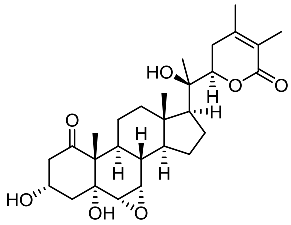

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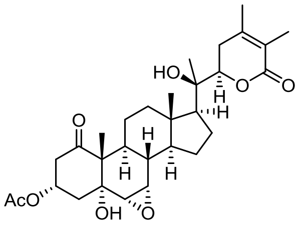

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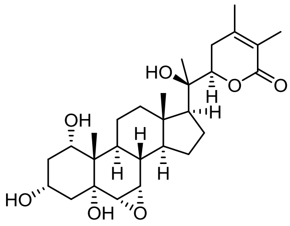

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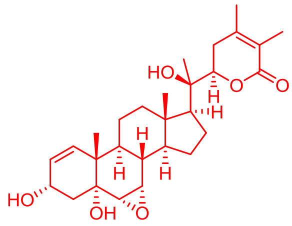

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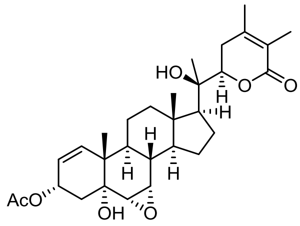

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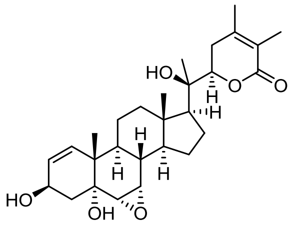

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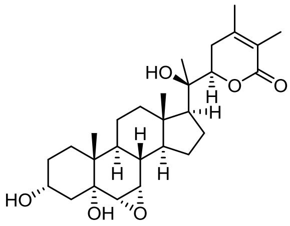

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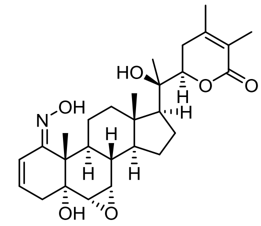

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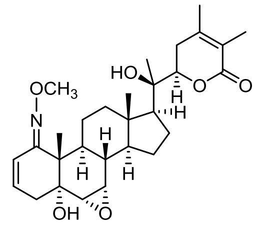

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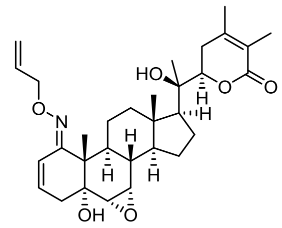

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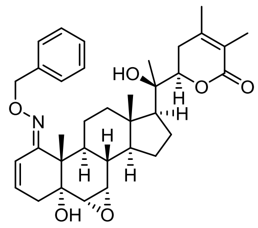

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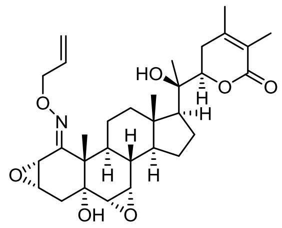

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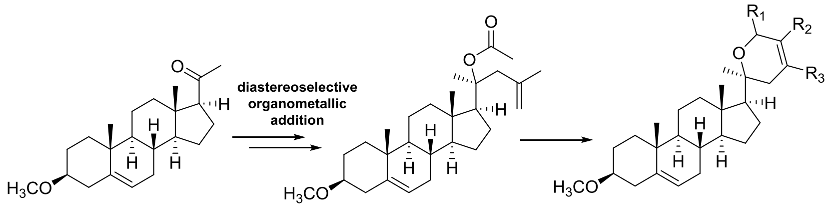
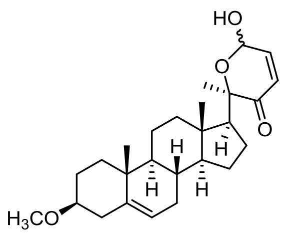


Scheme 2. Key point of the synthesis of *δ*-lactone analogues.[3]



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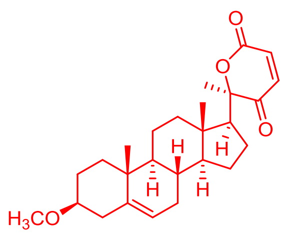

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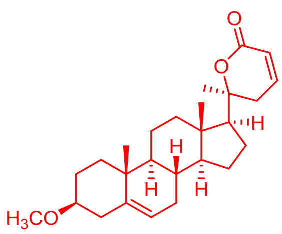

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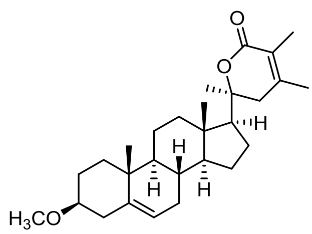

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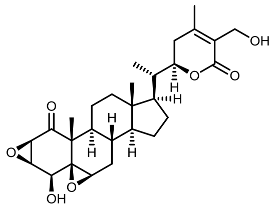

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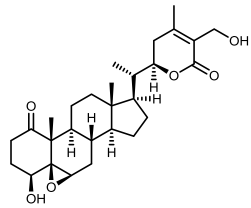

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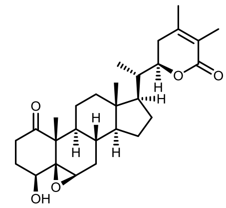

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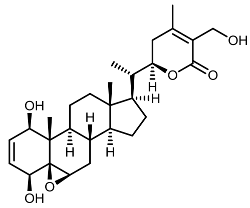

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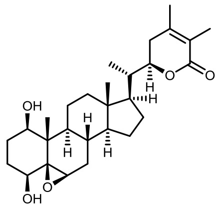

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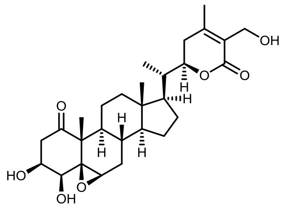

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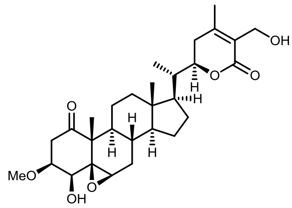

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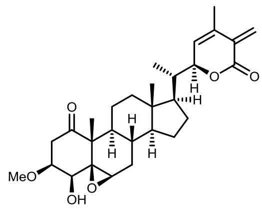

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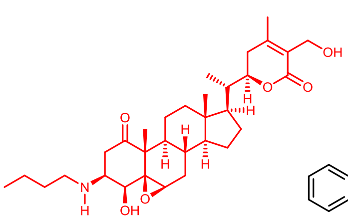

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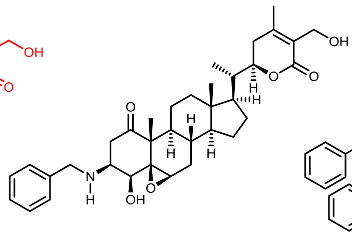

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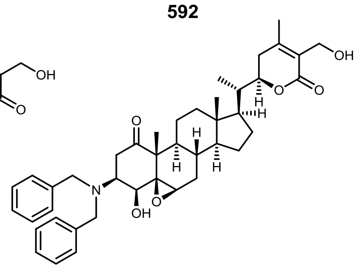

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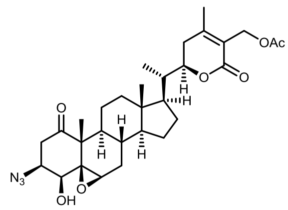

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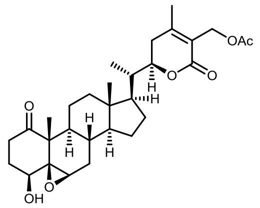

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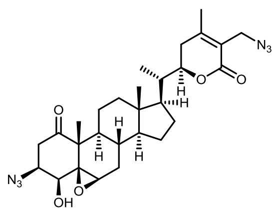

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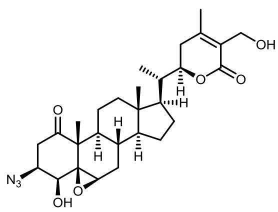

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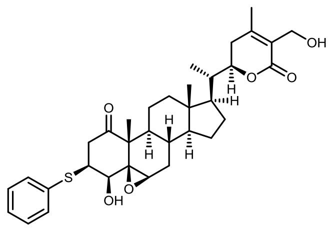

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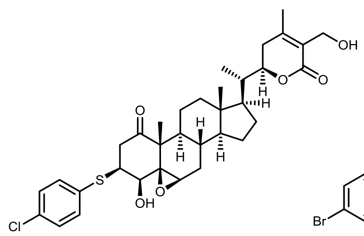

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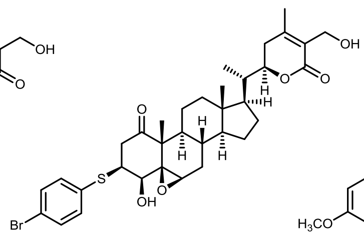

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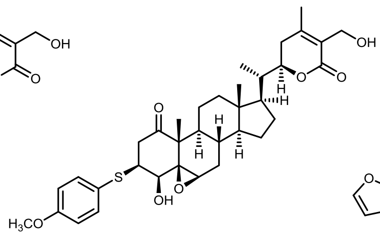

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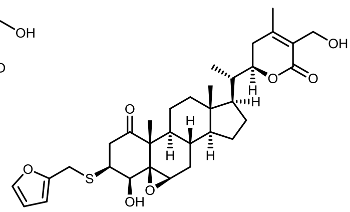

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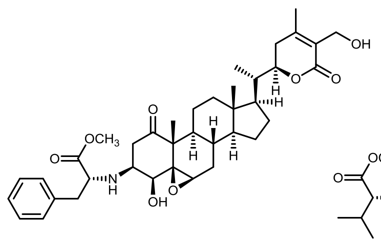

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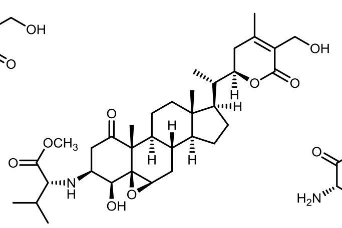

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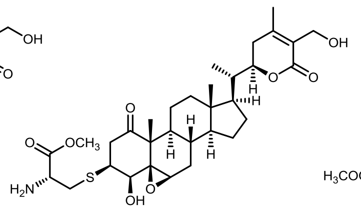

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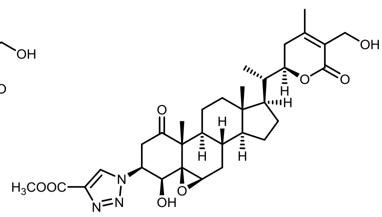

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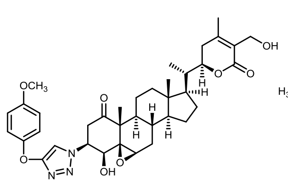

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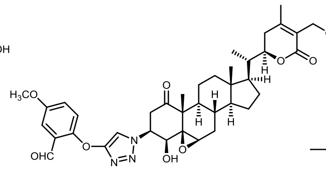

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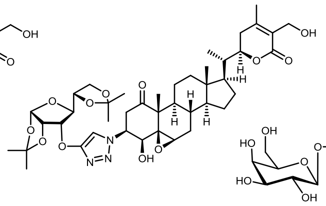

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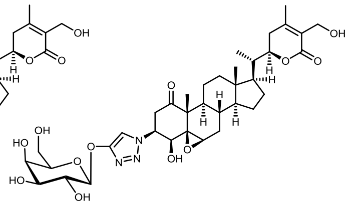

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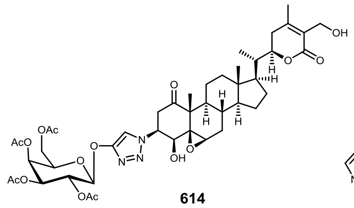

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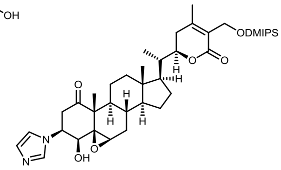

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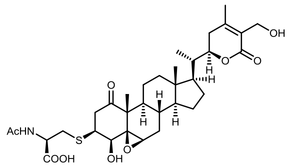

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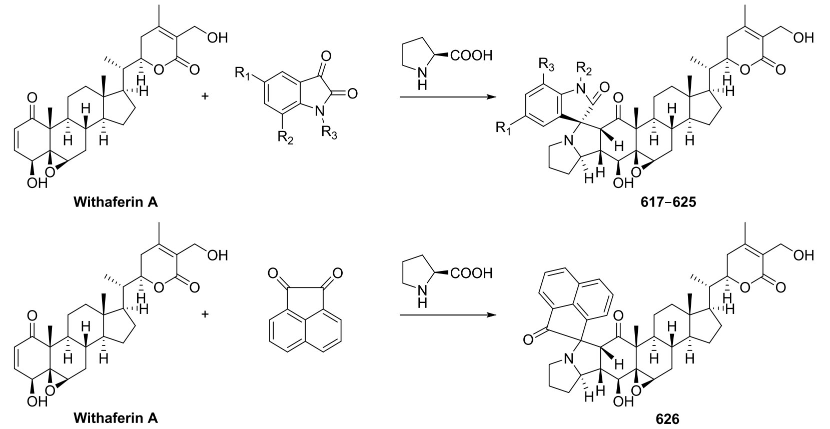
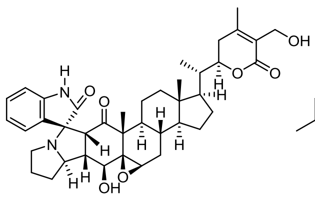


Scheme 3 Key point of the semi-synthesis withaferin A derivatives.[4]



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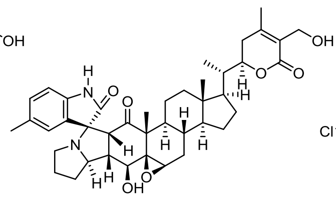

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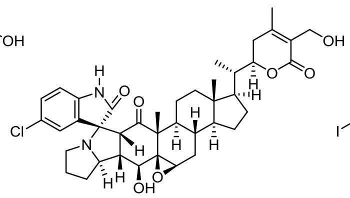

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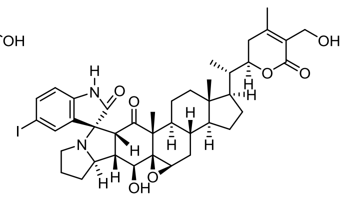

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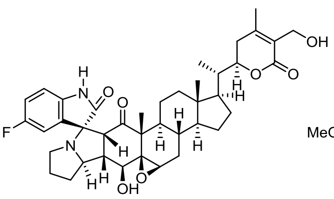

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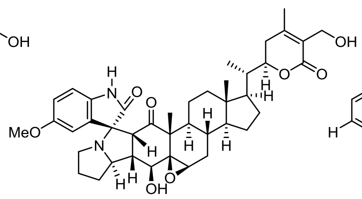

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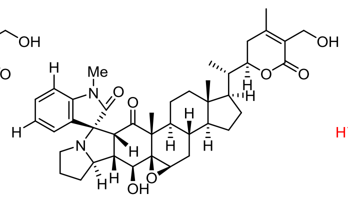

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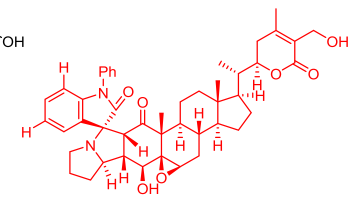

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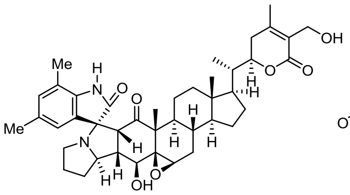

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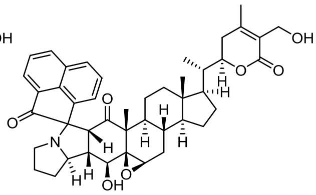

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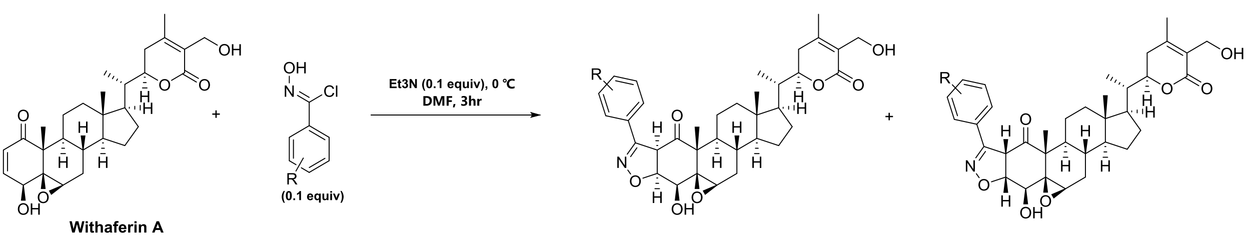
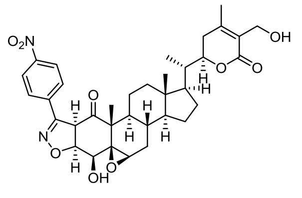


Scheme 4 Key point of the semi-synthesis withaferin A derivatives.[5]



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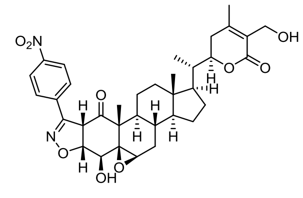

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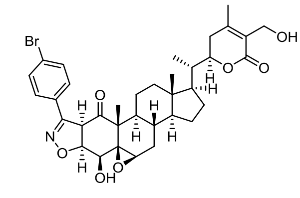

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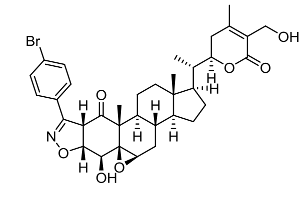

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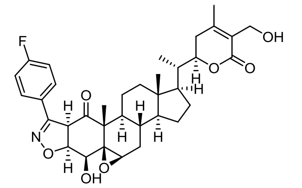

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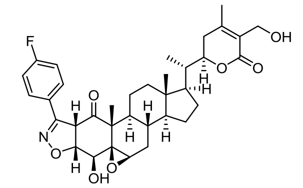

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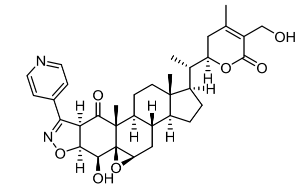

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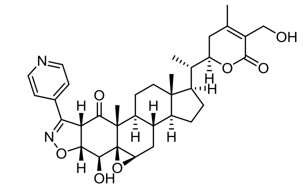

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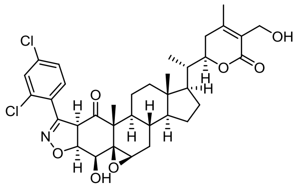

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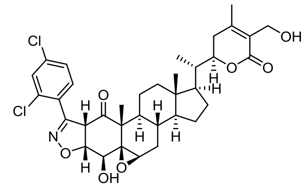

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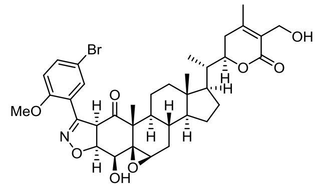

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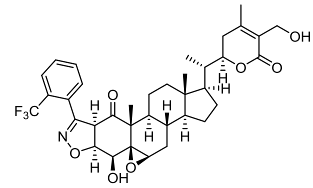

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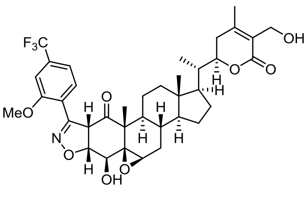

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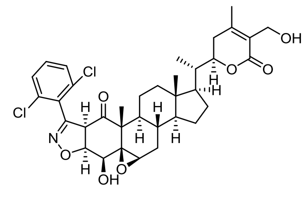

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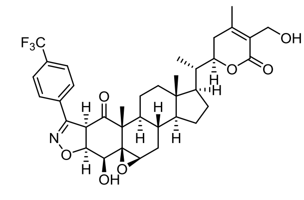

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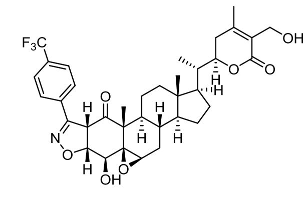

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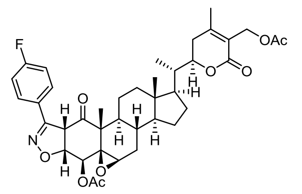

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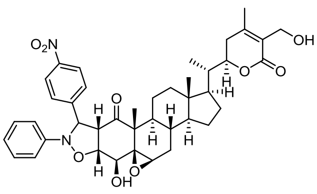

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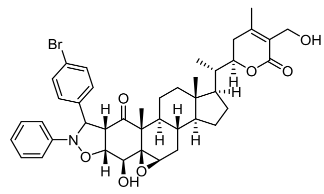

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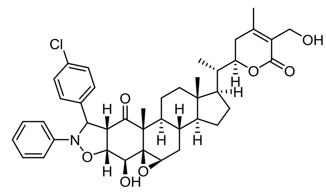

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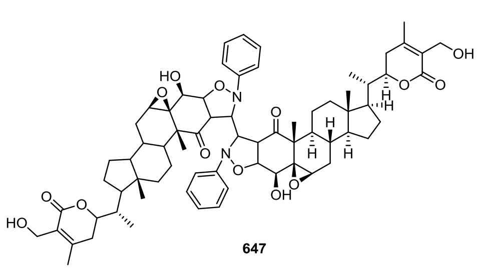

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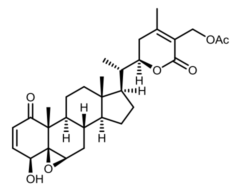
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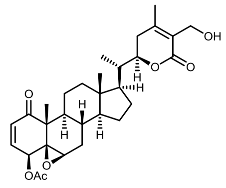
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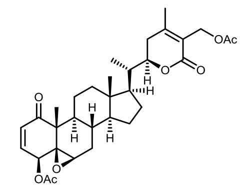
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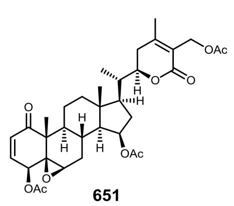
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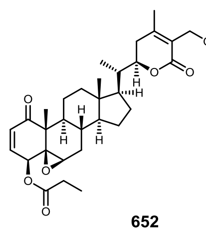
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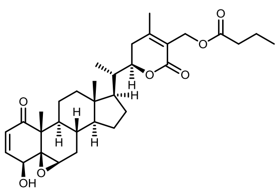
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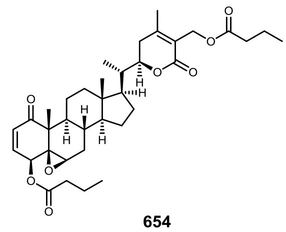
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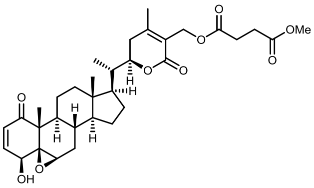
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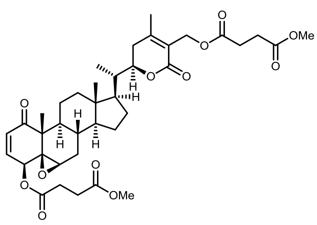
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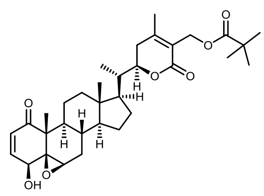
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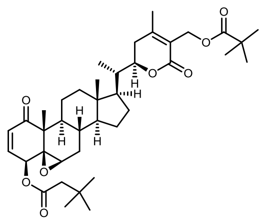
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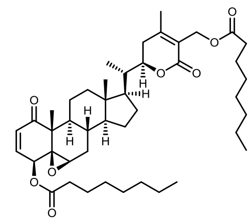
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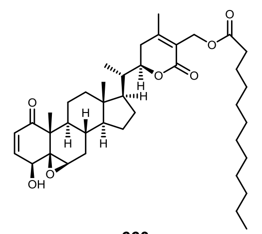
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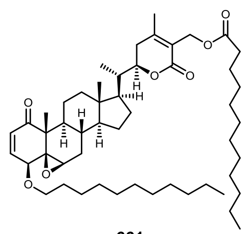
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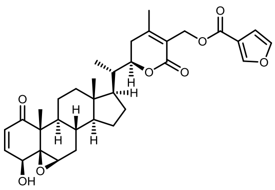
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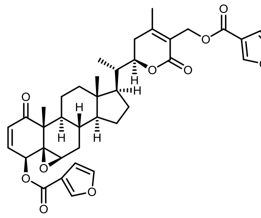
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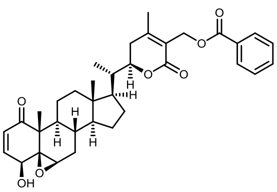
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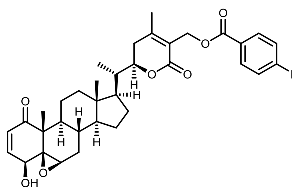
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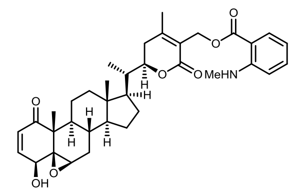
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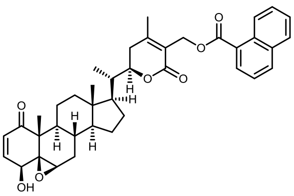
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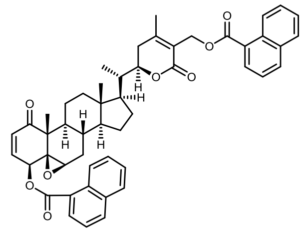
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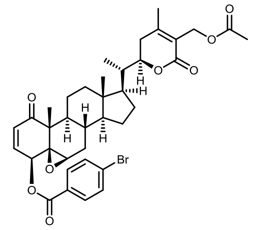
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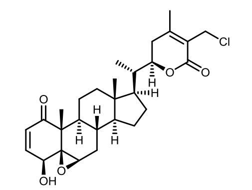
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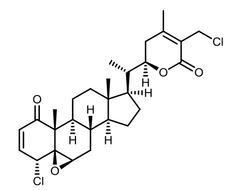
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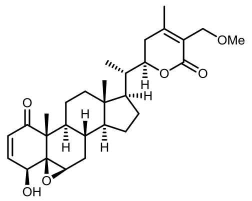

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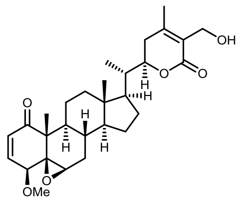

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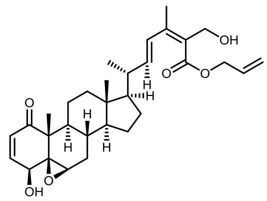

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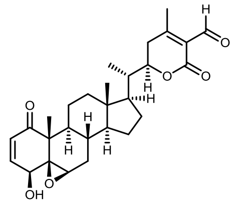

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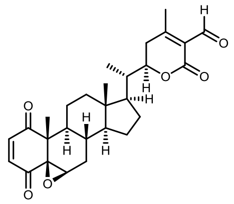

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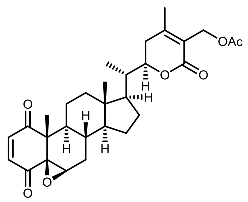

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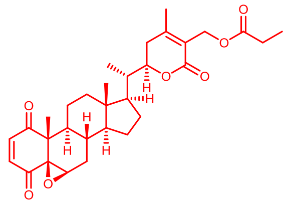

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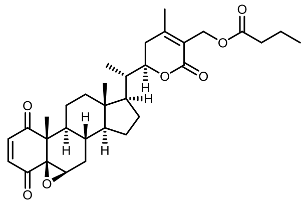

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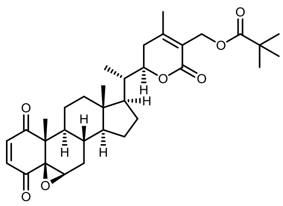

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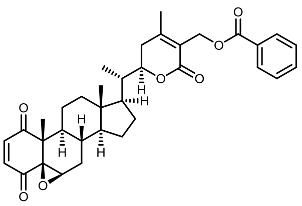

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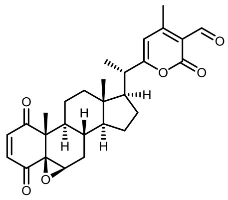

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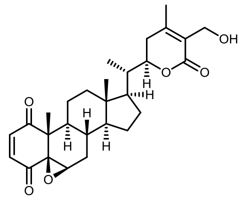

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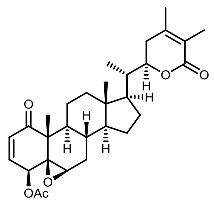

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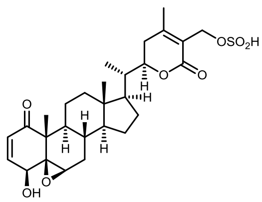

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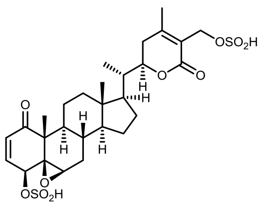

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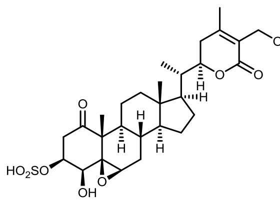

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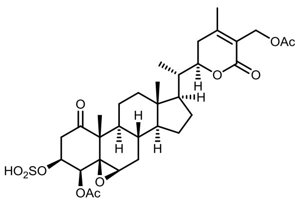

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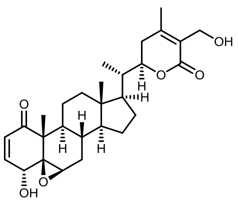

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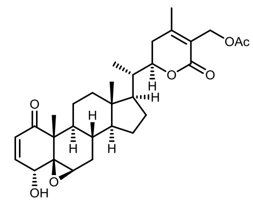

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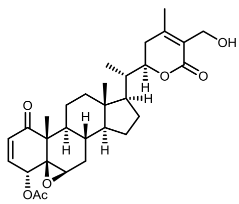

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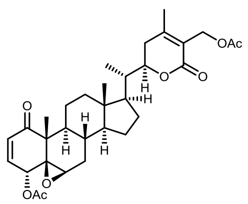

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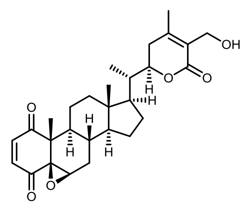

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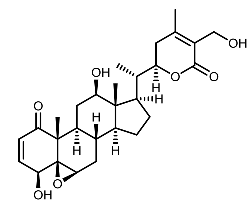

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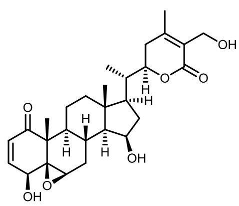

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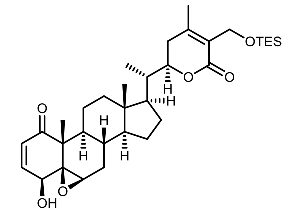

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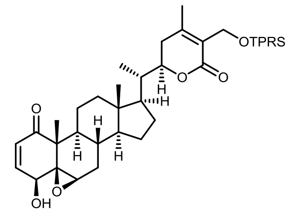

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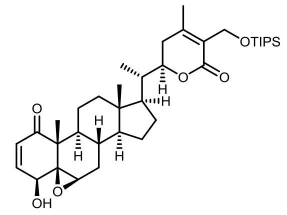

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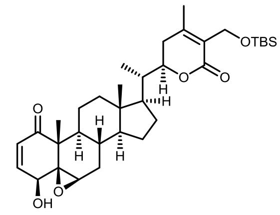

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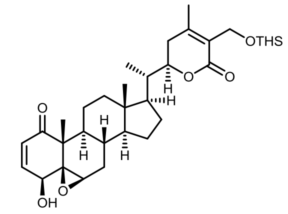

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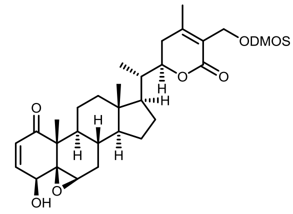

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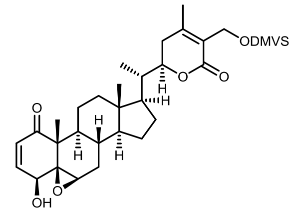

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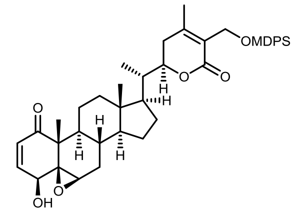

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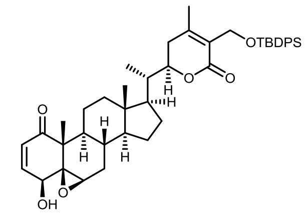

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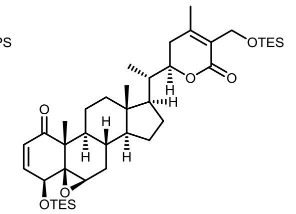

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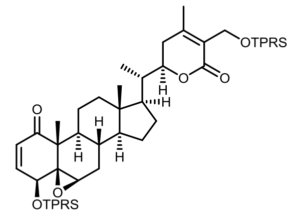

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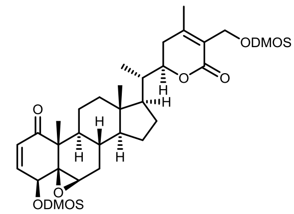

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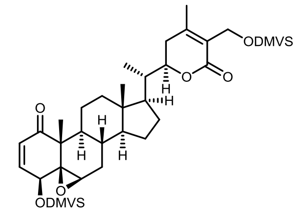

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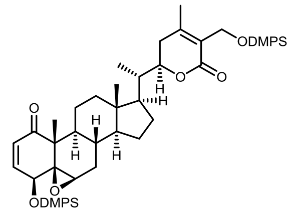

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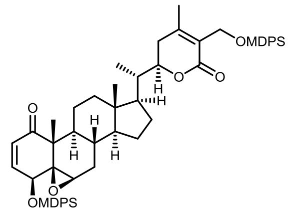

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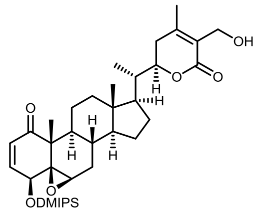

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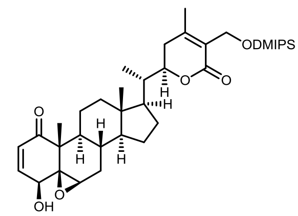

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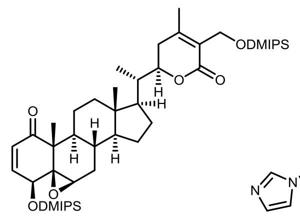

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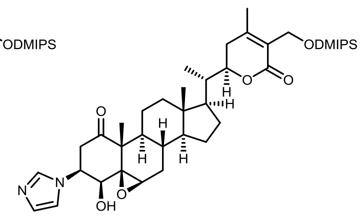

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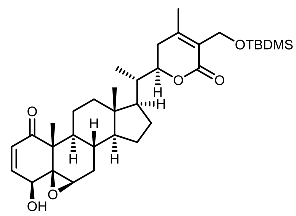

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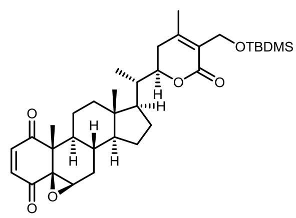

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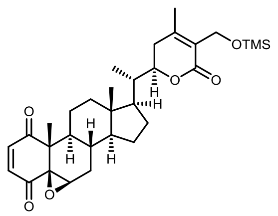

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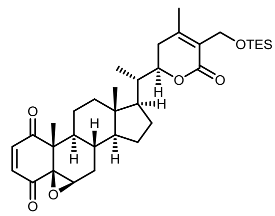

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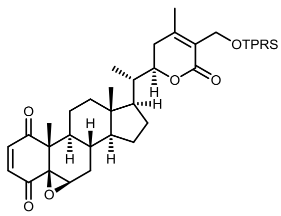

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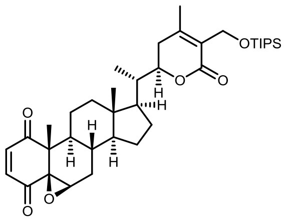
M, methyl; E, ethyl; IP, *iso*-propyl; PR, propyl; Bbutyl; TB, *tert*-butyl; H, hexyl; O, octyl; P, phenyl; V, vinyl; S, silicon



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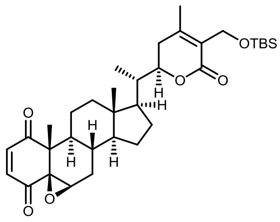

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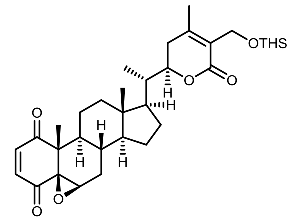

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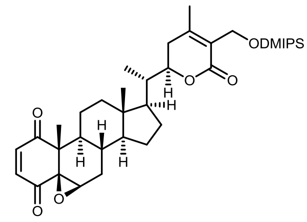

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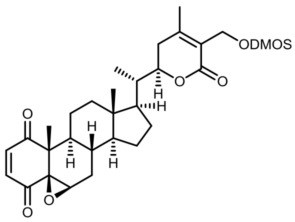

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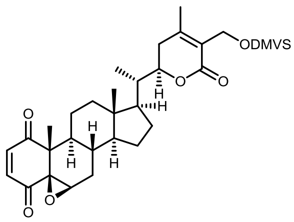

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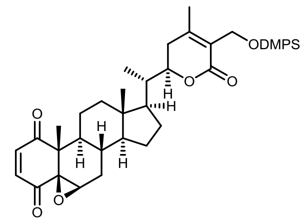

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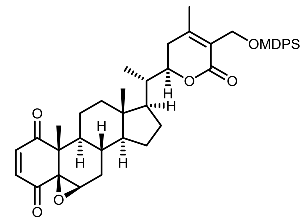

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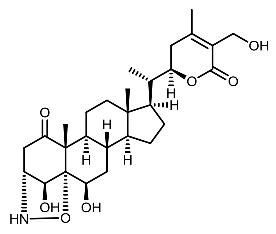
M, methyl; E, ethyl; IP, *iso*-propyl; PR, propyl; Bbutyl; TB, *tert*-butyl; H, hexyl; O, octyl; P, phenyl; V, vinyl; S, silicon



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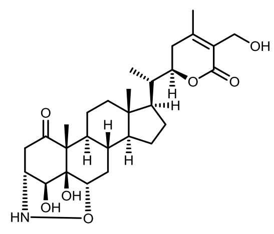

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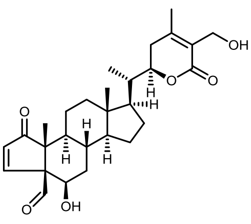

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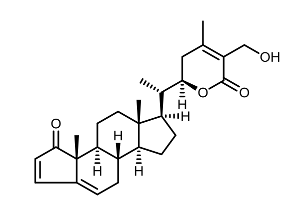

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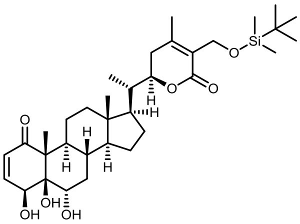

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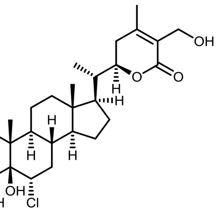

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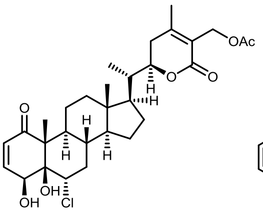

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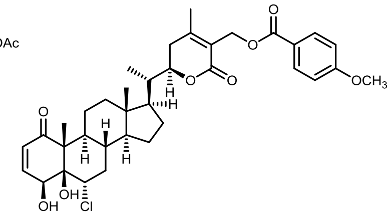

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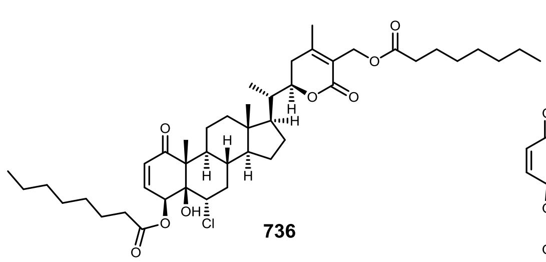

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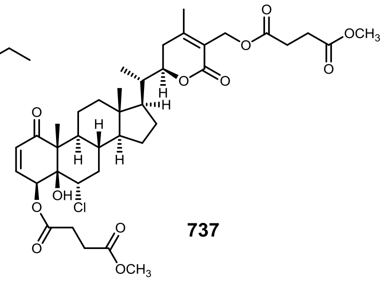

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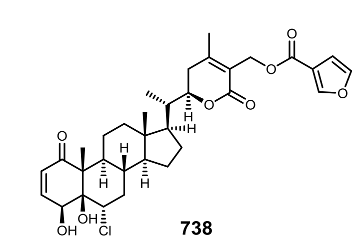

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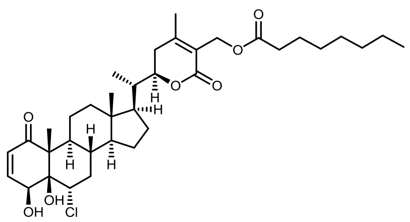

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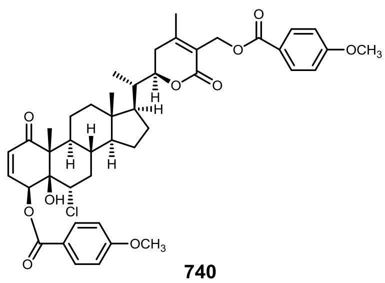

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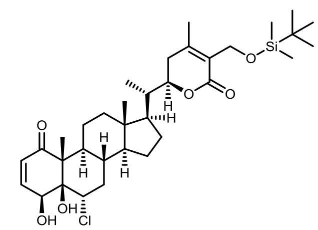

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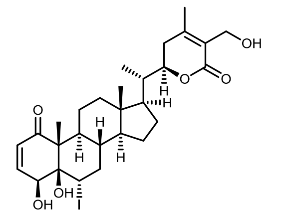

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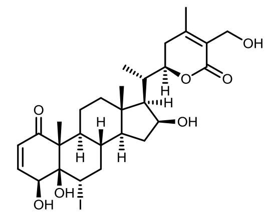

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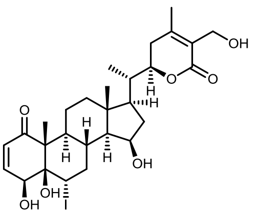

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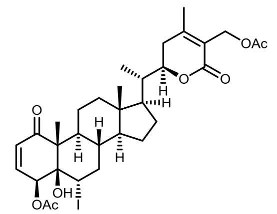

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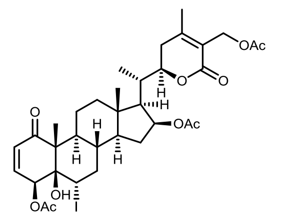

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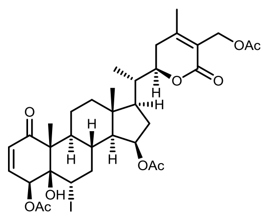

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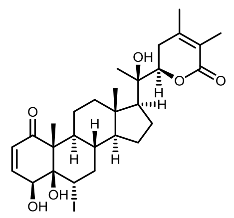

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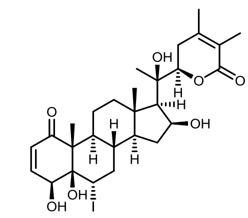

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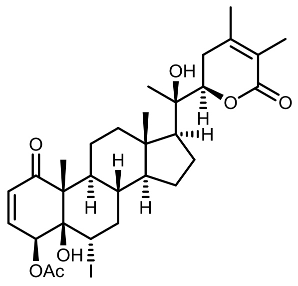

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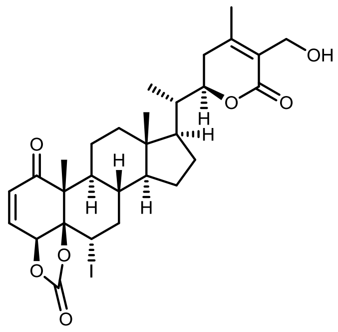

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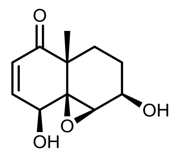

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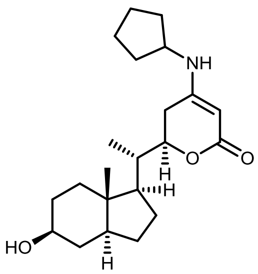

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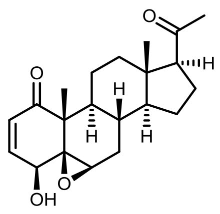

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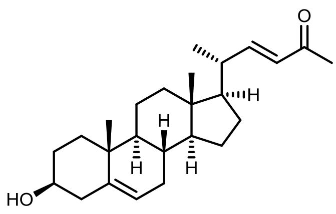

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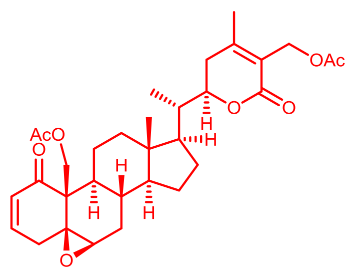

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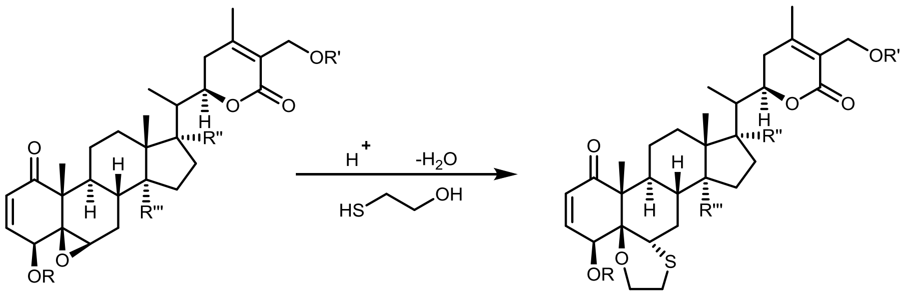
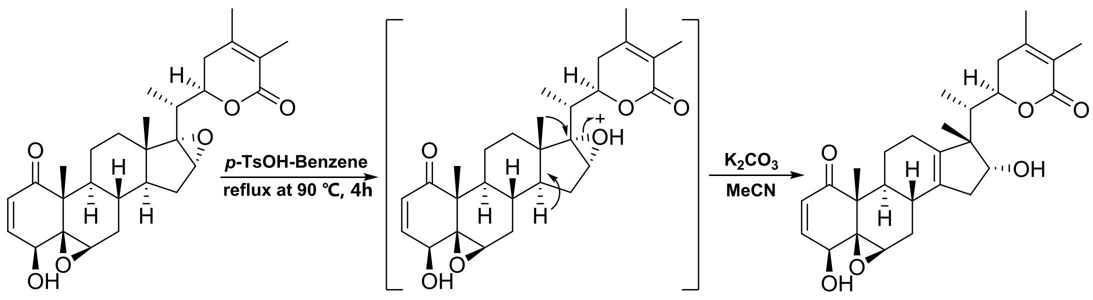


Scheme 5. Selective reactivity of 2-mercaptoethanol with 5,6-epoxide in steroids.[6]



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Scheme 6 Chemical conversion of 16α,17α-epoxywithanolide.[7]

References for Schemes 1-6

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