

Bacterial Terpenome

Supplementary Information

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1 Introduction

The Supplementary Information associated with this review article consists of two parts. The first file is a spreadsheet that contains a comprehensive table of all bacterial terpenoids that were found in NP databases or primary literature. Along with the names and associated compound numbers, this spreadsheet contains additional information including molecular formulas and weights, accurate masses, chemical identifiers (SMILES, InChIKey, InChI), genus and species names, isolation reference DOI or URL, discovery year, and

what NP database, if any, these compounds were found in. This spreadsheet was also submitted for deposition into the Natural Products Atlas.

The second file is this document and contains the structures of all of the bacterial terpenoids. In the main review document, only selected structures are shown. Compound numbers are shown under each NP; their names are fully listed in the accompanying spreadsheet. A list of abbreviations used in the main review document is also included in this file.

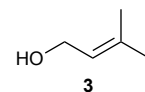
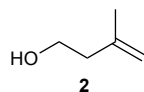
1.1 Abbreviations

ADHBA; 3-amino-2,4-dihydrobenzoic acid
ADHBSH; thiocarboxylic acid analogue of ADHBA
ATP; adenosine triphosphate
BChl; bacteriochlorophyll
BGC; biosynthetic gene cluster
CDPS; cyclodipeptide synthase
Chl; chlorophyll
CLPP; cyclolavandulyl diphosphate
CPP; copalyl diphosphate
DKP; 2,5-diketopiperazine
DMAPP; dimethylallyl diphosphate
DMK; dimethylmenaquinone
FPP; farnesyl diphosphate
FMN; flavin mononucleotide
GA; gibberellins
GAPDH; glyceraldehyde-3-phosphate dehydrogenase
GFPP; geranylgeranyl diphosphate
GGPP; geranylgeranyl diphosphate
GPP; geranyl diphosphate
HIF; hypoxia-induced factor
Hsp; heat shock protein
IL; interleukin
IPP; isopentenyl diphosphate
KG; ketoglutarate
LPP; linalyl diphosphate
MAPK; mitogen-activated protein kinase
MEP; methylerythritol phosphate
MIB; methylisoborneol
MIC; minimum inhibitory concentration
MK; menaquinone
MRSA; methicillin-resistant *Staphylococcus aureus*
MT; methyltransferase

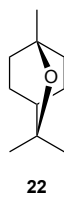
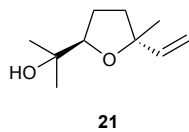
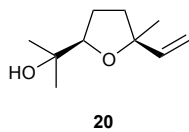
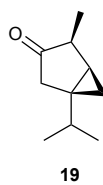
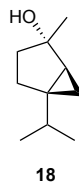
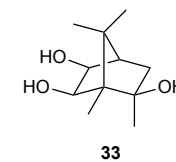
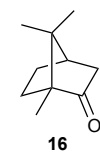
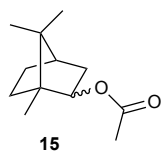
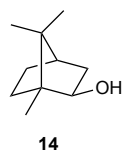
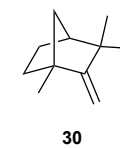
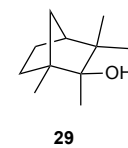
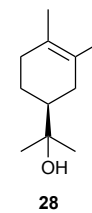
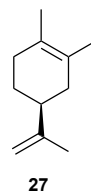
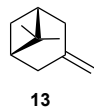
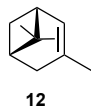
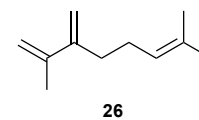
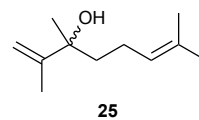
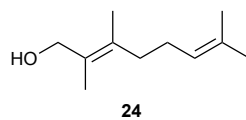
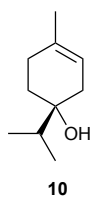
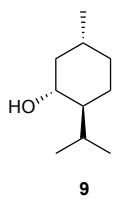
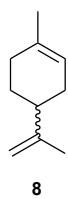
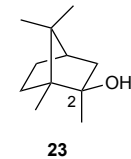
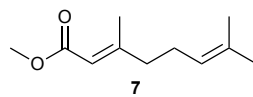
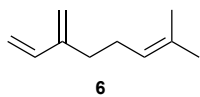
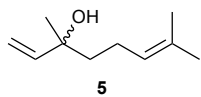
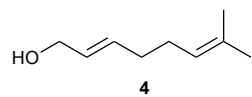
MVA; mevalonate
NO; nitric oxide
NP; natural products
NPP; nerolidyl diphosphate
NRPS; non-ribosomal peptide synthetase
PABA; *p*-aminobenzoic acid
PCA; phenazinecarboxylic acid
PG; phosphoglycerate
PKC; protein kinase C
PKS; polyketide synthase
PNT; pentalenolactone
PQ; plastoquinone
PT; prenyltransferase
PTM; platensimycin
PTN; platencin
RiPP; ribosomally-synthesized and posttranslationally-modified peptide
ROS; reactive oxygen species
RQ; rhodoquinone
SAM; *S*-adenosylmethionine
SAR; structure-activity relationship
SARS-CoV2; severe acute respiratory syndrome–coronavirus 2
THF; tetrahydrofuran
THN; 1,3,6,8-tetrahydroxynaphthalene
TIM; triosephosphate isomerase
TNF; tumor necrosis factor
TQ; tocopherolquinone
TRX; thioredoxin
TS; terpene synthase
VHPO; vanadium-dependent haloperoxidases
VOC; volatile organic compound
VRE; vancomycin-resistant Enterococci
WT; wild-type

2 Terpenoids

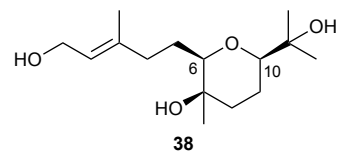
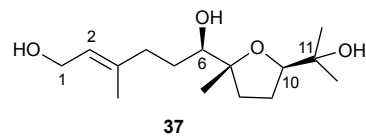
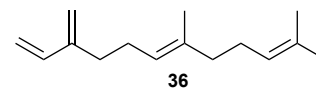
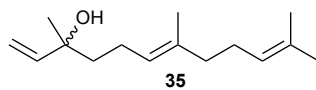
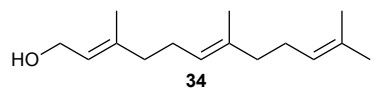
2.1 Hemiterpenoids



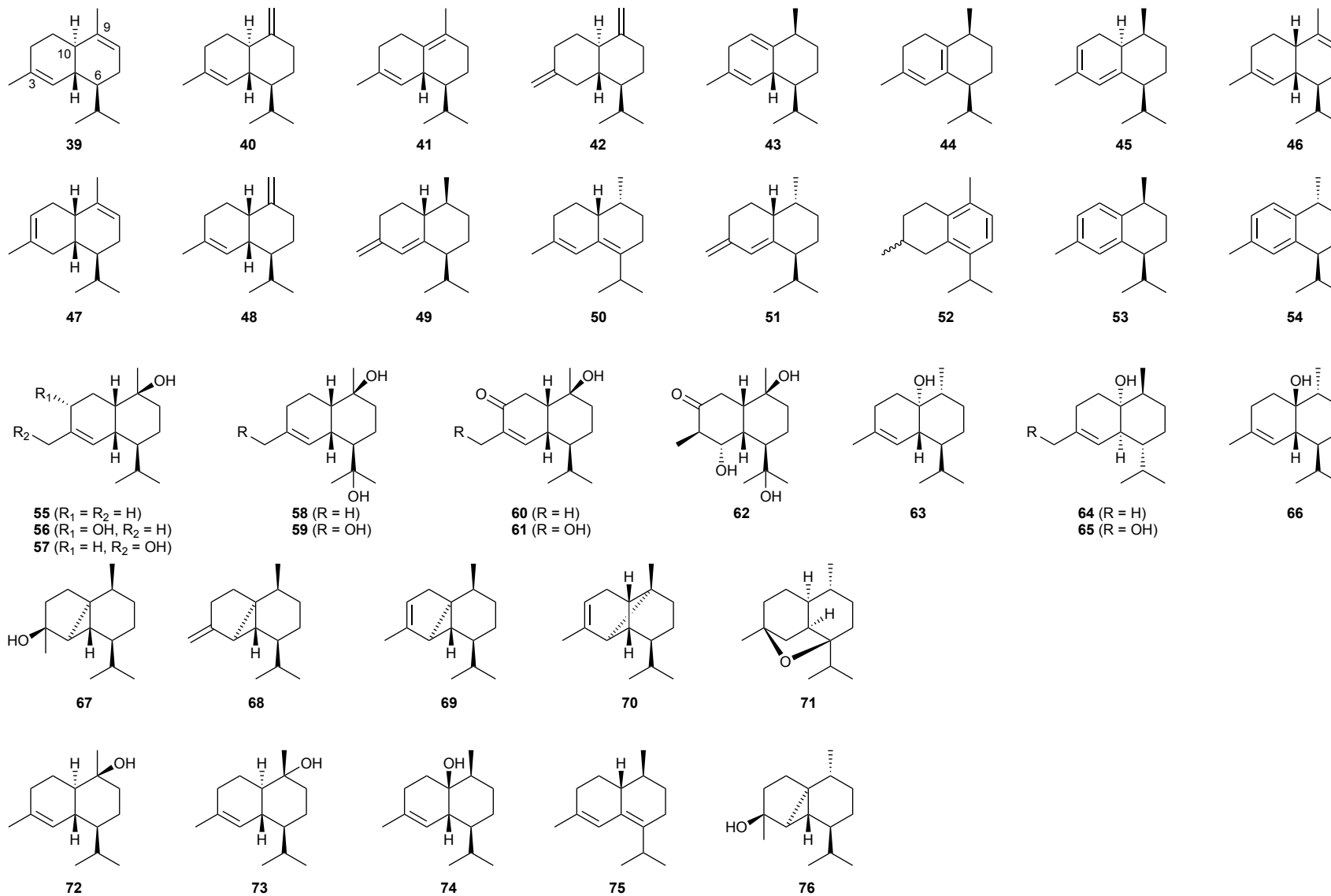
2.2 Monoterpenoids



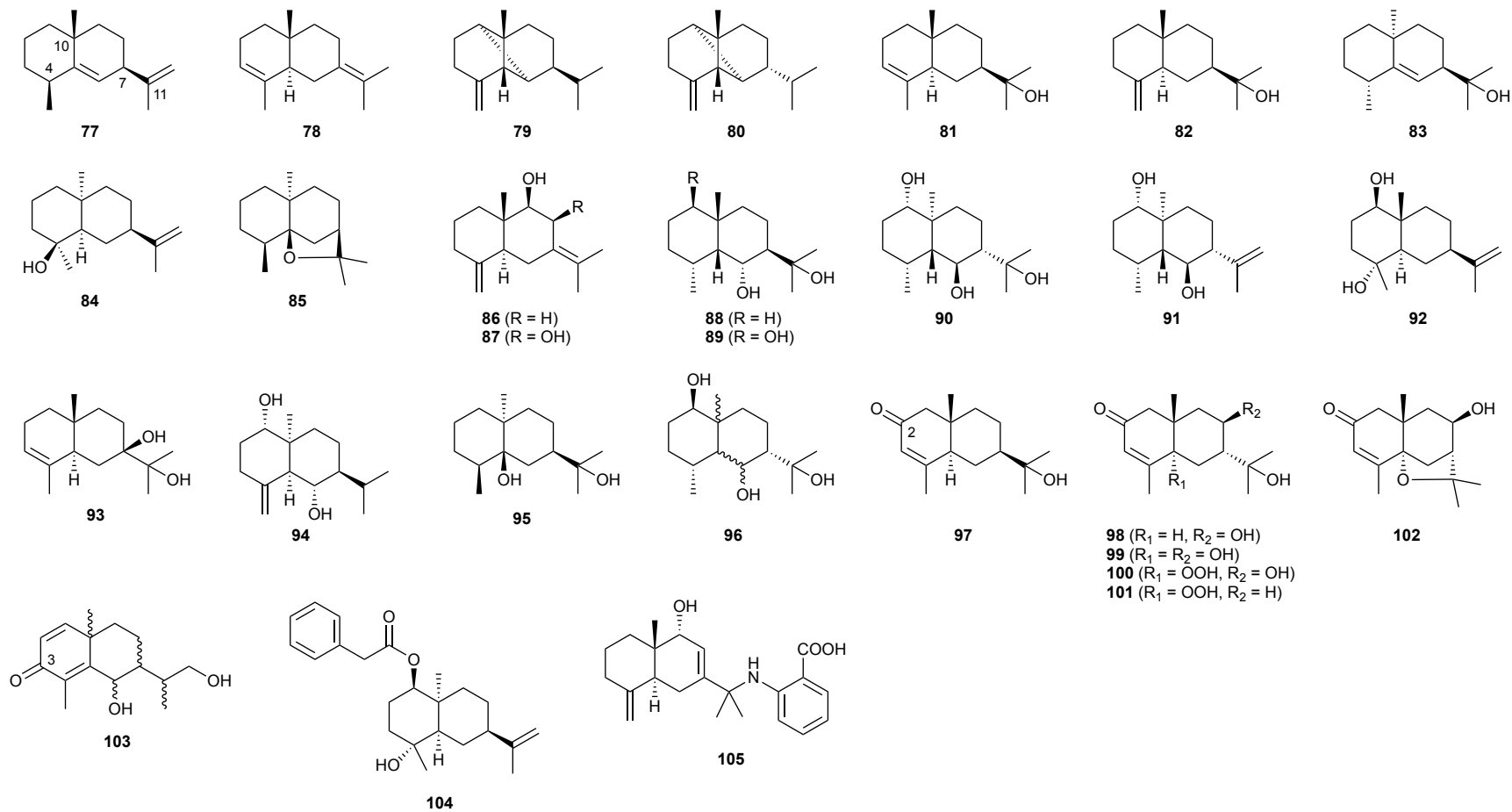
2.3.1 Sesquiterpenoids: Simple sesquiterpenoids



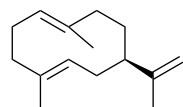
2.3.2 Sesquiterpenoids: Cadinanes



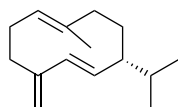
2.3.3 Sesquiterpenoids: Eudesmanes



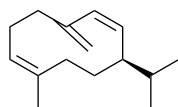
2.3.4 Sesquiterpenoids: Germacranes



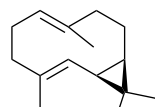
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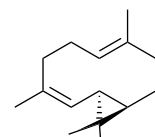
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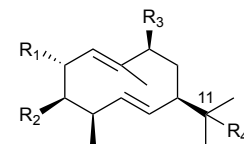
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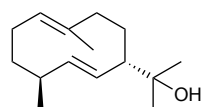


111 ($R_1 = R_2 = R_3 = H, R_4 = OH$)

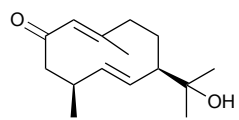
112 ($R_1 = R_4 = OH, R_2 = R_3 = H$)

113 ($R_1 = R_3 = H, R_2 = R_4 = OH$)

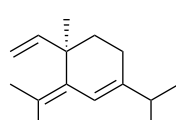
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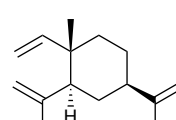
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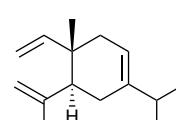
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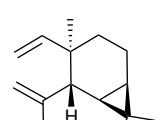
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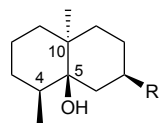


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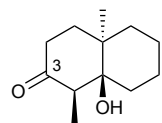


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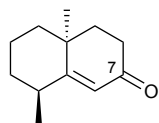
2.3.5 Sesquiterpenoids: Geosmins



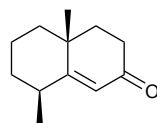
121 (R = H)
129 (R = OH)



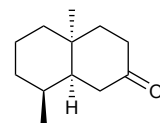
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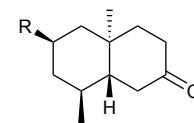
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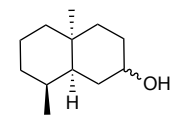
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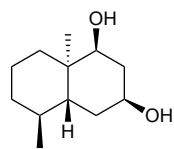
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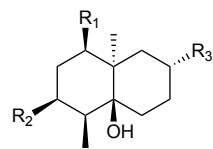
126 (R = H)
130 (R = OH)



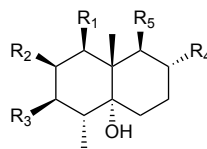
127/128



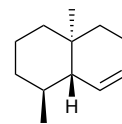
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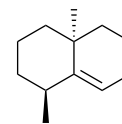
132 (R₁ = OH, R₂ = R₃ = H)
133 (R₁ = R₃ = H, R₂ = OH)
134 (R₁ = R₃ = OH, R₂ = H)



135 (R₁ = R₃ = R₄ = OH, R₂ = R₅ = H)
136 (R₁ = R₃ = R₄ = H, R₂ = R₅ = OH)

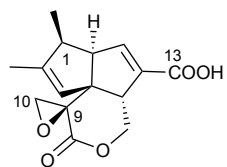


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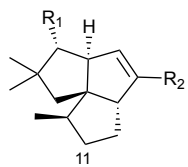


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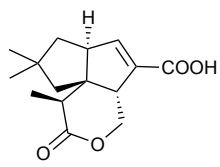
2.3.6 Sesquiterpenoids: Pentalenolactones



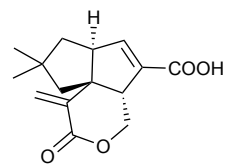
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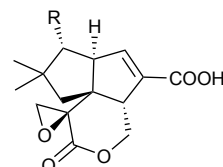
140 ($R_1 = R_2 = H$)
144 ($R_1 = OH$, $R_2 = COOH$)



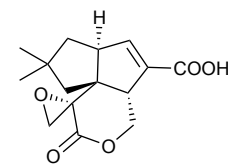
141



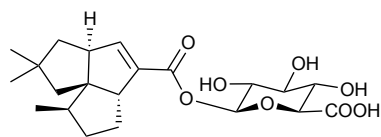
142



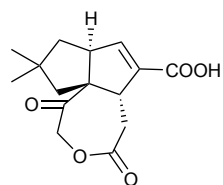
143 ($R = H$)
149 ($R = OH$)



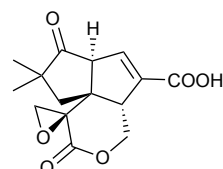
145



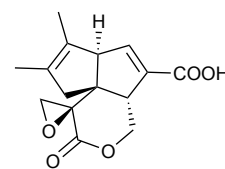
146



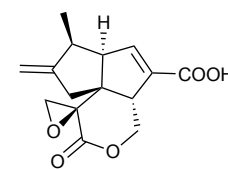
147



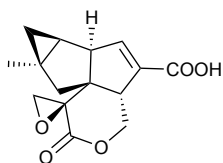
148



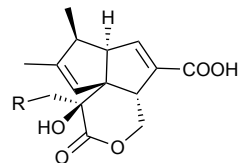
150



151

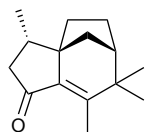


152

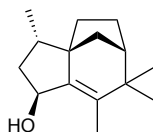


153 ($R = Cl$)
154 ($R = OH$)

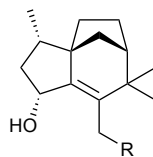
2.3.7 Sesquiterpenoids: Zizaanes



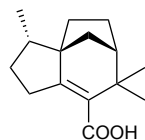
155



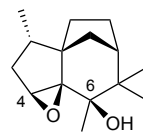
156



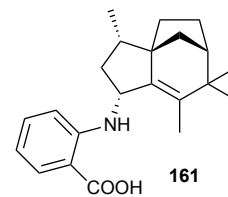
157 (R = H)
158 (R = OH)



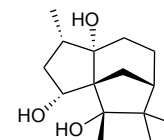
159



160

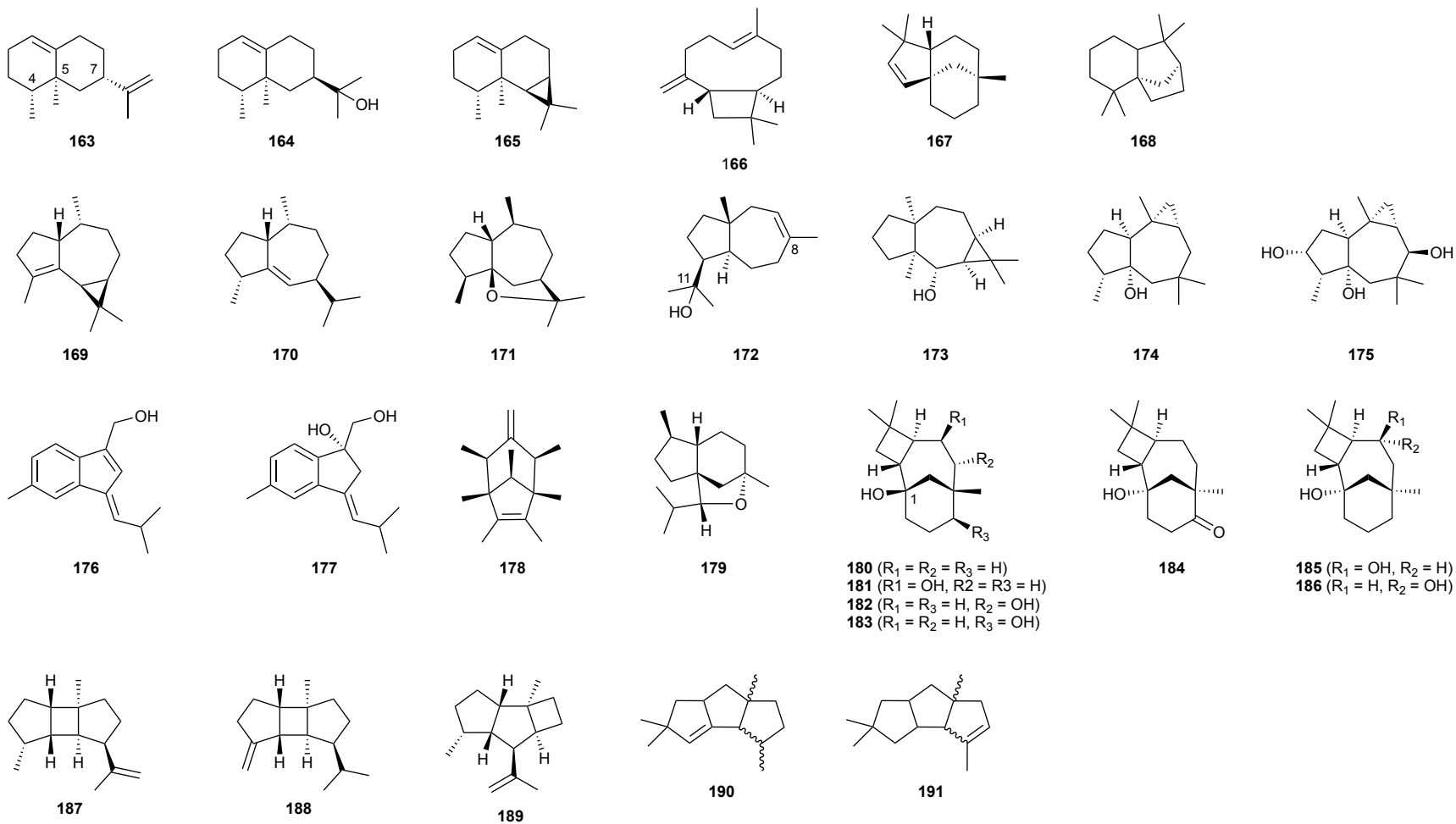


161

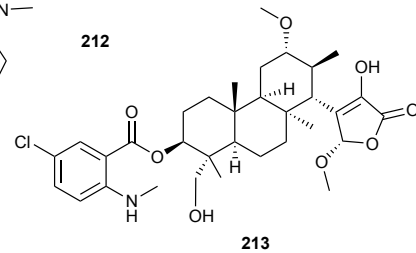
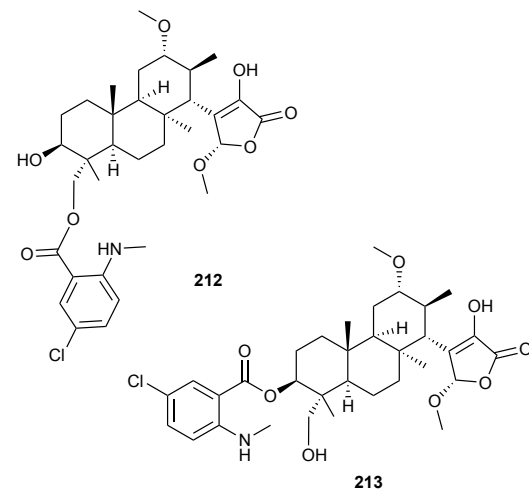
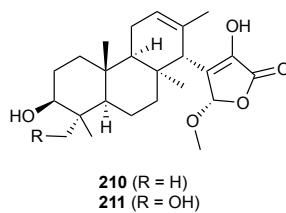
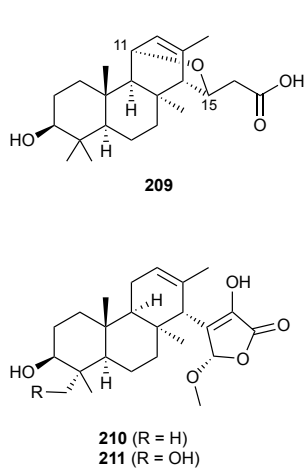
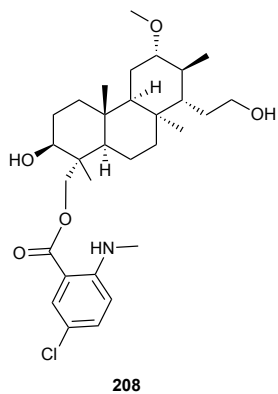
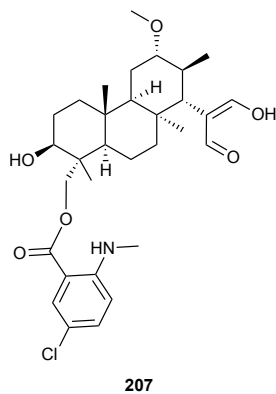
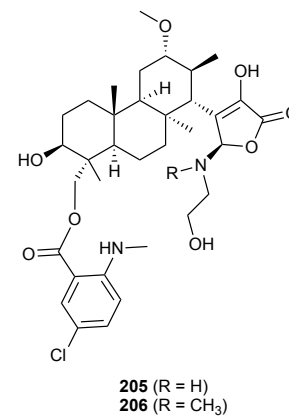
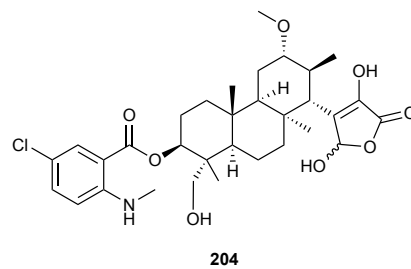
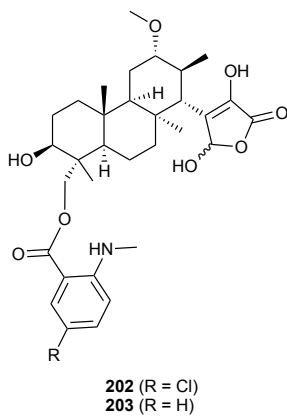
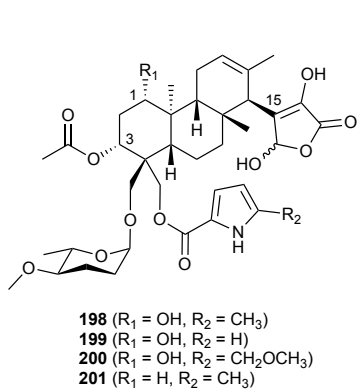
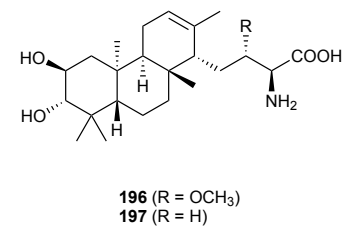
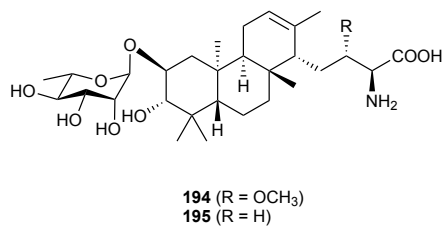
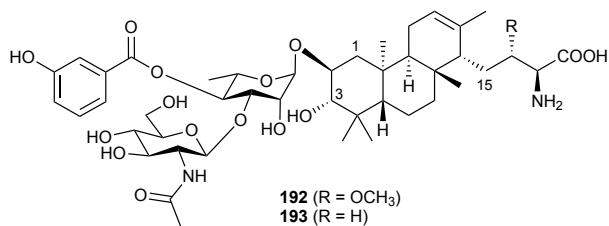


162

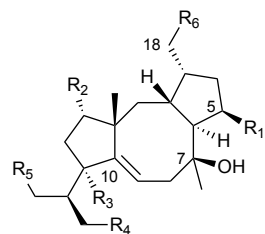
2.3.8 Sesquiterpenoids: Miscellaneous polycyclic sesquiterpenoids



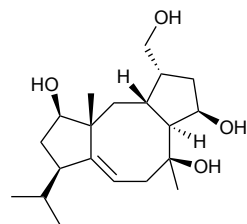
2.4.1 Diterpenoids: Basilicardins, phenalinolactones, and tiancilactones



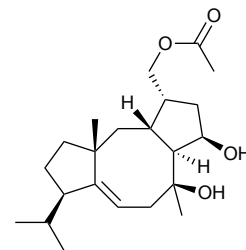
2.4.2 Diterpenoids: Cyclooctatins



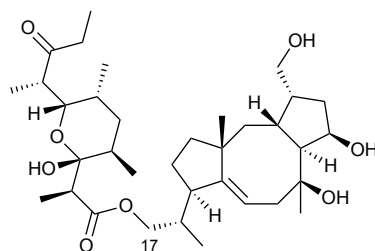
- 214** ($R_1 = R_6 = \text{OH}$, $R_2 = R_3 = R_4 = R_5 = \text{H}$)
215 ($R_1 = R_3 = R_6 = \text{OH}$, $R_2 = R_4 = R_5 = \text{H}$)
216 ($R_1 = R_2 = R_6 = \text{OH}$, $R_3 = R_4 = R_5 = \text{H}$)
217 ($R_1 = R_4 = R_6 = \text{OH}$, $R_2 = R_3 = R_5 = \text{H}$)
218 ($R_1 = R_4 = R_5 = R_6 = \text{OH}$, $R_2 = R_3 = \text{H}$)
219 ($R_1 = R_2 = R_3 = R_4 = R_5 = R_6 = \text{H}$)
220 ($R_1 = R_2 = R_3 = R_4 = R_5 = \text{H}$, $R_6 = \text{OH}$)



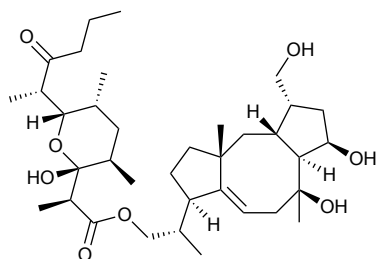
221



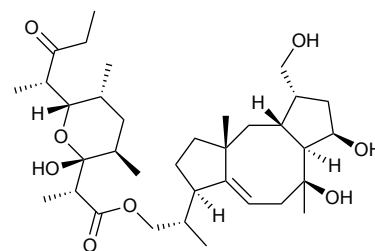
222



223

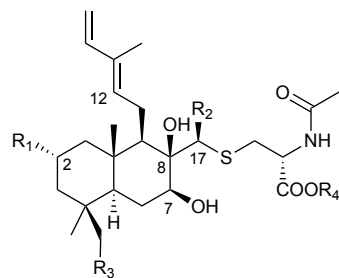


224

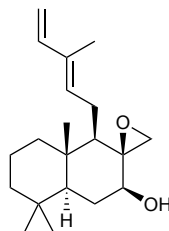


225

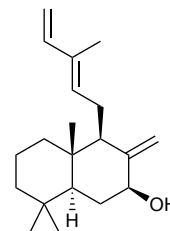
2.4.3 Diterpenoids: Cyslabdans



- 226** ($R_1 = R_2 = R_3 = R_4 = H$)
227 ($R_1 = R_2 = R_4 = H, R_3 = OH$)
228 ($R_1 = R_2 = R_3 = H, R_4 = CH_3$)
229 ($R_1 = OH, R_2 = R_3 = R_4 = H$)
230 ($R_1 = R_3 = R_4 = H, R_2 = OH$)

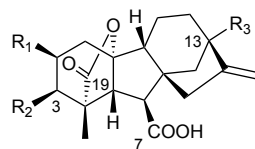


231

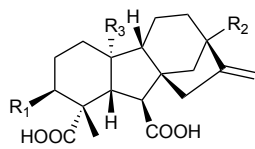


232

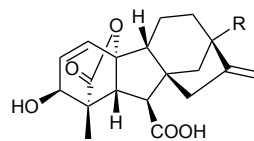
2.4.4 Diterpenoids: Gibberellins



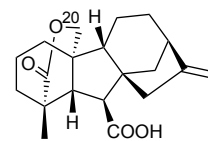
- 233** ($R_1 = H, R_2 = R_3 = OH$)
234 ($R_1 = R_3 = H, R_2 = OH$)
235 ($R_1 = R_2 = R_3 = H$)
236 ($R_1 = R_2 = H, R_3 = OH$)
237 ($R_1 = R_2 = R_3 = OH$)
238 ($R_1 = R_2 = OH, R_3 = H$)



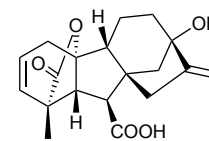
- 239** ($R_1 = R_2 = H, R_3 = CH_3$)
240 ($R_1 = H, R_2 = OH, R_3 = CHO$)
241 ($R_1 = R_2 = H, R_3 = CHO$)
242 ($R_1 = OH, R_2 = H, R_3 = CHO$)
243 ($R_1 = H, R_2 = OH, R_3 = CH_2OH$)
244 ($R_1 = H, R_2 = OH, R_3 = CH_3$)



- 245** ($R = OH$)
246 ($R = H$)

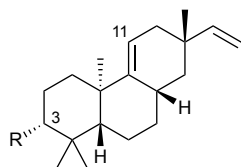


247

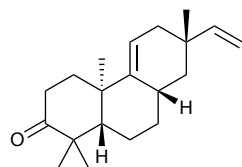


248

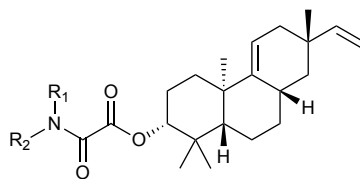
2.4.5 Diterpenoids: Oxaloterpins



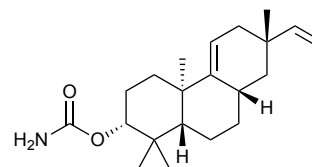
249 (R = OH)
250 (R = H)



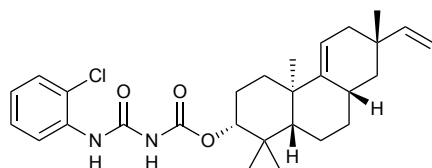
251



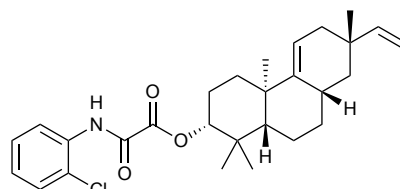
252 (R₁ = OH, R₂ = Ac)
253 (R₁ = OH, R₂ = CH₂CH₂OH)
254 (R₁ = OH, R₂ = H)
255 (R₁ = R₂ = H)



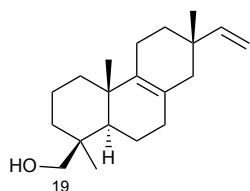
256



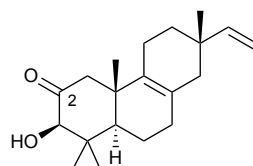
257



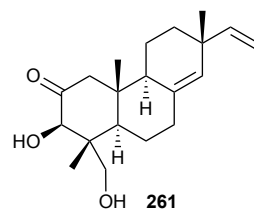
258



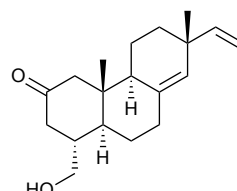
259



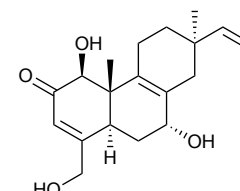
260



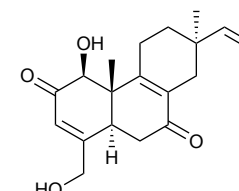
261



262

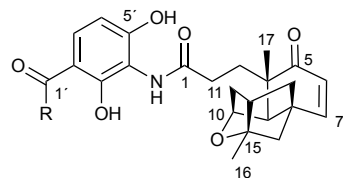


263

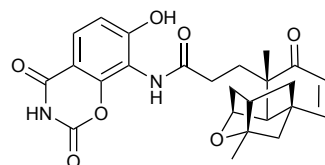


264

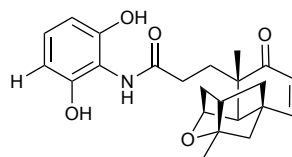
2.4.6.1 Diterpenoids: Platensimycin



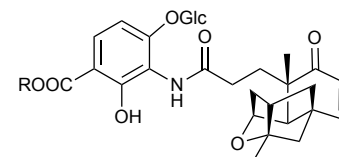
265 (R = OH)
268 (R = NH₂)
278 (R = SH)
280 (R = OCH₃)



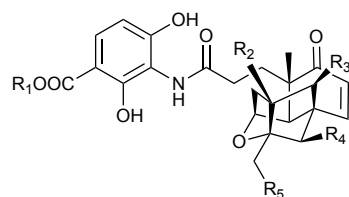
269



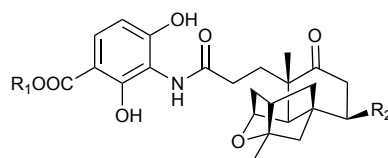
270



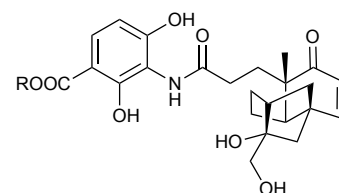
271 (R = H)
272 (R = CH₃)



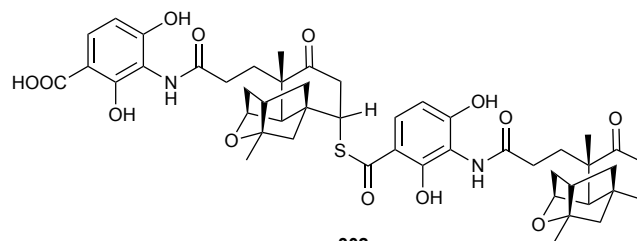
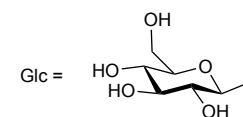
283 (R₁ = R₂ = R₃ = R₅ = H, R₄ = OH)
284 (R₁ = CH₃, R₂ = R₃ = R₅ = H, R₄ = OH)
285 (R₁ = R₂ = R₄ = R₅ = H, R₃ = OH)
286 (R₁ = CH₃, R₂ = R₄ = R₅ = H, R₃ = OH)
287 (R₁ = R₃ = R₄ = R₅ = H, R₂ = OH)
288 (R₁ = CH₃, R₂ = OH, R₃ = R₄ = R₅ = H)
289 (R₁ = R₂ = R₃ = R₄ = H, R₅ = OH)
290 (R₁ = CH₃, R₂ = R₃ = R₄ = H, R₅ = OH)



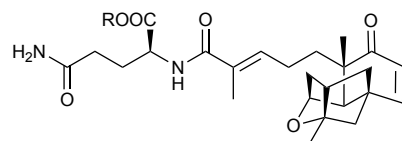
291 (R₁ = H, R₂ = OH)
292 (R₁ = CH₃, R₂ = OH)



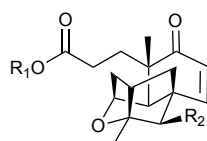
293 (R = H)
294 (R = CH₃)



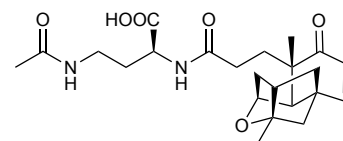
302



267 (R = H)
308 (R = CH₃)

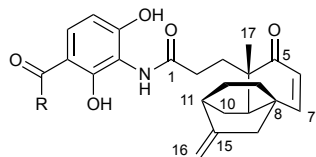


303 (R₁ = H, R₂ = H)
304 (R₁ = CH₃, R₂ = H)
305 (R₁ = H, R₂ = OH)
306 (R₁ = Me, R₂ = OH)

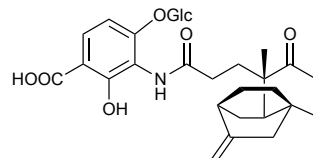


307

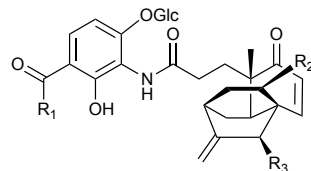
2.4.6.2 Diterpenoids: Platencin



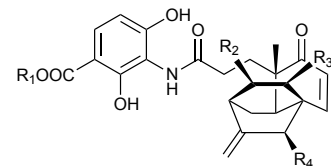
266 (R = OH)
279 (R = SH)



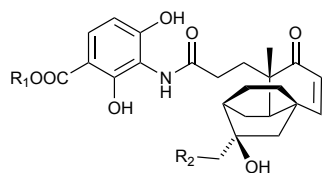
273



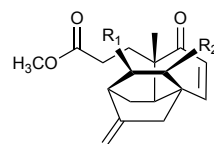
274 (R₁ = OH, R₂ = H, R₃ = H)
275 (R₁ = OH, R₂ = OH, R₃ = H)
276 (R₁ = OH, R₂ = H, R₃ = OH)
277 (R₁ = SCH₃, R₂ = OH, R₃ = H)



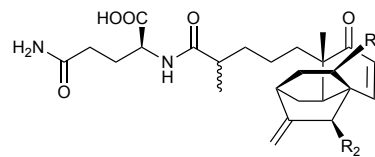
295 (R₁ = R₂ = R₄ = H, R₃ = OH)
296 (R₁ = CH₃, R₂ = R₄ = H, R₃ = OH)
297 (R₁ = R₃ = R₄ = H, R₂ = OH)
298 (R₁ = R₂ = R₃ = H, R₄ = OH)



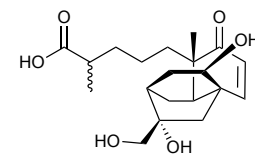
299 (R₁ = R₂ = H)
300 (R₁ = H, R₂ = OH)
301 (R₁ = CH₃, R₂ = OH)



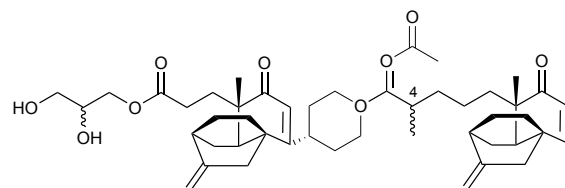
281 (R₁ = H, R₂ = OH)
282 (R₁ = OH, R₂ = H)



309 (R₁ = R₂ = H)
310 (R₁ = OH, R₂ = H)
311 (R₁ = H, R₂ = OH)

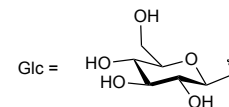


312

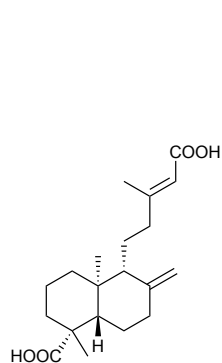


315

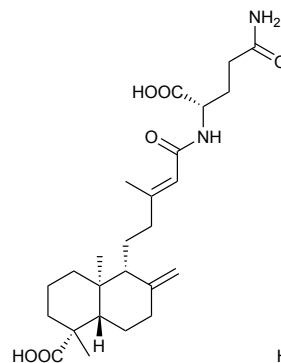
316 (4S)
317 (4R)



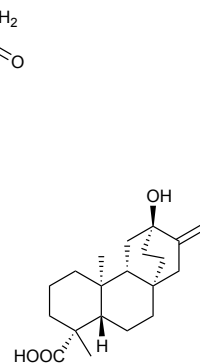
Glc =



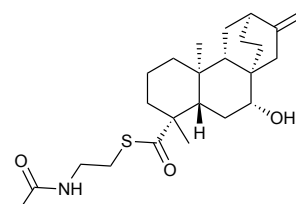
313



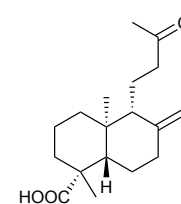
314



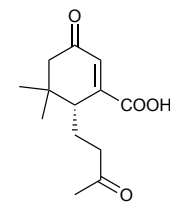
318



319

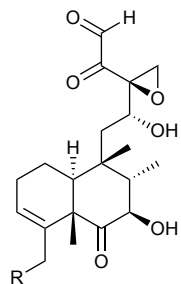


320

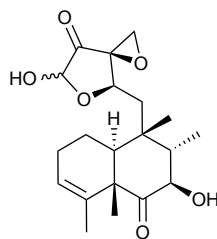


321

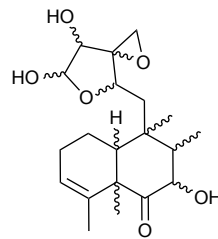
2.4.7 Diterpenoids: Terpentecins



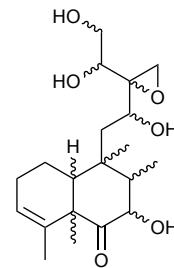
322 (R = H)
323 (R = OH)



322 – hemiacetal form

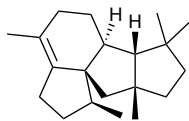


324

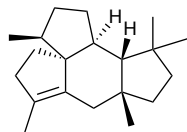


325

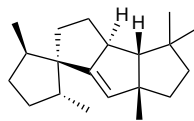
2.4.8 Diterpenoids: Miscellaneous diterpenoids



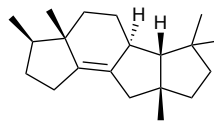
326



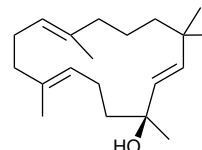
327



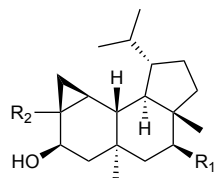
328



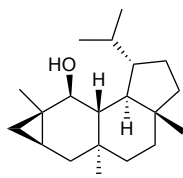
329



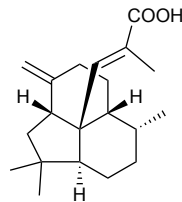
330



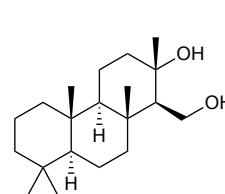
331 ($R_1 = H$, $R_2 = CH_3$)
 332 ($R_1 = OH$, $R_2 = CH_3$)
 333 ($R_1 = H$, $R_2 = CH_2OH$)
 334 ($R_1 = OH$, $R_2 = CH_2OH$)
 335 ($R_1 = OH$, $R_2 = CHO$)



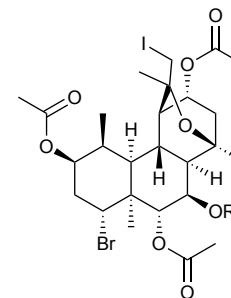
336



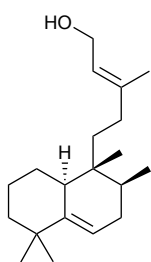
337



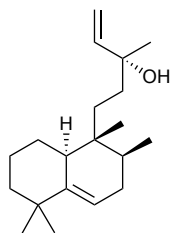
338



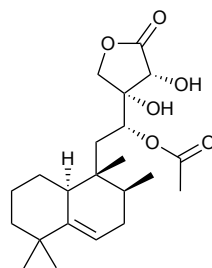
339 ($R = H$)
 340 ($R = Ac$)



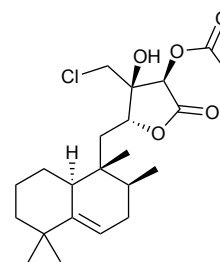
341



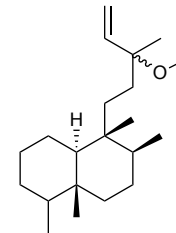
342



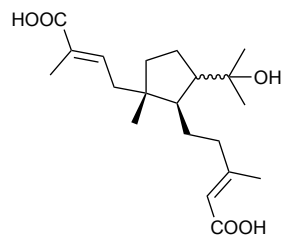
343



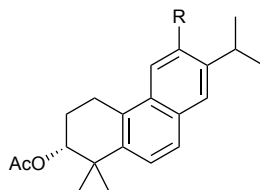
344



345

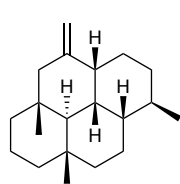


346

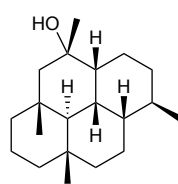


347 ($R = H$)
 348 ($R = OH$)

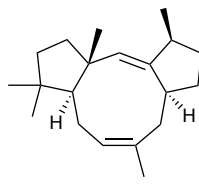
2.4.9 Diterpenoids: Heterologously expressed diterpenoids



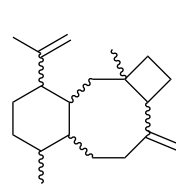
349



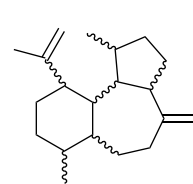
350



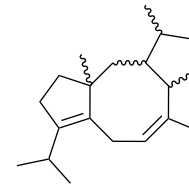
351



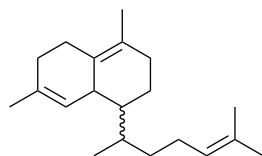
352



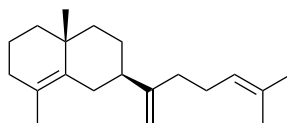
353



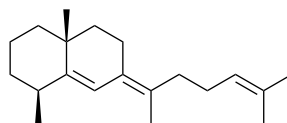
354



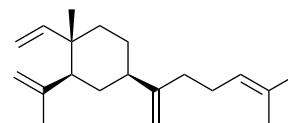
355



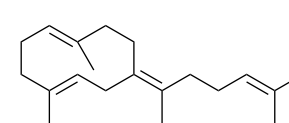
356



357

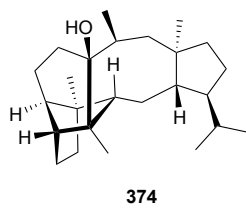
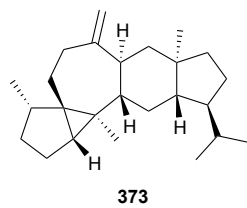
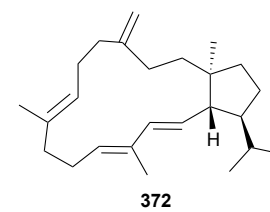
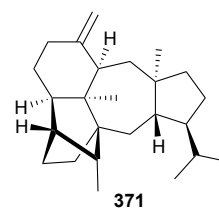
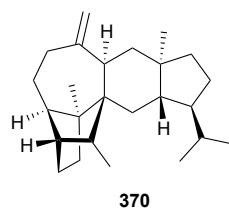
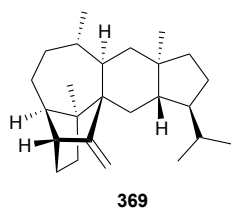
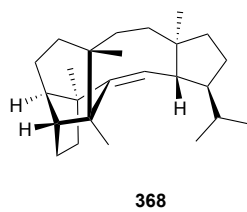
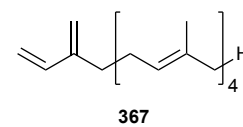
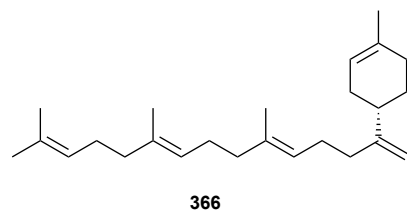
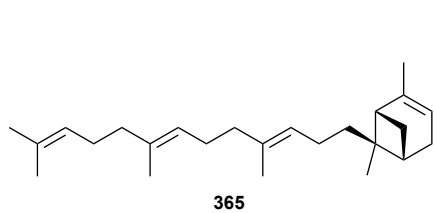
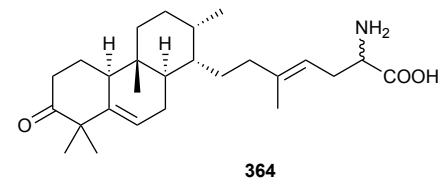
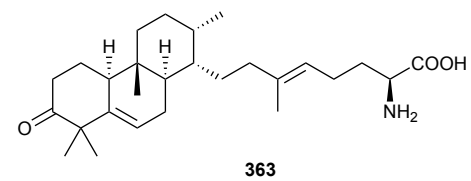
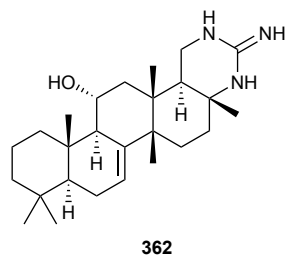
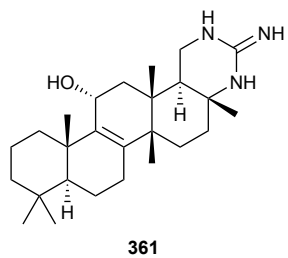
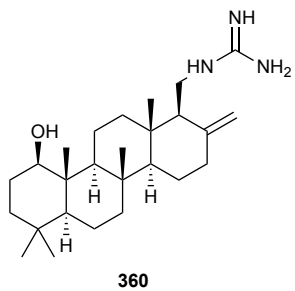


358

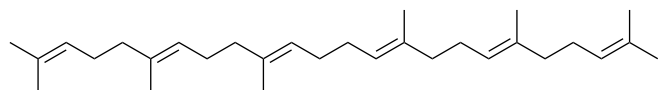


359

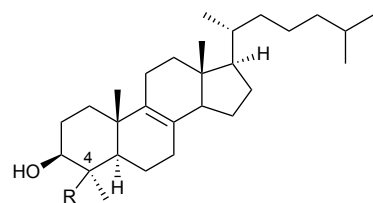
2.5 Sesterterpenoids



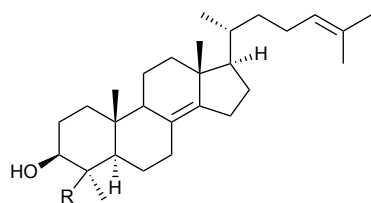
2.6.1 Triterpenoids: Sterols



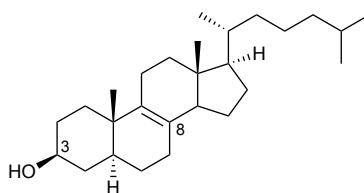
375



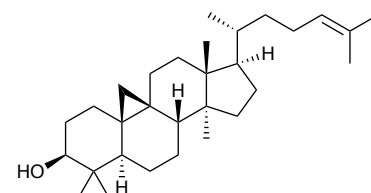
376 (R = H)
378 (R = CH₃)



377 (R = H)
379 (R = CH₃)

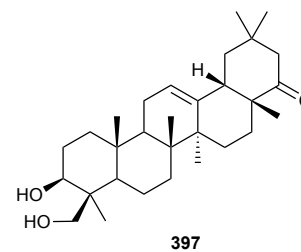
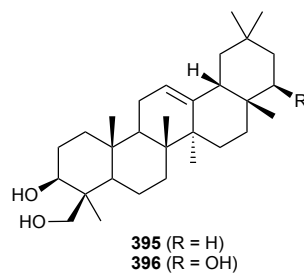
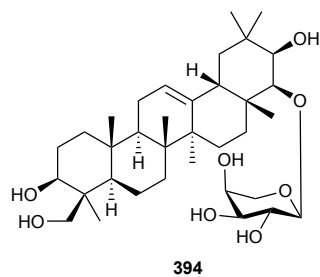
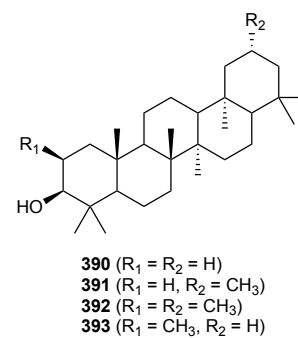
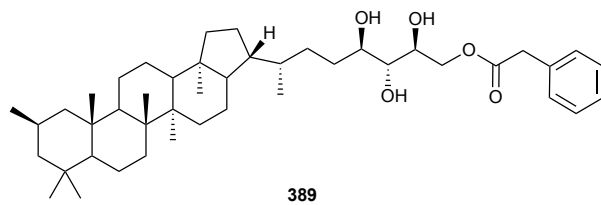
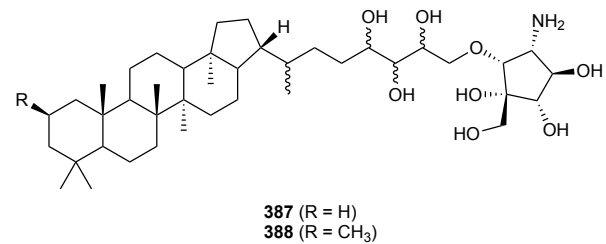
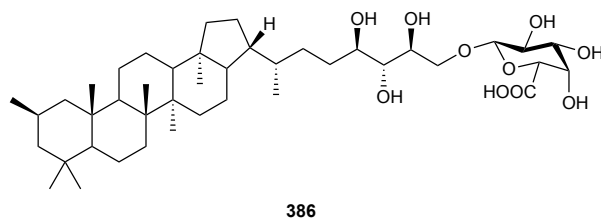
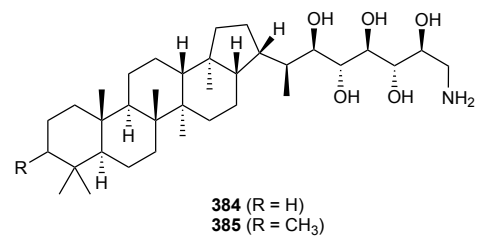
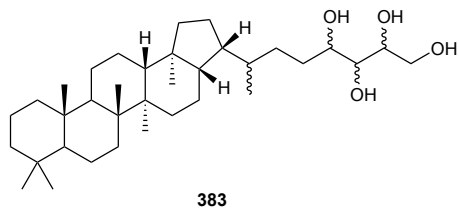
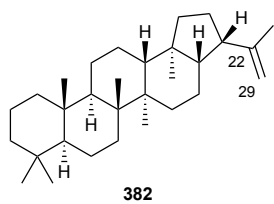


380

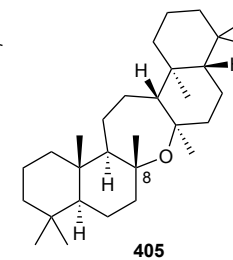
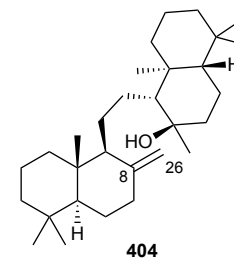
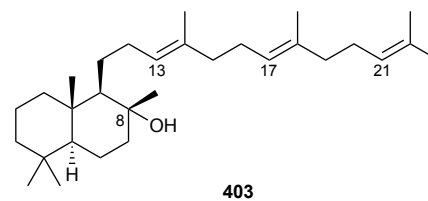
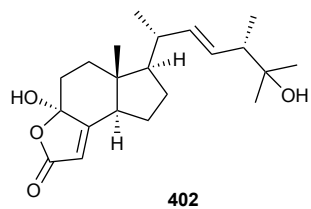
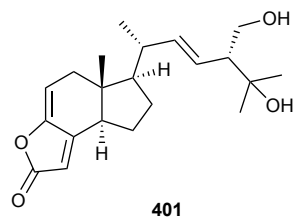
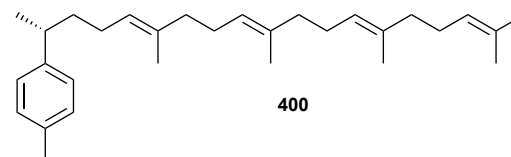
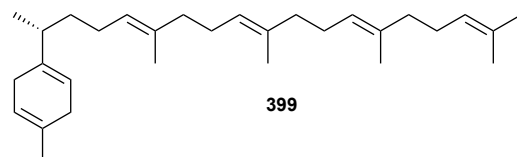
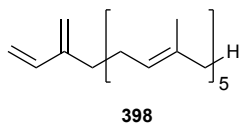


381

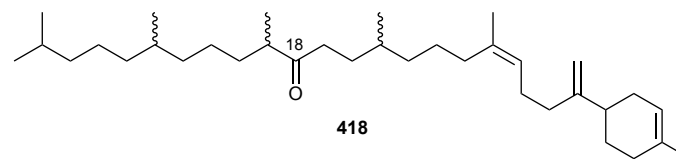
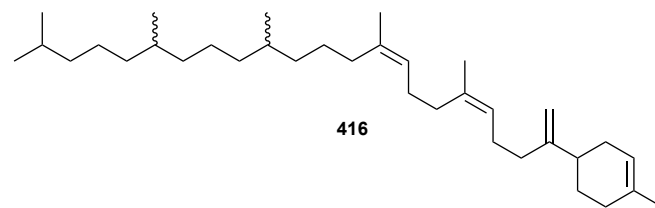
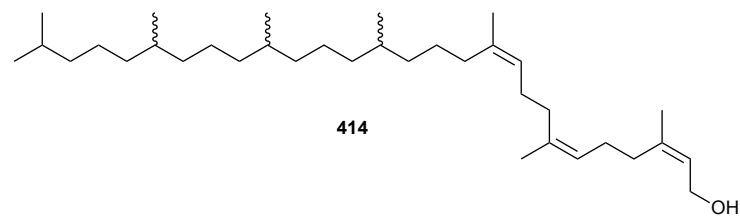
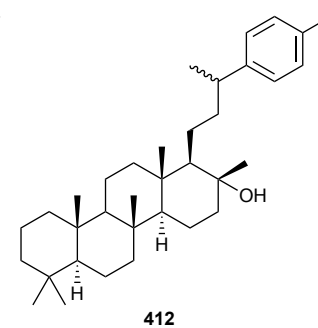
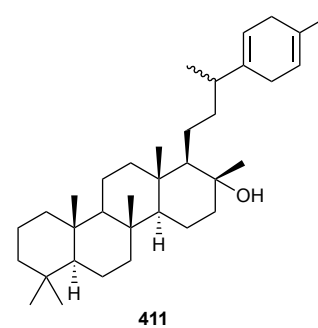
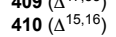
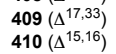
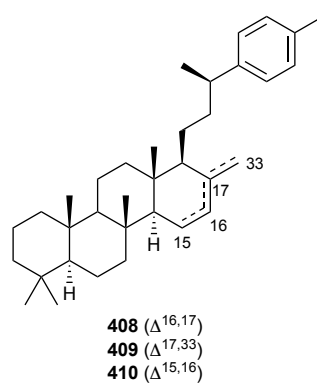
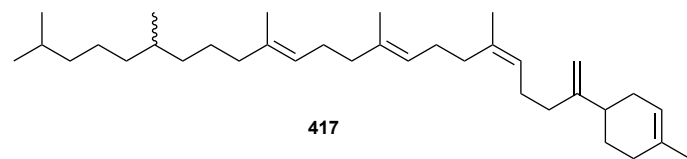
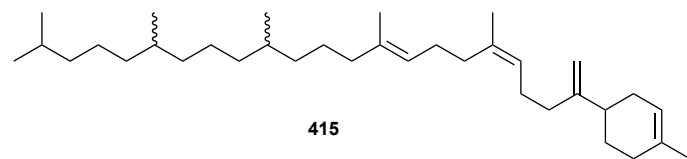
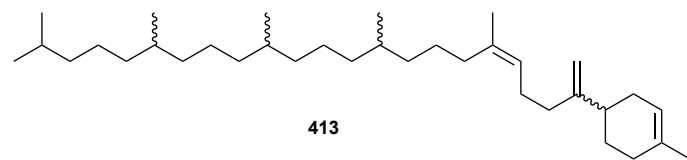
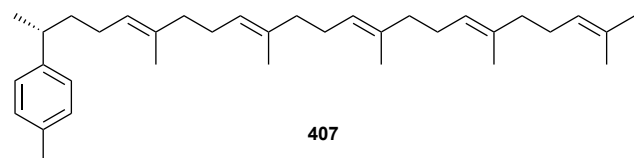
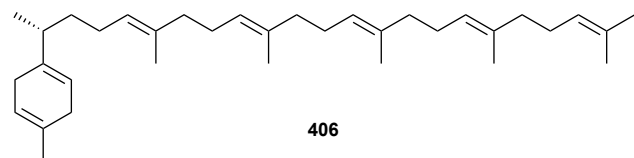
2.6.1 Triterpenoids: Hopanoids



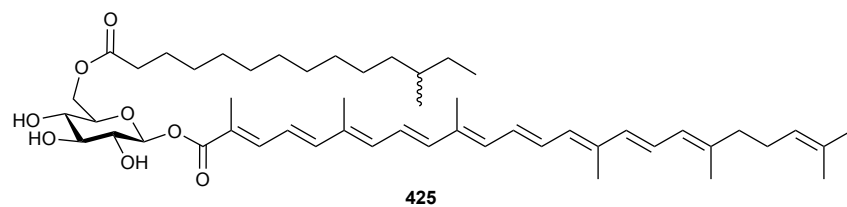
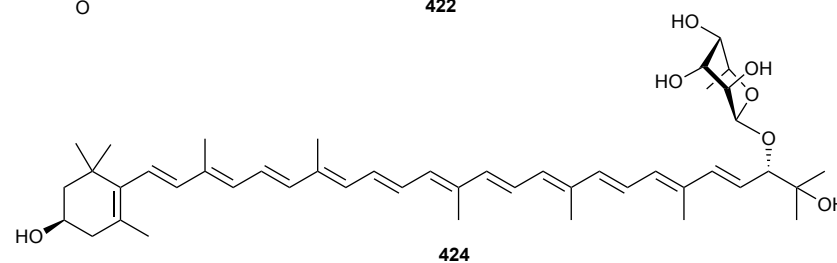
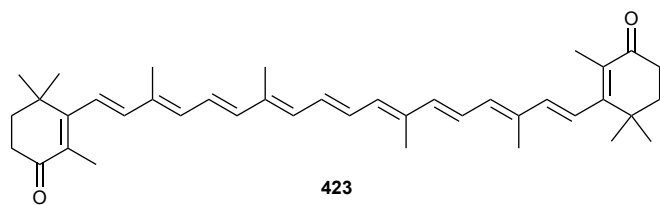
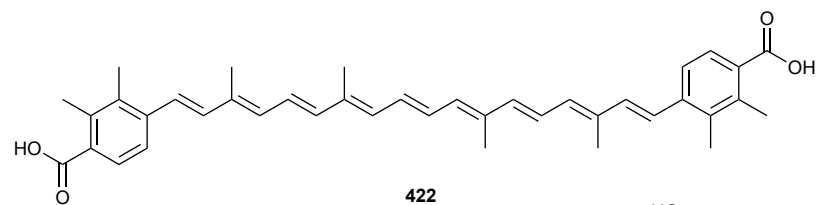
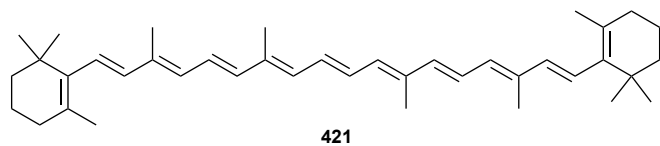
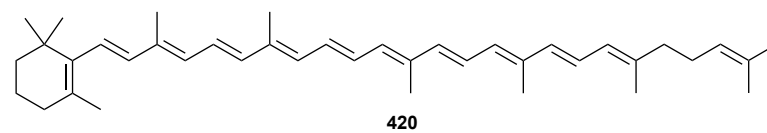
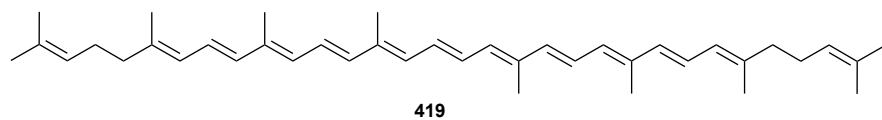
2.6.2 Triterpenoids: Miscellaneous triterpenoids



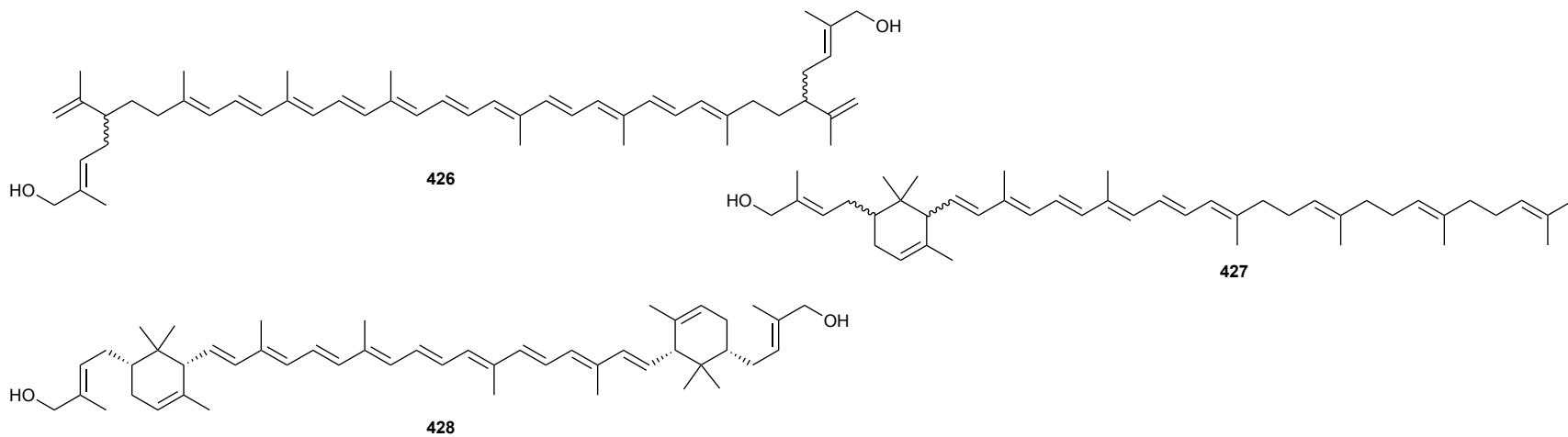
2.7 Sesquiterpenoids



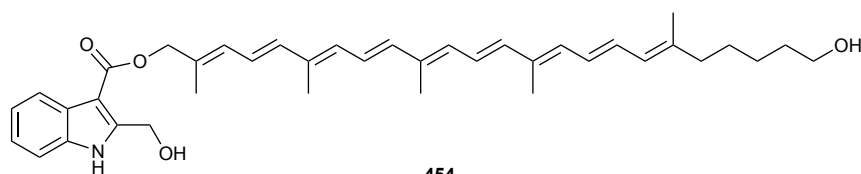
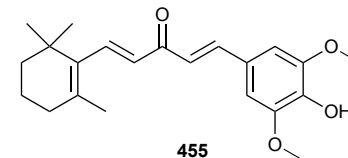
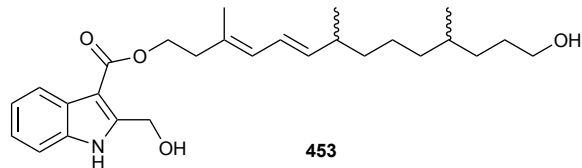
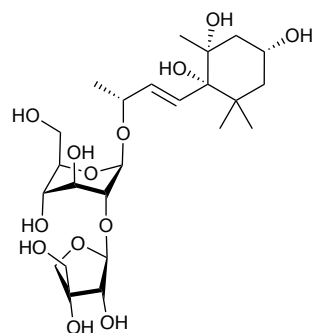
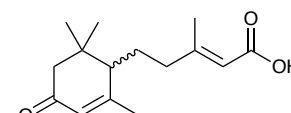
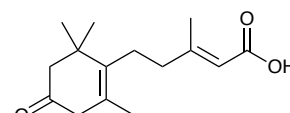
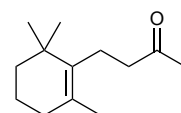
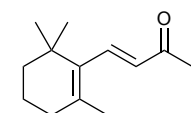
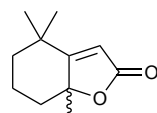
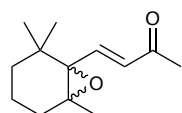
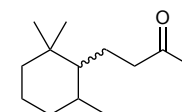
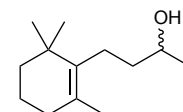
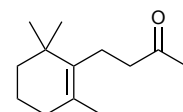
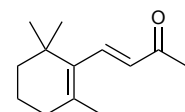
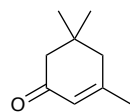
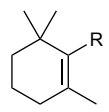
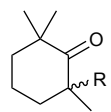
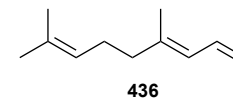
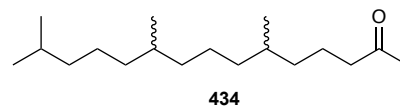
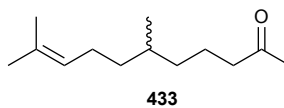
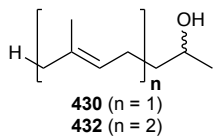
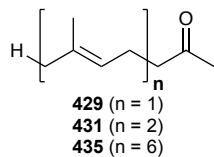
2.8.1 Tetraterpenoids: Carotenoids



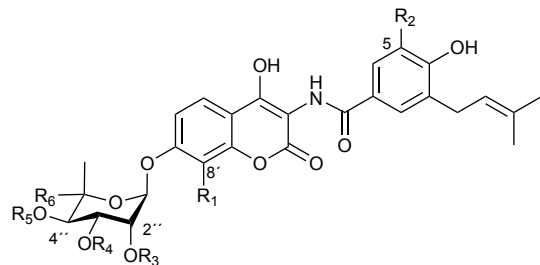
2.8.2 Tetraterpenoids: Other carotenoids



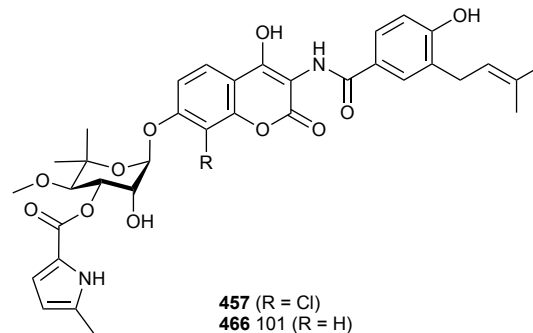
2.8.3 Tetraterpenoids: Norcarotenoids



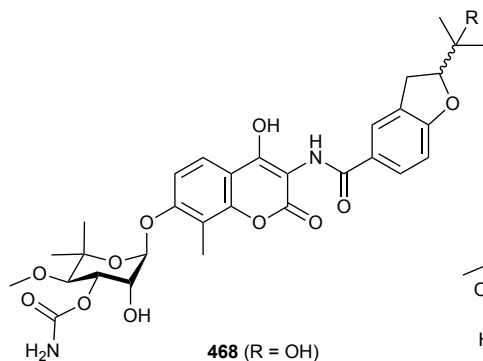
3.1 Aminocoumarins



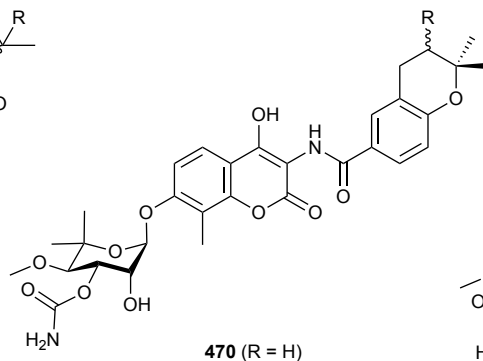
- 456** ($R_1 = R_5 = R_6 = \text{CH}_3$, $R_2 = R_3 = \text{H}$, $R_4 = \text{CONH}_2$)
458 ($R_1 = R_6 = \text{CH}_3$, $R_2 = R_3 = R_5 = \text{H}$, $R_4 = \text{CONH}_2$)
459 ($R_1 = R_2 = R_3 = \text{H}$, $R_5 = R_6 = \text{CH}_3$, $R_4 = \text{CONH}_2$)
460 ($R_1 = R_5 = \text{CH}_3$, $R_2 = R_3 = R_6 = \text{H}$, $R_4 = \text{CONH}_2$)
461 ($R_1 = R_5 = R_6 = \text{CH}_3$, $R_2 = R_3 = R_4 = \text{H}$)
462 ($R_1 = R_6 = \text{CH}_3$, $R_2 = R_3 = R_4 = R_5 = \text{H}$)
463 ($R_1 = R_5 = R_6 = \text{CH}_3$, $R_2 = \text{OH}$, $R_3 = \text{H}$, $R_4 = \text{CONH}_2$)
464 ($R_1 = R_6 = \text{CH}_3$, $R_2 = \text{OH}$, $R_3 = R_5 = \text{H}$, $R_4 = \text{CONH}_2$)
465 ($R_1 = R_6 = \text{CH}_3$, $R_2 = \text{OH}$, $R_3 = R_4 = R_5 = \text{H}$)
467 ($R_1 = R_5 = R_6 = \text{CH}_3$, $R_2 = R_4 = \text{H}$, $R_3 = \text{CONH}_2$)



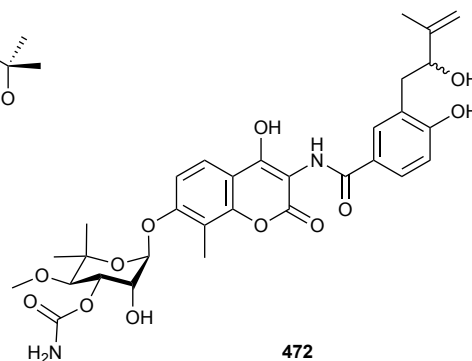
- 457** ($R = \text{Cl}$)
466 101 ($R = \text{H}$)



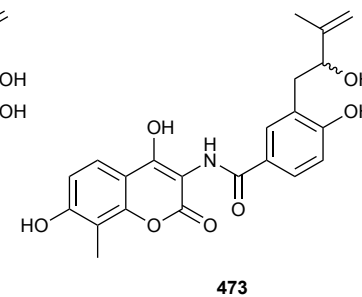
- 468** ($R = \text{OH}$)
469 ($R = \text{H}$)



- 470** ($R = \text{H}$)
471 ($R = \text{OH}$)

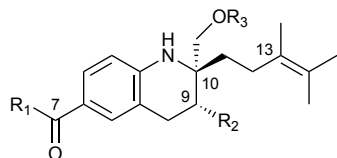


- 472**

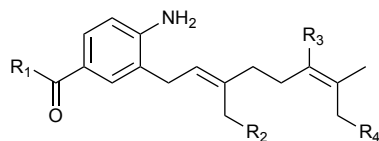


- 473**

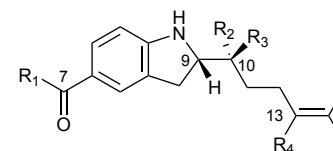
3.2 Benzazastatins



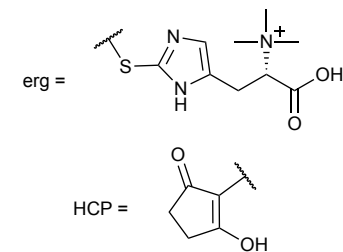
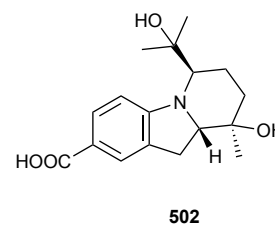
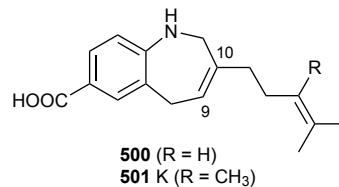
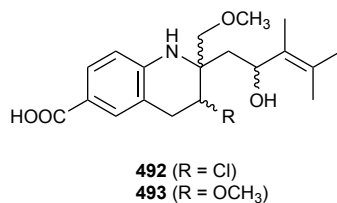
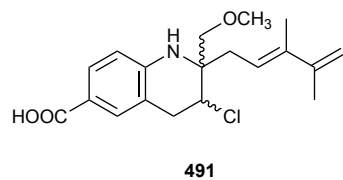
- 474** ($R_1 = \text{OH}, R_2 = \text{Cl}, R_3 = \text{CH}_3$)
477 ($R_1 = \text{NH}_2, R_2 = \text{Cl}, R_3 = \text{CH}_3$)
478 ($R_1 = \text{NH}_2, R_2 = \text{OH}, R_3 = \text{CH}_3$)
486 ($R_1 = R_2 = \text{OH}, R_3 = \text{CH}_3$)
488 ($R_1 = \text{OH}, R_2 = \text{erg}, R_3 = \text{CH}_3$)
489 ($R_1 = \text{NH-HCP}, R_2 = \text{OH}, R_3 = \text{CH}_3$)
494 ($R_1 = \text{OH}, R_2 = \text{Cl}, R_3 = \text{H}$)
495 ($R_1 = R_2 = \text{OH}, R_3 = \text{H}$)



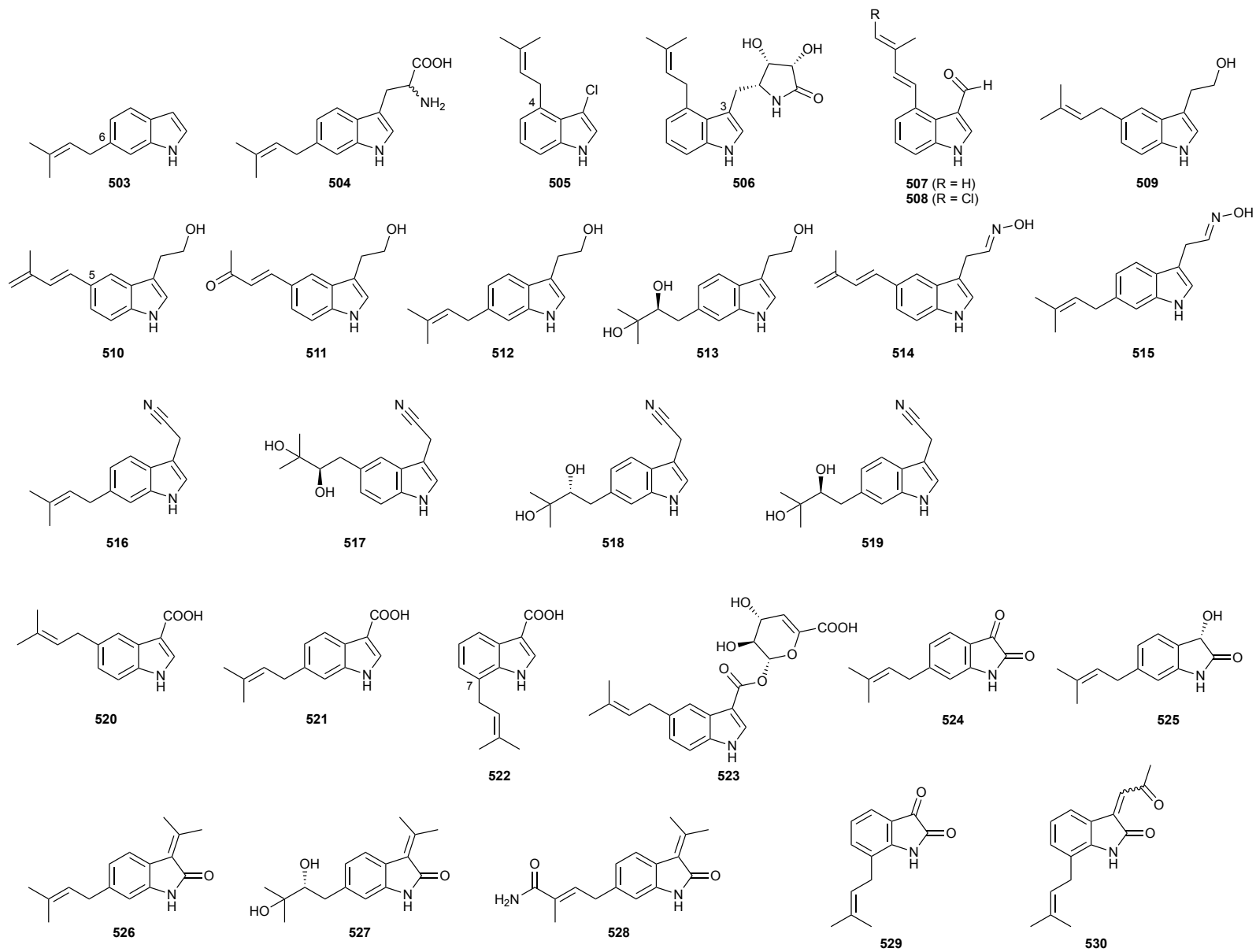
- 475** ($R_1 = \text{NH}_2, R_2 = \text{OCH}_3, R_3 = \text{CH}_3, R_4 = \text{H}$)
476 ($R_1 = \text{NH}_2, R_2 = R_4 = \text{H}, R_3 = \text{CH}_3$)
482 ($R_1 = \text{NH}_2, R_2 = R_4 = \text{H}, R_3 = \text{CH}_2\text{OH}$)
483 ($R_1 = \text{NH}_2, R_2 = \text{H}, R_3 = \text{CH}_3, R_4 = \text{OH}$)
496 ($R_1 = \text{OH}, R_2 = R_3 = R_4 = \text{H}$)
497 ($R_1 = \text{OH}, R_2 = R_4 = \text{H}, R_3 = \text{CH}_3$)
498 ($R_1 = R_2 = \text{OH}, R_3 = \text{CH}_3, R_4 = \text{H}$)



- 479** ($R_1 = \text{NH}_2, R_2 = \text{OH}, R_3 = \text{CH}_2\text{OCH}_3, R_4 = \text{CH}_3$)
480 ($R_1 = \text{NH}_2, R_2 = \text{OH}, R_3 = R_4 = \text{CH}_3$)
481 ($R_1 = \text{NH}_2, R_2 = \text{OH}, R_3 = \text{CH}_3, R_4 = \text{H}$)
484 ($R_1 = \text{OH}, R_2 = \text{OH}, R_3 = \text{CH}_3, R_4 = \text{H}$)
485 ($R_1 = R_2 = \text{OH}, R_3 = \text{CH}_2\text{OCH}_3, R_4 = \text{CH}_3$)
487 ($R_1 = \text{OH}, R_2 = \text{Cl}, R_3 = \text{CH}_2\text{OCH}_3, R_4 = \text{CH}_3$)
490 ($R_1 = \text{NH-HCP}, R_2 = \text{OH}, R_3 = \text{CH}_2\text{OCH}_3, R_4 = \text{CH}_3$)
499 ($R_1 = R_2 = \text{OH}, R_3 = R_4 = \text{CH}_3$)

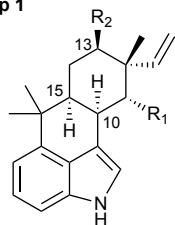


3.3.1 Indoles: Simple Indoles

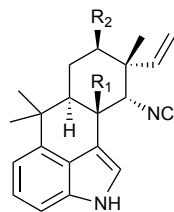


3.3.2.1 Indoles: Hapalindole-like indole alkaloids group 1

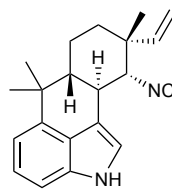
Group 1



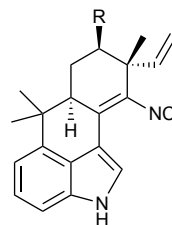
- 531 ($R_1 = \text{NC}$, $R_2 = \text{Cl}$)
 532 ($R_1 = \text{NCS}$, $R_2 = \text{Cl}$)
 533 ($R_1 = \text{NC}$, $R_2 = \text{H}$)
 534 ($R_1 = \text{NCS}$, $R_2 = \text{H}$)
 535 ($R_1 = \text{NCS}$, $R_2 = \text{OH}$)
 536 ($R_1 = \text{NHCHO}$, $R_2 = \text{Cl}$)
 537 ($R_1 = \text{NHCHO}$, $R_2 = \text{H}$)



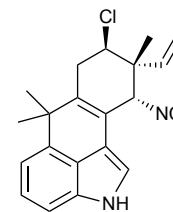
- 538 ($R_1 = \text{H}$, $R_2 = \text{Cl}$)
 539 ($R_1 = R_2 = \text{H}$)
 540 ($R_1 = \text{OH}$, $R_2 = \text{Cl}$)



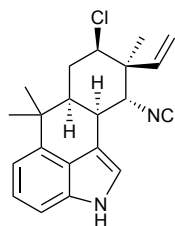
541



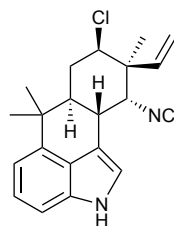
- 542 ($R = \text{Cl}$)
 543 ($R = \text{H}$)



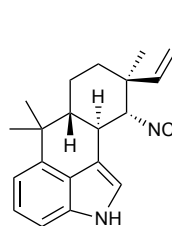
544



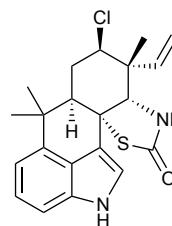
- 545 ($R = \text{Cl}$)
 546 ($R = \text{H}$)



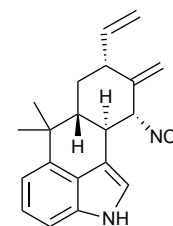
547



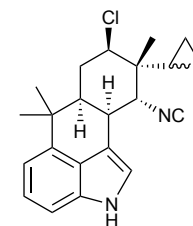
548



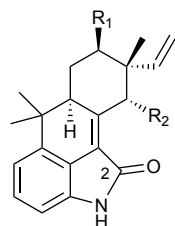
549



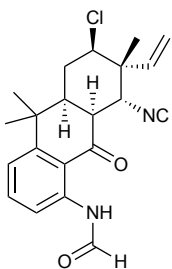
550



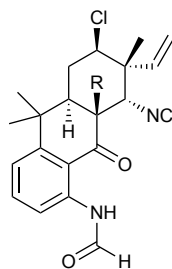
- 551/552
 (epimers not determined)



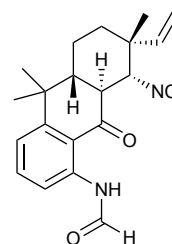
- 553 ($R_1 = \text{Cl}$, $R_2 = \text{NC}$)
 554 ($R_1 = \text{Cl}$, $R_2 = \text{NCS}$)
 555 ($R_1 = \text{H}$, $R_2 = \text{NCS}$)



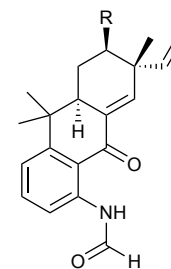
556



- 557 ($R = \text{H}$)
 558 ($R = \text{OH}$)



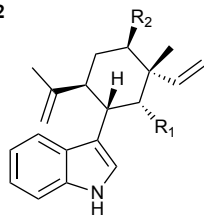
559



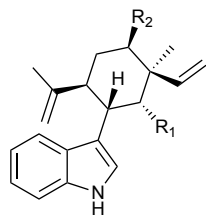
- 560 ($R = \text{Cl}$)
 561 ($R = \text{H}$)
 562 ($R = \text{OH}$)

3.3.2.2 Indoles: Hapalindole-like indole alkaloids groups 2–5

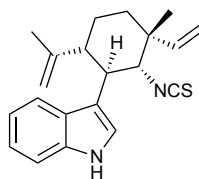
Group 2



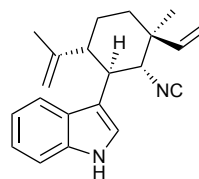
563 ($R_1 = \text{NC}, R_2 = \text{H}$)
564 ($R_1 = \text{NCS}, R_2 = \text{H}$)
565 ($R_1 = \text{NC}, R_2 = \text{Cl}$)
566 ($R_1 = \text{NCS}, R_2 = \text{Cl}$)



567 ($R_1 = \text{NC}, R_2 = \text{H}$)
568 ($R_1 = \text{NCS}, R_2 = \text{H}$)
569 ($R_1 = \text{NC}, R_2 = \text{Cl}$)
570 ($R_1 = \text{NCS}, R_2 = \text{Cl}$)

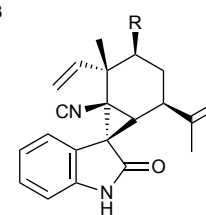


571



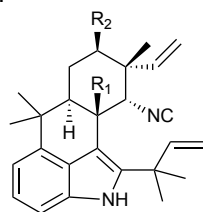
572

Group 3



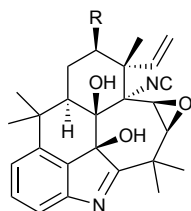
573 ($R = \text{Cl}$)
574 ($R = \text{H}$)

Group 4

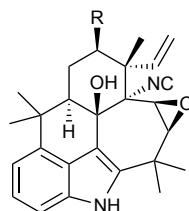


575 ($R_1 = \text{H}, R_2 = \text{Cl}$)
576 ($R_1 = \text{OH}, R_2 = \text{Cl}$)
577 ($R_1 = \text{OH}, R_2 = \text{H}$)
578 ($R_1 = \text{H}, R_2 = \text{H}$)

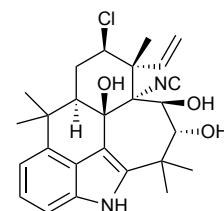
Group 5



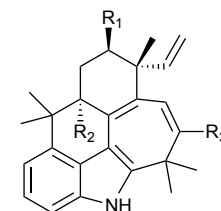
579 ($R = \text{Cl}$)
580 ($R = \text{H}$)



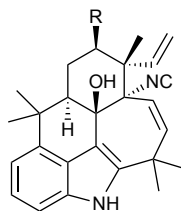
581 ($R = \text{Cl}$)
582 ($R = \text{H}$)



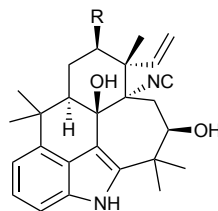
583



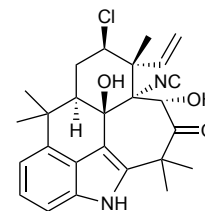
584 ($R_1 = \text{Cl}, R_2 = \text{H}, R_3 = \text{CN}$)
585 ($R_1 = R_3 = \text{H}, R_2 = \text{OH}$)
586 ($R_1 = R_2 = \text{H}, R_3 = \text{CN}$)



587 ($R = \text{Cl}$)
588 ($R = \text{H}$)



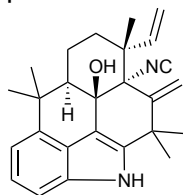
589 ($R = \text{Cl}$)
590 ($R = \text{H}$)



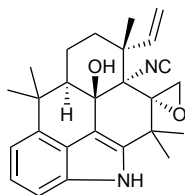
591

3.3.2.3 Indoles: Hapalindole-like indole alkaloids groups 6–9

Group 6

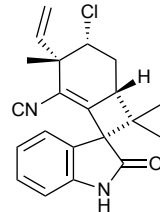


592



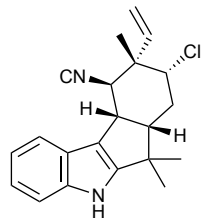
593

Group 8

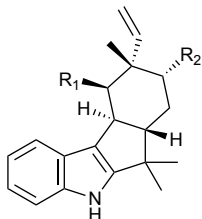


603

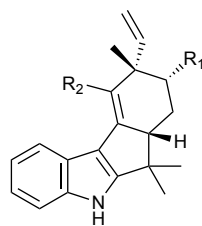
Group 7



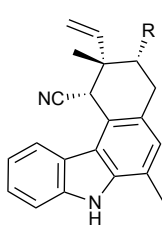
594



595 ($R_1 = \text{NC}$, $R_2 = \text{Cl}$)
596 ($R_1 = \text{NC}$, $R_2 = \text{H}$)
597 ($R_1 = \text{NCS}$, $R_2 = \text{H}$)

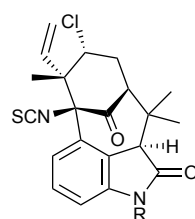


598 ($R_1 = \text{Cl}$, $R_2 = \text{NC}$)
599 ($R_1 = \text{Cl}$, $R_2 = \text{CN}$)
600 ($R_1 = \text{H}$, $R_2 = \text{CN}$)

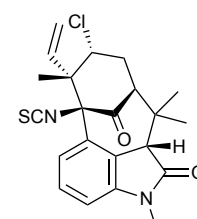


601 ($R = \text{Cl}$)
602 ($R = \text{H}$)

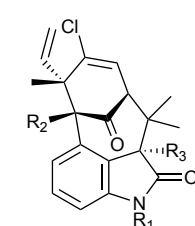
Group 9



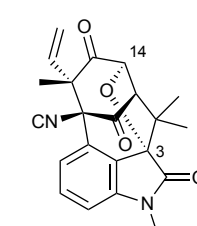
604 ($R = \text{H}$)
605 ($R = \text{CH}_3$)



606

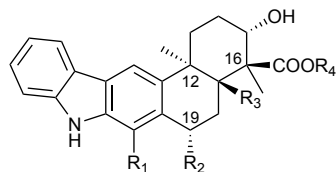


607 ($R_1 = \text{CH}_3$, $R_2 = \text{NC}$, $R_3 = \text{H}$)
608 ($R_1 = \text{H}$, $R_2 = \text{NCS}$, $R_3 = \text{H}$)
609 ($R_1 = \text{CH}_3$, $R_2 = \text{NCS}$, $R_3 = \text{H}$)
610 ($R_1 = \text{CH}_3$, $R_2 = \text{NC}$, $R_3 = \text{OH}$)
611 ($R_1 = \text{CH}_3$, $R_2 = \text{NCS}$, $R_3 = \text{OH}$)

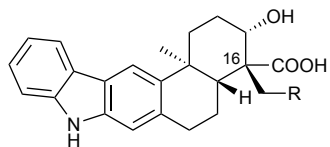


612

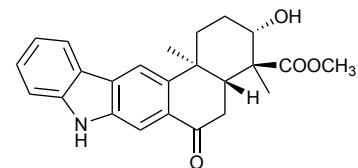
3.3.3.1 Indoles: Xiamycin monomers



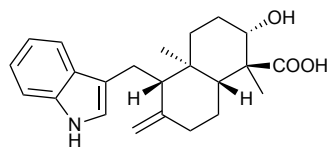
- 613** ($R_1 = R_2 = R_3 = R_4 = H$)
614 ($R_1 = R_2 = R_3 = H, R_4 = CH_3$)
617 ($R_1 = R_2 = R_4 = H, R_3 = OH$)
618 ($R_1 = R_3 = R_4 = H, R_2 = OH$)
619 ($R_1 = R_3 = H, R_2 = OH, R_4 = CH_3$)
621 ($R_1 = Cl, R_2 = R_3 = R_4 = H$)



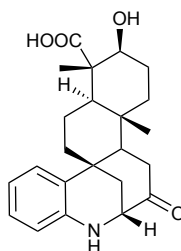
- 615** ($R = H$)
616 ($R = OH$)



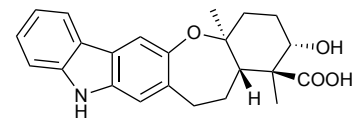
620



622

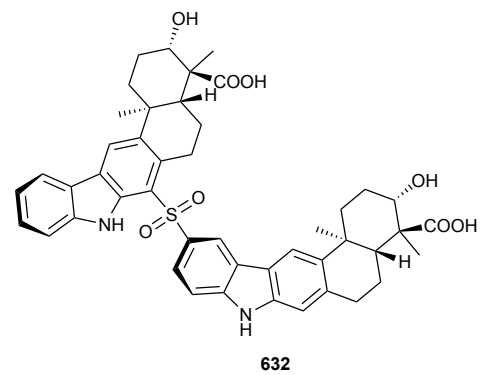
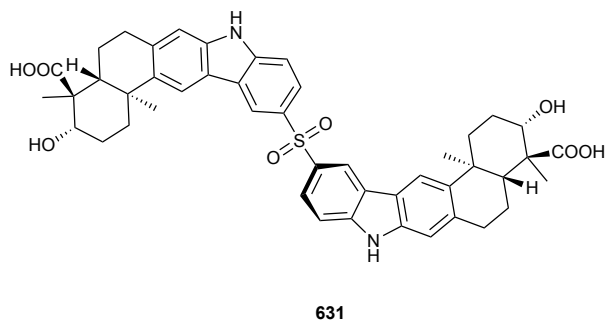
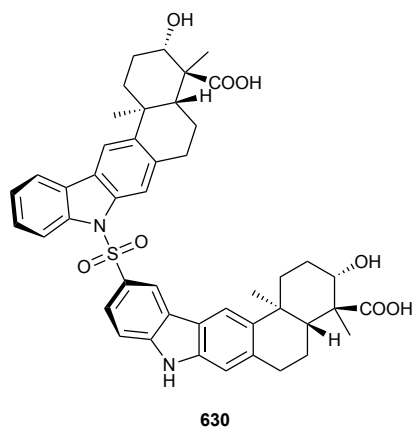
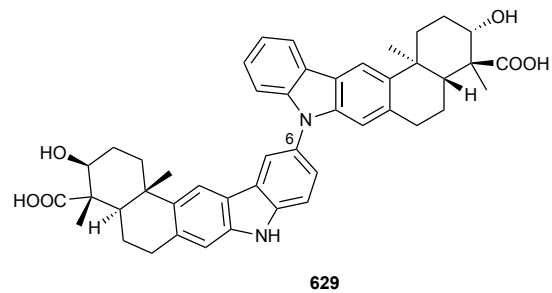
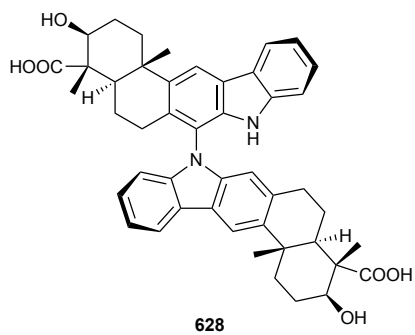
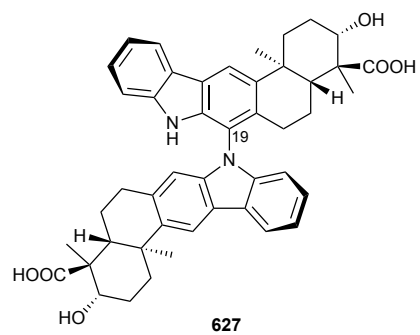
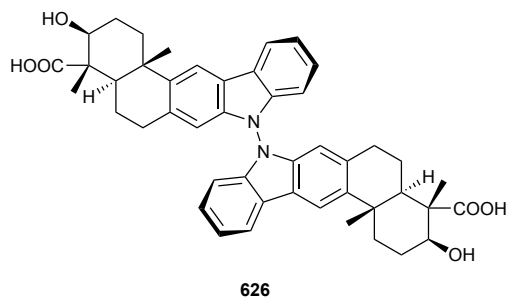
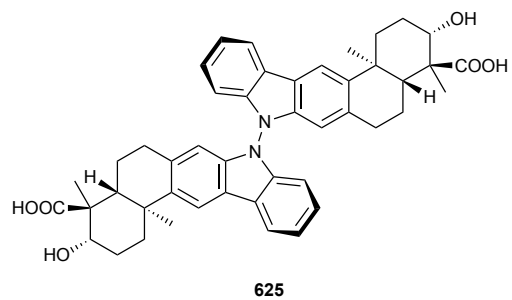


623

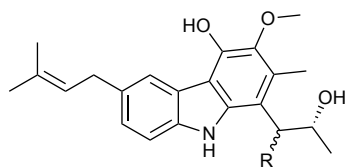


624

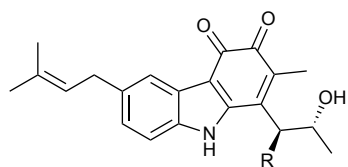
3.3.3.2 Indoles: Xiamycin dimers



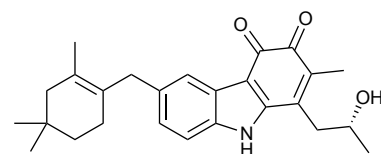
3.3.4 Indoles: Miscellaneous polycyclic indoles



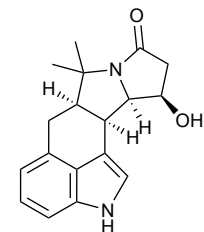
633 (R = OH)
634 (R = H)
635 (R = OCH₃)



636 (R = H)
637 (R = OH)



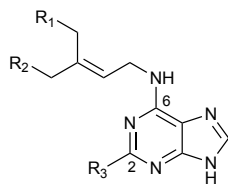
638



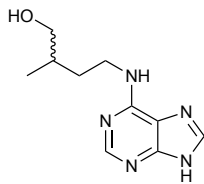
639

3.4

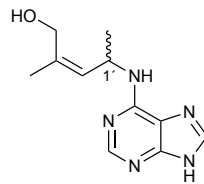
Nucleobases and nucleosides



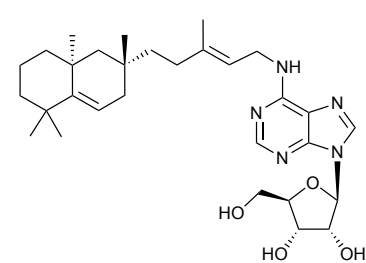
- 640 ($R_1 = R_2 = R_3 = H$)
 641 ($R_1 = OH, R_2 = R_3 = H$)
 642 ($R_1 = R_3 = H, R_2 = OH$)
 645 ($R_1 = OH, R_2 = H, R_3 = SCH_3$)



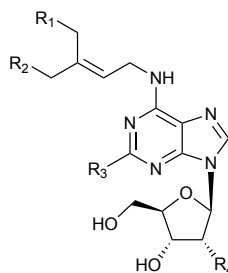
643



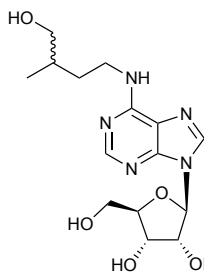
644



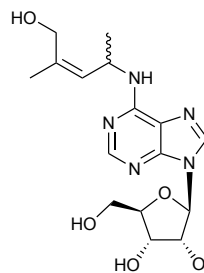
657



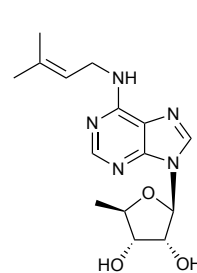
- 646 ($R_1 = R_2 = R_3 = H, R_4 = OH$)
 647 ($R_1 = OH, R_2 = R_3 = H$)
 648 ($R_1 = R_3 = H, R_2 = R_4 = OH$)
 649 ($R_1 = R_3 = R_4 = H, R_2 = OH$)
 650 ($R_1 = R_2 = H, R_3 = SCH_3$)
 651 ($R_1 = OH, R_2 = H, R_3 = SCH_3$)



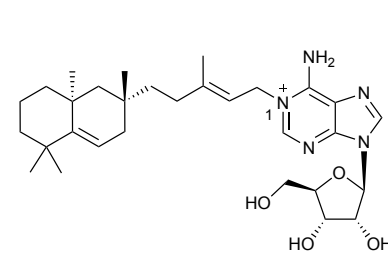
652



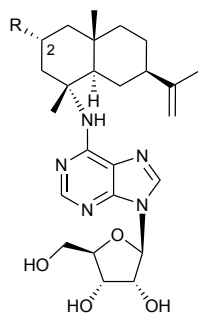
653



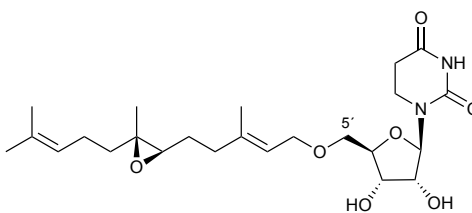
654



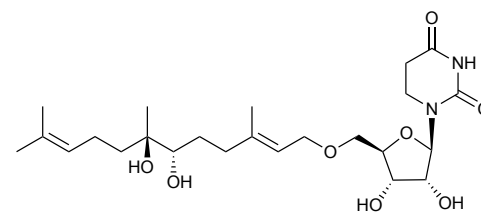
658



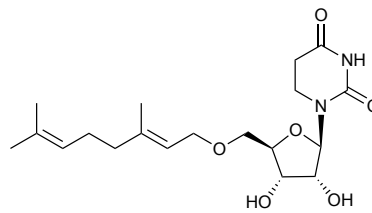
- 655 ($R = H$)
 656 ($R = OH$)



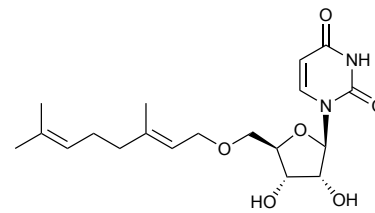
659



660

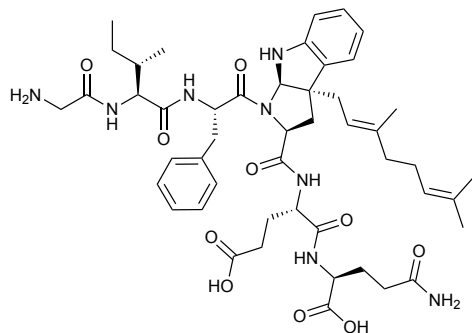


661

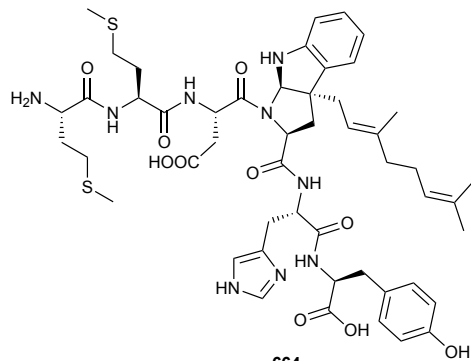


662

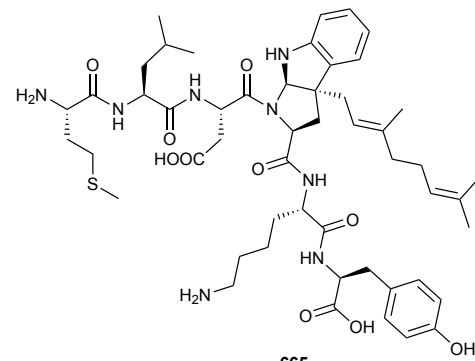
3.5.1.1 Peptides: Ribosomal peptides: ComX



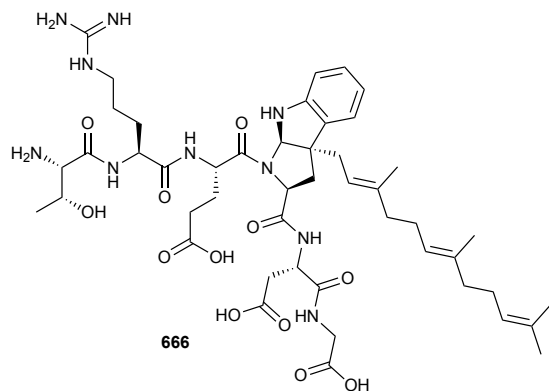
663



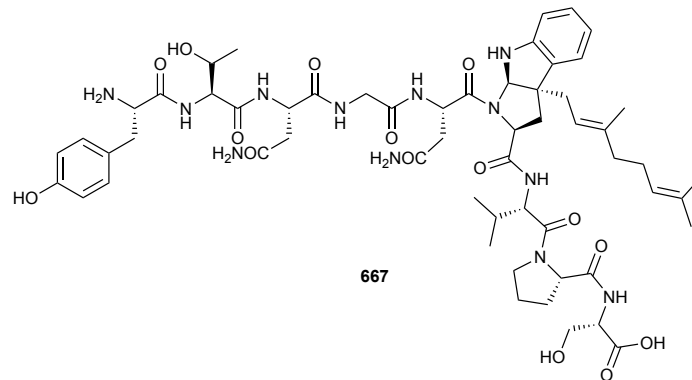
664



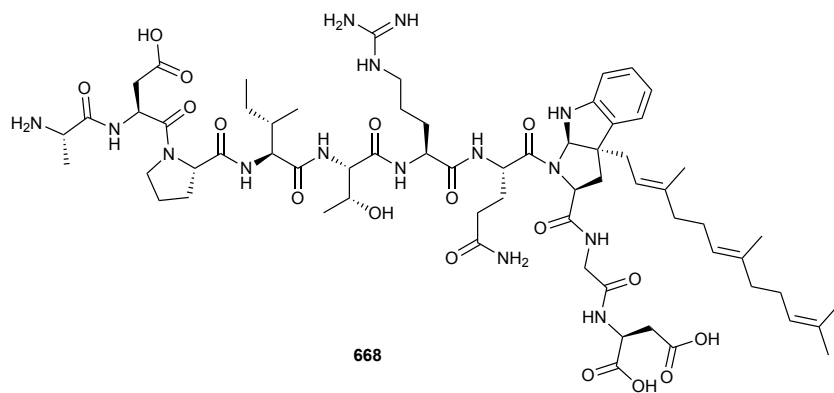
665



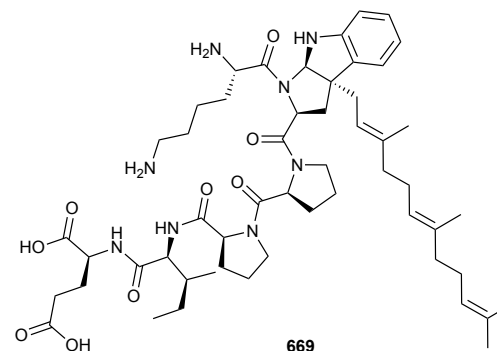
666



667

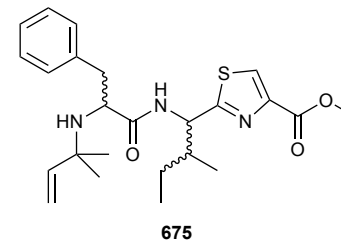
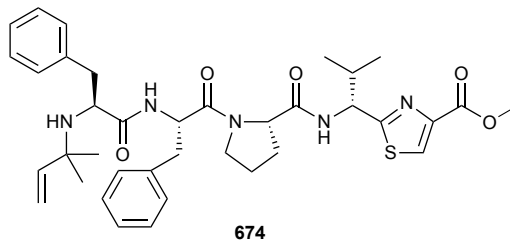
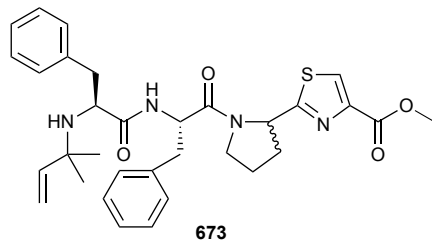
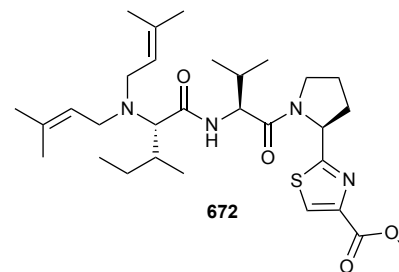
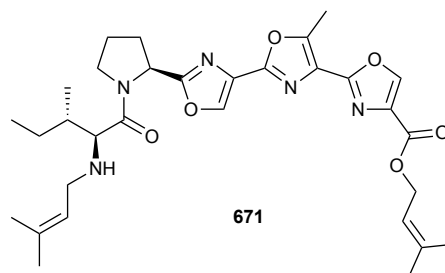
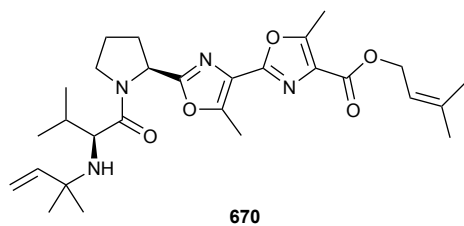


668

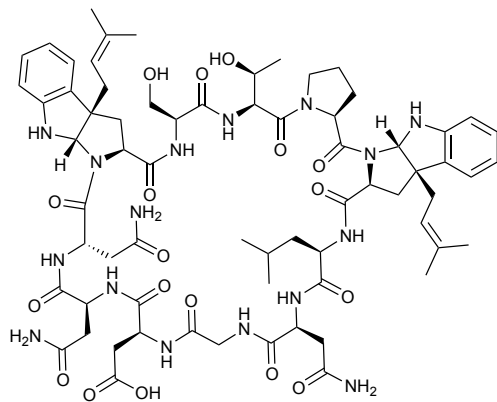


669

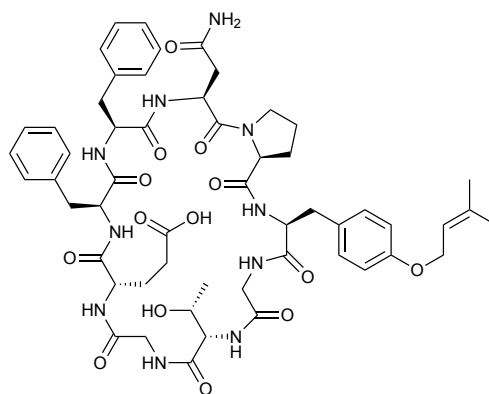
3.5.1.1 Peptides: Ribosomal peptides: Linear cyanobactins



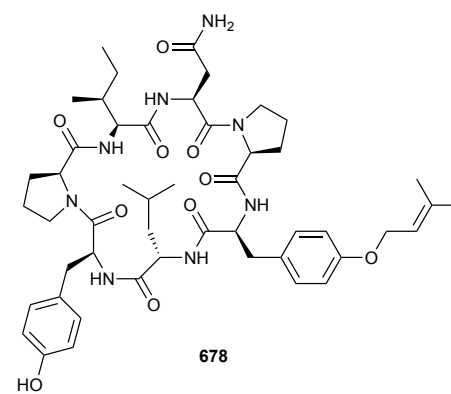
3.5.1.1 Peptides: Ribosomal peptides: Cyclic cyanobactins



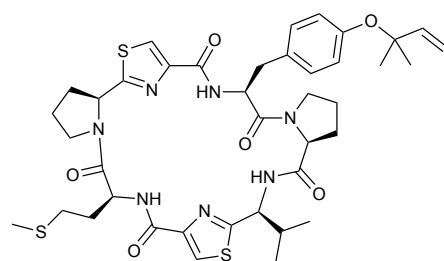
676



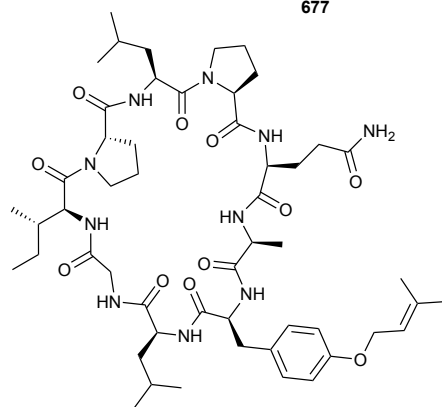
677



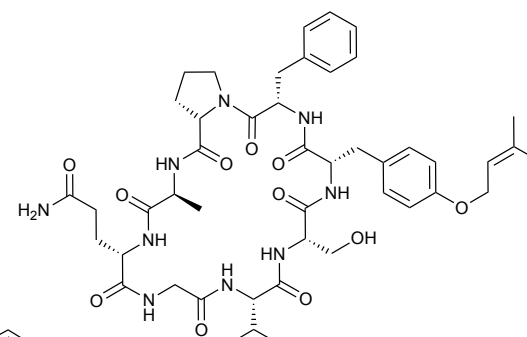
678



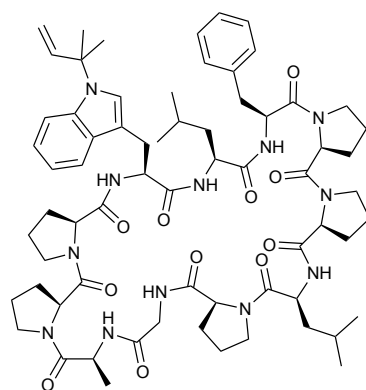
679



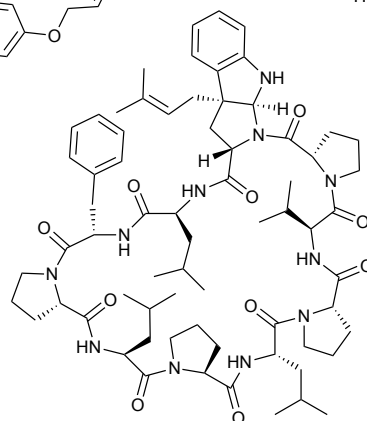
680



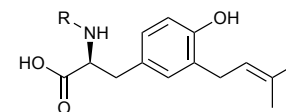
681



682

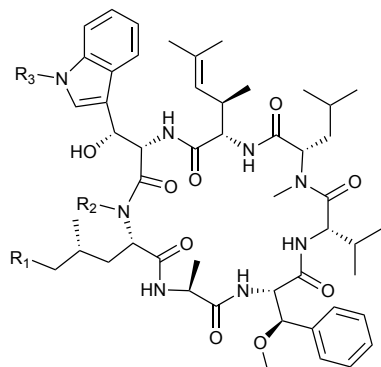


683

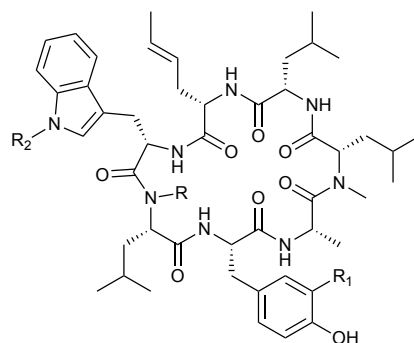


684 (R = H)
685 (R = COCH₃)

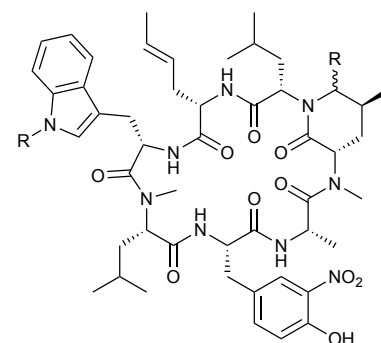
3.5.2 Nonribosomal peptides



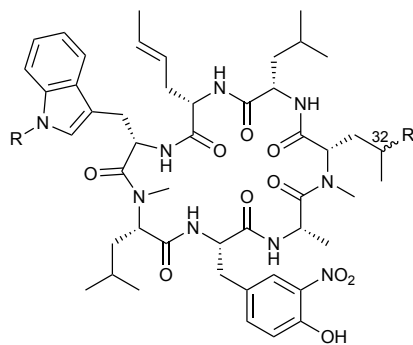
686 ($R_1 = \text{OH}$, $R_2 = \text{CH}_3$, $R_3 = \text{epoxy-r-prenyl}$)
687 ($R_1 = \text{H}$, $R_2 = \text{CH}_3$, $R_3 = \text{epoxy-r-prenyl}$)
688 ($R_1 = \text{OH}$, $R_2 = \text{CH}_3$, $R_3 = \text{r-prenyl}$)
689 ($R_1 = \text{OH}$, $R_2 = \text{H}$, $R_3 = \text{r-prenyl}$)



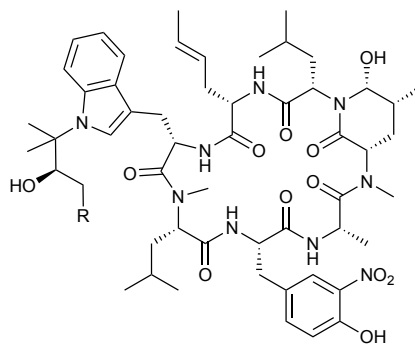
690 ($R_1 = \text{NO}_2$, $R_2 = \text{CH}_3$, $R_3 = \text{r-prenyl}$)
691 ($R_1 = \text{NO}_2$, $R_2 = \text{CH}_3$, $R_3 = \text{epoxy-r-prenyl}$)
699 ($R_1 = \text{H}$, $R_2 = \text{CH}_3$, $R_3 = \text{r-prenyl}$)
701 ($R_1 = \text{NO}_2$, $R_2 = \text{H}$, $R_3 = \text{epoxy-r-prenyl}$)



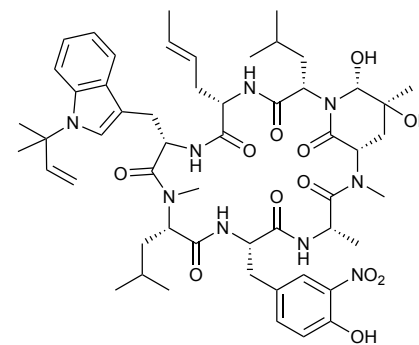
692 ($R_1 = \alpha\text{-OH}$, $R_2 = \text{epoxy-r-prenyl}$)
693 ($R_1 = \beta\text{-OH}$, $R_2 = \text{epoxy-r-prenyl}$)
695 ($R_1 = \alpha\text{-OH}$, $R_2 = \text{r-prenyl}$)



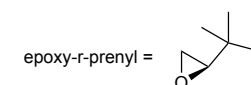
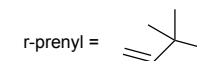
694 (32S, $R_1 = \text{COOH}$, $R_2 = \text{epoxy-r-prenyl}$)
696 (32S, $R_1 = \text{CH}_2\text{OH}$, $R_2 = \text{epoxy-r-prenyl}$)
697 (32R, $R_1 = \text{CH}_2\text{OH}$, $R_2 = \text{epoxy-r-prenyl}$)
698 (32S, $R_1 = \text{CH}_2\text{OH}$, $R_2 = \text{r-prenyl}$)
700 ($R_1 = \text{CH}(\text{OCH}_3)_2$, $R_2 = \text{epoxy-r-prenyl}$)



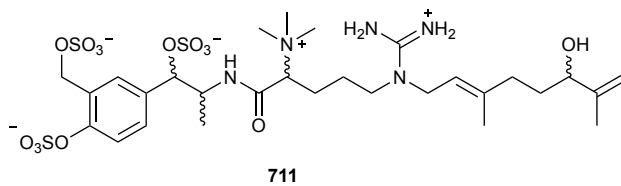
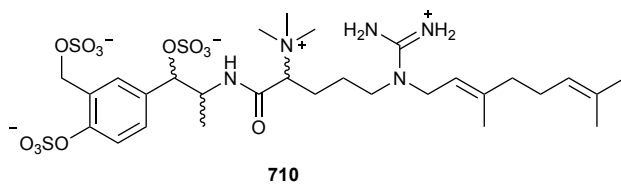
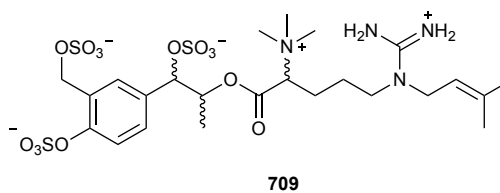
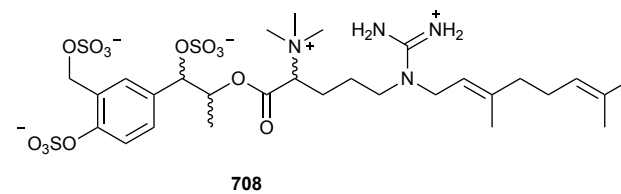
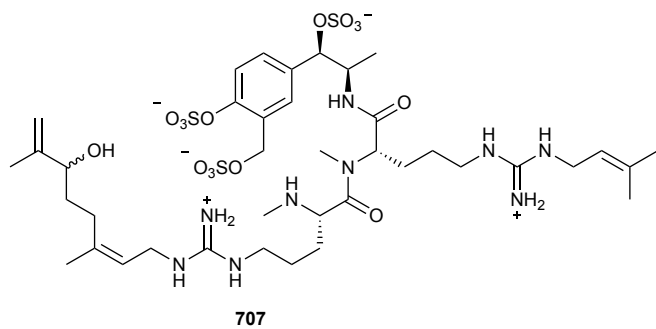
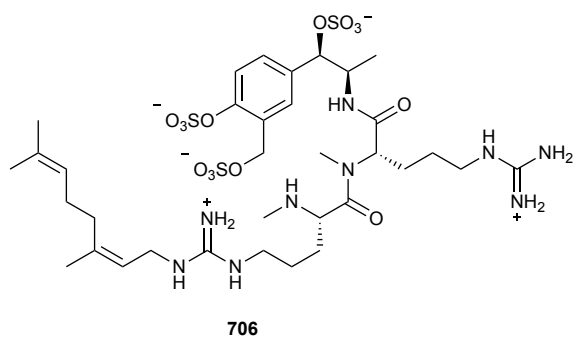
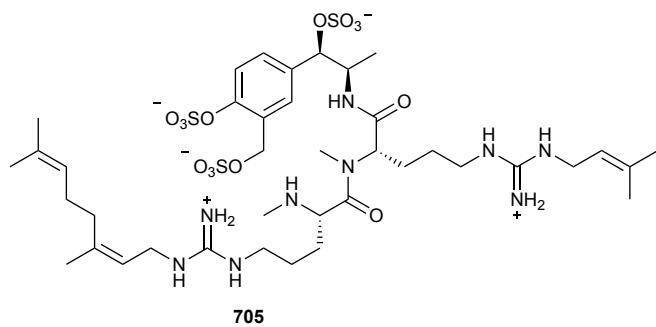
702 ($R = \text{OH}$)
704 ($R = \text{Cl}$)



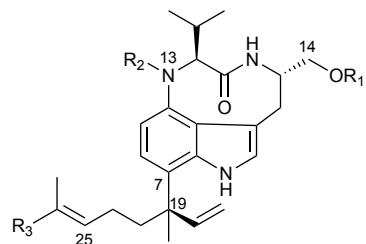
703



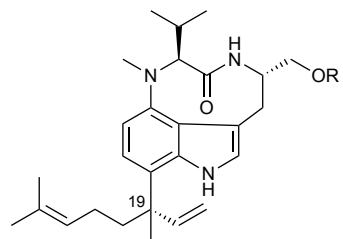
3.5.2 Nonribosomal peptides



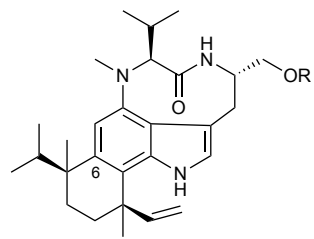
3.5.3 Nonribosomal peptides: Teleocidins



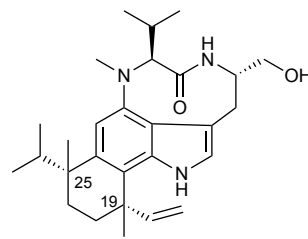
712 ($R_1 = H, R_2 = R_3 = CH_3$)
731 ($R_1 = H, R_2 = CH_3, R_3 = COOH$)
737 ($R_1 = R_2 = H, R_3 = CH_3$)
739 ($R_1 = R_2 = R_3 = CH_3$)



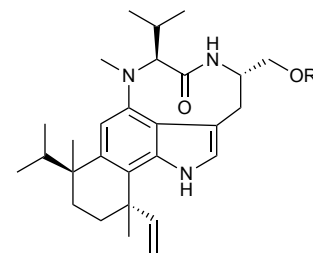
713 ($R = H$)
740 ($R = Ac$)



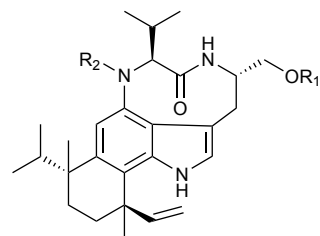
714 ($R = H$)
719 ($R = CH_3$)



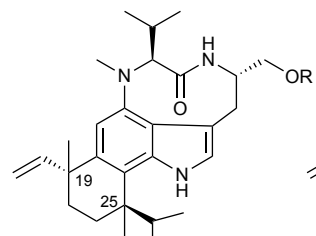
715



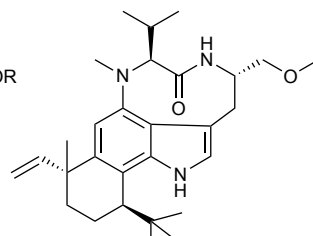
716 ($R = H$)
741 ($R = Ac$)



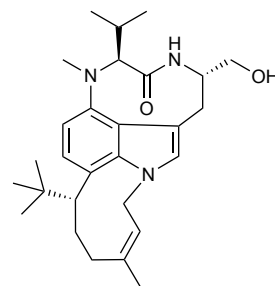
717 ($R_1 = H, R_2 = CH_3$)
718 ($R_1 = R_2 = CH_3$)
736 ($R_1 = R_2 = H$)



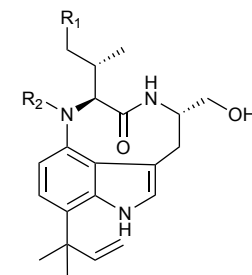
720 ($R = CH_3$)
721 ($R = H$)



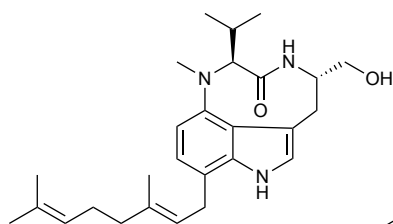
722



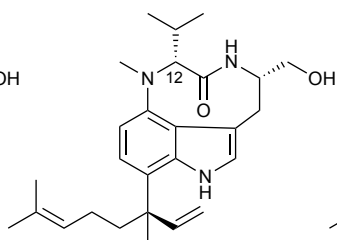
723



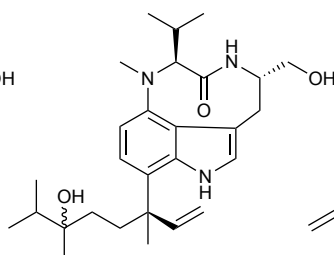
724 ($R_1 = H, R_2 = CH_3$)
726 ($R_1 = R_2 = CH_3$)
738 ($R_1 = CH_3, R_2 = H$)



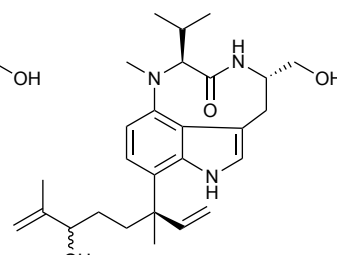
725



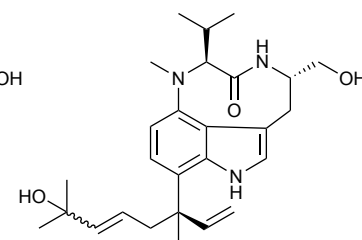
727



728

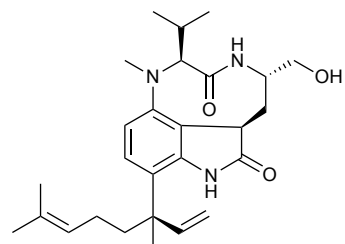


729

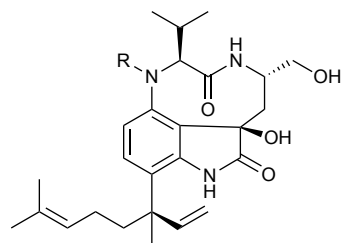


730

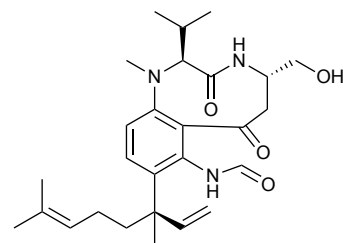
3.5.3 Nonribosomal peptides: Teleocidins



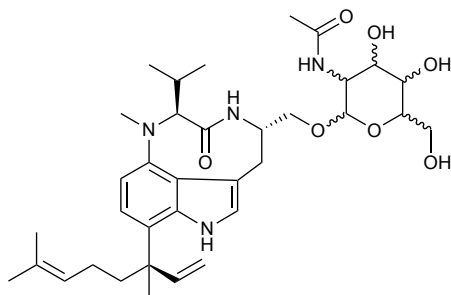
732



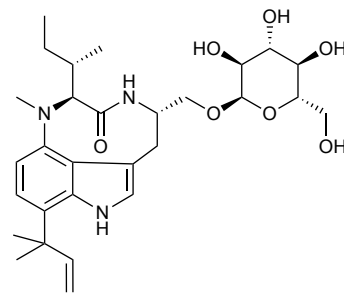
733 (R = CH₃)
734 (R = H)



735

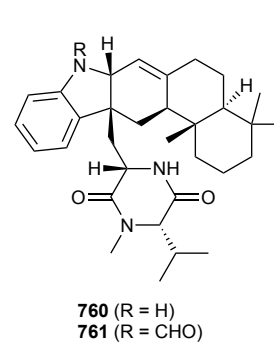
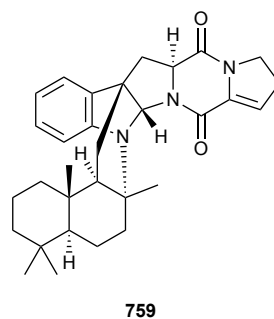
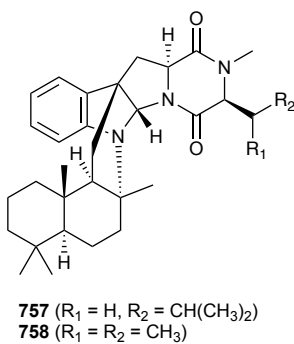
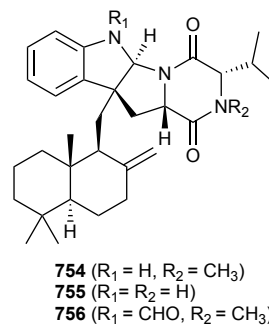
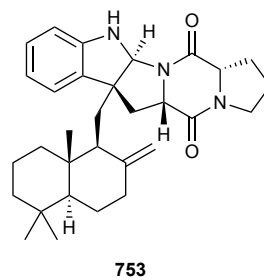
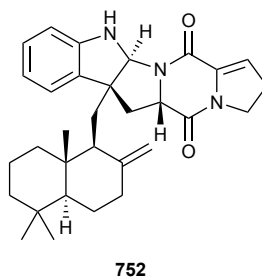
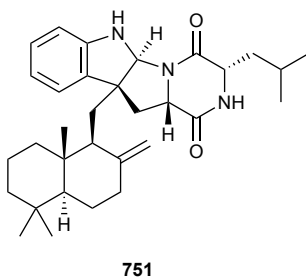
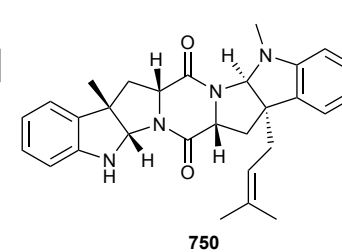
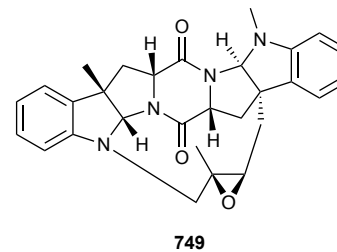
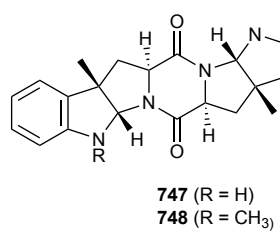
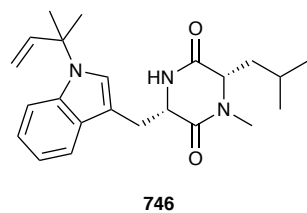
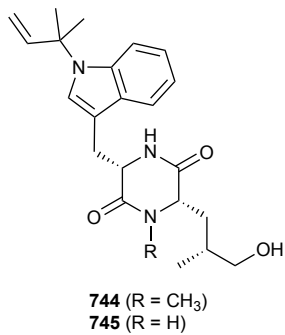


742

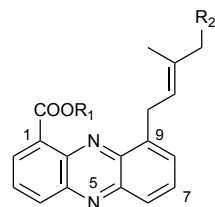


743

3.5.4 Diketopiperazines



3.6 Phenazines



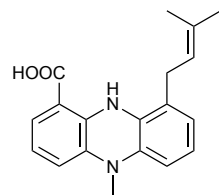
762 ($R_1 = R_2 = H$)

766 ($R_1 = H, R_2 = OH$)

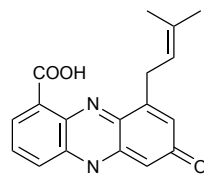
780 ($R_1 = 6\text{-deoxy-}\alpha\text{-L-talopyranose}, R_2 = H$)

781 ($R_1 = L\text{-rhamnose}, R_2 = OH$)

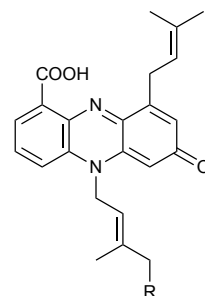
782 ($R_1 = 2'\text{-O-methyl-L-rhamnose}, R_2 = OH$)



763

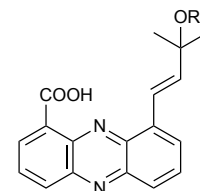


764



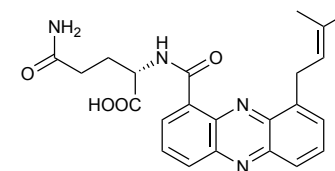
765 ($R = H$)

767 ($R = OH$)

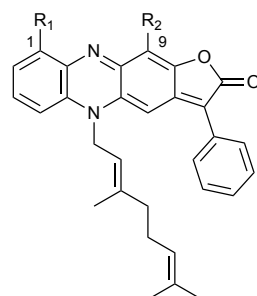


768 ($R = H$)

783 ($R = L\text{-rhamnose}$)

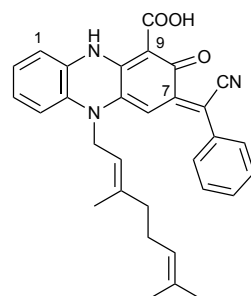


769

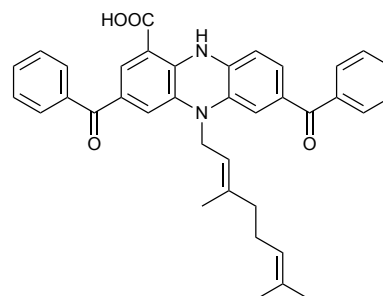


770 ($R_1 = COOH, R_2 = H$)

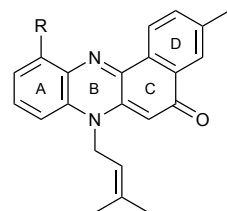
771 ($R_1 = H, R_2 = COOH$)



772

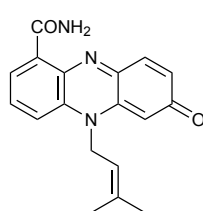


773

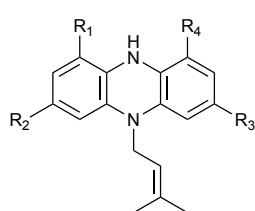


774 ($R = H$)

775 ($R = COOH$)



776



777 ($R_1 = COOH, R_2 = C_6H_5CO-, R_3 = R_4 = H$)

778 ($R_1 = COOH, R_2 = R_3 = C_6H_5CO-, R_4 = H$)

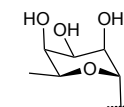
779 ($R_1 = CONH_2, R_2 = R_3 = C_6H_5CO-, R_4 = H$)

784 ($R_1 = COO\text{-L-rhamnose}, R_2 = R_4 = H, R_3 = C_6H_5CO-$)

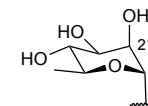
785 ($R_1 = COO\text{-L-rhamnose}, R_2 = H, R_3 = C_6H_5CO-, R_4 = DMA$)

786 ($R_1 = COO\text{-L-rhamnose}, R_2 = R_3 = H, R_4 = DMA$)

6-deoxy- α -L-talopyranose =



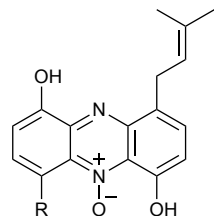
L-rhamnose =



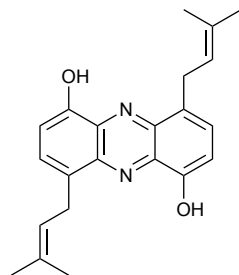
DMA =



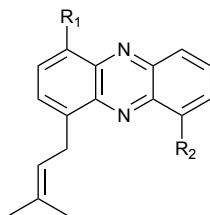
3.6 Phenazines



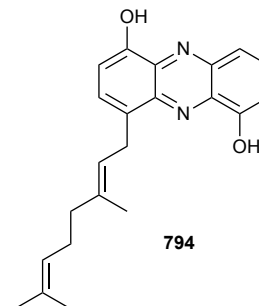
787 (R = H)
789 (R = DMA)



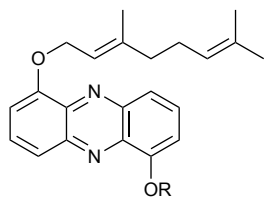
788



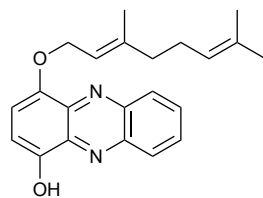
790 (R₁ = R₂ = OCH₃)
791 (R₁ = OCH₃, R₂ = OH)
792 (R₁ = R₂ = OH)
793 (R₁ = OH, R₂ = H)



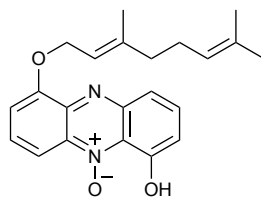
794



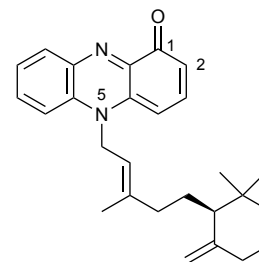
795 (R = H)
796 B (R = CH₃)



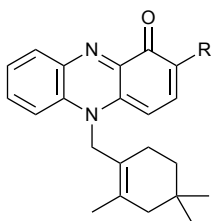
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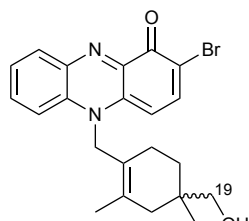
798



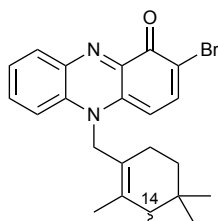
800



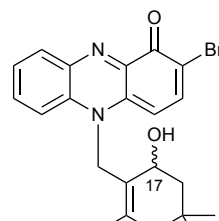
799 (R = H)
801 (R = Cl)
802 (R = Br)



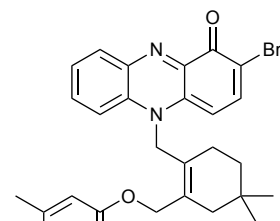
803



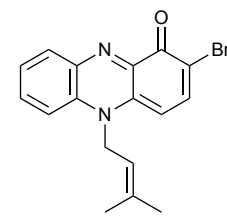
804



805

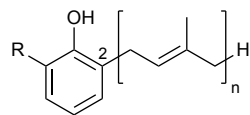


806

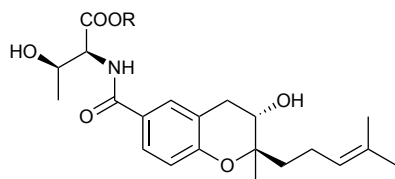


807

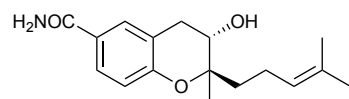
3.7 Phenols



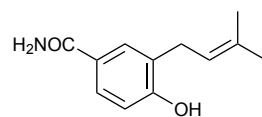
- 808** (R = H, n = 4)
809 (R = H, n = 9)
810 (R = H, n = 10)
811 (R = OCH₃, n = 10)



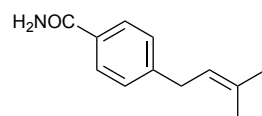
- 812** (R = H)
813 (R = CH₃)



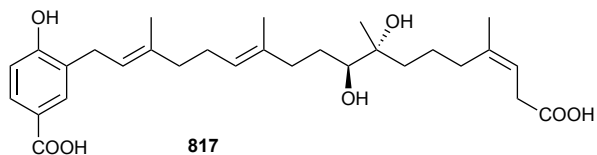
814



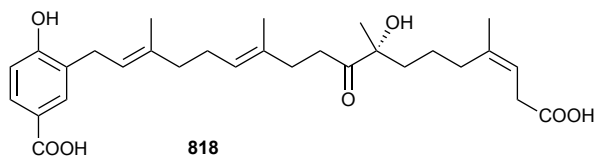
815



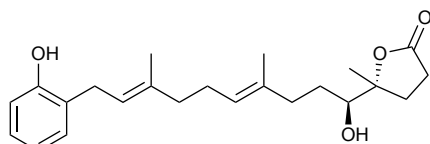
816



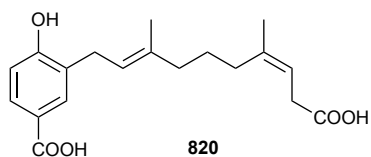
817



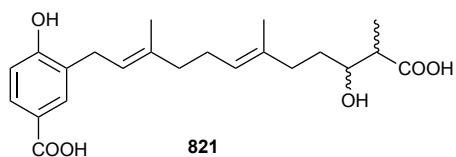
818



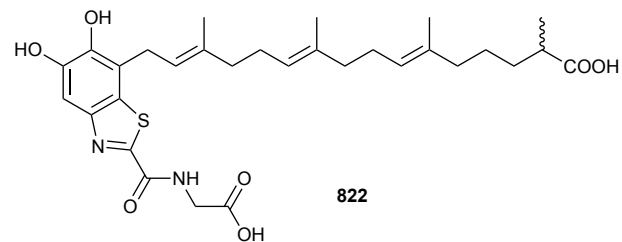
819



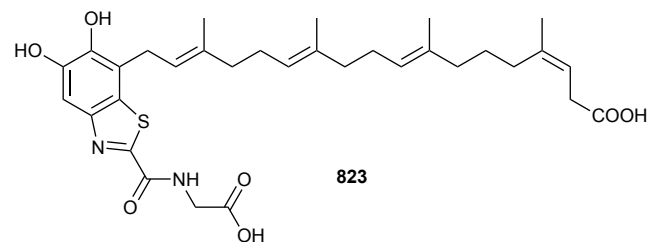
820



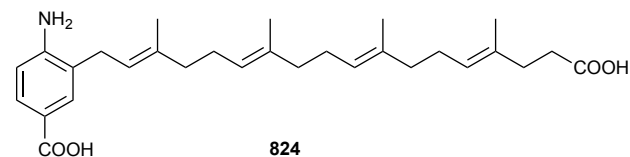
821



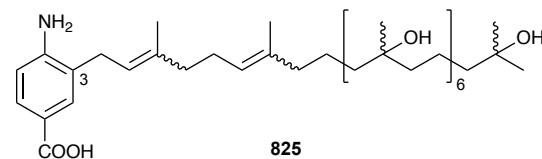
822



823

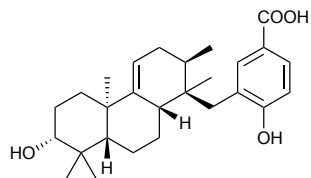


824

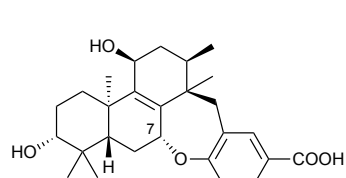


825

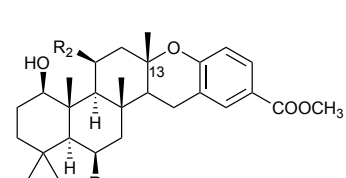
3.7 Phenols



826



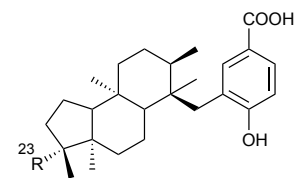
827



828 ($R_1 = OH, R_2 = H$)

829 ($R_1 = R_2 = H$)

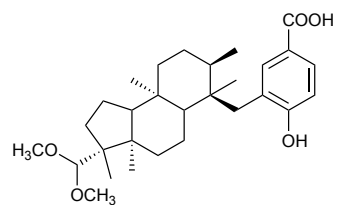
830 ($R_1 = R_2 = OH$)



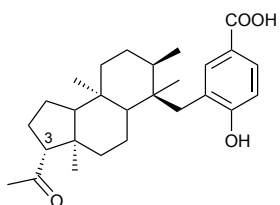
831 ($R = CH_2OH$)

832 ($R = CHO$)

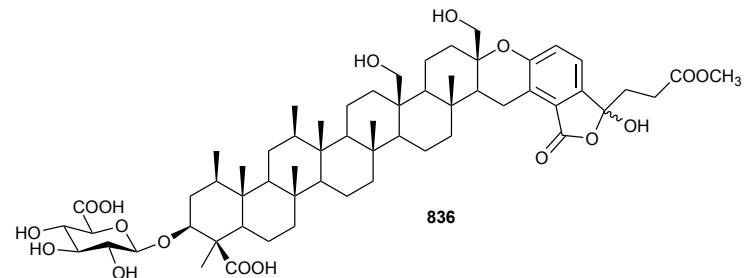
833 ($R = COOH$)



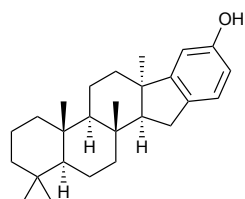
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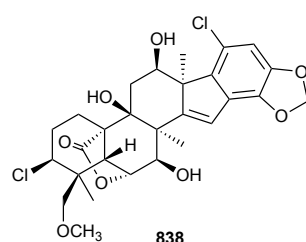
835



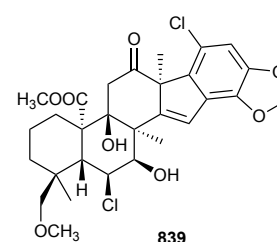
836



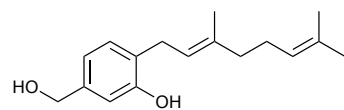
837



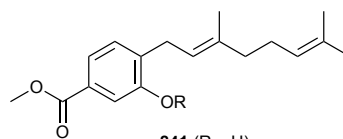
838



839

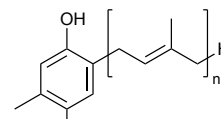


840



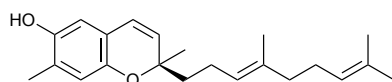
841 ($R = H$)

842 ($R = CH_3$)

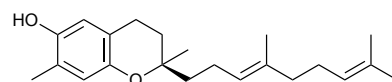


843 ($n = 3$)

846 ($n = 2$)

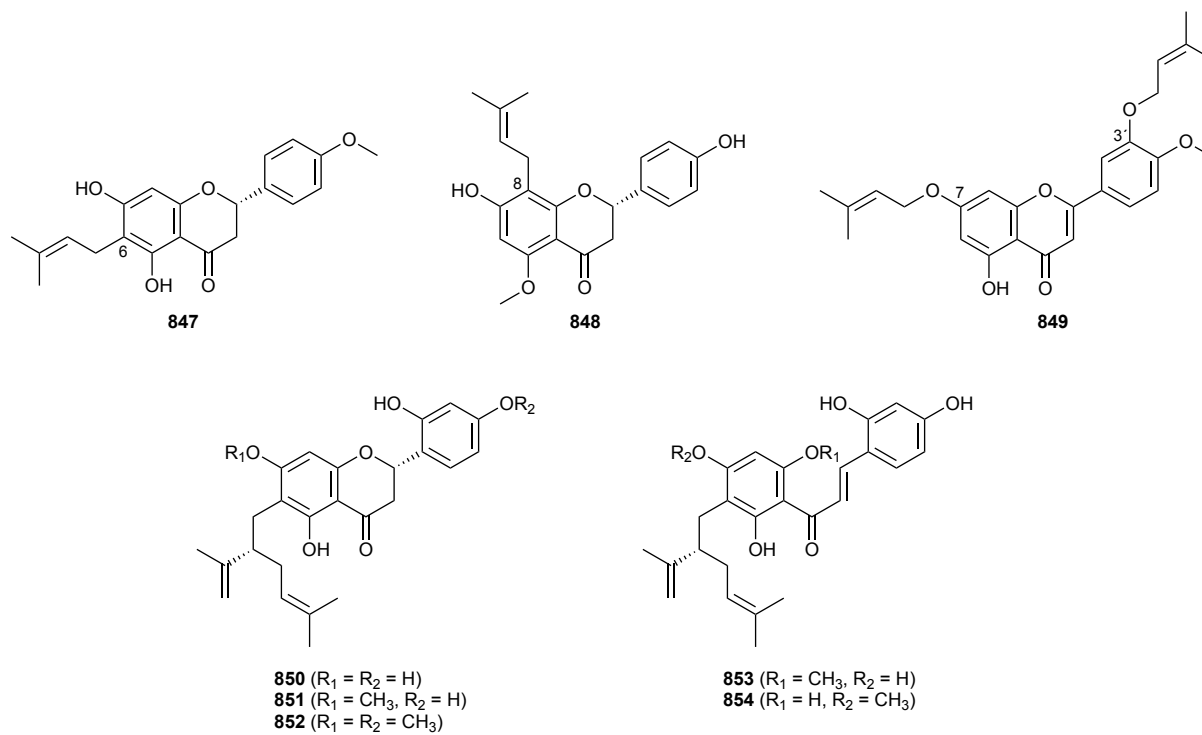


844

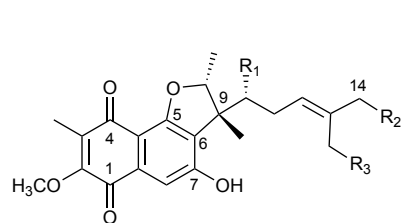


845

3.8.1 Polyketides: Flavonoids



3.8.2 Polyketides: Furaquinocins



855 ($R_1 = R_3 = \text{OH}, R_2 = \text{H}$)

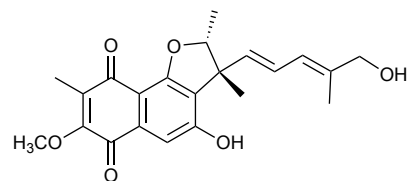
856 ($R_1 = R_2 = \text{OH}, R_3 = \text{H}$)

857 ($R_1 = R_2 = R_3 = \text{H}$)

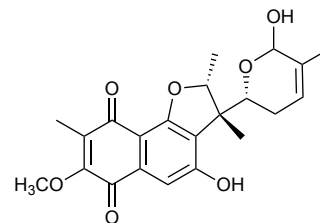
858 ($R_1 = \text{OH}, R_2 = R_3 = \text{H}$)

859 ($R_1 = R_3 = \text{H}, R_2 = \text{OH}$)

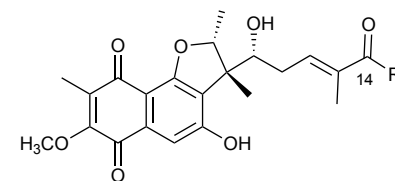
860 ($R_1 = R_2 = R_3 = \text{OH}$)



861

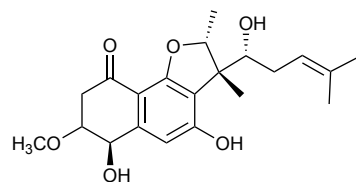


862

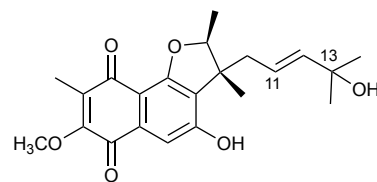


863 ($R = \text{OH}$)

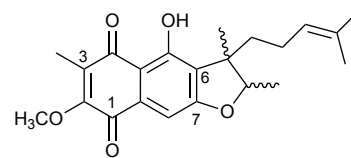
864 ($R = \text{NH}_2$)



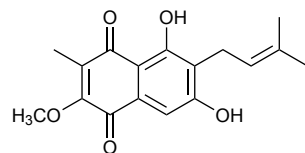
865



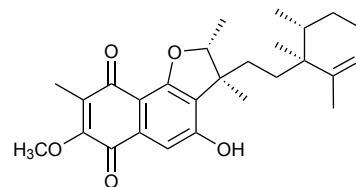
866



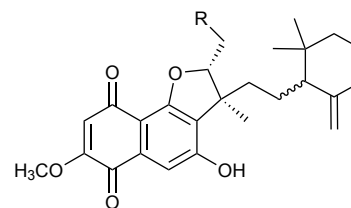
867



868

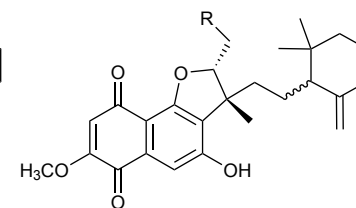


869



870 ($R = \text{H}$)

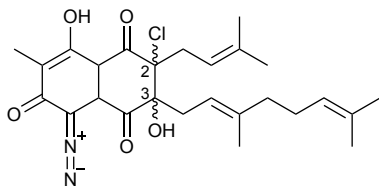
872 ($R = \text{OH}$)



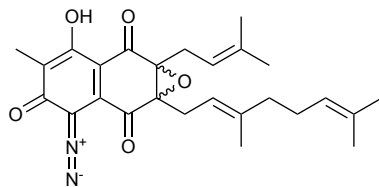
871 ($R = \text{H}$)

873 ($R = \text{OH}$)

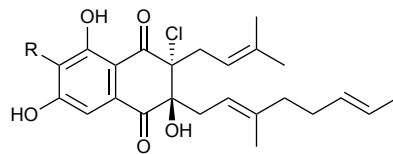
3.8.3.1 Polyketides: Napyradiomycins type A



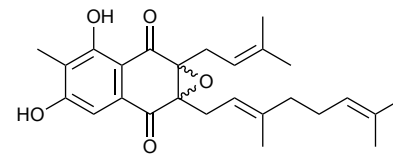
880



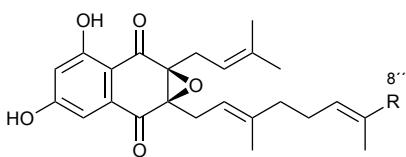
881



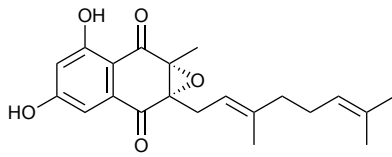
882 (R = CH₃)
888 (R = H)



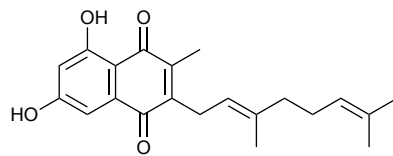
883



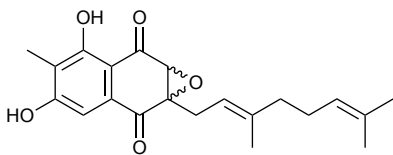
886 (R = CH₃)
887 (R = COOH)



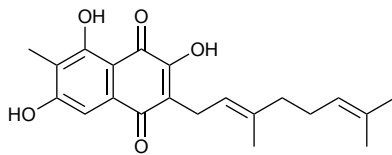
889



890

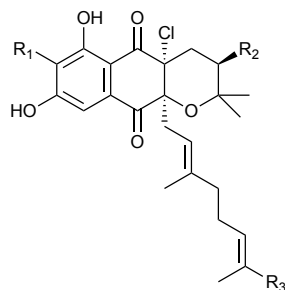


891

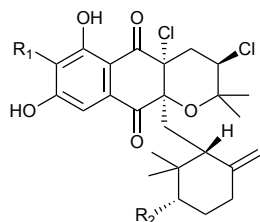


892

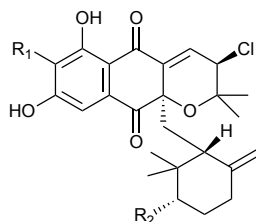
3.8.3.2 Polyketides: Napyradiomycins type B



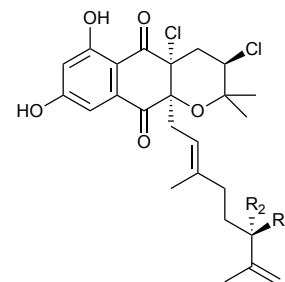
874 ($R_1 = \text{H}$, $R_2 = \text{Cl}$, $R_3 = \text{CH}_3$)
885 ($R_1 = R_3 = \text{CH}_3$, $R_2 = \text{Cl}$)
896 ($R_1 = R_3 = \text{CH}_3$, $R_2 = \text{Br}$)
897 ($R_1 = \text{H}$, $R_2 = \text{Br}$, $R_3 = \text{CH}_3$)
898 ($R_1 = \text{H}$, $R_2 = \text{Cl}$, $R_3 = \text{CH}_2\text{OH}$)
899 ($R_1 = \text{H}$, $R_2 = \text{Cl}$, $R_3 = \text{CHO}$)



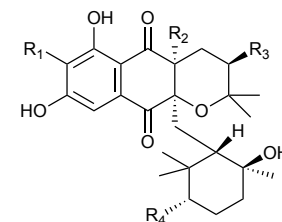
875 ($R_1 = \text{H}$, $R_2 = \text{Cl}$)
877 ($R_1 = \text{H}$, $R_2 = \text{Br}$)
906 ($R_1 = \text{CH}_3$, $R_2 = \text{Cl}$)



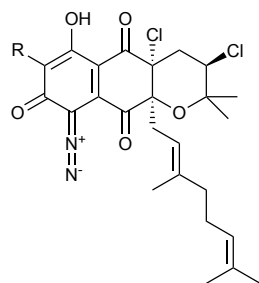
876 ($R_1 = \text{H}$, $R_2 = \text{Cl}$)
910 ($R_1 = \text{CH}_3$, $R_2 = \text{Cl}$)
911 ($R_1 = \text{H}$, $R_2 = \text{Br}$)



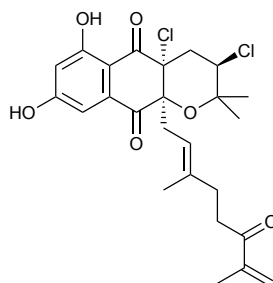
893 ($R_1 = \text{OH}$, $R_2 = \text{H}$)
894 ($R_1 = \text{H}$, $R_2 = \text{OH}$)



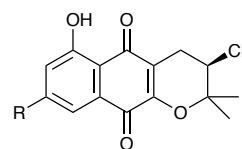
895 ($R_1 = \text{H}$, $R_2 = R_3 = R_4 = \text{Cl}$)
907 ($R_1 = \text{CH}_3$, $R_2 = R_3 = R_4 = \text{Cl}$)
912 ($R_1 = \text{CH}_3$, $R_2 = \text{H}$, $R_3 = R_4 = \text{Cl}$)
913 ($R_1 = \text{CH}_3$, $R_2 = \text{Cl}$, $R_3 = R_4 = \text{Br}$)
914 ($R_1 = R_2 = \text{H}$, $R_3 = R_4 = \text{Cl}$)
915 ($R_1 = \text{H}$, $R_2 = \text{OH}$, $R_3 = R_4 = \text{Cl}$)



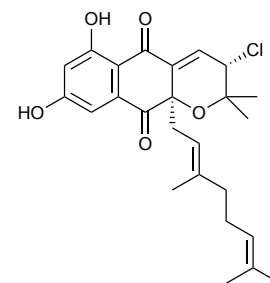
900 ($R = \text{H}$)
884 ($R = \text{CH}_3$)



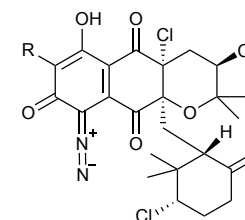
901



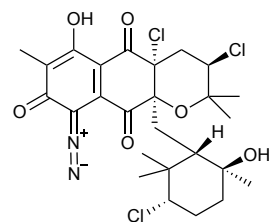
902 ($R = \text{OH}$)
903 ($R = \text{OCH}_3$)



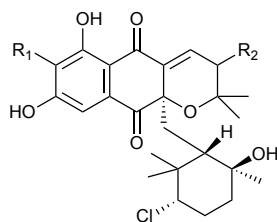
904 ($R = \beta\text{-Cl}$)
905 ($R = \alpha\text{-OH}$)



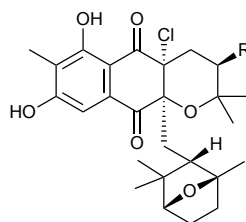
908 ($R = \text{CH}_3$)
920 ($R = \text{H}$)



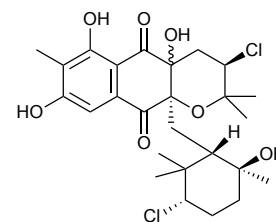
909



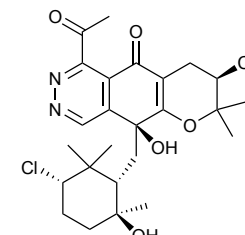
916 ($R_1 = \text{CH}_3$, $R_2 = \beta\text{-Cl}$)
917 ($R_1 = \text{H}$, $R_2 = \alpha\text{-OH}$)
918 ($R_1 = \text{H}$, $R_2 = \beta\text{-Cl}$)
919 ($R_1 = \text{H}$, $R_2 = \alpha\text{-Cl}$)



921 ($R = \text{Cl}$)
922 ($R = \text{Br}$)

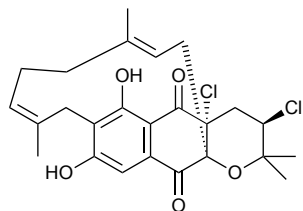


923

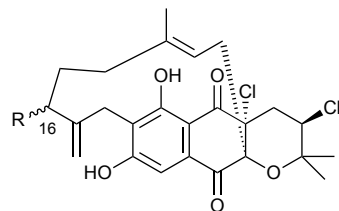


931

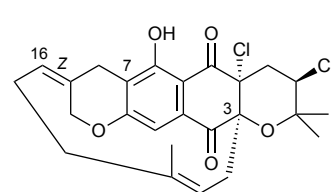
3.8.3.3 Polyketides: Napyradiomycins type C



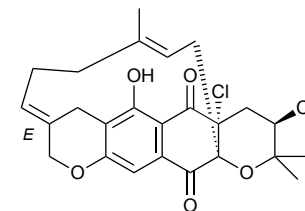
878



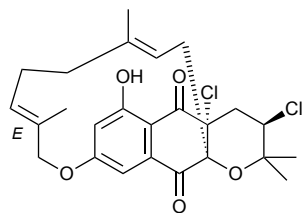
879 (R = Cl)
927 (R = OH)



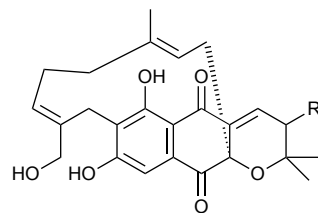
924



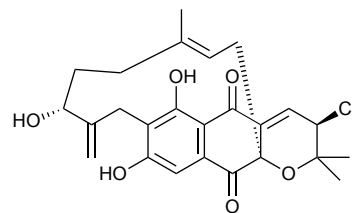
925



926

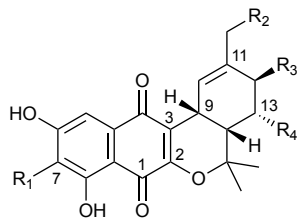


928 (R = β -Cl)
929 (R = α -OH)



930

3.8.4 Polyketides: Naphterpins



932 ($R_1 = \text{CH}_3$, $R_2 = R_3 = R_4 = \text{H}$)

935 ($R_1 = \text{CH}_3$, $R_2 = R_4 = \text{H}$, $R_3 = \text{OH}$)

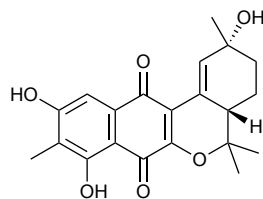
936 ($R_1 = \text{CH}_3$, $R_2 = R_4 = \text{H}$, $R_3 = \text{OAc}$)

937 ($R_1 = R_2 = R_3 = R_4 = \text{H}$)

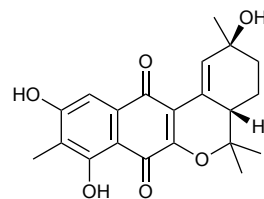
938 ($R_1 = R_3 = R_4 = \text{H}$, $R_2 = \text{OH}$)

939 ($R_1 = R_4 = \text{H}$, $R_2 = R_3 = \text{OH}$)

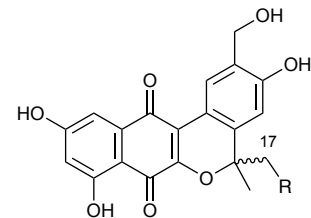
940 ($R_1 = \text{H}$, $R_2 = R_3 = R_4 = \text{OH}$)



933

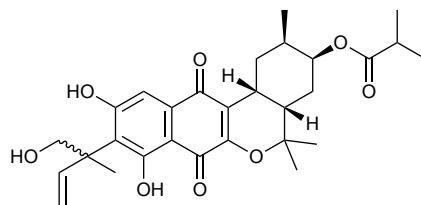


934

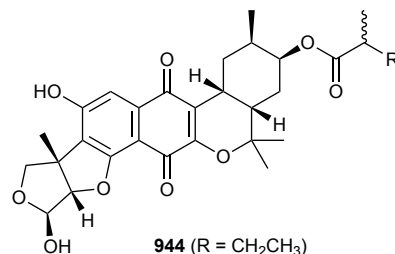


941 ($R = \text{H}$)

942 ($R = \text{OH}$)

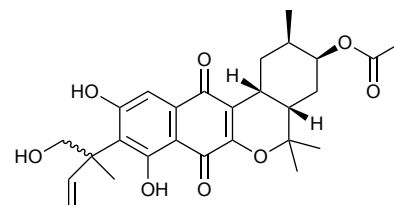


943

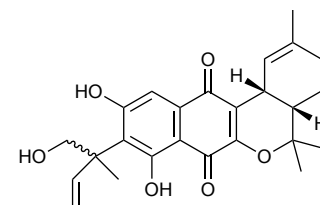


944 ($R = \text{CH}_2\text{CH}_3$)

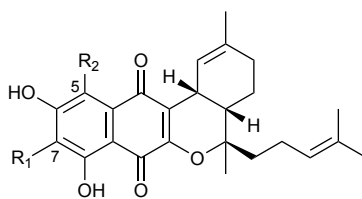
945 ($R = \text{CH}_3$)



946



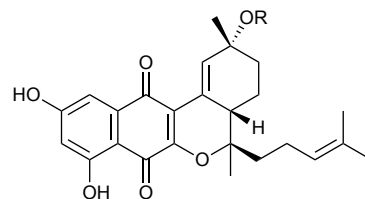
947



948 ($R_1 = \text{H}$, $R_2 = \text{Br}$)

949 ($R_1 = \text{Br}$, $R_2 = \text{H}$)

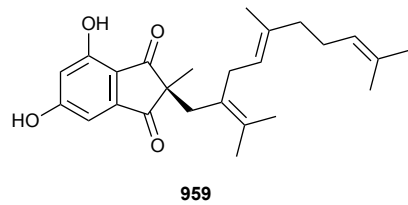
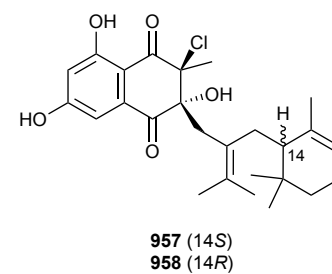
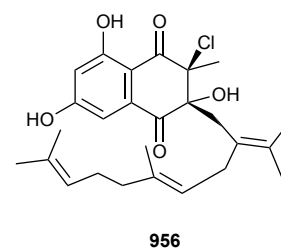
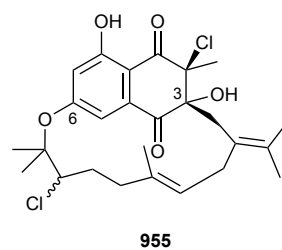
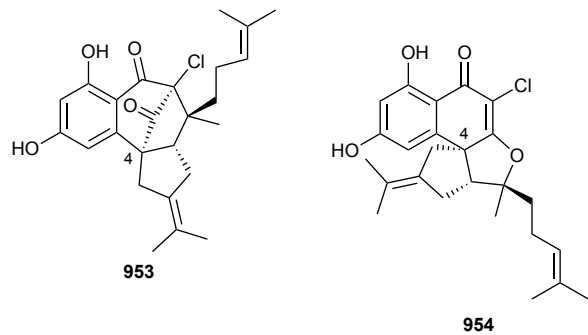
950 ($R_1 = R_2 = \text{H}$)



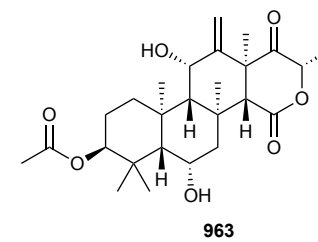
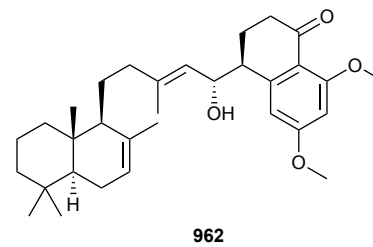
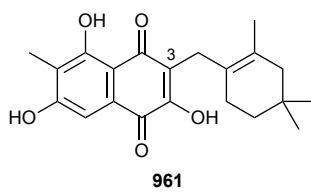
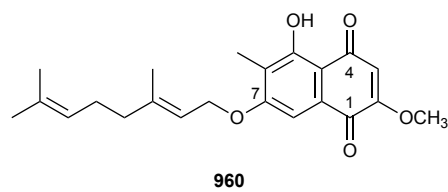
951 ($R = \text{H}$)

952 ($R = \text{CH}_3$)

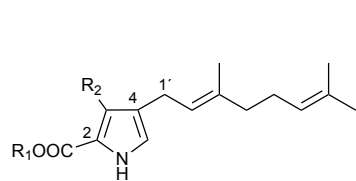
3.8.5 Polyketides: Merochlorins



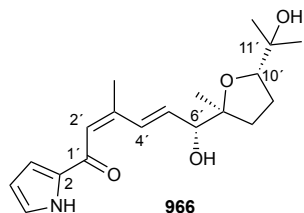
3.8.6 Polyketides: Miscellaneous polyketides



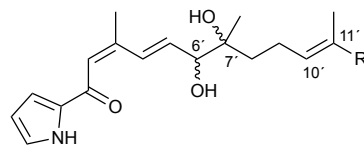
3.9 Pyrroles



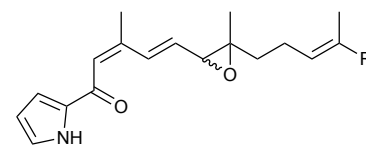
964 ($R_1 = \text{H}$, $R_2 = \text{H}$)
965 ($R_1 = \text{CH}_3$, $R_2 = \text{NHCOCH}_3$)



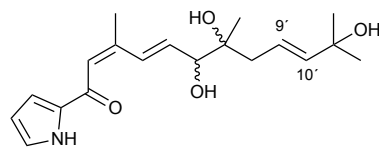
966



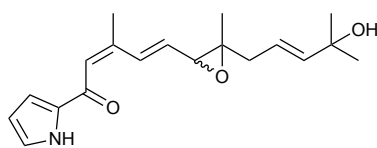
967 ($R = \text{H}$)
969 ($R = \text{CH}_2\text{OH}$)
970 ($R = \text{CHO}$)



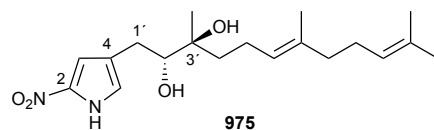
968 ($R = \text{CH}_3$)
971 ($R = \text{CH}_2\text{OH}$)
972 ($R = \text{CHO}$)



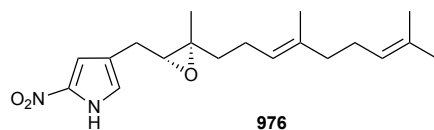
973



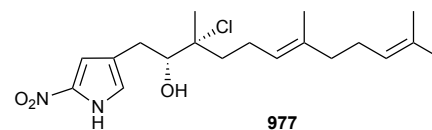
974



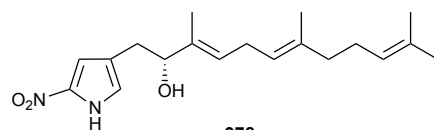
975



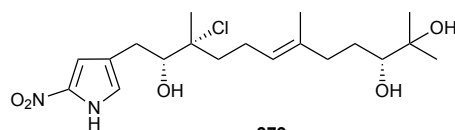
976



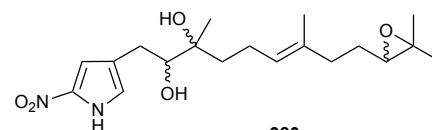
977



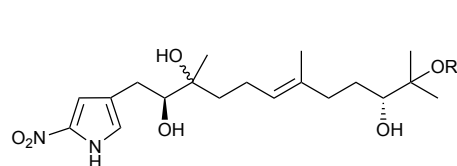
978



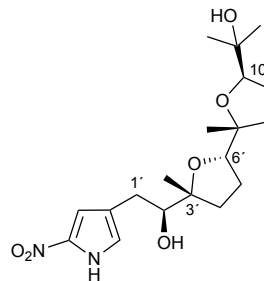
979



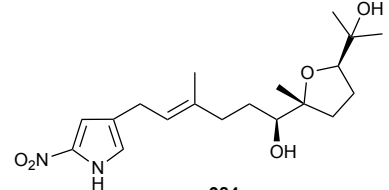
980



981 ($R = \text{CH}_3$)
982 ($R = \text{H}$)

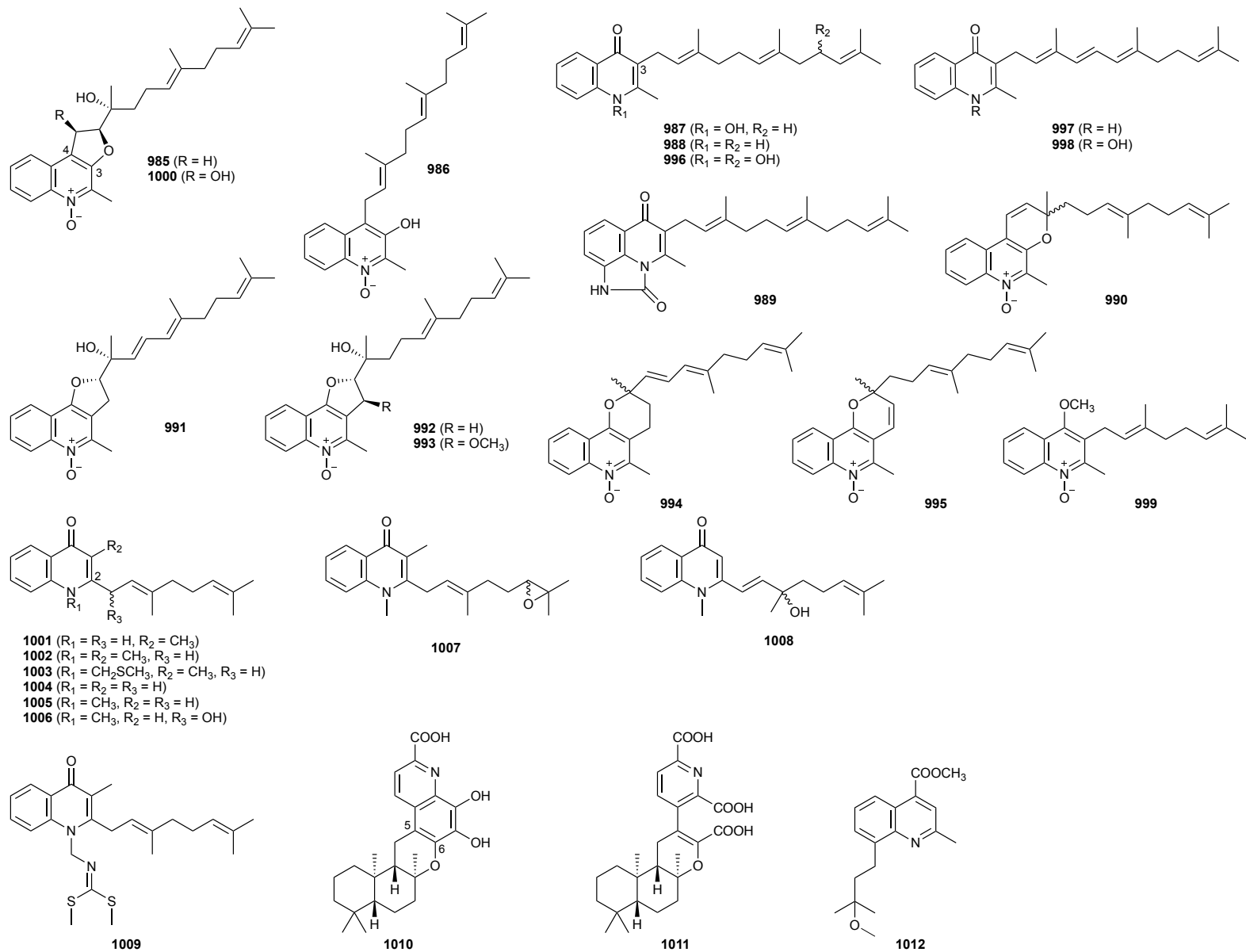


983

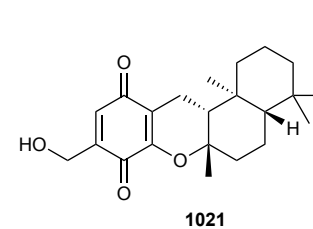
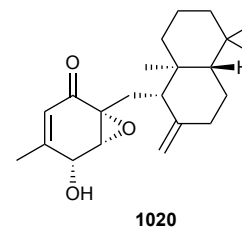
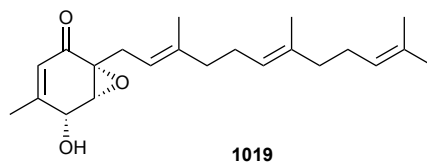
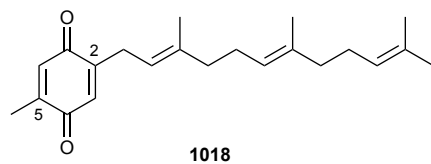
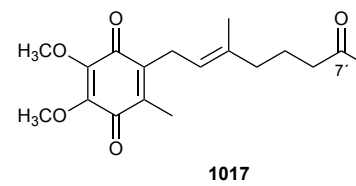
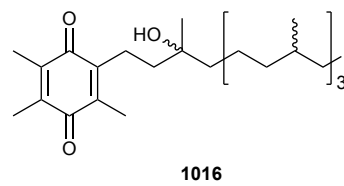
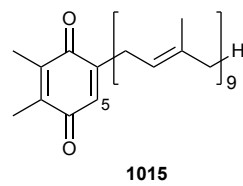
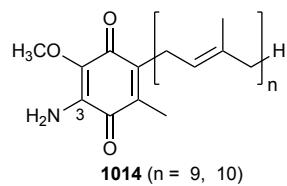
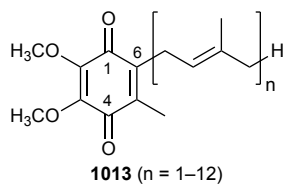


984

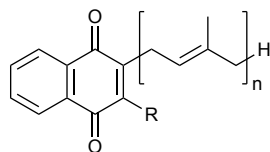
3.10 Quinolines



3.11.1 Quinones: Benzoquinones

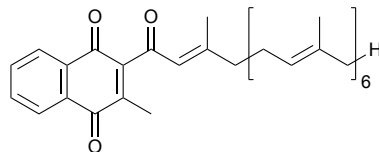


3.11.2 Quinones: Naphthoquinones

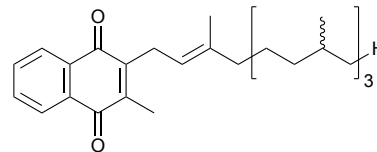


1022 (R = CH₃, n = 1-14)

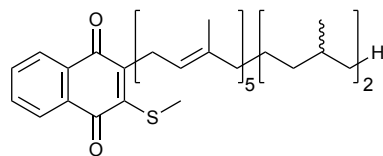
1023 (R = H, n = 1–9)



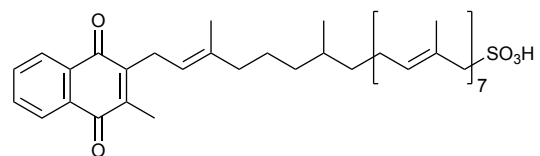
1024



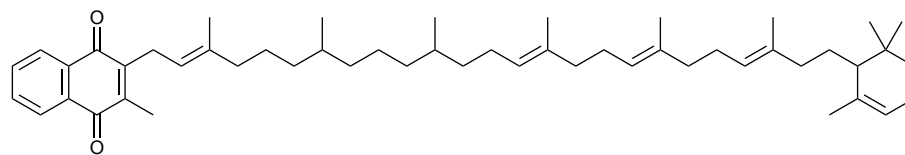
1025



1026

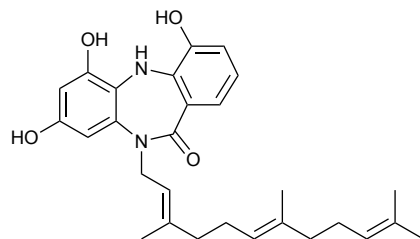


1027



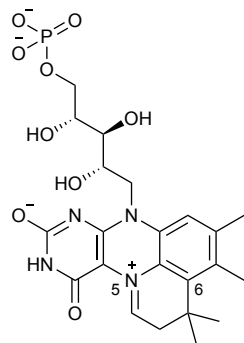
1028

3.12.1 Miscellaneous: Dibenzodiazepinones

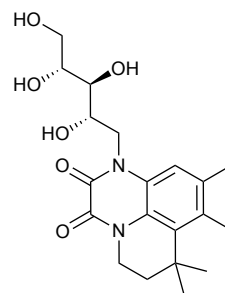


1029

3.12.2 Miscellaneous: Flavins

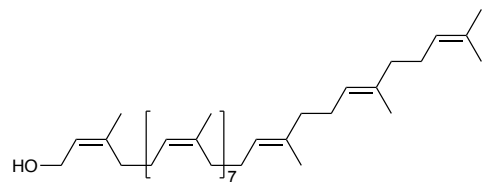


1030

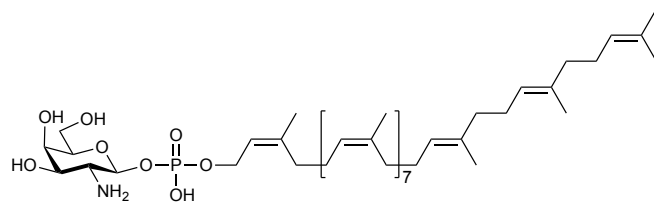


1031

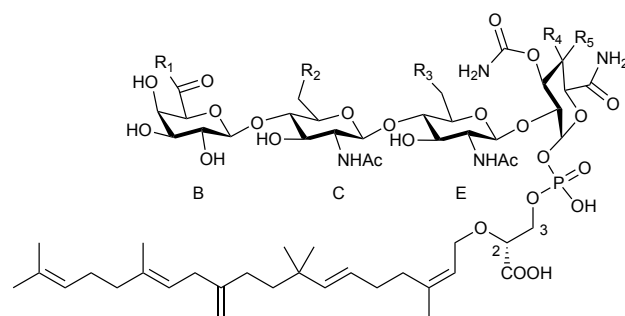
3.12.3 Miscellaneous: Phosphoglycolipids



1032

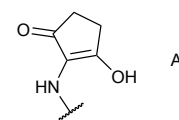


1033



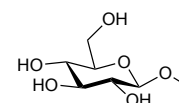
F

acpd =

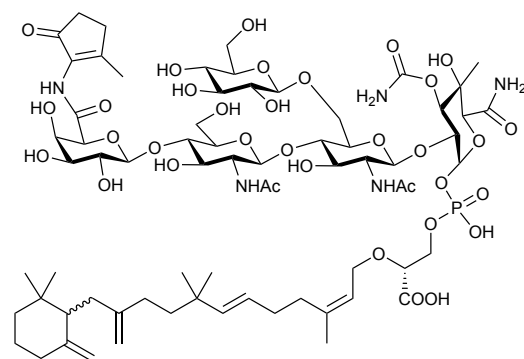


A

D-glucose =

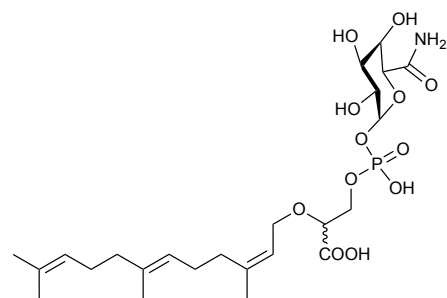


D



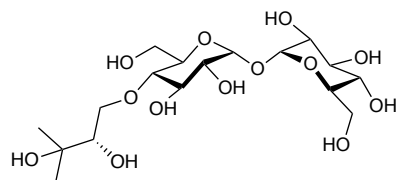
1044

- 1034 ($R_1 = \text{acpd}$, $R_2 = \text{H}$, $R_3 = \text{D-glucose}$, $R_4 = \text{OH}$, $R_5 = \text{CH}_3$)
 1035 ($R_1 = \text{acpd}$, $R_2 = R_4 = \text{H}$, $R_3 = \text{D-glucose}$, $R_5 = \text{OH}$)
 1036 ($R_1 = \text{acpd}$, $R_2 = R_3 = R_4 = \text{H}$, $R_5 = \text{OH}$)
 1037 ($R_1 = \text{acpd}$, $R_2 = R_3 = \text{H}$, $R_4 = \text{OH}$, $R_5 = \text{CH}_3$)
 1038 ($R_1 = \text{acpd}$, $R_2 = \text{H}$, $R_3 = R_4 = \text{OH}$, $R_5 = \text{CH}_3$)
 1039 ($R_1 = R_4 = \text{OH}$, $R_2 = \text{H}$, $R_3 = \text{D-glucose}$, $R_5 = \text{CH}_3$)
 1040 ($R_1 = \text{NH}_2$, $R_2 = \text{H}$, $R_3 = \text{D-glucose}$, $R_4 = \text{OH}$, $R_5 = \text{CH}_3$)
 1041 ($R_1 = R_3 = R_4 = \text{OH}$, $R_2 = \text{H}$, $R_5 = \text{CH}_3$)
 1042 ($R_1 = \text{NH}_2$, $R_2 = \text{H}$, $R_3 = R_4 = \text{OH}$, $R_5 = \text{CH}_3$)
 1043 ($R_1 = \text{acpd}$, $R_2 = R_3 = R_4 = \text{OH}$, $R_5 = \text{CH}_3$)

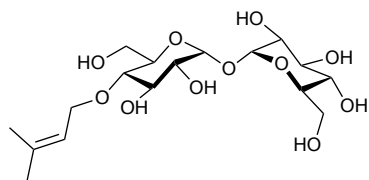


1045

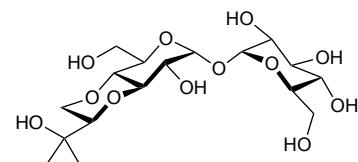
3.12.4 Miscellaneous: Saccharides



1046

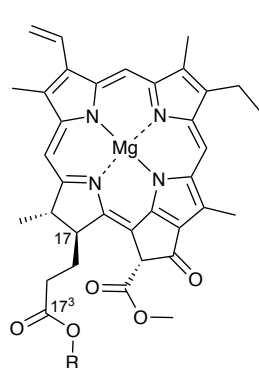


1047

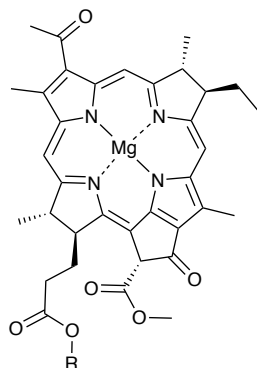


1048

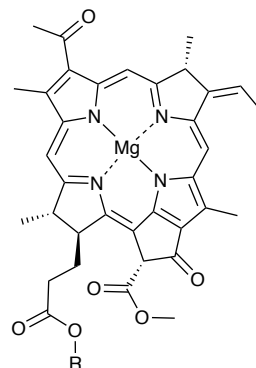
3.12.5 Miscellaneous: Chlorophylls



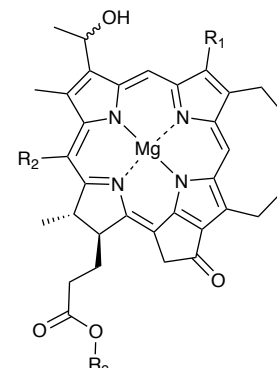
1049 (R = p)
1060 (R = pd)



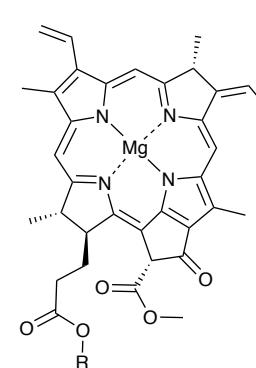
1050 (R = p)
1056 (R = gg)
1057 (R = dhgg)
1058 (R = thgg)



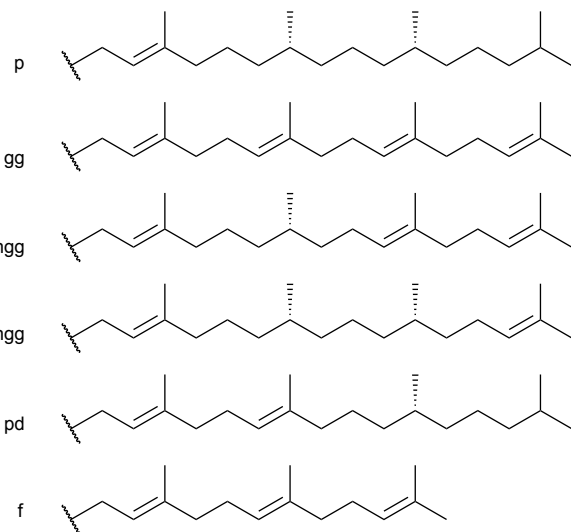
1051 (R = p)



1052 (R₁ = R₂ = CH₃, R₃ = f)
1053 (R₁ = CH₃, R₂ = H, R₃ = f)
1054 (R₁ = CHO, R₂ = H, R₃ = f)



1055 (R = f)
1059 (R = gg)



3.12.6 Miscellaneous: Hemes

