CLAIMS:

1. A method of producing a phytocannabinoid or phytocannabinoid analogue in a host cell that produces a polyketide and a prenyl donor, said method comprising:

transforming said host cell with a sequence encoding a prenyltransferase PT296 protein, and

culturing said transformed host cell under conditions sufficient for production of the prenyltransferase PT296 protein to produce said phytocannabinoid or phytocannabinoid analogue;

wherein the wherein the prenyltransferase PT296 protein comprises a prenyltransferase protein as set forth in SEQ ID NO:440.

2. The method of claim 1, wherein the prenyltransferase PT296 protein comprises or consists of a prenyltransferase protein with at least 95% identity with SEQ ID NO:440.

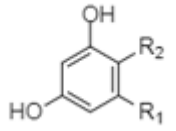
3. The method of claim 1, wherein the sequence encoding the prenyltransferase PT296 protein comprises or consists of:

(a) a nucleotide sequence encoding the protein of SEQ ID NO:440; or a nucleotide having a sequence according to SEQ ID NO:461;

(b) a nucleotide sequence having at least 85% identity with the nucleotide sequence of (a); or having at least 85% identity with SEQ ID NO:461; or

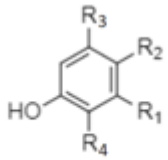
(c) a nucleotide sequence that hybridizes with the complementary strand of the nucleic acid of (a) under conditions of high stringency.

4. The method of claim 1, wherein said polyketide is:



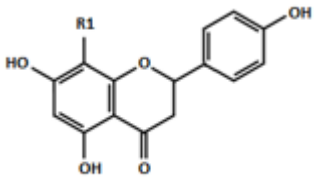
R1: CH_3, C_2H_5, C_3H_7, C_4H_9, C_5H_{11}, C_6H_{13}, C_7H_{15}, C_8H_{17}, $C_{16}H_{33}$, $C_{18}H_{37}$,
R2: H, COOH, CH_3

(5-I),

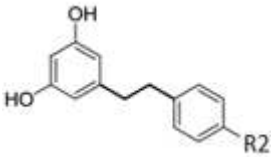


R1: CH_3, C_2H_5, C_3H_7, C_4H_9, C_5H_{11}, C_6H_{13}, C_7H_{15}, C_8H_{17}, $C_{16}H_{33}$, $C_{18}H_{37}$,
R2: H, COOH, CH_3
R3: OH, =O
R4: H, OH, =O, CH_3

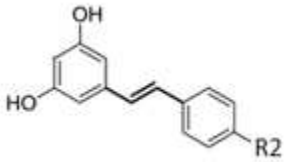
(5-II),



R1: H, COOH
R2: H, OH (5-III),

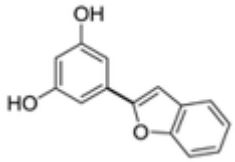


R1: H, COOH
R2: H, OH (5-IV),



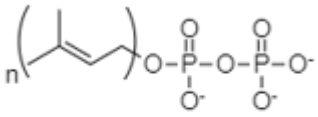
R1: H, COOH
R2: H, OH (5-V),

or



R1: H, COOH
R2: H, OH (5-VI).

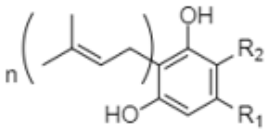
5. The method of claim 1, wherein said prenyl donor is:



n: 1 (DMAPP, or IPP isomer),
2 (GPP, NPP), 3(FPP)
(5-VII).

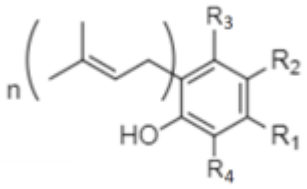
6. The method of claim 5, wherein the prenyl donor is geranyl diphosphate (GPP), farnesyl diphosphate (FPP), or neryl diphosphate (NPP).

7. The method of claim 1, wherein said phytocannabinoid or phytocannabinoid analogue is:



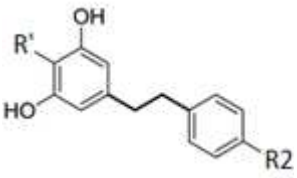
R1: CH_3, C_2H_5, C_3H_7, C_4H_9, C_5H_{11}, C_6H_{13}, C_7H_{15}, C_8H_{17}, $C_{16}H_{33}$, $C_{18}H_{37}$,
R2: H, COOH, CH_3
n: 1 (DMAPP, or IPP isomer), 2 (GPP, NPP), 3(FPP)

(5-VIII),



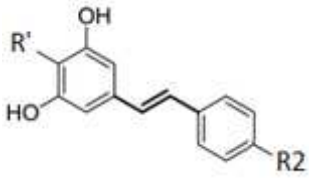
R1: CH_3, C_2H_5, C_3H_7, C_4H_9, C_5H_{11}, C_6H_{13}, C_7H_{15}, C_8H_{17}, $C_{16}H_{33}$, $C_{18}H_{37}$,
R2: H, COOH, CH_3,
R3: OH, =O
R4: H, OH, =O, CH_3
n: 1 (DMAPP, or IPP isomer), 2 (GPP, NPP), 3(FPP)

(5-IX),



R1: H, COOH
R2: H, OH

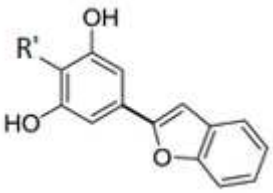
(5-X),



R1: H, COOH
R2: H, OH

(5-XI),

or



R1: H, COOH
R2: H, OH

(5-XII).

8. The method of claim 1, wherein said polyketide is olivetolic acid and said phytocannabinoid is cannabigerolic acid (CBGa).

9. An expression vector comprising a nucleotide sequence encoding prenyltransferase PT296 protein, wherein said nucleotide sequence comprises:

at least 85% identity with a nucleotide sequence encoding SEQ ID NO:440; or

at least 85% identity with a nucleotide having a sequence according to SEQ ID NO:461.

10. A host cell transformed with the expression vector according to claim 9.

11. The host cell of claim 10, additionally comprising one or more of:

(a) a nucleic acid as set forth in any one of SEQ ID NO:441 to SEQ ID NO:453;

(b) a nucleic acid having at least 85% identity with the nucleotide sequence of (a);

(c) a nucleic acid that hybridizes with the complementary strand of the nucleic acid of (a) under stringent conditions; or

(d) a nucleic acid encoding a protein with the same enzyme activity as the protein encoded by any one of the nucleic acid sequences of (a).

12. A method of producing a phytocannabinoid comprising culturing a host cell under suitable culture conditions to form a phytocannabinoid, said host cell comprising:

(a) a polynucleotide encoding a polyketide synthase (PKS) enzyme;

(b) a polynucleotide encoding an olivetolic acid cyclase (OAC) enzyme;

(c) a polynucleotide encoding a prenyltransferase (PT) enzyme; and

(d) a polynucleotide encoding a THCa synthase (OXC) enzyme;

wherein the OXC enzyme comprises a protein with at least 85% sequence identity to any one of SEQ ID NO. 498-501;

and optionally comprising:

(e) a polynucleotide encoding an acyl-CoA synthase (Alk) enzyme; and/or

(f) a polynucleotide encoding a fatty acyl CoA activating (CsAAE) enzyme.

13. The method of claim 12, wherein:

PKS comprises DiPKS-1 - DiPKS-5 bearing G1516R, PKS73, or PKS80-PKS110;

OAC comprises csOAC or PC20;

PT comprises PT296;

CsAAE comprises CsAAE1; and/or

Alk comprises Alk1-Alk30.

14. The method of claim 12, wherein the host cell is cultured together with a butyric acid feed.

15. A method of transforming a host cell for production of a phytocannabinoid comprising:

introducing into the host cell line a polynucleotide encoding:

(a) a polyketide synthase (PKS) enzyme;

(b) an olivetolic acid cyclase (OAC) enzyme;

(c) a prenyltransferase (PT) enzyme; and

(d) a polynucleotide encoding a THCa synthase (OXC) enzyme;

wherein the OXC enzyme comprises a protein with at least 85% sequence identity to any one of SEQ ID NO. 498-501;

and optionally said polynucleotide additionally encoding:

(e) a polynucleotide encoding an acyl-CoA synthase (Alk) enzyme; and/or

(f) a polynucleotide encoding a fatty acyl CoA activating (CsAAE) enzyme.

16. The method of claim 15, wherein:

PKS comprises DiPKS-1 - DiPKS-5 bearing G1516R, PKS73, or PKS80-PKS110;

OAC comprises csOAC or PC20;

PT comprises PT296;

CsAAE comprises CsAAE1; and/or

Alk comprises Alk1-Alk30.

17. An expression vector comprising:

a polynucleotide encoding a polyketide synthase (PKS) enzyme;

a polynucleotide encoding an olivetolic acid cyclase (OAC) enzyme; ~~and~~

a polynucleotide encoding a prenyltransferase (PT) enzyme; and

a polynucleotide encoding a THCa synthase (OXC) enzyme of at least 85% sequence identity with SEQ ID NO. 498-501.

18. The expression vector of claim 17, additionally comprising:

a polynucleotide encoding an acyl-CoA synthase (Alk) enzyme; and/or

a polynucleotide encoding CsAAE1.

19. The expression vector of claim 17, wherein the polynucleotide encoding the OXC enzyme encodes a protein according to SEQ ID NO: 500; and/or

the polynucleotide encoding the prenyltransferase enzyme encodes a protein having at least 85% sequence identity to SEQ ID NO:440.

20. A host cell comprising the expression vector of claim 17.

21. The host cell of claim 20, wherein said host cell comprises a nucleotide encoding: SEQ ID NOs: 440 and 500.

22. The expression vector of claim 9, additionally comprising a nucleotide sequence encoding an OXC enzyme according to SEQ ID NO. 498-501.

23. A host cell comprising the expression vector of claim 22.

24. A prenyltransferase (PT) enzyme having a sequence according to SEQ ID NO:440, prepared by the host cell of claim 10.

25. A THCa synthase (OXC) enzyme having a sequence according to any one of SEQ ID NO:498-501, prepared by the host cell of claim 20.