Figure 1

1-
*atg*tgtgcgacctcttctcaatttactcagattaccgagcataattcccgtcgttccgcaaactatcagccaaa
cctgtggaatttcgaattcctgcaatccctggagaacgacctgaaagtggaaaagctggaggagaaagc
gaccaaactggaggaagaagttcgctgcatgatcaaccgtgtagacacccagccgctgtccctgctgga
gctgatcgacgatgtgcagcgcctgggtctgacctacaaatttgaaaaagacatcattaaagccctggaa
aacatcgtactgctggacgaaaacaaaaagaacaaatctgacctgcacgcaaccgctctgtctttccgtct
gctgcgtcagcacggtttcgaggtttctcaggatgtttttgagcgtttcaaggataaagaaggtggtttcagcg
gtgaactgaaaggtgacgtccaaggcctgctgagcctgtatgaagcgtcttacctgggtttcgagggtgag
aacctgctggaggaggcgcgtacctttccatcacccacctgaagaacaacctgaaagaaggcattaata
ccaaggttgcagaacaagtgagccacgccctggaactgccatatcaccagcgtctgcaccgtctggagg
cacgttggttcctggataaatacgaaccgaaagaaccgcatcaccagctgctgctggagctggcgaagct
ggattttaacatggtacagaccctgcaccagaaagagctgcaagatctgtcccgctggtggaccgagatg
ggcctggctagcaaactggattttgtacgcgaccgcctgatggaagtttatttctgggcactgggtatggcgc
cagacccgcagtttggtgaatgtcgcaaagctgttactaaaatgtttggtctggtgacgatcatcgatgacgt
gtatgacgtttatggcactctggacgaactgcaactgttcaccgatgctgtagagcgctgggacgttaacgct
attaacaccctgccggactatatgaaactgtgtttcctggcactgtacaacaccgttaacgacacgtcctattc
tattctgaaagagaaaggtcataacaacctgtcctatctgacgaaaagctggcgtgaactgtgcaaagcct
ttctgcaagaggcgaaatggtccaacaacaaaattatcccggctttctccaagtacctggaaaacgccag
cgtttcctcctccggtgtagcgctgctggcgccgtcttacttttccgtatgccagcagcaggaagacatctccg
accacgcgctgcgttccctgaccgacttccatggtctggtgcgttctagctgcgttatcttccgcctgtgcaac
gatctggccacctctgcggcggagctggaacgtggcgagactaccaattctatcattagctacatgcacga
aaacgatggtaccagcgaggaacaggcccgcgaagaactgcgtaaactgatcgacgccgaatggaaa
aagatgaatcgtgaacgcgttagcgactccaccctgctgcctaaagcgttcatggaaatcgcagttaacat
ggcacgtgtttcccactgcacctaccagtatggcgatggtctgggtcgcccagactacgcgactgaaaacc
gcatcaaactgctgctgattgacccttcccgattaaccagctgatgtatgtc
taactgcag
(SEQ ID NO:1)

Figure 2

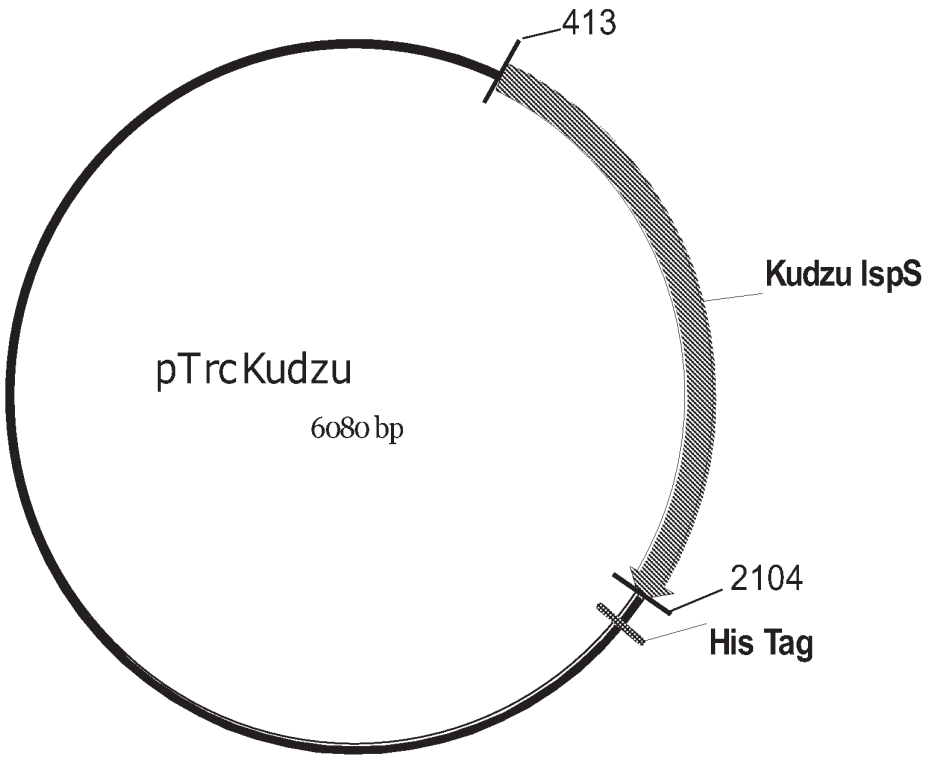


Figure 3A

1-
gtttgacagcttatcatcgactgcacggtgcaccaatgcttctggcgtcaggcagccatcggaagctgtggtatg
gctgtgcaggtcgtaaatcactgcataattcgtgtcgctcaaggcgcactcccgttctggataatgttttttgcgcc
gacatcataacggttctggcaaatattctgaaatgagctgttgacaattaatcatccggctcgtataatgtgtgga
attgtgagcggataacaatttcacacaggaaacagcgccgctgagaaaaagcgaagcggcactgctcttta
acaatttatcagacaatctgtgtgggcactcgaccggaattatcgattaactttattattaaaaattaaagaggtat
atattaatgtatcgattaaataaggaggaataaaccATGtgtgcgacctcttctcaatttactcagattaccgag
cataattcccgtcgttccgcaaactatcagccaaacctgtggaatttcgaattcctgcaatccctggagaacga
cctgaaagtggaaaagctggaggagaaagcgaccaaactggaggaagaagttcgctgcatgatcaaccgt
gtagacacccagccgctgtccctgctggagctgatcgacgatgtgcagcgcctgggtctgacctacaaatttg
aaaaagacatcattaaagccctggaaaacatcgtactgctggacgaaaacaaaaagaacaaatctgacct
gcacgcaaccgctctgtctttccgtctgctgcgtcagcacggtttcgaggtttctcaggatgtttttgagcgtttcaa
ggataaagaaggtggtttcagcggtgaactgaaaggtgacgtccaaggcctgctgagcctgtatgaagcgtct
tacctgggtttcgagggtgagaacctgctggaggaggcgcgtacctttccatcacccacctgaagaacaacc
tgaaagaaggcattaataccaaggttgcagaacaagtgagccacgccctggaactgccatatcaccagcgt
ctgcaccgtctggaggcacgttggttcctggataaatacgaaccgaaagaaccgcatcaccagctgctgctg
gagctggcgaagctggattttaacatggtacagaccctgcaccagaaagagctgcaagatctgtcccgctgg
tggaccgagatgggcctggctagcaaactggattttgtacgcgaccgcctgatggaagtttatttctgggcactg
ggtatggcgccagacccgcagtttggtgaatgtcgcaaagctgttactaaaatgtttggtctggtgacgatcatc
gatgacgtgtatgacgtttatggcactctggacgaactgcaactgttcaccgatgctgtagagcgctgggacgtt
aacgctattaacaccctgccggactatatgaaactgtgtttcctggcactgtacaacaccgttaacgacacgtc
ctattctattctgaaagagaaaggtcataacaacctgtcctatctgacgaaaagctggcgtgaactgtgcaaag
cctttctgcaagaggcgaaatggtccaacaacaaaattatcccggctttctccaagtacctggaaaacgccag
cgtttcctcctccggtgtagcgctgctggcgccgtcttacttttccgtatgccagcagcaggaagacatctccgac
cacgcgctgcgttccctgaccgacttccatggtctggtgcgttctagctgcgttatcttccgcctgtgcaacgatct
ggccacctctgcggcggagctggaacgtggcgagactaccaattctatcattagctacatgcacgaaaacga
tggtaccagcgaggaacaggcccgcgaagaactgcgtaaactgatcgacgccgaatggaaaaagatgaa
tcgtgaacgcgttagcgactccaccctgctgcctaaagcgttcatggaaatcgcagttaacatggcacgtgtttc
ccactgcacctaccagtatggcgatggtctgggtcgcccagactacgcgactgaaaaccgcatcaaactgct
gctgattgacccttttcccgattaaccagctgatgtatgtcTAActgcagctggtaccatatgggaattcgaagct
ttctagaacaaaaactcatctcagaagaggatctgaatagcgccgtcgaccatcatcatcatcatcattgagttt
aaacggtctccagcttggctgttttggcggatgagagaagattttcagcctgatacagattaaatcagaacgca
gaagcggtctgataaaacagaatttgcctggcggcagtagcgcggtggtcccacctgaccccatgccgaact
cagaagtgaaacgccgtagcgccgatggtagtgtggggtctccccatgcgagagtagggaactgccaggc
atcaaataaaacgaaaggctcagtcgaaagactgggcctttcgttttatctgttgtttgtcggtgaacgctctcctg
agtaggacaaatccgccgggagcggatttgaacgttgcgaagcaacggcccgg

Figure 3B

agggtggcgggcaggacgcccgccataaactgccaggcatcaaattaagcagaaggccatcctgac
ggatggccttttgcgtttctacaaactctttttgtttatttttctaaatacattcaaatatgtatccgctcatgagac
aataaccctgataaatgcttcaataatattgaaaaaggaagagtatgagtattcaacatttccgtgtcgccc
ttattccctttttttgcggcattttgccttcctgtttttgctcacccagaaacgctggtgaaagtaaaagatgctga
agatcagttgggtgcacgagtgggttacatcgaactggatctcaacagcggtaagatccttgagagttttc
gccccgaagaacgttttccaatgatgagcacttttaaagttctgctatgtggcgcggtattatcccgtgttgac
gccgggcaagagcaactcggtcgccgcatacactattctcagaatgacttggttgagtactcaccagtca
cagaaaagcatcttacggatggcatgacagtaagagaattatgcagtgctgccataaccatgagtgata
acactgcggccaacttacttctgacaacgatcggaggaccgaaggagctaaccgcttttttgcacaacat
gggggatcatgtaactcgccttgatcgttgggaaccggagctgaatgaagccataccaaacgacgagc
gtgacaccacgatgcctgtagcaatggcaacaacgttgcgcaaactattaactggcgaactacttactct
agcttcccggcaacaattaatagactggatggaggcggataaagttgcaggaccacttctgcgctcggc
ccttccggctggctggtttattgctgataaatctggagccggtgagcgtgggtctcgcggtatcattgcagca
ctggggccagatggtaagccctcccgtatcgtagttatctacacgacggggagtcaggcaactatggatg
aacgaaatagacagatcgctgagataggtgcctcactgattaagcattggtaactgtcagaccaagttta
ctcatatatactttagattgatttaaaacttcatttttaatttaaaaggatctaggtgaagatccttttgataatct
catgaccaaaatcccttaacgtgagttttcgttccactgagcgtcagaccccgtagaaaagatcaaagga
tcttcttgagatcctttttttctgcgcgtaatctgctgcttgcaaacaaaaaaaccaccgctaccagcggtggt
ttgtttgccggatcaagagctaccaactctttttccgaaggtaactggcttcagcagagcgcagataccaa
atactgtccttctagtgtagccgtagttaggccaccacttcaagaactctgtagcaccgcctacatacctcg
ctctgctaatcctgttaccagtggctgctgccagtggcgataagtcgtgtcttaccgggttggactcaagac
gatagttaccggataaggcgcagcggtcgggctgaacgggggttcgtgcacacagcccagcttggag
cgaacgacctacaccgaactgagatacctacagcgtgagctatgagaaagcgccacgcttcccgaag
ggagaaaggcggacaggtatccggtaagcggcagggtcggaacaggagagcgcacgagggagctt
ccaggggaaacgcctggtatctttatagtcctgtcgggtttcgccacctctgacttgagcgtcgatttttgtg
atgctcgtcaggggggcggagcctatggaaaaacgccagcaacgcggccttttacggttcctggccttttt
gctggccttttgctcacatgttctttcctgcgttatcccctgattctgtggataaccgtattaccgcctttgagtga
gctgataccgctcgccgcagccgaacgaccgagcgcagcgagtcagtgagcgaggaagcggaaga
gcgcctgatgcggtattttctccttacgcatctgtgcggtatttcacaccgcatatggtgcactctcagtacaa
tctgctctgatgccgcatagttaagccagtatacactccgctatcgctacgtgactgggtcatggctgcgcc
ccgacacccgccaacacccgctgacgcgccctgacgggcttgtctgctcccggcatccgcttacagaca
agctgtgaccgtctccgggagctgcatgtgtcagaggttttcaccgtcatcaccgaaacgcgcgaggca
gcagatcaattcgcgcgcgaaggcgaagcggcatgcatttacgttgacaccatcgaatggtgcaaaac
ctttcgcggtatggcatgatagcgcccggaagagagtcaattcagggtggtgaatgtgaaaccagtaac
gttatacgatgtcgcagagtatgccggtgtctcttatcagaccgtttcccgcgtggtgaaccaggccagcc
acgtttctgcgaaaacgcgggaaaaagtggaagcggcgatggcggagctgaattacattcccaaccgc
gtggcacaacaactggcgggcaaacagtcgttgctgattggcgttgccacctccagtctggccctgcacg
cgccgtcgcaaattgtcgcggcgattaaatctcgcgccgatcaactgggtgccagcgtggtggtgtcgat
ggtagaacgaagcggcgtcgaagcctgtaaagcggcggtgcacaatcttctcgcgcaacgcgtcagtg
ggctgatcattaactatccgctggatgaccaggatgccattgctgtggaagctgcct

Figure 3C

Gcactaatgttccggcgttatttcttgatgtctctgaccagacacccatcaacagtattattttctc
ccatgaagacggtacgcgactgggcgtggagcatctggtcgcattgggtcaccagcaaat
cgcgctgttagcgggcccattaagttctgtctcggcgcgtctgcgtctggctggctggcataaa
tatctcactcgcaatcaaattcagccgatagcggaacgggaaggcgactggagtgccatgt
ccggttttcaacaaaccatgcaaatgctgaatgagggcatcgttcccactgcgatgctggttg
ccaacgatcagatggcgctgggcgcaatgcgcgccattaccgagtccgggctgcgcgttg
gtgcggatatctcggtagtgggatacgacgataccgaagacagctcatgttatatcccgccg
tcaaccaccatcaaacaggattttcgcctgctggggcaaaccagcgtggaccgcttgctgc
aactctctcagggccaggcggtgaagggcaatcagctgttgcccgtctcactggtgaaaag
aaaaaccaccctggcgcccaatacgcaaaccgcctctccccgcgcgttggccgattcatta
atgcagctggcacgacaggtttcccgactggaaagcgggcagtgagcgcaacgcaatta
atgtgagttagcgcgaattgatctg
(SEQ ID NO:2)

Figure 4

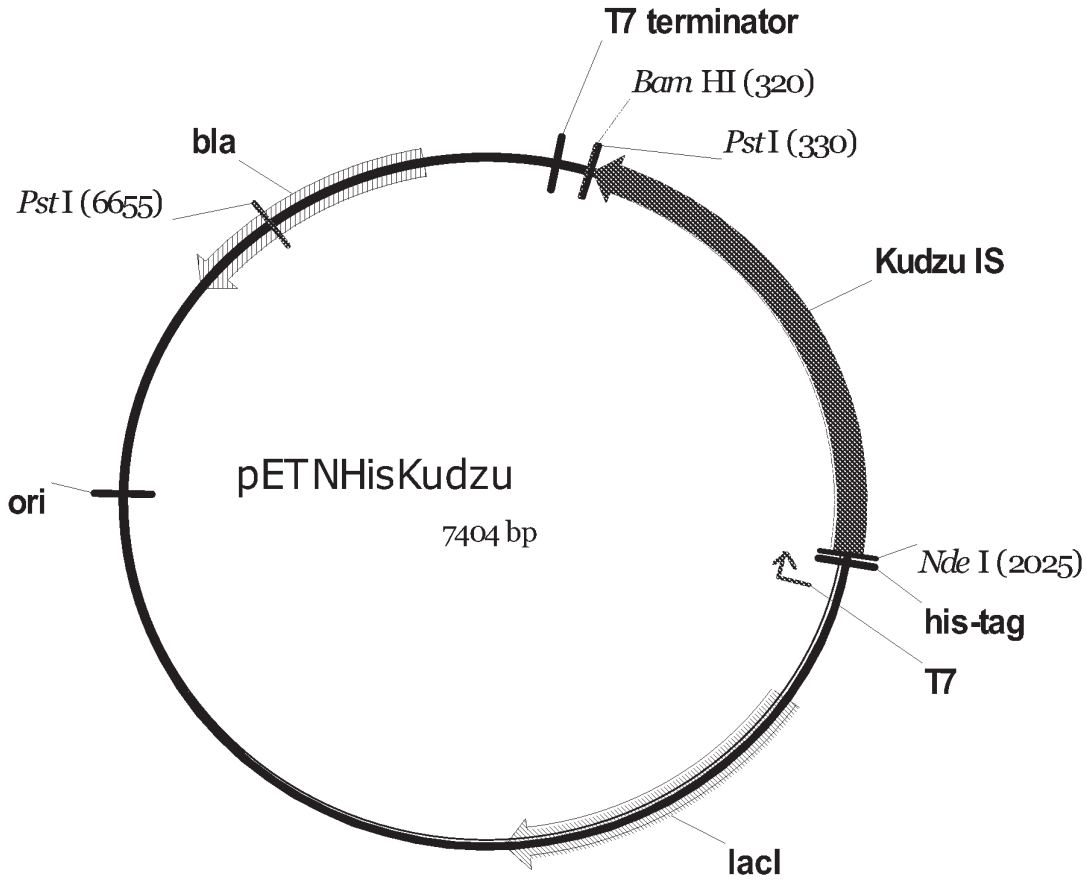

T7 terminator
Bam HI (320)
Pst I (330)
bla
Pst I (6655)
Kudzu IS
pETNHisKudzu
7404 bp
ori
Nde I (2025)
his-tag
T7
lacI

Figure 5A

1-

ttctcatgtttgacagcttatcatcgataagctttaatgcggtagtttatcacagttaaattgctaacgcagtca
ggcaccgtgtatgaaatctaacaatgcgctcatcgtcatcctcggcaccgtcaccctggatgctgtaggca
taggcttggttatgccggtactgccgggcctcttgcgggatatccggatatagttcctcctttcagcaaaaaa
cccctcaagacccgtttagaggccccaaggggttatgctagttattgctcagcggtggcagcagccaact
cagcttcctttcgggctttgttagcagccggatccctgcagttagacatacatcagctggttaatcgggaaa
gggtcaatcagcagcagtttgatgcggttttcagtcgcgtagtctgggcgacccagaccatcgccatactg
gtaggtgcagtgggaaacacgtgccatgttaactgcgatttccatgaacgctttaggcagcagggtggag
tcgctaacgcgttcacgattcatctttttccattcggcgtcgatcagtttacgcagttcttcgcgggcctgttcct
cgctggtaccatcgttttcgtgcatgtagctaatgatagaattggtagtctcgccacgttccagctccgccgc
agaggtggccagatcgttgcacaggcggaagataacgcagctagaacgcaccagaccatggaagtc
ggtcagggaacgcagcgcgtggtcggagatgtcttcctgctgctggcatacggaaaagtaagacggcg
ccagcagcgctacaccggaggaggaaacgctggcgttttccaggtacttggagaaagccgggataattt
tgttgttggaccatttcgcctcttgcagaaaggctttgcacagttcacgccagcttttcgtcagataggacag
gttgttatgacctttctctttcagaatagaataggacgtgtcgttaacggtgttgtacagtgccaggaaacac
agtttcatatagtccggcagggtgttaatagcgttaacgtcccagcgctctacagcatcggtgaacagttgc
agttcgtccagagtgccataaacgtcatacacgtcatcgatgatcgtcaccagaccaaacattttagtaac
agctttgcgacattcaccaaactgcgggtctggcgccatacccagtgcccagaaataaacttccatcagg
cggtcgcgtacaaaatccagtttgctagccaggcccatctcggtccaccagcgggacagatcttgcagct
ctttctggtgcagggtctgtaccatgttaaaatccagcttcgccagctccagcagcagctggtgatgcggtt
ctttcggttcgtatttatccaggaaccaacgtgcctccagacggtgcagacgctggtgatatggcagttcca
gggcgtggctcacttgttctgcaaccttggtattaatgccttctttcaggttgttcttcaggtgggtgatggaaa
aggtacgcgcctcctccagcaggttctcaccctcgaaacccaggtaagacgcttcatacaggctcagca
ggccttggacgtcacctttcagttcaccgctgaaaccaccttctttatccttgaaacgctcaaaaacatcctg
agaaacctcgaaaccgtgctgacgcagcagacggaaagacagagcggttgcgtgcaggtcagatttgt
tctttttgttttcgtccagcagtacgatgttttccagggctttaatgatgtctttttcaaatttgtaggtcagaccca
ggcgctgcacatcgtcgatcagctccagcagggacagcggctgggtgtctacacggttgatcatgcagc
gaacttcttcctccagtttggtcgctttctcctccagcttttccactttcaggtcgttctccagggattgcaggaat
tcgaaattccacaggtttggctgatagtttgcggaacgacgggaattatgctcggtaatctgagtaaattga
gaagaggtcgcacacatatgacgaccttcgatatggccgctgctgtgatgatgatgatgatgatgatgatg
atggcccatggtatatctccttcttaaagttaaacaaaattatttctagaggggaattgttatccgctcacaatt
cccctatagtgagtcgtattaatttcgcgggatcgagatctcgatcctctacgccggacgcatcgtggccgg
catcaccggcgccacaggtgcggttgctggcgcctatatcgccgacatcaccgatggggaagatcggg
ctcgccacttcgggctcatgagcgcttgtttcggcgtgggtatggtggcaggccccgtggccgggggact
gttgggcgccatctccttgcatgcaccattccttgcggcggcggtgctcaacggcctcaacctactactgg
gctgcttcctaatgcaggagtcgcataagggagagcgtcgagatcccggacaccatcgaatggcgcaa
aacctttcgcggtatggcatgatagcgcccggaagagagtcaattcagggtggtgaatgtgaaaccagt
aacgttatacgatgtcgcagagtatgccggtgtctcttatcagaccgtttcccgcgtggtgaaccaggcca
gccacgtttctgcgaaaacgcgggaaaaagtggaagcggcgatggcggagctgaattacattcccaac
cgcgtggcacaacaactggcgggcaaacagtcgttgctgattggcgttgccacctccagtctggccctgc
acgcgccgtcgcaaattgtcgcggcgattaaatct

Figure 5B

cgcgccgatcaactgggtgccagcgtggtggtgtcgatggtagaacgaagcggcgtcgaagcctgta
aagcggcggtgcacaatcttctcgcgcaacgcgtcagtgggctgatcattaactatccgctggatgacc
aggatgccattgctgtggaagctgcctgcactaatgttccggcgttatttcttgatgtctctgaccagacac
ccatcaacagtattattttctcccatgaagacggtacgcgactgggcgtggagcatctggtcgcattgggt
caccagcaaatcgcgctgttagcgggcccattaagttctgtctcggcgcgtctgcgtctggctggctggc
ataaatatctcactcgcaatcaaattcagccgatagcggaacgggaaggcgactggagtgccatgtcc
ggttttcaacaaaccatgcaaatgctgaatgagggcatcgttcccactgcgatgctggttgccaacgatc
agatggcgctgggcgcaatgcgcgccattaccgagtccgggctgcgcgttggtgcggatatctcggta
gtgggatacgacgataccgaagacagctcatgttatatcccgccgttaaccaccatcaaacaggatttt
cgcctgctggggcaaaccagcgtggaccgcttgctgcaactctctcagggccaggcggtgaagggca
atcagctgttgcccgtctcactggtgaaaagaaaaaccaccctggcgcccaatacgcaaaccgcctct
ccccgcgcgttggccgattcattaatgcagctggcacgacaggtttcccgactggaaagcgggcagtg
agcgcaacgcaattaatgtaagttagctcactcattaggcaccgggatctcgaccgatgcccttgagag
ccttcaacccagtcagctccttccggtgggcgcggggcatgactatcgtcgccgcacttatgactgtcttc
tttatcatgcaactcgtaggacaggtgccggcagcgctctgggtcattttcggcgaggaccgctttcgctg
gagcgcgacgatgatcggcctgtcgcttgcggtattcggaatcttgcacgccctcgctcaagccttcgtc
actggtcccgccaccaaacgtttcggcgagaagcaggccattatcgccggcatggcggccgacgcg
ctgggctacgtcttgctggcgttcgcgacgcgaggctggatggccttccccattatgattcttctcgcttccg
gcggcatcgggatgcccgcgttgcaggccatgctgtccaggcaggtagatgacgaccatcagggaca
gcttcaaggatcgctcgcggctcttaccagcctaacttcgatcactggaccgctgatcgtcacggcgattt
atgccgcctcggcgagcacatggaacgggttggcatggattgtaggcgccgccctataccttgtctgcct
ccccgcgttgcgtcgcggtgcatggagccgggccacctcgacctgaatggaagccggcggcacctcg
ctaacggattcaccactccaagaattggagccaatcaattcttgcggagaactgtgaatgcgcaaacc
aacccttggcagaacatatccatcgcgtccgccatctccagcagccgcacgcggcgcatctcgggca
gcgttgggtcctggccacgggtgcgcatgatcgtgctcctgtcgttgaggacccggctaggctggcggg
gttgccttactggttagcagaatgaatcaccgatacgcgagcgaacgtgaagcgactgctgctgcaaa
acgtctgcgacctgagcaacaacatgaatggtcttcggtttccgtgtttcgtaaagtctggaaacgcgga
agtcagcgccctgcaccattatgttccggatctgcatcgcaggatgctgctggctaccctgtggaacacc
tacatctgtattaacgaagcgctggcattgaccctgagtgatttttctctggtcccgccgcatccataccgc
cagttgtttaccctcacaacgttccagtaaccgggcatgttcatcatcagtaacccgtatcgtgagcatcct
ctctcgtttcatcggtatcattacccccatgaacagaaatcccccttacacggaggcatcagtgaccaaa
caggaaaaaaccgcccttaacatggcccgctttatcagaagccagacattaacgcttctggagaaact
caacgagctggacgcggatgaacaggcagacatctgtgaatcgcttcacgaccacgctgatgagcttt
accgcagctgcctcgcgcgtttcggtgatgacggtgaaaacctctgacacatgcagctcccggagacg
gtcacagcttgtctgtaagcggatgccgggagcagacaagcccgtcagggcgcgtcagcgggtgttg
gcgggtgtcggggcgcagccatgacccagtcacgtagcgatagcggagtgtatactggcttaactatg
cggcatcagagcagattgtactgagagtgcaccatatatgcggtgtgaaataccgcacagatgcgtaa
ggagaaaataccgcatcaggcgctcttccgcttcctcgctcactgactcgctgcgctcggtcgttcggctg
cggcgagcggtatcagctcactcaaaggcggtaatacggttatccacagaatcaggggataacgcag
gaaagaacatgtgagcaaaaggccagcaaaaggccaggaaccgtaaaaaggccgcgttgctggc
gtttttccataggctccgccccctgacgagcatcacaaaaatcgacgctcaagtcaga

Figure 5C

ggtggcgaaacccgacaggactataaagataccaggcgtttccccctggaagctccctcgtgcgctctcct
gttccgaccctgccgcttaccggatacctgtccgcctttctcccttcgggaagcgtggcgctttctcatagctca
cgctgtaggtatctcagttcggtgtaggtcgttcgctccaagctgggctgtgtgcacgaacccccgttcagc
ccgaccgctgcgccttatccggtaactatcgtcttgagtccaacccggtaagacacgacttatcgccactgg
cagcagccactggtaacaggattagcagagcgaggtatgtaggcggtgctacagagttcttgaagtggtg
gcctaactacggctacactagaaggacagtatttggtatctgcgctctgctgaagccagttaccttcggaaa
aagagttggtagctcttgatccggcaaacaaaccaccgctggtagcggtggtttttttgtttgcaagcagcag
attacgcgcagaaaaaaaggatctcaagaagatcctttgatcttttctacggggtctgacgctcagtggaac
gaaaactcacgttaagggattttggtcatgagattatcaaaaaggatcttcacctagatccttttaaattaaaa
atgaagttttaaatcaatctaaagtatatatgagtaaacttggtctgacagttaccaatgcttaatcagtgagg
cacctatctcagcgatctgtctatttcgttcatccatagttgcctgactccccgtcgtgtagataactacgatacg
ggagggcttaccatctggccccagtgctgcaatgataccgcgagacccacgctcaccggctccagatttat
cagcaataaaccagccagccggaagggccgagcgcagaagtggtcctgcaactttatccgcctccatcc
agtctattaattgttgccgggaagctagagtaagtagttcgccagttaatagtttgcgcaacgttgttgccattg
ctgcaggcatcgtggtgtcacgctcgtcgtttggtatggcttcattcagctccggttcccaacgatcaaggcg
agttacatgatcccccatgttgtgcaaaaaagcggttagctccttcggtcctccgatcgttgtcagaagtaagt
tggccgcagtgttatcactcatggttatggcagcactgcataattctcttactgtcatgccatccgtaagatgctt
ttctgtgactggtgagtactcaaccaagtcattctgagaatagtgtatgcggcgaccgagttgctcttgcccgg
cgtcaacacgggataataccgcgccacatagcagaactttaaaagtgctcatcattggaaaacgttcttcg
gggcgaaaactctcaaggatcttaccgctgttgagatccagttcgatgtaacccactcgtgcacccaactg
atcttcagcatcttttactttcaccagcgtttctgggtgagcaaaaacaggaaggcaaaatgccgcaaaaa
agggaataagggcgacacggaaatgttgaatactcatactcttccttttcaatattattgaagcatttatcagg
gttattgtctcatgagcggatacatatttgaatgtatttagaaaaataaacaaataggggttccgcgcacattt
ccccgaaaagtgccacctgacgtctaagaaaccattattatcatgacattaacctataaaaataggcgtatc
acgaggccctttcgtcttcaagaa

(SEQ ID NO:3)

Figure 6

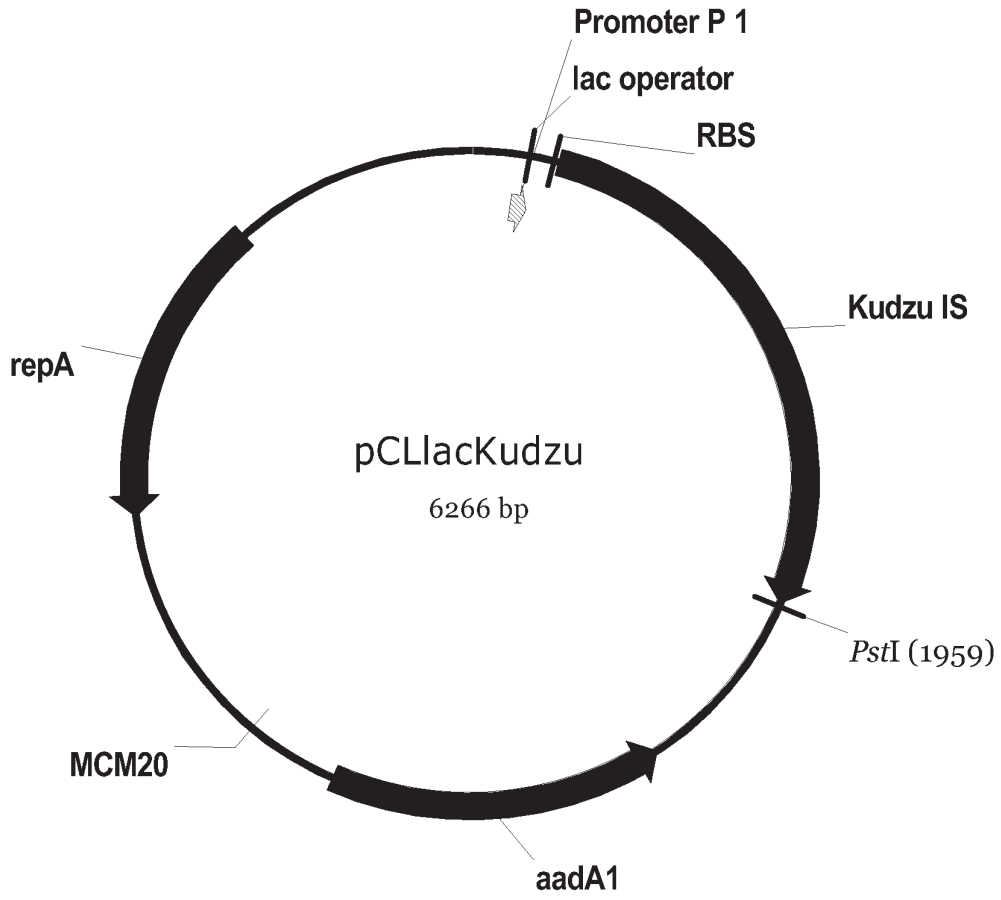

Promoter P 1
lac operator
RBS
Kudzu IS
repA
pCLlacKudzu
6266 bp
PstI (1959)
MCM20
aadA1

Figure 7A

1-

cccgtcttactgtcgggaattcgcgttggccgattcattaatgcagctggcacgacaggtttcccgactggaa
agcgggcagtgagcgcaacgcaattaatgtgagttagctcactcattaggcaccccaggctttacactttat
gcttccggctcgtatgttgtgtggaattgtgagcggataacaatttcacacaggaaacagctatgaccatgat
tacgccaagcttgtatcgattaaataaggaggaataaaccatgtgtgcgacctcttctcaatttactcagatta
ccgagcataattcccgtcgttccgcaaactatcagccaaacctgtggaatttcgaattcctgcaatccctgga
gaacgacctgaaagtggaaaagctggaggagaaagcgaccaaactggaggaagaagttcgctgcatg
atcaaccgtgtagacacccagccgctgtccctgctggagctgatcgacgatgtgcagcgcctgggtctgac
ctacaaatttgaaaaagacatcattaaagccctggaaaacatcgtactgctggacgaaaacaaaaagaa
caaatctgacctgcacgcaaccgctctgtctttccgtctgctgcgtcagcacggtttcgaggtttctcaggatgt
ttttgagcgtttcaaggataaagaaggtggtttcagcggtgaactgaaaggtgacgtccaaggcctgctga
gcctgtatgaagcgtcttacctgggtttcgagggtgagaacctgctggaggaggcgcgtacctttccatcac
ccacctgaagaacaacctgaaagaaggcattaataccaaggttgcagaacaagtgagccacgccctgg
aactgccatatcaccagcgtctgcaccgtctggaggcacgttggttcctggataaatacgaaccgaaaga
accgcatcaccagctgctgctggagctggcgaagctggattttaacatggtacagaccctgcaccagaaa
gagctgcaagatctgtcccgctggtggaccgagatgggcctggctagcaaactggattttgtacgcgaccg
cctgatggaagtttatttctgggcactgggtatggcgccagacccgcagtttggtgaatgtcgcaaagctgtt
actaaaatgtttggtctggtgacgatcatcgatgacgtgtatgacgtttatggcactctggacgaactgcaact
gttcaccgatgctgtagagcgctgggacgttaacgctattaacaccctgccggactatatgaaactgtgtttc
ctggcactgtacaacaccgttaacgacacgtcctattctattctgaaagagaaaggtcataacaacctgtcc
tatctgacgaaaagctggcgtgaactgtgcaaagcctttctgcaagaggcgaaatggtccaacaacaaa
attatcccggctttctccaagtacctggaaaacgccagcgtttcctcctccggtgtagcgctgctggcgccgt
cttacttttccgtatgccagcagcaggaagacatctccgaccacgcgctgcgttccctgaccgacttccatg
gtctggtgcgttctagctgcgttatcttccgcctgtgcaacgatctggccacctctgcggcggagctggaacgt
ggcgagactaccaattctatcattagctacatgcacgaaaacgatggtaccagcgaggaacaggcccgc
gaagaactgcgtaaactgatcgacgccgaatggaaaaagatgaatcgtgaacgcgttagcgactccacc
ctgctgcctaaagcgttcatggaaatcgcagttaacatggcacgtgtttcccactgcacctaccagtatggc
gatggtctgggtcgcccagactacgcgactgaaaaccgcatcaaactgctgctgattgacccttcccgatt
aaccagctgatgtatgtctaactgcaggtcgactctagaggatccccgggtaccgagctcgaattcactgg
ccgtcgttttacaacgtcgtgactgggaaaaccctggcgttacccaacttaatcgccttgcagcacatcccc
ctttcgccagctggcgtaatagcgaagaggcccgcaccgatcgcccttcccaacagttgcgcagcctgaa
tggcgaatggcgcctgatgcggtattttctccttacgcatctgtgcggtatttcacaccgcatatggtgcactct
cagtacaatctgctctgatgccgcatagttaagccagccccgacacccgccaacacccgctgacgagctt
agtaaagccctcgctagattttaatgcggatgttgcgattacttcgccaactattgcgataacaagaaaaag
ccagcctttcatgatatatctcccaatttgtgtagggcttattatgcacgcttaaaaataataaaagcagacttg
acctgatagtttggctgtgagcaattatgtgcttagtgcatctaacgcttgagttaagccgcgccgcgaagcg
gcgtcggcttgaacgaattgttagacattatttgccgactaccttggtgatctcgcctttcacgtagtggacaaa
ttcttccaactgatctgcgcgcgaggccaagcgatcttcttcttgtccaagataagcctgtctagcttcaagtat
gacgggctgatactgggccggcaggcgctccattgcccagtcggcagcgacatccttcggcgcgattttgc
cggttactgcgctgtaccaaatgcgggacaacgtaagcactacatttcgctcatcgccagcccagtcgggc
ggcgagttccatag

Figure 7B

cgttaaggtttcatttagcgcctcaaatagatcctgttcaggaaccggatcaaagagttcctccgccgctg
gacctaccaaggcaacgctatgttctcttgcttttgtcagcaagatagccagatcaatgtcgatcgtggct
ggctcgaagatacctgcaagaatgtcattgcgctgccattctccaaattgcagttcgcgcttagctggata
acgccacggaatgatgtcgtcgtgcacaacaatggtgacttctacagcgcggagaatctcgctctctcc
aggggaagccgaagtttccaaaaggtcgttgatcaaagctcgccgcgttgtttcatcaagccttacggtc
accgtaaccagcaaatcaatatcactgtgtggcttcaggccgccatccactgcggagccgtacaaatgt
acggccagcaacgtcggttcgagatggcgctcgatgacgccaactacctctgatagttgagtcgatact
tcggcgatcaccgcttccctcatgatgtttaactttgttttagggcgactgccctgctgcgtaacatcgttgct
gctccataacatcaaacatcgacccacggcgtaacgcgcttgctgcttggatgcccgaggcatagact
gtaccccaaaaaaacagtcataacaagccatgaaaaccgccactgcgccgttaccaccgctgcgttc
ggtcaaggttctggaccagttgcgtgagcgcatacgctacttgcattacagcttacgaaccgaacaggc
ttatgtccactgggttcgtgccttcatccgtttccacggtgtgcgtcacccggcaaccttgggcagcagcg
aagtcgaggcatttctgtcctggctggcgaacgagcgcaaggtttcggtctccacgcatcgtcaggcatt
ggcggccttgctgttcttctacggcaaggtgctgtgcacggatctgccctggcttcaggagatcggaaga
cctcggccgtcgcggcgcttgccggtggtgctgaccccggatgaagtggttcgcatcctcggttttctgga
aggcgagcatcgtttgttcgcccagcttctgtatggaacgggcatgcggatcagtgagggtttgcaactg
cgggtcaaggatctggatttcgatcacggcacgatcatcgtgcgggagggcaagggctccaaggatc
gggccttgatgttacccgagagcttggcacccagcctgcgcgagcaggggaattaattcccacgggttt
tgctgcccgcaaacgggctgttctggtgttgctagtttgttatcagaatcgcagatccggcttcagccggttt
gccggctgaaagcgctatttcttccagaattgccatgatttttttccccacgggaggcgtcactggctcccgt
gttgtcggcagctttgattcgataagcagcatcgcctgtttcaggctgtctatgtgtgactgttgagctgtaa
caagttgtctcaggtgttcaatttcatgttctagttgctttgttttactggtttcacctgttctattaggtgttacatg
ctgttcatctgttacattgtcgatctgttcatggtgaacagctttgaatgcaccaaaaactcgtaaaagctct
gatgtatctatctttttttacaccgttttcatctgtgcatatggacagttttcccttgatatgtaacggtgaacagt
tgttctacttttgtttgttagtcttgatgcttcactgatagatacaagagccataagaacctcagatccttccgt
atttagccagtatgttctctagtgtggttcgttgtttttgcgtgagccatgagaacgaaccattgagatcatac
ttactttgcatgtcactcaaaaattttgcctcaaaactggtgagctgaatttttgcagttaaagcatcgtgtag
tgtttttcttagtccgttatgtaggtaggaatctgatgtaatggttgttggtattttgtcaccattcatttttatctggt
tgttctcaagttcggttacgagatccatttgtctatctagttcaacttggaaaatcaacgtatcagtcgggcg
gcctcgcttatcaaccaccaatttcatattgctgtaagtgtttaaatctttacttattggtttcaaaacccattgg
ttaagccttttaaactcatggtagttatttttcaagcattaacatgaacttaaattcatcaaggctaatctctata
tttgccttgtgagttttcttttgtgttagttcttttaataaccactcataaatcctcatagagtatttgttttcaaaag
acttaacatgttccagattatattttatgaatttttttaactggaaaagataaggcaatatctcttcactaaaa
actaattctaatttttcgcttgagaacttggcatagtttgtccactggaaaatctcaaagcctttaaccaaag
gattcctgatttccacagttctcgtcatcagctctctggttgctttagctaatacaccataagcattttccctact
gatgttcatcatctgagcgtattggttataagtgaacgataccgtccgttctttccttgtagggttttcaatcgt
ggggttgagtagtgccacacagcataaaattagcttggtttcatgctccgttaagtcatagcgactaatcg
ctagttcatttgctttgaaaacaactaattcagacatacatctcaattggtctaggtgattttaatcactatac
caattgagatgggctagtcaatgataattactagtccttttcctttgagttgtgggtatctgta

Figure 7C

Aattctgctagacctttgctggaaaacttgtaaattctgctagaccctctgtaaattccgctagacctttgtg
tgttttttttgtttatattcaagtggttataatttatagaataaagaaagaataaaaaaaagataaaaagaat
agatcccagccctgtgtataactcactactttagtcagttccgcagtattacaaaaggatgtcgcaaac
gctgtttgctcctctacaaaacagaccttaaaaccctaaaggcttaagtagcaccctcgcaagctcgg
gcaaatcgctgaatattccttttgtctccgaccatcaggcacctgagtcgctgtctttttcgtgacattcagtt
cgctgcgctcacggctctggcagtgaatgggggtaaatggcactacaggcgccttttatggattcatgc
aaggaaactacccataatacaagaaaagcccgtcacgggcttctcagggcgttttatggcgggtctg
ctatgtggtgctatctgactttttgctgttcagcagttcctgccctctgattttccagtctgaccacttcggatta
tcccgtgacaggtcattcagactggctaatgcacccagtaaggcagcggtatcatcaacaggctta

(SEQ ID NO:4)

Figure 8A

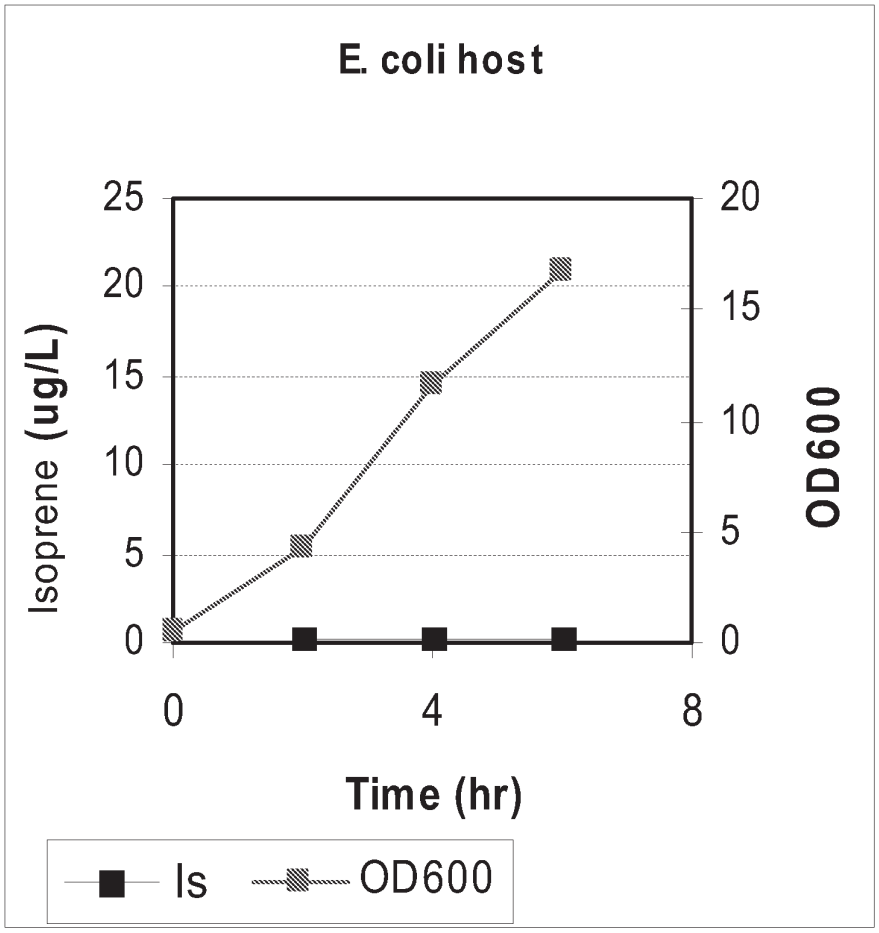

E. coli host
Isoprene (ug/L)
OD600
Time (hr)
25
20
15
10
5
0
20
15
10
5
0
0
4
8
Is
OD600

Figure 8B

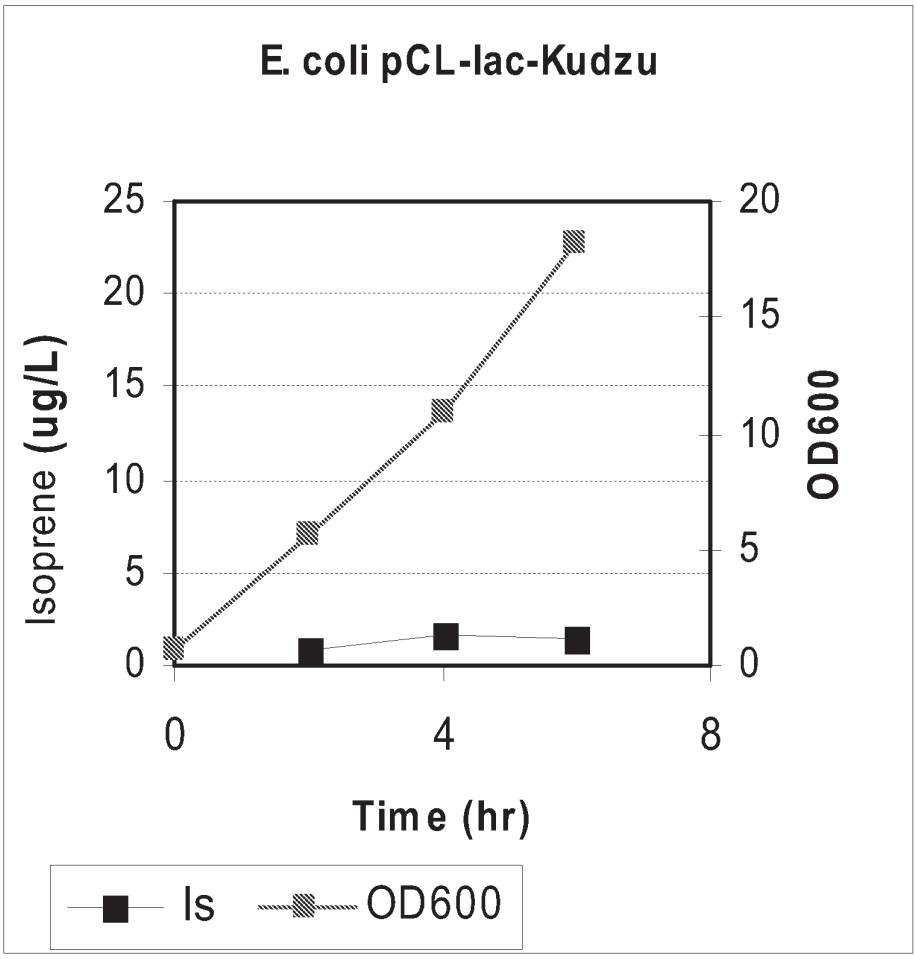

E. coli pCL-lac-Kudzu
Isoprene (ug/L)
OD600
Time (hr)
Is
OD600
0
5
10
15
20
25
0
4
8

Figure 8C

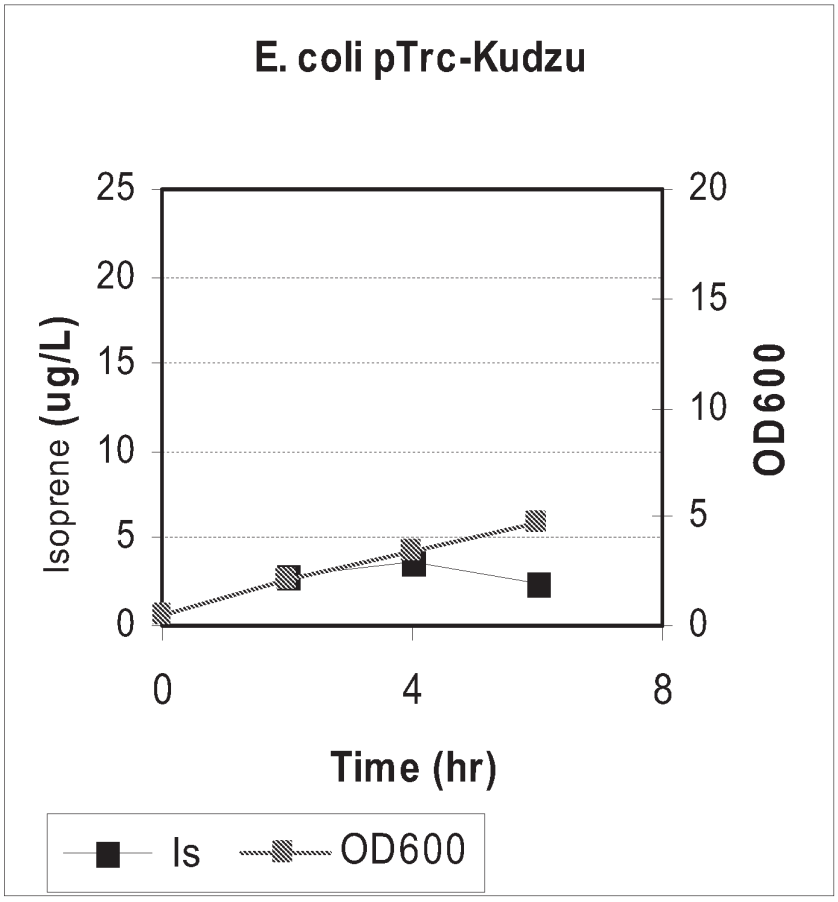

E. coli pTrc-Kudzu
Isoprene (ug/L)
OD600
25
20
15
10
5
0
20
15
10
5
0
0
4
8
Time (hr)
Is
OD600

Figure 8D

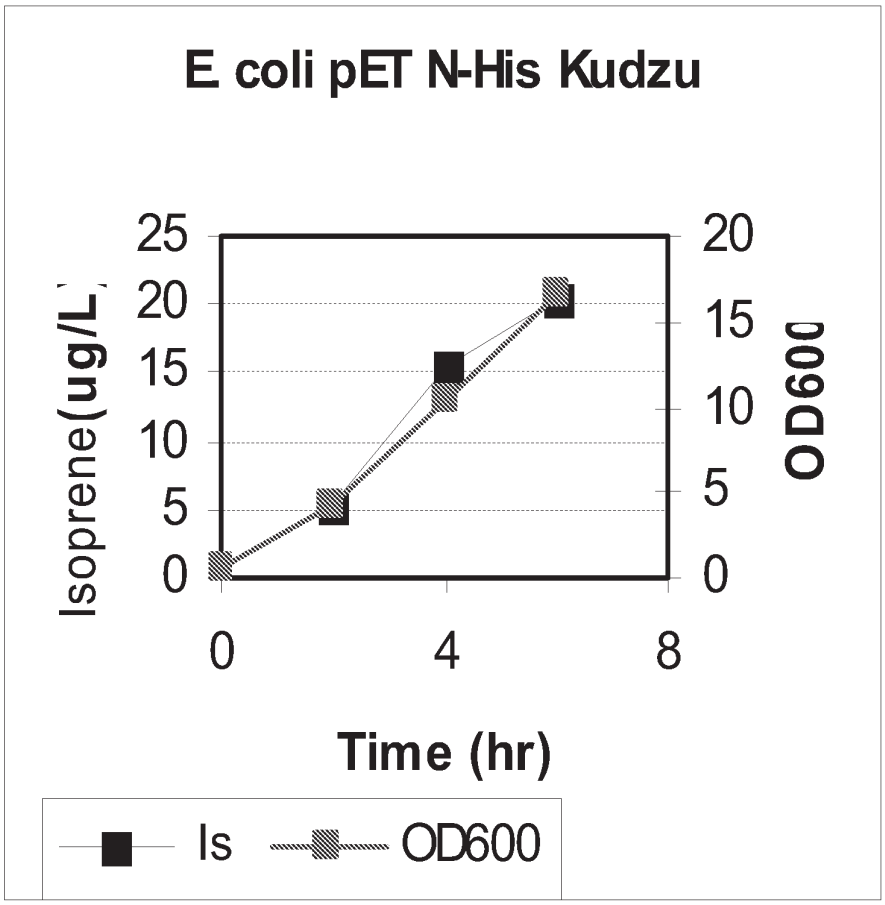

E coli pET N-His Kudzu
Isoprene(ug/L)
25
20
15
10
5
0
20
15
10
5
0
OD600
0
4
8
Time (hr)
Is
OD600

Figure 9A

A.

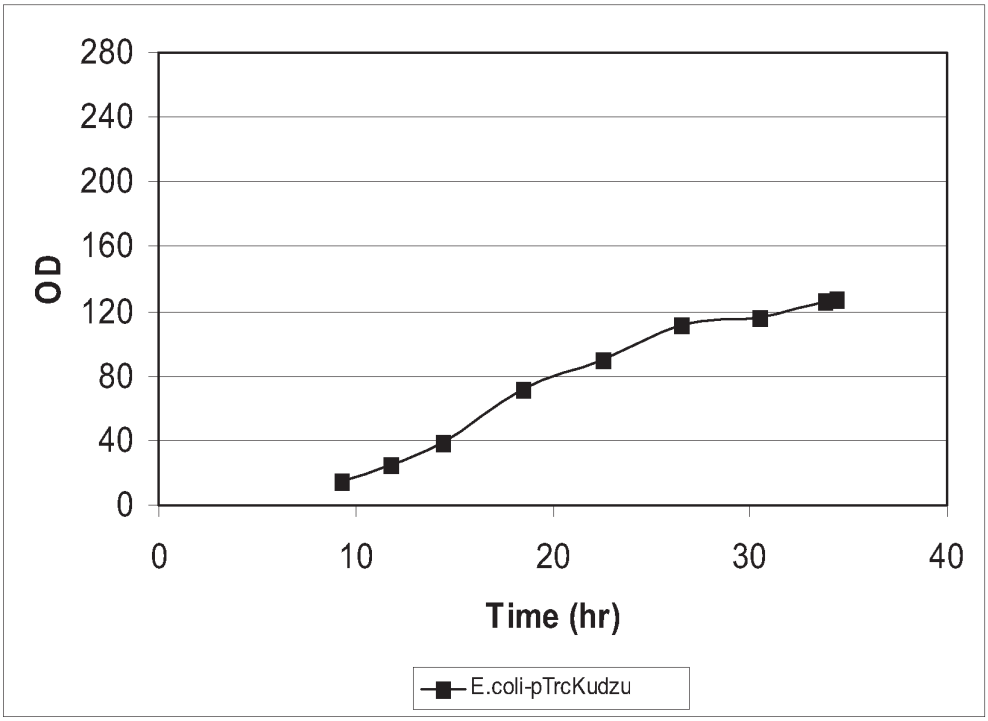

280
240
200
160
120
80
40
0
OD
0
10
20
30
40
Time (hr)
E.coli-pTrcKudzu

Figure 9B

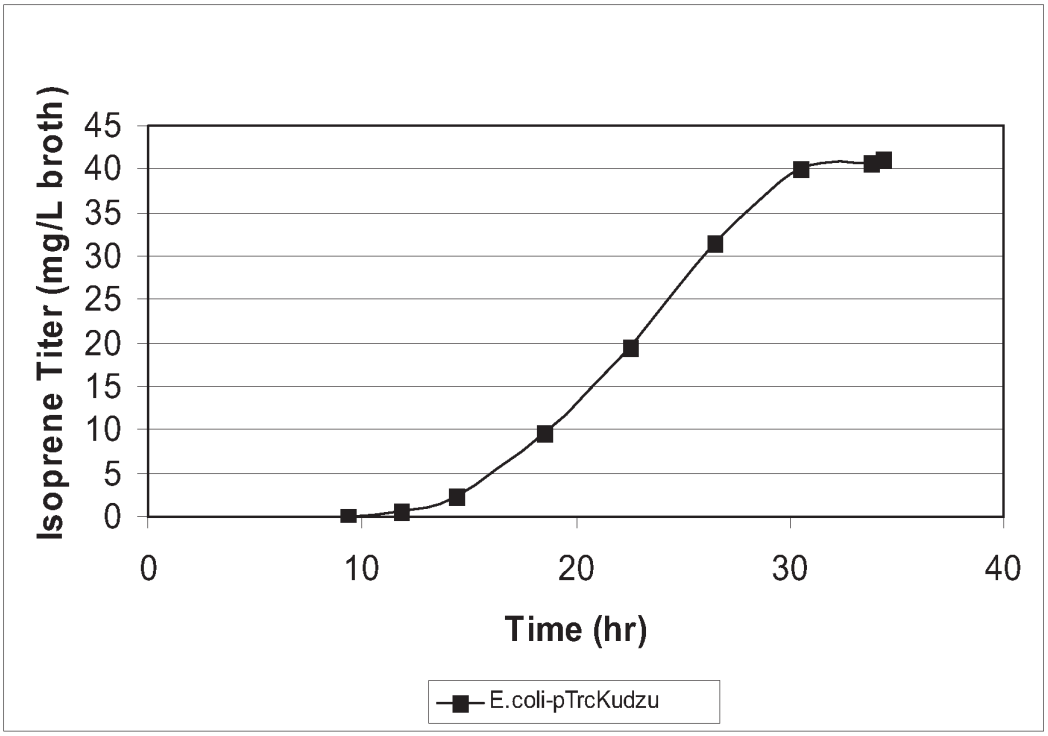

Isoprene Titer (mg/L broth)
45
40
35
30
25
20
15
10
5
0
0
10
20
30
40
Time (hr)
E.coli-pTrcKudzu

Figure 10A

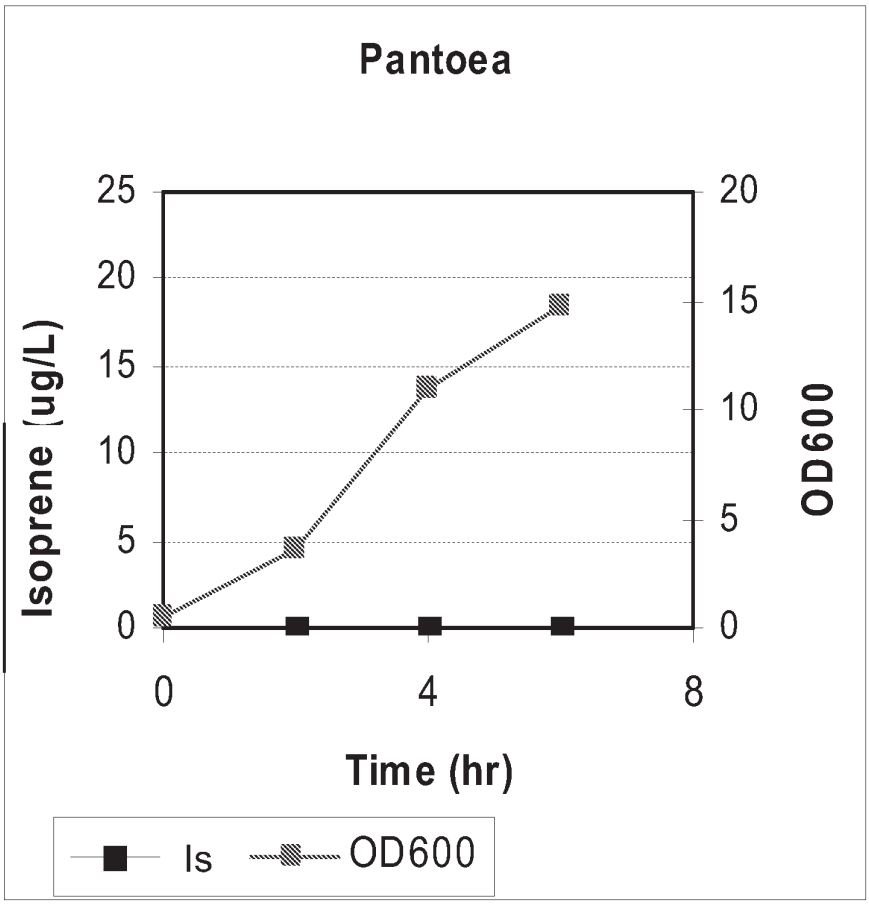

Pantoea
Isoprene (ug/L)
OD600
25
20
15
10
5
0
20
15
10
5
0
0
4
8
Time (hr)
Is
OD600

Figure 10B

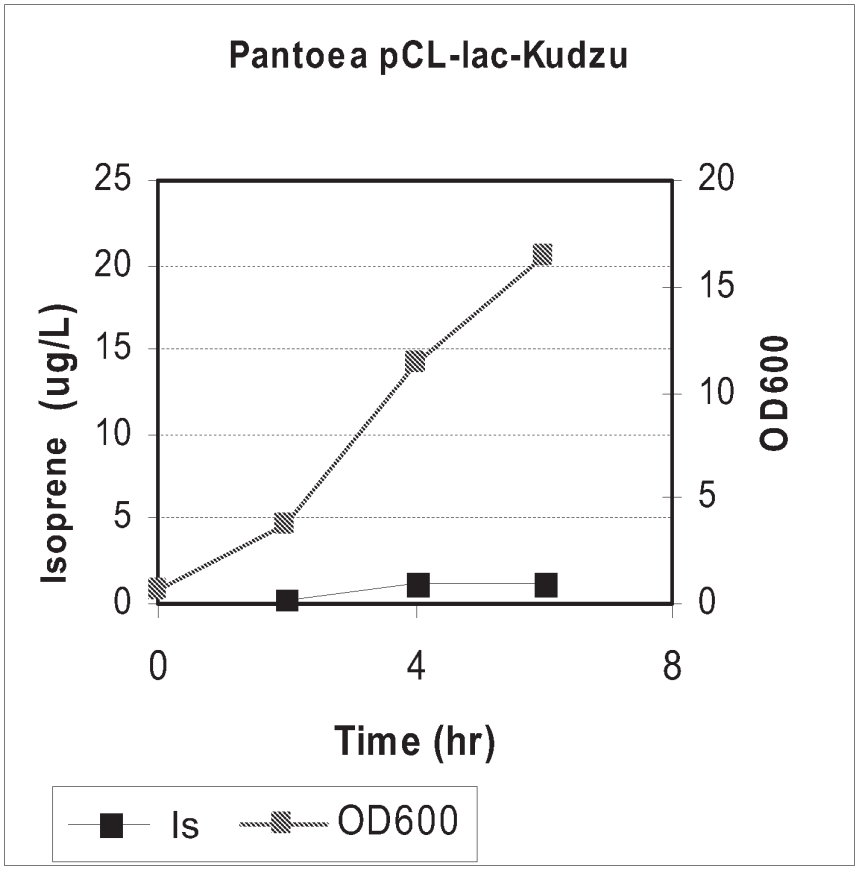

Pantoea pCL-lac-Kudzu
Isoprene (ug/L)
OD600
Time (hr)
Is
OD600
25
20
15
10
5
0
20
15
10
5
0
0
4
8

Figure 10C

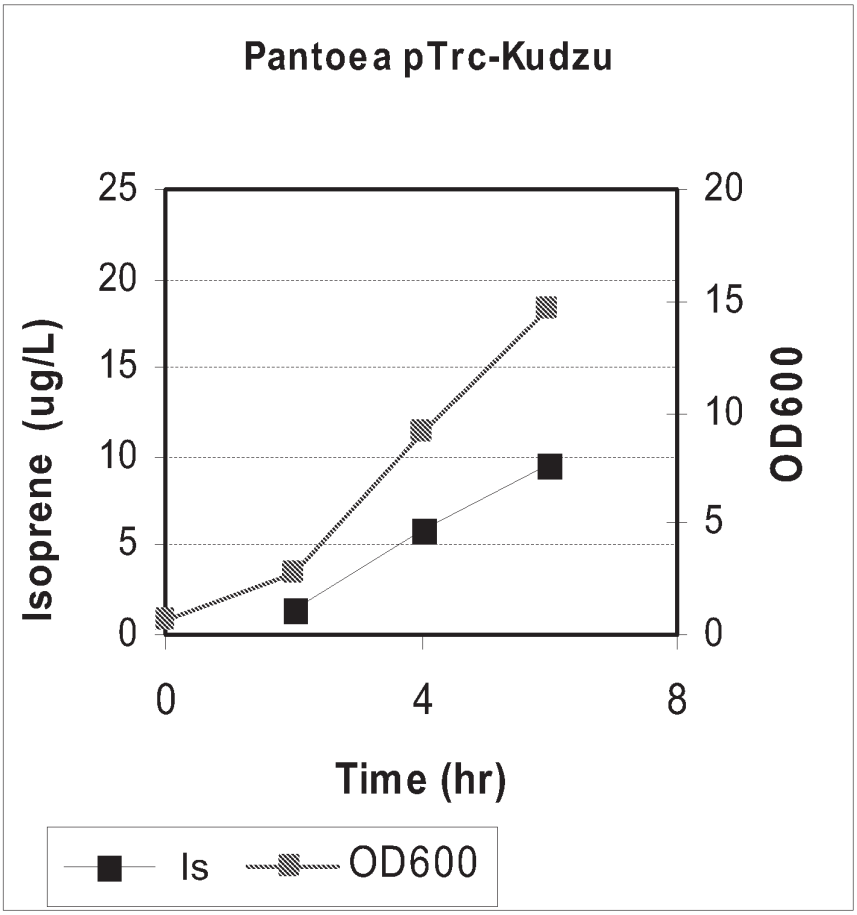

Pantoea pTrc-Kudzu
Isoprene (ug/L)
OD600
Time (hr)
25
20
15
10
5
0
20
15
10
5
0
0
4
8
Is
OD600

Figure 11

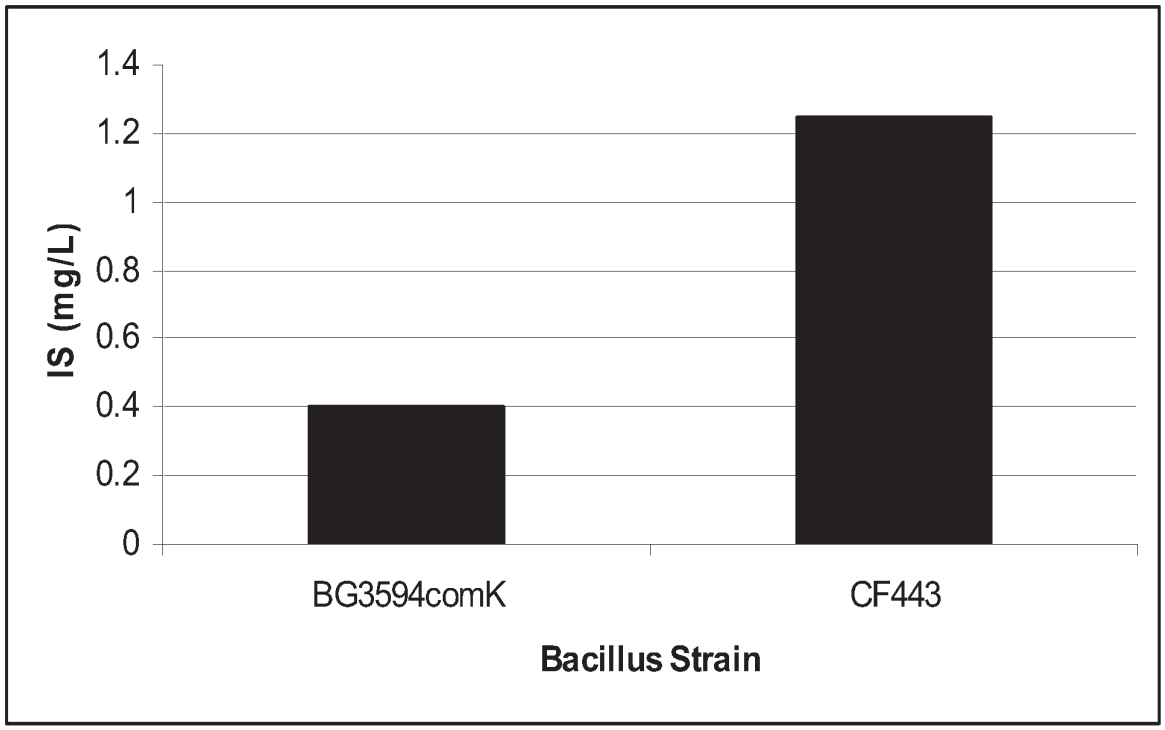


Figure 12A

1-

gaattgctccatttttcttctgctatcaaaataacagactcgtgattttccaaacgagctttcaaaaaagcctctgcc
ccttgcaaatcggatgcctgtctataaaattcccgatattggttaaacagcggcgcaatggcggccgcatctgat
gtctttgcttggcgaatgttcatcttatttcttcctccctctcaataatttttttcattctatccctttttctgtaaagtttatttttc
agaatacttttatcatcatgctttgaaaaaatatcacgataatatccattgttctcacggaagcacacgcaggtca
tttgaacgaatttttttcgacaggaatttgccgggactcaggagcatttaacctaaaaaaagcatgacatttcagcat
aatgaacatttactcatgtctattttcgttcttttctgtatgaaaatagttatttcgagtctctacggaaatagcgagag
atgatatacctaaatagagataaaatcatctcaaaaaaatgggtctactaaaatattattccatctattacaataa
attcacagaatagtcttttaagtaagtctactctgaatttttttaaaaggagagggtaaagagtgtgtgcgacctctt
ctcaatttactcagattaccgagcataattcccgtcgttccgcaaactatcagccaaacctgtggaatttcgaatt
cctgcaatccctggagaacgacctgaaagtggaaaagctggaggagaaagcgaccaaactggaggaag
aagttcgctgcatgatcaaccgtgtagacacccagccgctgtccctgctggagctgatcgacgatgtgcagcg
cctgggtctgacctacaaatttgaaaaagacatcattaaagccctggaaaacatcgtactgctggacgaaaa
caaaaagaacaaatctgacctgcacgcaaccgctctgtctttccgtctgctgcgtcagcacggtttcgaggtttc
tcaggatgtttttgagcgtttcaaggataaagaaggtggtttcagcggtgaactgaaaggtgacgtccaaggcc
tgctgagcctgtatgaagcgtcttacctgggtttcgagggtgagaacctgctggaggaggcgcgtacctttcca
tcacccacctgaagaacaacctgaaagaaggcattaataccaaggttgcagaacaagtgagccacgccct
ggaactgccatatcaccagcgtctgcaccgtctggaggcacgttggttcctggataaatacgaaccgaaaga
accgcatcaccagctgctgctggagctggcgaagctggattttaacatggtacagaccctgcaccagaaaga
gctgcaagatctgtcccgctggtggaccgagatgggcctggctagcaaactggattttgtacgcgaccgcctg
atggaagtttatttctgggcactgggtatggcgccagacccgcagtttggtgaatgtcgcaaagctgttactaaa
atgtttggtctggtgacgatcatcgatgacgtgtatgacgtttatggcactctggacgaactgcaactgttcaccg
atgctgtagagcgctgggacgttaacgctattaacaccctgccggactatatgaaactgtgtttcctggcactgt
acaacaccgttaacgacacgtcctattctattctgaaagagaaaggtcataacaacctgtcctatctgacgaaa
agctggcgtgaactgtgcaaagcctttctgcaagaggcgaaatggtccaacaacaaaattatcccggctttctc
caagtacctggaaaacgccagcgtttcctcctccggtgtagcgctgctggcgccgtcttacttttccgtatgccag
cagcaggaagacatctccgaccacgcgctgcgttccctgaccgacttccatggtctggtgcgttctagctgcgtt
atcttccgcctgtgcaacgatctggccacctctgcggcggagctggaacgtggcgagactaccaattctatcat
tagctacatgcacgaaaacgatggtaccagcgaggaacaggcccgcgaagaactgcgtaaactgatcgac
gccgaatggaaaaagatgaatcgtgaacgcgttagcgactccaccctgctgcctaaagcgttcatggaaatc
gcagttaacatggcacgtgtttcccactgcacctaccagtatggcgatggtctgggtcgcccagactacgcga
ctgaaaaccgcatcaaactgctgctgattgacccttcccgattaaccagctgatgtatgtctaaaaaaaaccg
gccttggccccgccggttttttattattttcttcctccgcatgttcaatccgctccataatcgacggatggctccctct
gaaaattttaacgagaaacggcgggttgacccggctcagtcccgtaacggccaagtcctgaaacgtctcaat
cgccgcttcccggtttccggtcagctcaatgccgtaacggtcggcggcgttttcctgataccgggagacggcatt
cgtaatcggatcctctagagtcgacctgcaggcatgcaagctttgcctcgcgcgtttcggtgatgacggtgaaa
acctctgacacatgcagctcccggagacggtcacagcttgtctgtaagcggatgccgggagcagacaagcc
cgtcagggcgcgtcagcgggtgttggcgggtgtcggggcgcagccatgacccagtcacgtagcgata

Figure 12B

gcggagtgtatactggcttaactatgcggcatcagagcagattgtactgagagtgcaccatatgcggtgt
gaaataccgcacagatgcgtaaggagaaaataccgcatcaggcgctcttccgcttcctcgctcactga
ctcgctgcgctcggtcgttcggctgcggcgagcggtatcagctcactcaaaggcggtaatacggttatcc
acagaatcaggggataacgcaggaaagaacatgtgagcaaaaggccagcaaaaggccaggaac
cgtaaaaaggccgcgttgctggcgtttttccataggctccgccccctgacgagcatcacaaaaatcga
cgctcaagtcagaggtggcgaaacccgacaggactataaagataccaggcgtttcccccctggaagct
ccctcgtgcgctctcctgttccgaccctgccgcttaccggatacctgtccgcctttctcccttcgggaagcgt
ggcgctttctcaatgctcacgctgtaggtatctcagttcggtgtaggtcgttcgctccaagctgggctgtgtg
cacgaacccccccgttcagcccgaccgctgcgccttatccggtaactatcgtcttgagtccaacccggta
agacacgacttatcgccactggcagcagccactggtaacaggattagcagagcgaggtatgtaggcg
gtgctacagagttcttgaagtggtggcctaactacggctacactagaaggacagtatttggtatctgcgct
ctgctgaagccagttaccttcggaaaaagagttggtagctcttgatccggcaaacaaaccaccgctggt
agcggtggtttttttgtttgcaagcagcagattacgcgcagaaaaaaaggatctcaagaagatcctttgat
cttttctacggggtctgacgctcagtggaacgaaaactcacgttaagggattttggtcatgagattatcaa
aaaggatcgaagtcggttcagaaaaagaaggatatggatctggagctgtaatataaaaaccttcttcaa
ctaacggggcaggttagtgacattagaaaaccgactgtaaaaagtacagtcggcattatctcatattata
aaagccagtcattaggcctatctgacaattcctgaatagagttcataaacaatcctgcatgataaccatc
acaaacagaatgatgtacctgtaaagatagcggtaaatatattgaattacctttattaatgaattttcctgct
gtaataatgggtagaaggtaattactattattattgatatttaagttaaacccagtaaatgaagtccatgga
ataatagaaagagaaaaagcattttcaggtataggtgttttgggaaacaatttaaaagaaccattatattt
ctctacatcagaaaggtataaatcataaaactctttgaagtcattctttacaggagtccaaataccagag
aatgttttagatacaccatcaaaaattgtataaagtggctctaacttatcccaataacctaactctccgtcg
ctattgtaaccagttctaaaagctgtatttgagtttatcacccttgtcactaagaaaataaatgcagggtaa
aatttatatccttcttgttttatgtttcggtataaaacactaatatcaatttctgtggttatactaaaagtcgtttgtt
ggttcaaataatgattaaatatctcttttctcttccaattgtctaaatcaattttattaaagttcatttgatatgcct
cctaaatttttatctaaagtgaatttaggaggcttacttgtctgctttcttcattagaatcaatccttttttaaagtc
aatattactgtaacataaatatatattttaaaaatatcccactttatccaattttcgtttgttgaactaatgggtg
ctttagttgaagaataaagaccacattaaaaaatgtggtcttttgtgttttttttaaaggatttgagcgtacgcg
aaaaatccttttctttcttttcttatcttgataataagggtaactattgccggttgtccattcatggctgaactctgc
ttcctctgttgacatgacacacatcatctcaatatccgaatagggcccatcagtctgacgaccaagagag
ccataaacaccaatagccttaacatcatccccatatttatccaatattcgttccttaatttcatgaacaatctt
cattctttcttctctagtcattattattggtccattcactattctcattccctttttcagataattttagatttgcttttcta
aataagaatatttggagagcaccgttcttattcagctattaataactcgtcttcctaagcatccttcaatccttt
taataacaattatagcatctaatcttcaacaaactggcccgtttgttgaactactctttaataaaataatttttc
cgttcccaattccacattgcaataatagaaaatccatcttcatcggctttttcgtcatcatctgtatgaatcaa
atcgccttcttctgtgtcatcaaggtttaatttttttatgtatttcttttaacaaaccaccataggagattaacctttt
acggtgtaaaccttcctccaaatcagacaaacgtttcaaattcttttcttcatcatcggtcataaaatccgta
tcctttacaggatattttgcagtttcgtcaattgccgattgtatatccgatttatatttatttttcggtcgaatcattt
gaacttttacatttggatcatagtctaatttcattgccttttttccaaaattgaatccattgttt

Figure 12C

ttgattcacgtagttttctgttattctaaaataagttggttccacacataccattacatgcatgtgctgattata
agaattatctttattatttattgtcacatccgttgcacgcataaaaccaacaagatttttattaatttttttatatt
gcatcattcggcgaaatccttgagccatatctgtcaaactcttatttaattcttcgccatcataaacatttttta
actgttaatgtgagaaacaaccaacgaactgttggcttttgtttaataacttcagcaacaacctttttgtgac
tgaatgccatgtttcattgctctcctccagttgcacattggacaaagcctggatttgcaaaaccacactcg
ataccactttctttcgcctgtttcacgattttgtttatactctaatatttcagcacaatcttttactctttcagccttt
ttaaattcaagaatatgcagaagttcaaagtaatcaacattagcgattttctttttctctccatggtctcacttt
tccacttttttgtcttgtccactaaaaccccttgatttttcatctgaataaatgctactattaggacacataatatt
aaaagaaaccccccatctatttagttatttgtttagtcacttataactttaacagatggggtttttctgtgcaac
caattttaagggttttcaatactttaaaacacatacataccaacacttcaacgcacctttcagcaactaa
aataaaaatgacgttatttctatatgtatcaagataagaaagaacaagttcaaaaccatcaaaaaaag
acacctttttcaggtgctttttttattttataaactcattccctgatctcgacttcgttctttttttacctctcggttatg
agttagttcaaattcgttctttttaggttctaaatcgtgtttttcttggaattgtgctgttttatcctttaccttgtcta
caaacccctttaaaaacgtttttaaaggcttttaagccgtctgtacgttccttaag

(SEQ ID NO:5)

Figure 13

ATGTGTGCAACCTCCTCCCAGTTTACTCAGATTACCGAGCATAATTCTCGAC
GATCTGCTAACTACCAGCCGAACCTTTGGAACTTTGAGTTTCTCCAGTCTCT
CGAAAATGACCTGAAGGTGGAAAAGCTCGAGGAGAAGGCGACCAAACTCG
AGGAGGAGGTGCGATGTATGATCAACAGAGTTGACACCCAACCCCTGTCTT
TGCTGGAGCTGATCGACGATGTGCAGCGGTTGGGTTTGACTTATAAATTCG
AGAAGGACATTATCAAGGCACTGGAGAACATTGTGCTCCTCGACGAGAACA
AGAAGAACAAGTCTGATCTTCACGCTACCGCTCTCTCTTTCCGACTTCTTCG
ACAACACGGCTTCGAGGTGTCGCAGGACGTCTTCGAGAGATTTAAGGACA
AGGAGGGAGGATTTAGCGGCGAGCTGAAGGGAGACGTTCAGGGTCTTCTC
TCCTTGTACGAGGCGTCCTACCTGGGATTCGAGGGAGAGAACCTCCTGGA
GGAAGCTCGTACATTTTCCATCACTCACCTTAAGAATAACCTTAAGGAGGG
AATTAACACCAAGGTGGCCGAGCAGGTTTCTCACGCCCTGGAGCTCCCCT
ACCACCAACGGCTCCATAGACTGGAGGCTCGTTGGTTCCTGGACAAATATG
AGCCAAAGGAGCCTCATCATCAGTTGCTGTTGGAGTTGGCCAAGCTGGACT
TCAATATGGTTCAGACGCTGCACCAAAAGGAGTTGCAGGACCTGTCTCGAT
GGTGGACCGAGATGGGATTGGCCTCGAAGCTGGATTTTGTCCGTGACCGA
CTTATGGAGGTCTATTTTTGGGCCCTTGGAATGGCGCCTGACCCCCAGTTC
GGAGAGTGCCGGAAGGCGGTGACGAAGATGTTCGGTCTTGTGACTATCAT
CGACGACGTCTACGATGTCTACGGCACACTCGACGAGTTGCAGCTGTTCA
CTGACGCCGTCGAGCGATGGGATGTGAACGCCATTAATACTCTCCCTGACT
ATATGAAGCTGTGCTTCCTGGCTCTGTACAACACTGTCAACGATACCTCGT
ACTCTATCCTCAAGGAGAAGGGACACAACAATCTCTCCTACTTGACCAAAT
CCTGGCGAGAACTGTGCAAGGCTTTTCTGCAGGAGGCTAAATGGTCCAATA
ACAAGATCATTCCTGCTTTTTCTAAATACCTGGAAAATGCCTCGGTGTCGAG
CTCTGGCGTCGCCCTTCTGGCCCCTTCCTACTTCTCCGTCTGCCAGCAGCA
GGAGGATATTTCCGATCATGCTCTTAGATCGCTGACCGATTTTCACGGCCT
CGTGCGATCTTCCTGCGTGATTTTTCGGTTGTGTAATGACCTTGCGACCTC
TGCTGCTGAGCTGGAACGAGGCGAGACTACAAATTCCATTATTTCTTACAT
GCACGAAAACGATGGAACATCTGAAGAACAGGCTAGAGAGGAACTGCGAA
AGTTGATCGACGCCGAGTGGAAGAAGATGAACAGAGAGCGGGTGTCCGAC
TCTACCCTGCTTCCCAAGGCCTTCATGGAGATCGCCGTGAACATGGCTCGA
GTTTCCCATTGTACTTACCAGTACGGTGACGGCCTGGGTCGTCCGGACTAC
GCTACAGAGAACCGAATCAAGCTGCTGCTCATCGACCCCTTCCCTATCAAC
CAATTGATGTACGTGTAA

(SEQ ID NO:6)

Figure 14

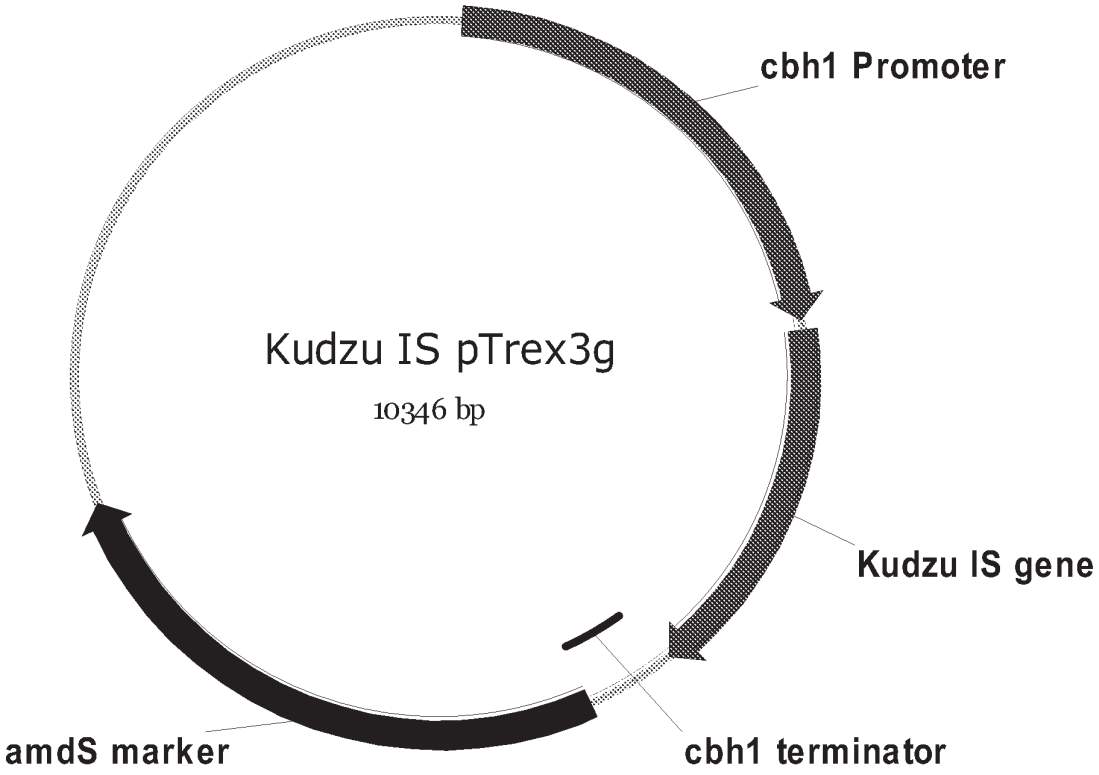

cbh1 Promoter
Kudzu IS pTrex3g
10346 bp
Kudzu IS gene
amdS marker
cbh1 terminator

Figure 15A

```
   1 TCGACCGGTG AGAAGAACAG CATCGGGACA AGGGAAGGAA GAACAAAGAC AAAGAAAACA
  61 AAAGAAAGCA ATTGAAAACA AAACAAAACA ATTTTCATTC CTTCTCTTAT CATTCCTTTT
 121 CTTTTCTTTT CTCTCATTCA ACGCACTCCA TCGTATCCGT ATTCCTCTTA TTTTTTCTCT
 181 TTCTCTATAT CCATTTCTTT CTCTCTAGGT GTGTCCTCTC TCTCTCTTCA ATTTCTCTAC
 241 TCCGCATTCC AACGCATCCT TCCCCCAACC TCCCATTTCC TCCTTACGGC CCGATAGCGA
 301 TCGTCTTTCC CTCGCTATCA CTCGCTACCG GCCCCTCCTC TGCACCGTAA CCTCCTACGT
 361 ATTTACCATA TCATAAAGTT TTTTCCGACG CTTATCGCTG ACCCCCTGTC GCCCTCCTAT
 421 TGGCTTCCGG ATTATCTTCT TGTCCATAAG GTGATCCATG CTTCCTGAAG ATTCCCGAAA
 481 TGTGTCCACT TTGGCGGGGA ATCATTCCAT CCACTTCTTT CTCTCTCGCT TTCCTCATTC
 541 GGCGCTCCCC TTCCGCGTCT CATTGGTCTT CCGCTCCGTT TTTGCTTTGC CGATGTTACT
 601 TGGGGAGAGG TGCGATAATC CTTTCGCAAA AACTCGGTTT GACGCCTCCC ATGGTATAAA
 661 TAGTGGGTGG TGGACAGGTG CCTTCGCTTT TCTTTAAGCA AGAGAATCCC ATTGTCTTGA
 721 CTATCACGAA TTCACATACA TTATGAAGAT CACCGCTGTC ATTGCCCTTT TATTCTCACT
 781 TGCTGCTGCC TCACCTATTC CAGTTGCCGA TCCTGGTGTG GTTTCAGTTA GCAAGTCATA
 841 TGCTGATTTC CTTCGTGTTT ACCAAAGTTG GAACACTTTT GCTAATCCTG ATAGACCCAA
 901 CCTTAAGAAG AGAAATGATA CACCTGCAAG TGGATATCAA GTTGAAAAAG TCGTAATTTT
 961 GTCACGTCAC GGTGTTAGGG CCCCTACAAA AATGACTCAA ACCATGCGTG ATGTCACTCC
1021 TAATACATGG CCAGAATGGC CCGTTAAATT AGGATATATT ACACCAAGAG GTGAACACTT
1081 GATATCACTT ATGGGCGGTT TTTACCGTCA AAAATTCCAG CAACAAGGAA TCCTTTCTCA
1141 GGGCTCCTGT CCTACTCCTA ACTCCATATA TGTCTGGGCT GACGTCGATC AGCGTACTTT
1201 AAAAACTGGT GAAGCATTCC TTGCTGGTTT GGCACCACAA TGTGGCTTGA CAATTCATCA
1261 CCAACAAAAT CTTGAGAAAG CTGATCCTCT TTTTCATCCC GTTAAAGCTG GAACCTGCTC
1321 TATGGATAAA ACTCAAGTTC AACAAGCTGT TGAGAAGGAG GCACAAACTC CTATAGATAA
1381 TTTGAATCAA CATTACATCC CCTTTTTAGC TTTAATGAAT ACAACATTAA ATTTTAGTAC
1441 TTCTGCCTGG TGCCAAAAAC ACTCTGCTGA TAAATCCTGT GACCTAGGTT TATCCATGCC
1501 TTCTAAATTG TCCATAAAAG ATAATGGTAA CAAGGTCGCA TTGGATGGAG CTATTGGTCT
1561 ATCCTCTACT TTGGCCGAGA TTTTTCTTCT TGAATATGCT CAAGGCATGC CTCAAGCTGC
1621 TTGGGGTAAC ATCCACTCAG AGCAAGAGTG GGCTTCCTTG CTAAAGTTGC ATAATGTTCA
1681 ATTCGATTTG ATGGCCCGAA CACCTTATAT TGCTCGACAT AACGGTACTC CTTTATTGCA
1741 AGCTATATCA AATGCCCTTA ATCCCAACGC CACTGAATCA AAACTTCCAG ATATTTCACC
1801 TGATAACAAA ATATTGTTCA TTGCAGGTCA TGACACAAAT ATTGCTAATA TAGCCGGCAT
1861 GTTAAATATG CGTTGGACAT TACCAGGTCA ACCAGATAAT ACTCCTCCAG GTGGTGCCCT
1921 AGTATTTGAA CGTCTTGCTG ATAAAAGTGG AAAACAATAT GTTTCTGTAT CTATGGTTTA
1981 TCAAACACTA GAACAACTTC GATCACAGAC TCCCCTTTCT CTAAATCAGC CTGCCGGATC
2041 TGTTCAACTT AAAATTCCAG GTTGCAATGA TCAAACAGCC GAGGGTTACT GTCCTCTTTC
2101 CACTTTTACA AGAGTTGTTT CCCAATCTGT TGAACCTGGA TGCCAACTTC AATAATGAGG
2161 ATCCAAGTAA GGGAATGAGA ATGTGATCCA CTTTTAATTC CTAATGAATA CATGCCTATA
2221 GTTCTTTTCT TTTGTTCTTT ATGTCGTTTT TCGATGGTAC GGCCGTTGTC AATCTCAGTT
2281 TGTGTGCTTG GTTGCAGCTT GGTTTCAAAT CTGTTCATCT CATGAATCTT TTACCATTTC
2341 ACCACACGTT TATACCATTC TCTCATAGAA TCTTCATCAA ACCATCTCGG GGTTAGAGTG
2401 GAAAGAAAGT CTTGTTCTTT TATTTCCTTT TTTCCATCTT CAAGGCTTTT CTTTTCTTCC
2461 TCCTCCTCGT TCATCTTGAG GTTTGACGTG TCTGTTTAGA ATTTTGAGCT GTTGCAGCAT
2521 CTTATTTTTT GTTTTGCGAA AACGAAGCGC TTTACTCTCT TCATCAGTTG GACGATTGTA
2581 CCTTTGAAAA CCAACTACTT TTGCATGTTT TGTATAGAAA TCAATGATAT TAGAATCCCA
2641 TCCTTTAATT TCTTTCAAAG TAGTTGAGCT ATAGTTAAGT GTAAGGGCCC TACTGCGAAA
2701 GCATTTGCCA AGGATGTTTT CATTAATCAA GAACGAAAGT TAGGGGATCG AAGACGATCA
2761 GATACCGTCG TAGTCTTAAC CATAAACTAT GCCGACTAGG GATCGGGCAA TGTTTCATTT
2821 ATCGACTTGC TCGGCACCTT ACGAGAAATC AAAGTCTTTG GGTTCCGGGG GGAGTATGGT
2881 CGCAAGGCTG AAACTTAAAG GAATTGACGG AAGGGCACCA CAATGGAGTG GAGCCTGCGG
2941 CTTAATTTGA CTCAACACGG GGAAACTCAC CAGGTCCAGA CATAGTAAGG ATTGACAGAT
3001 TGAGAGCTCT TTCTTGATTC TATGGGTGGT GGTGCATGGC CGTTCTTAGT TGGTGGAGTG
3061 ATTTGTCTGC TTAATTGCGA TAACGAACGA GACCTTAACC TGCTAAATAG CTGGATCAGC
3121 CATTTTGGCT GATCATTAGC TTCTTAGAGG GACTATTGGC ATAAAGCCAA TGGAAGTTTG
3181 AGGCAATAAC AGGTCTGTGA TGCCCTTAGA TGTTCTGGGC CGCACGCGCG CTACACTGAC
3241 GGAGCCAACG AGTTGAAAAA AATCTTTTGA TTTTTTATCC TTGGCCGGAA GGTCTGGGTA
3301 ATCTTGTTAA ACTCCGTCGT GCTGGGGATA GAGCATTGCA ATTATTGCGG CCGCTCCTCA
3361 ATTCGATGTT GCAGATTTTA CAAGTTTTTA AAATGTATTT CATTATTACT TTTTATATGC
3421 CTAATAAAAA AGCCATAGTT TAATCTATAG ATAACTTTTT TTCCAGTGCA CTAACGGACG
```

Figure 15B

```
3481 TTACATTCCC ATACAAAACT GCGTAGTTAA AGCTAAGGAA AAGTTAATAT CATGTTAATT
3541 AAATACGCTA TTTACAATAA GACATTGAAC TCATTTATAT CGTTGAATAT GAATAACCAA
3601 TTTCAGCGAA TTTTTAACAA ACATCGTTCA CCTCGTTTAA GGATATCTTG TGTATGGGGT
3661 GTTGACTTGC TTTATCGAAT AATTACCGTA CCTGTAATTG GCTTGCTGGA TATAGCGGTA
3721 GTCTAATATC TAGCAAAAAT CTTTTGGGTG AAAAGGCTTG CAATTTCACG ACACCGAACT
3781 ATTTGTCATT TTTTAATAAG GAAGTTTTCC ATAAATTCCT GTAATTCTCG GTTGATCTAA
3841 TTGAAAAGAG TAGTTTTGCA TCACGATGAG GAGGGCTTTT GTAGAAAGAA ATACGAACGA
3901 AACGAAAATC AGCGTTGCCA TCGCTTTGGA CAAAGCTCCC TTACCTGAAG AGTCGAATTT
3961 TATTGATGAA CTTATAACTT CCAAGCATGC AAACCAAAAG GGAGAACAAG TAATCCAAGT
4021 AGACACGGGA ATTGGATTCT TGGATCACAT GTATCATGCA CTGGCTAAAC ATGCAGGCTG
4081 GAGCTTACGA CTTTACTCAA GAGGTGATTT AATCATCGAT GATCATCACA CTGCAGAAGA
4141 TACTGCTATT GCACTTGGTA TTGCATTCAA GCAGGCTATG GGTAACTTTG CCGGCGTTAA
4201 AAGATTTGGA CATGCTTATT GTCCACTTGA CGAAGCTCTT TCTAGAAGCG TAGTTGACTT
4261 GTCGGGACGG CCCTATGCTG TTATCGATTT GGGATTAAAG CGTGAAAAGG TTGGGGAATT
4321 GTCCTGTGAA ATGATCCCTC ACTTACTATA TTCCTTTTCG GTAGCAGCTG GAATTACTTT
4381 GCATGTTACC TGCTTATATG GTAGTAATGA CCATCATCGT GCTGAAAGCG CTTTTAAATC
4441 TCTGGCTGTT GCCATGCGCG CGGCTACTAG TCTTACTGGA AGTTCTGAAG TCCCAAGCAC
4501 GAAGGGAGTG TTGTAAAGAT GAATTGGATT ATGTCAGGAA AAGAACGACA ATTTTGCATC
4561 CAAATTGTCT AAATTTTAGA GTTGCTTGAA AACAATAGAA CCTTACTTGC TTTATAATTA
4621 CGTTAATTAG AAGCGTTATC TCGTGAAGGA ATATAGTACG TAGCCGTATA AATTGAATTG
4681 AATGTTCAGC TTATAGAATA GAGACACTTT GCTGTTCAAT GCGTCGTCAC TTACCATACT
4741 CACTTTATTA TACGACTTTA AGTATAAACT CCGCGGTTAT GGTAAAATTA ATGATGCACA
4801 AACGTCCGAT TCCATATGGG TACACTACAA TTAAATACTT TTAAGCTGAT CCCCCACACA
4861 CCATAGCTTC AAAATGTTTC TACTCCTTTT TTACTCTTCC AGATTTTCTC GGACTCCGCG
4921 CATCGCCGTA CCACTTCAAA ACACCCAAGC ACAGCATACT AAATTTTCCC TCTTTCTTCC
4981 TCTAGGGTGT CGTTAATTAC CCGTACTAAA GGTTTGGAAA AGAAAAAAGA GACCGCCTCG
5041 TTTCTTTTTC TTCGTCGAAA AAGGCAATAA AAATTTTTAT CACGTTTCTT TTTCTTGAAA
5101 TTTTTTTTTT TAGTTTTTTT CTCTTTCAGT GACCTCCATT GATATTTAAG TTAATAAACG
5161 GTCTTCAATT TCTCAAGTTT CAGTTTCATT TTTCTTGTTC TATTACAACT TTTTTTACTT
5221 CTTGTTCATT AGAAAGAAAG CATAGCAATC TAATCTAAGG GCGGTGTTGA CAATTAATCA
5281 TCGGCATAGT ATATCGGCAT AGTATAATAC GACAAGGTGA GGAACTAAAC CATGGCCAAG
5341 TTGACCAGTG CCGTTCCGGT GCTCACCGCG CGCGACGTCG CCGGAGCGGT CGAGTTCTGG
5401 ACCGACCGGC TCGGGTTCTC CCGGGACTTC GTGGAGGACG ACTTCGCCGG TGTGGTCCGG
5461 GACGACGTGA CCCTGTTCAT CAGCGCGGTC CAGGACCAGG TGGTGCCGGA CAACACCCTG
5521 GCCTGGGTGT GGGTGCGCGG CCTGGACGAG CTGTACGCCG AGTGGTCGGA GGTCGTGTCC
5581 ACGAACTTCC GGGACGCCTC CGGGCCGGCC ATGACCGAGA TCGGCGAGCA GCCGTGGGGG
5641 CGGGAGTTCG CCCTGCGCGA CCCGGCCGGC AACTGCGTGC ACTTCGTGGC CGAGGAGCAG
5701 GACTGACACG TCCGACGGCG GCCCACGGGT CCCAGGCCTC GGAGATCCGT CCCCCTTTTC
5761 CTTTGTCGAT ATCATGTAAT TAGTTATGTC ACGCTTACAT TCACGCCCTC CCCCCACATC
5821 CGCTCTAACC GAAAAGGAAG GAGTTAGACA ACCTGAAGTC TAGGTCCCTA TTTATTTTTT
5881 TATAGTTATG TTAGTATTAA GAACGTTATT TATATTTCAA ATTTTTCTTT TTTTTCTGTA
5941 CAGACGCGAG CTTCCCAGTA AATGTGCCAT CTCGTAGGCA GAAAACGGTT CCCCCGTAGG
6001 GTCTCTCTCT TGGCCTCCTT TCTAGGTCGG GCTGATTGCT CTTGAAGCTC TCTAGGGGGG
6061 CTCACACCAT AGGCAGATAA CGTTCCCCAC CGGCTCGCCT CGTAAGCGCA CAAGGACTGC
6121 TCCCAAAGAT CCTAGGCGGG ATTTTGCCGA TTTCGGCCTA AAGGAACCGG AACACGTAGA
6181 AAGCCAGTCC GCAGAAACGG TGCTGACCCC GGATGAATGT CAGCTACTGG GCTATCTGGA
6241 CAAGGGAAAA CGCAAGCGCA AAGAGAAAGC AGGTAGCTTG CAGTGGGCTT ACATGGCGAT
6301 AGCTAGACTG GGCGGTTTTA TGGACAGCAA GCGAACCGGA ATTGCCAGCT GGGGCGCCCT
6361 CTGGTAAGGT TGGGAAGCCC TGCAAAGTAA ACTGGATGGC TTTCTTGCCG CCAAGGATCT
6421 GATGGCGCAG GGGATCAAGA TCTGATCAAG AGACAGGATG AGGATCGTTT CGCATGATTG
6481 AACAAGATGG ATTGCACGCA GGTTCTCCGG CCGCTTGGGT GGAGAGGCTA TTCGGCTATG
6541 ACTGGGCACA ACAGACAATC GGCTGCTCTG ATGCCGCCGT GTTCCGGCTG TCAGCGCAGG
6601 GGCGCCCGGT TCTTTTTGTC AAGACCGACC TGTCCGGTGC CCTGAATGAA CTGCAGGACG
6661 AGGCAGCGCG GCTATCGTGG CTGGCCACGA CGGGCGTTCC TTGCGCAGCT GTGCTCGACG
6721 TTGTCACTGA AGCGGGAAGG GACTGGCTGC TATTGGGCGA AGTGCCGGGG CAGGATCTCC
6781 TGTCATCTCG CCTTGCTCCT GCCGAGAAAG TATCCATCAT GGCTGATGCA ATGCGGCGGC
6841 TGCATACGCT TGATCCGGCT ACCTGCCCAT TCGACCACCA AGCGAAACAT CGCATCGAGC
6901 GAGCACGTAC TCGGATGGAA GCCGGTCTTG TCGATCAGGA TGATCTGGAC GAAGAGCATC
6961 AGGGGCTCGC GCCAGCCGAA CTGTTCGCCA GGCTCAAGGC GCGCATGCCC GACGGCGAGG
```

Figure 15C

```
7021 ATCTCGTCGT GATCCATGGC GATGCCTGCT TGCCGAATAT CATGGTGGAA AATGGCCGCT
7081 TTTCTGGATT CAACGACTGT GGCCGGCTGG GTGTGGCGGA CCGCTATCAG GACATAGCGT
7141 TGGATACCCG TGATATTGCT GAAGAGCTTG GCGGCGAATG GGCTGACCGC TTCCTCGTGC
7201 TTTACGGTAT CGCCGCTCCC GATTCGCAGC GCATCGCCTT CTATCGCCTT CTTGACGAGT
7261 TCTTCTGAAT TGAAAAAGGT ACCAAGTTTA CTCATATATA CTTTAGATTG ATTTAAAACT
7321 TCATTTTTAA TTTAAAAGGA TCTAGGTGAA GATCCTTTTT GATAATCTCA TGACCAAAAT
7381 CCCTTAACGT GAGTTTTCGT TCCACTGAGC GTCAGACCCC GTAGAAAAGA TCAAAGGATC
7441 TTCTTGAGAT CCTTTTTTTC TGCGCGTAAT CTGCTGCTTG CAAACAAAAA AACCACCGCT
7501 ACCAGCGGTG GTTTGTTTGC CGGATCAAGA GCTACCAACT CTTTTTCCGA AGGTAACTGG
7561 CTTCAGCAGA GCGCAGATAC CAAATACTGT CCTTCTAGTG TAGCCGTAGT TAGGCCACCA
7621 CTTCAAGAAC TCTGTAGCAC CGCCTACATA CCTCGCTCTG CTAATCCTGT TACCAGTGGC
7681 TGCTGCCAGT GGCGATAAGT CGTGTCTTAC CGGGTTGGAC TCAAGACGAT AGTTACCGGA
7741 TAAGGCGCAG CGGTCGGGCT GAACGGGGGG TTCGTGCACA CAGCCCAGCT TGGAGCGAAC
7801 GACCTACACC GAACTGAGAT ACCTACAGCG TGAGCATTGA GAAAGCGCCA CGCTTCCCGA
7861 AGGGAGAAAG GCGGACAGGT ATCCGGTAAG CGGCAGGGTC GGAACAGGAG AGCGCACGAG
7921 GGAGCTTCCA GGGGGAAACG CCTGGTATCT TTATAGTCCT GTCGGGTTTC GCCACCTCTG
7981 ACTTGAGCGT CGATTTTTGT GATGCTCGTC AGGGGGGCGG AGCCTATGGA AAAACGCCAG
8041 CAACGCGGCC TTTTTACGGT TCCTGGCCTT TTGCTGGCCT TTTGCTCACA TGTTCTTTCC
8101 TGCGTTATCC CCTGATTCTG TGGATAACCG TATTACCGCC TTTGAGTGAG CTGATACCGC
8161 TCGCCGCAGC CGAACGACCG AGCGCAGCGA G
```

(SEQ ID NO:7)

Figure 16

```
   1 GAATTCAAAA CAAAATGTGT GCAACCTCCT CCCAGTTTAC TCAGATTACC GAGCATAATT
  61 CTCGACGATC TGCTAACTAC CAGCCGAACC TTTGGAACTT TGAGTTTCTC CAGTCTCTCG
 121 AAAATGACCT GAAGGTGGAA AAGCTCGAGG AGAAGGCGAC CAAACTCGAG GAGGAGGTGC
 181 GATGTATGAT CAACAGAGTT GACACCCAAC CCCTGTCTTT GCTGGAGCTG ATCGACGATG
 241 TGCAGCGGTT GGGTTTGACT TATAAATTCG AGAAGGACAT TATCAAGGCA CTGGAGAACA
 301 TTGTGCTCCT CGACGAGAAC AAGAAGAACA AGTCTGATCT TCACGCTACC GCTCTCTCTT
 361 TCCGACTTCT TCGACAACAC GGCTTCGAGG TGTCGCAGGA CGTCTTCGAG AGATTTAAGG
 421 ACAAGGAGGG AGGATTTAGC GGCGAGCTGA AGGGAGACGT TCAGGGTCTT CTCTCCTTGT
 481 ACGAGGCGTC CTACCTGGGA TTCGAGGGAG AGAACCTCCT GGAGGAAGCT CGTACATTTT
 541 CCATCACTCA CCTTAAGAAT AACCTTAAGG AGGGAATTAA CACCAAGGTG GCCGAGCAGG
 601 TTTCTCACGC CCTGGAGCTC CCCTACCACC AACGGCTCCA TAGACTGGAG GCTCGTTGGT
 661 TCCTGGACAA ATATGAGCCA AAGGAGCCTC ATCATCAGTT GCTGTTGGAG TTGGCCAAGC
 721 TGGACTTCAA TATGGTTCAG ACGCTGCACC AAAAGGAGTT GCAGGACCTG TCTCGATGGT
 781 GGACCGAGAT GGGATTGGCC TCGAAGCTGG ATTTTGTCCG TGACCGACTT ATGGAGGTCT
 841 ATTTTTGGGC CCTTGGAATG GCGCCTGACC CCCAGTTCGG AGAGTGCCGG AAGGCGGTGA
 901 CGAAGATGTT CGGTCTTGTG ACTATCATCG ACGACGTCTA CGATGTCTAC GGCACACTCG
 961 ACGAGTTGCA GCTGTTCACT GACGCCGTCG AGCGATGGGA TGTGAACGCC ATTAATACTC
1021 TCCCTGACTA TATGAAGCTG TGCTTCCTGG CTCTGTACAA CACTGTCAAC GATACCTCGT
1081 ACTCTATCCT CAAGGAGAAG GGACACAACA ATCTCTCCTA CTTGACCAAA TCCTGGCGAG
1141 AACTGTGCAA GGCTTTTCTG CAGGAGGCTA AATGGTCCAA TAACAAGATC ATTCCTGCTT
1201 TTTCTAAATA CCTGGAAAAT GCCTCGGTGT CGAGCTCTGG CGTCGCCCTT CTGGCCCCTT
1261 CCTACTTCTC CGTCTGCCAG CAGCAGGAGG ATATTTCCGA TCATGCTCTT AGATCGCTGA
1321 CCGATTTTCA CGGCCTCGTG CGATCTTCCT GCGTGATTTT TCGGTTGTGT AATGACCTTG
1381 CGACCTCTGC TGCTGAGCTG GAACGAGGCG AGACTACAAA TTCCATTATT TCTTACATGC
1441 ACGAAAACGA TGGAACATCT GAAGAACAGG CTAGAGAGGA ACTGCGAAAG TTGATCGACG
1501 CCGAGTGGAA GAAGATGAAC AGAGAGCGGG TGTCCGACTC TACCCTGCTT CCCAAGGCCT
1561 TCATGGAGAT CGCCGTGAAC ATGGCTCGAG TTTCCCATTG TACTTACCAG TACGGTGACG
1621 GCCTGGGTCG TCCGGACTAC GCTACAGAGA ACCGAATCAA GCTGCTGCTC ATCGACCCCT
1681 TCCCTATCAA CCAATTGATG TACGTGTAAT AGTCTAGAGG ATCC
```

(SEQ ID NO:8)

Figure 17

```
   1 GAATTCAACA AAAATGTGCT CTGTTTCCAC TGAGAACGTG TCCTTTACTG AGACTGAGAC
  61 TGAAGCACGT AGAAGCGCCA ACTACGAACC CAACTCCTGG GATTATGACT TTCTGCTGTC
 121 TTCTGACACC GACGAGTCGA TCGAGGTTTA TAAGGATAAG GCCAAGAAAC TTGAGGCCGA
 181 GGTCAGACGA GAGATTAACA ACGAGAAGGC CGAGTTCCTG ACCCTTCTTG AGCTGATCGA
 241 CAACGTTCAA CGACTTGGTC TTGGTTACCG TTTCGAATCC GATATCCGAC GTGCATTGGA
 301 TCGATTTGTC TCGTCCGGAG GTTTCGATGG TGTGACTAAG ACGTCGCTGC ACGCCACAGC
 361 TCTTTCCTTC AGACTGTTGC GGCAGCATGG ATTTGAGGTT TCCCAGGAAG CCTTTTCTGG
 421 TTTCAAGGAT CAGAACGGAA ACTTTTTGGA GAATCTCAAG GAGGACACCA AGGCCATCCT
 481 GTCGTTGTAT GAGGCCTCGT TCCTGGCTCT TGAGGGCGAG AATATTCTGG ATGAGGCTCG
 541 GGTTTTCGCT ATTTCGCACC TGAAGGAGTT GTCGGAGGAA AAGATCGGAA AGGAACTGGC
 601 CGAGCAGGTC AACCATGCAC TTGAACTTCC CCTGCATCGA CGTACCCAGC GACTGGAGGC
 661 CGTGTGGAGC ATCGAGGCGT ACAGAAAAAA GGAGGATGCT AATCAGGTTC TGCTCGAACT
 721 CGCTATCCTC GACTATAACA TGATTCAGAG CGTGTACCAG CGTGACTTGC GAGAGACAAG
 781 CCGGTGGTGG CGACGGGTGG GACTGGCCAC GAAGCTCCAC TTTGCTAAAG ATCGATTGAT
 841 TGAGTCGTTC TACTGGGCAG TGGGTGTGGC CTTTGAGCCT CAGTACTCCG ACTGCCGAAA
 901 CTCCGTTGCA AAGATGTTTT CTTTTGTCAC TATCATCGAC GACATCTACG ATGTTTACGG
 961 CACTCTCGAT GAACTCGAAC TCTTCACGGA CGCTGTCGAG CGATGGGATG TGAATGCCAT
1021 TAATGATCTG CCAGATTATA TGAAGTTGTG TTTCTTGGCG CTCTACAACA CAATTAATGA
1081 AATTGCCTAC GACAACCTCA AGGACAAGGG AGAGAACATT CTGCCCTACC TTACTAAAGC
1141 CTGGGCCGAC CTGTGTAACG CCTTTTTGCA GGAAGCCAAG TGGCTCTATA ACAAATCTAC
1201 TCCTACATTT GATGACTACT TCGGCAACGC TTGGAAGTCT TCCAGCGGCC CTCTCCAGTT
1261 GATCTTCGCT TACTTTGCAG TGGTCCAGAA CATCAAGAAA GAGGAGATTG AGAACCTCCA
1321 GAAGTATCAC GACATCATCT CCCGACCTTC GCACATCTTT CGACTGTGCA ATGACCTTGC
1381 CTCCGCATCC GCTGAGATTG CCCGAGGAGA AACAGCCAAT TCTGTGTCGT GTTACATGCG
1441 TACAAAGGGC ATCTCCGAGG AGCTGGCTAC CGAGTCTGTG ATGAACCTGA TCGATGAAAC
1501 CTGTAAGAAG ATGAACAAAG AGAAACTGGG CGGTTCTCTG TTCGCCAAAC CATTTGTTGA
1561 AACCGCGATC AATCTGGCTC GTCAGTCTCA TTGTACTTAC CATAACGGTG ACGCGCACAC
1621 TTCGCCGGAC GAATTGACCC GTAAGCGTGT GCTTTCGGTG ATTACCGAGC CGATCCTGCC
1681 GTTCGAAAGA TAATAGGATC C
```

(SEQ ID NO:9)

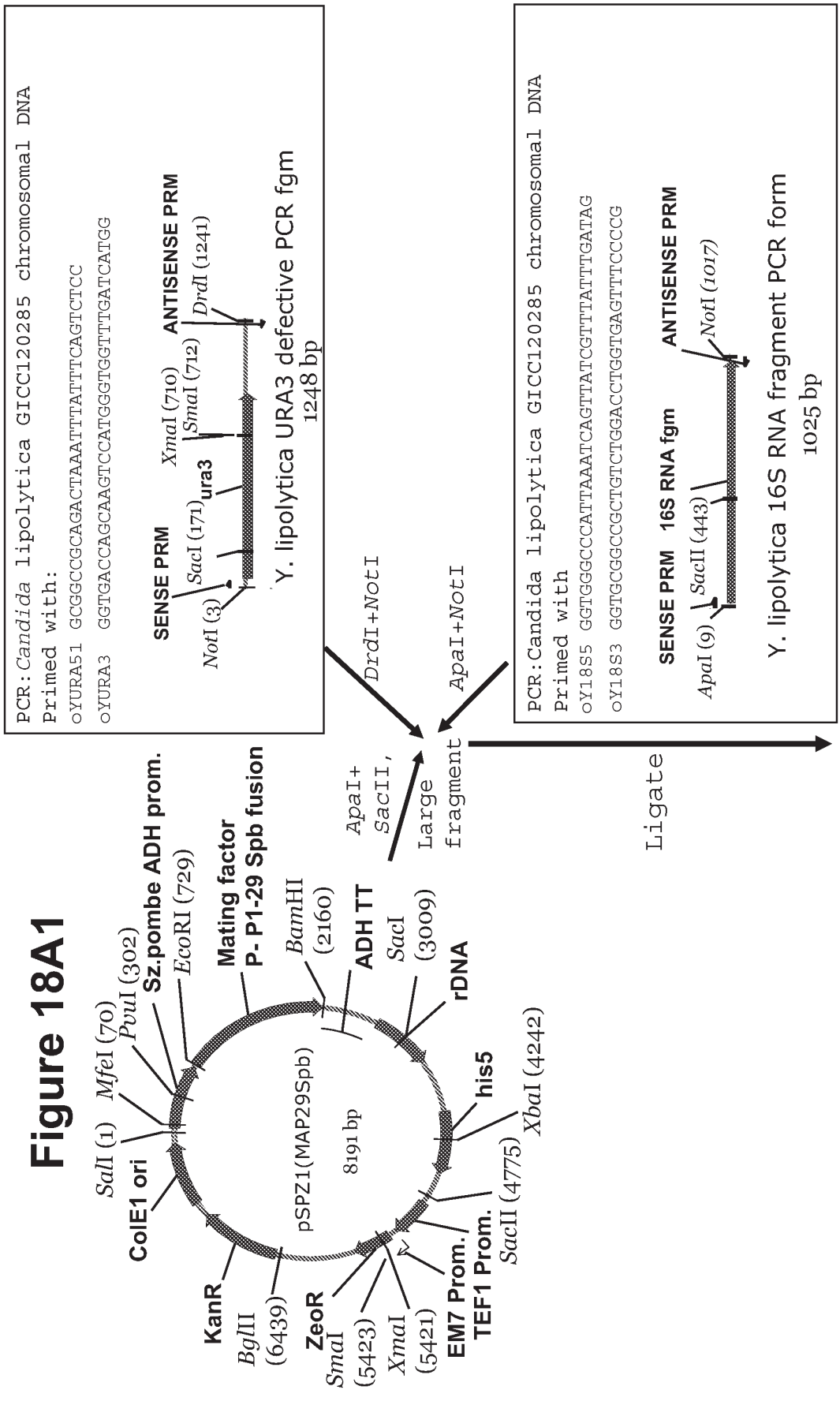
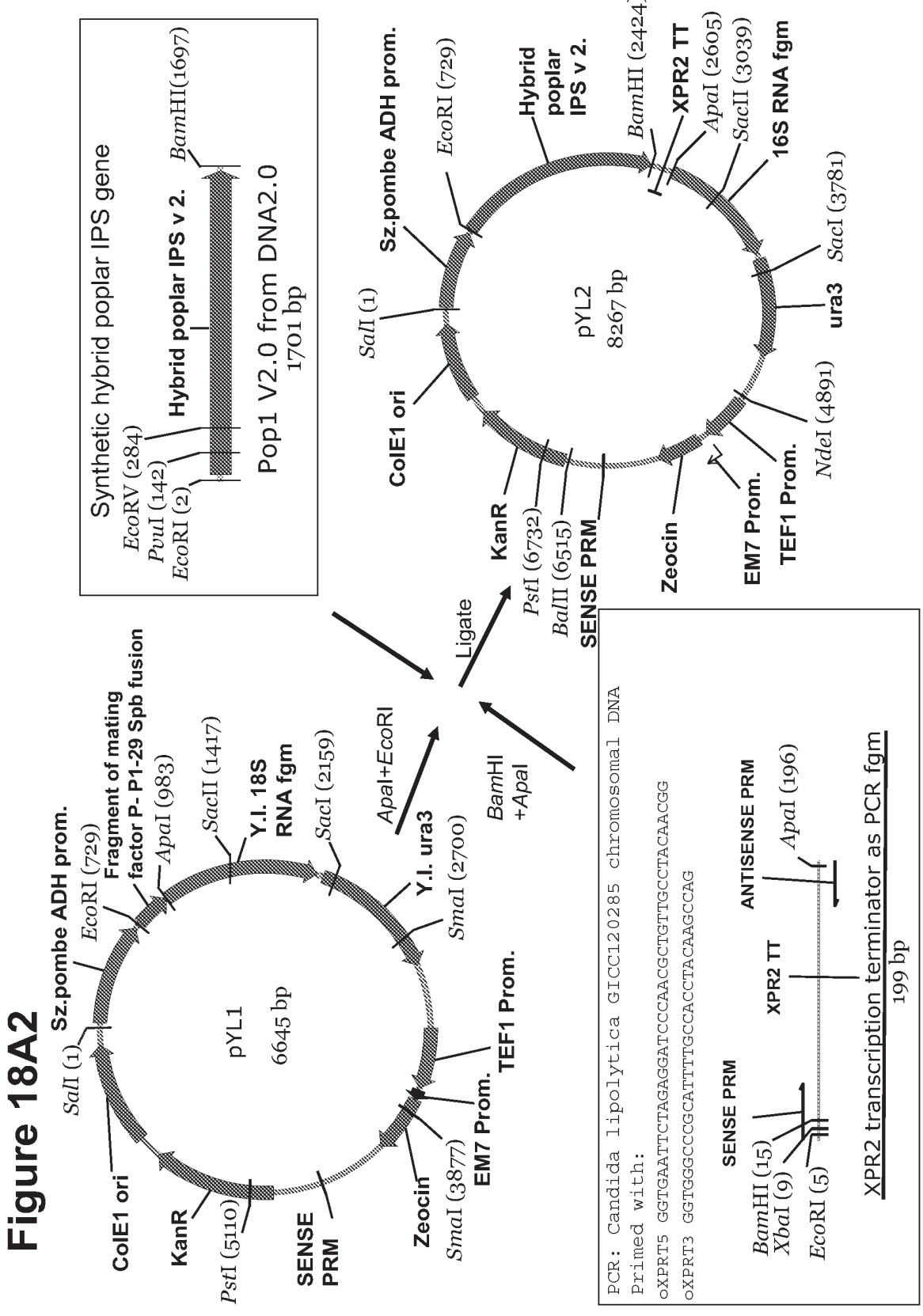

Figure 18A1
pSPZ1(MAP29Spb)
8191 bp
SalI (1)
MfeI (70)
PvuI (302)
Sz.pombe ADH prom.
EcoRI (729)
Mating factor
P- P1-29 Spb fusion
BamHI (2160)
ADH TT
SacI (3009)
rDNA
his5
XbaI (4242)
SacII (4775)
EM7 Prom.
TEF1 Prom.
XmaI (5421)
SmaI (5423)
ZeoR
BglII (6439)
KanR
ColE1 ori
PCR:Candida lipolytica GICC120285 chromosomal DNA
Primed with:
oYURA51 GCGGCCGCAGACTAAATTTATTTCAGTCTCC
oYURA3 GGTGACCAGCAAGTCCATGGGTGGTTTGATCATGG
SENSE PRM
NotI (3)
SacI (171)
ura3
XmaI (710)
SmaI (712)
ANTISENSE PRM
DrdI (1241)
Y. lipolytica URA3 defective PCR fgm
1248 bp
DrdI+NotI
ApaI+NotI
ApaI+
SacII,
Large
fragment
Ligate
PCR:Candida lipolytica GICC120285 chromosomal DNA
Primed with
oY18S5 GGTGGGCCCATTAAATCAGTTATCGTTTATTTGATAG
oY18S3 GGTGCGGCCGCTGTCTGGACCTGGTGAGTTTCCCCG
SENSE PRM 16S RNA fgm
ApaI (9)
SacII (443)
ANTISENSE PRM
NotI (1017)
Y. lipolytica 16S RNA fragment PCR form
1025 bp

Figure 18A2


Sz.pombe ADH prom.
SalI (1)
EcoRI (729)
Fragment of mating factor P- P1-29 Spb fusion
ApaI (983)
SacII (1417)
Y.I. 18S RNA fgm
SacI (2159)
ApaI+EcoRI
Y.I. ura3
SmaI (2700)
BamHI +ApaI
TEF1 Prom.
EM7 Prom.
Zeocin
SmaI (3877)
SENSE PRM
PstI (5110)
KanR
ColE1 ori
pYL1
6645 bp
Synthetic hybrid poplar IPS gene
EcoRV (284)
PvuI (142)
EcoRI (2)
Hybrid poplar IPS v 2.
BamHII(1697)
Pop1 V2.0 from DNA2.0
1701 bp
Ligate
Sz.pombe ADH prom.
EcoRI (729)
Hybrid poplar IPS v 2.
BamHI (2424)
XPR2 TT
ApaI (2605)
SacII (3039)
16S RNA fgm
SacI (3781)
ura3
NdeI (4891)
TEF1 Prom.
EM7 Prom.
Zeocin
SENSE PRM
BalII (6515)
PstI (6732)
KanR
ColE1 ori
SalI (1)
pYL2
8267 bp
PCR: Candida lipolytica GICC120285 chromosomal DNA
Primed with:
oXPRT5 GGTGAATTCTAGAGGATCCCAACGCTGTTGCCTACAACGG
oXPRT3 GGTGGGCCCGCATTTTGCCACCTACAAGCCAG
SENSE PRM
ANTISENSE PRM
BamHI (15)
XbaI (9)
EcoRI (5)
XPR2 TT
ApaI (196)
XPR2 transcription terminator as PCR fgm
199 bp

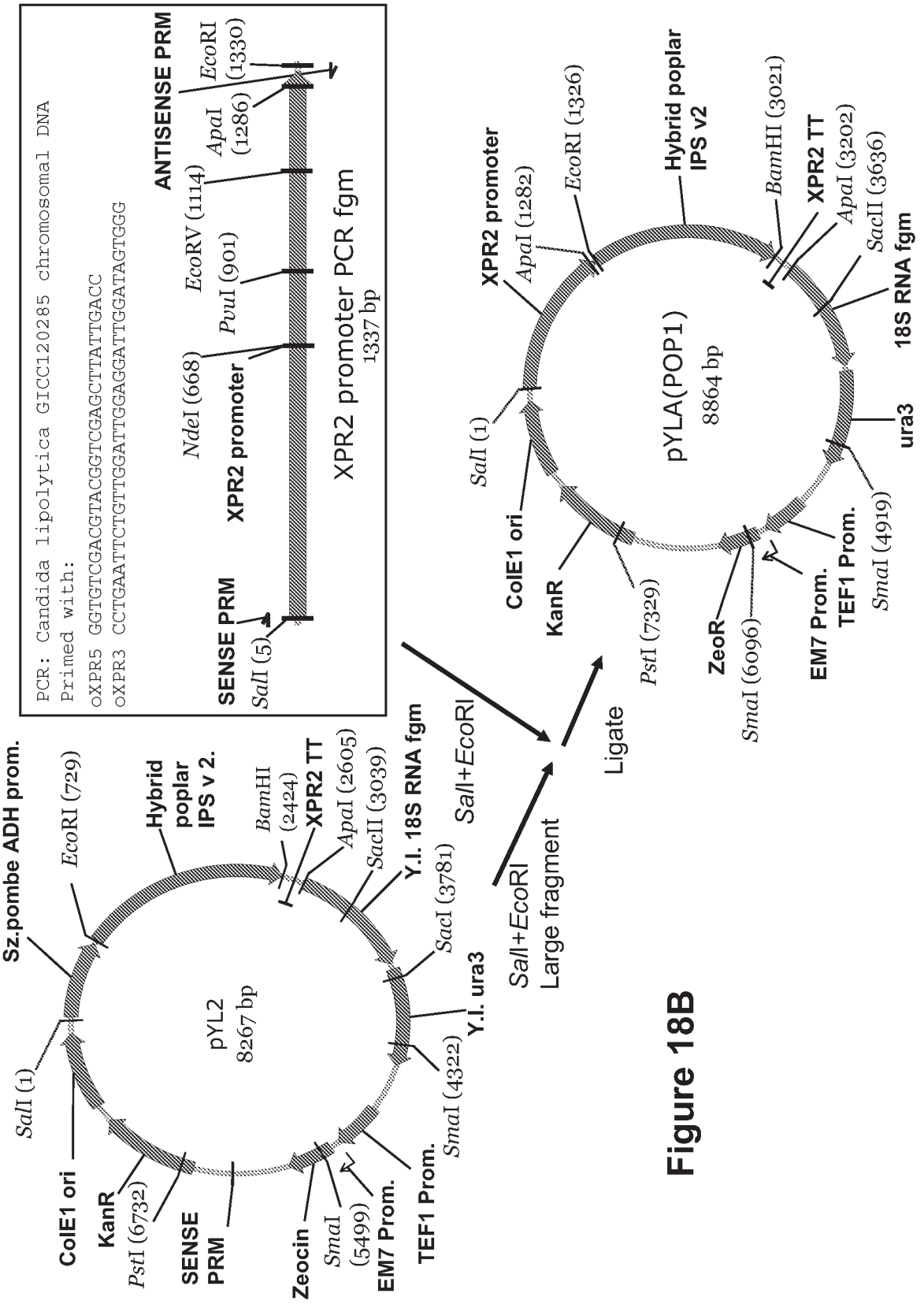

PCR: Candida lipolytica GICC120285 chromosomal DNA
Primed with:
oXPR5 GGTGTCGACGTACGGTCGAGCTTATTGACC
oXPR3 CCTGAATTCTGTTGGATTGGAGGATTGGATAGTGGG
ANTISENSE PRM
EcoRI (1330)
ApaI (1286)
EcoRV (1114)
PvuI (901)
NdeI (668)
XPR2 promoter
SENSE PRM
SalI (5)
XPR2 promoter PCR fgm
1337 bp
Sz.pombe ADH prom.
EcoRI (729)
Hybrid poplar IPS v 2.
BamHI (2424)
XPR2 TT
ApaI (2605)
SacII (3039)
Y.l. 18S RNA fgm
SacI (3781)
Y.l. ura3
SmaI (4322)
TEF1 Prom.
EM7 Prom.
SmaI (5499)
Zeocin
SENSE PRM
KanR
PstI (6732)
ColE1 ori
SalI (1)
pYL2
8267 bp
SalI+EcoRI
Large fragment
Ligate
SalI+EcoRI
XPR2 promoter
ApaI (1282)
EcoRI (1326)
Hybrid poplar IPS v2
BamHI (3021)
XPR2 TT
ApaI (3202)
SacII (3636)
18S RNA fgm
ura3
SmaI (4919)
TEF1 Prom.
EM7 Prom.
SmaI (6096)
ZeoR
PstI (7329)
KanR
ColE1 ori
SalI (1)
pYLA(POP1)
8864 bp

Figure 18B

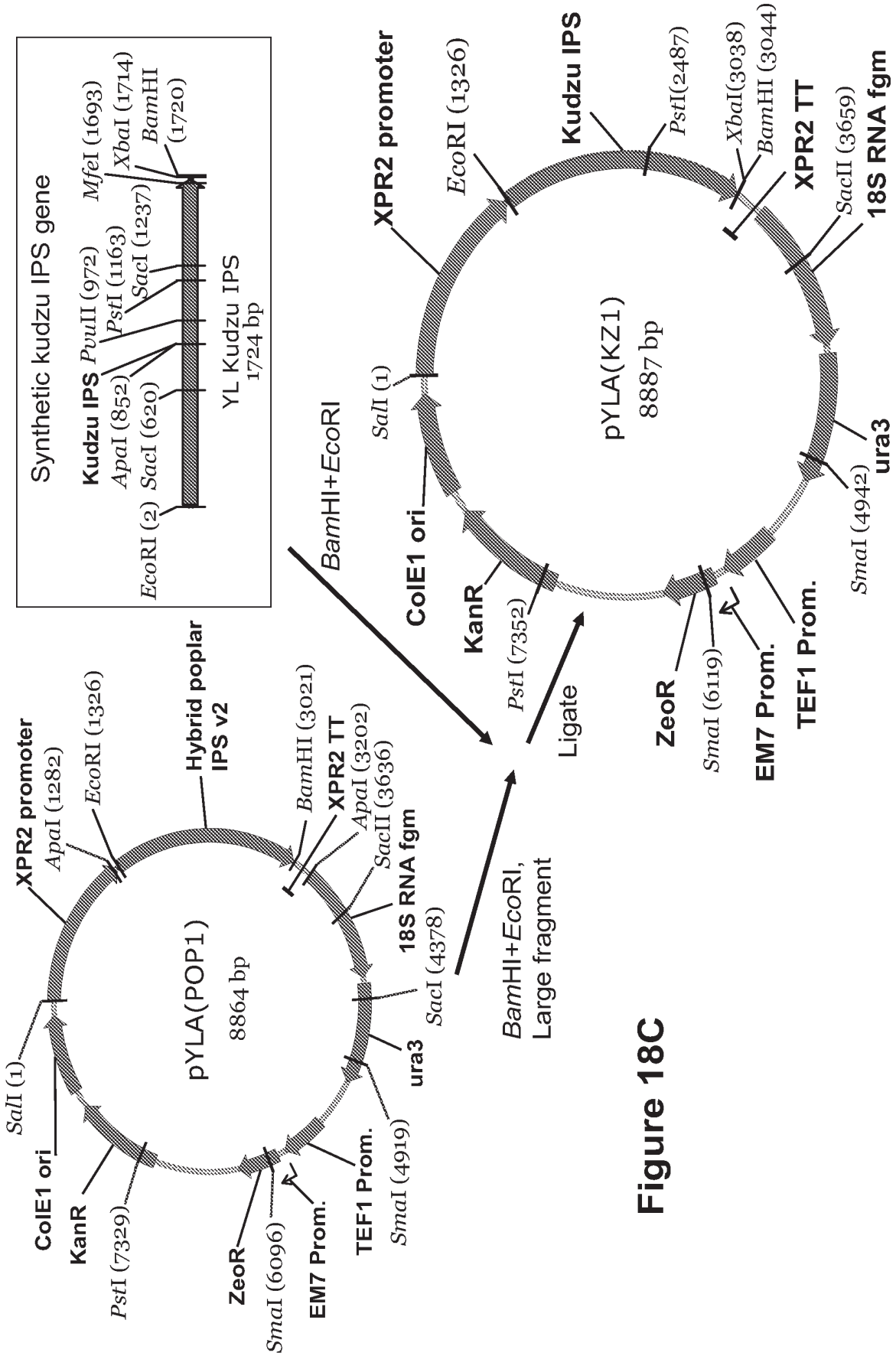
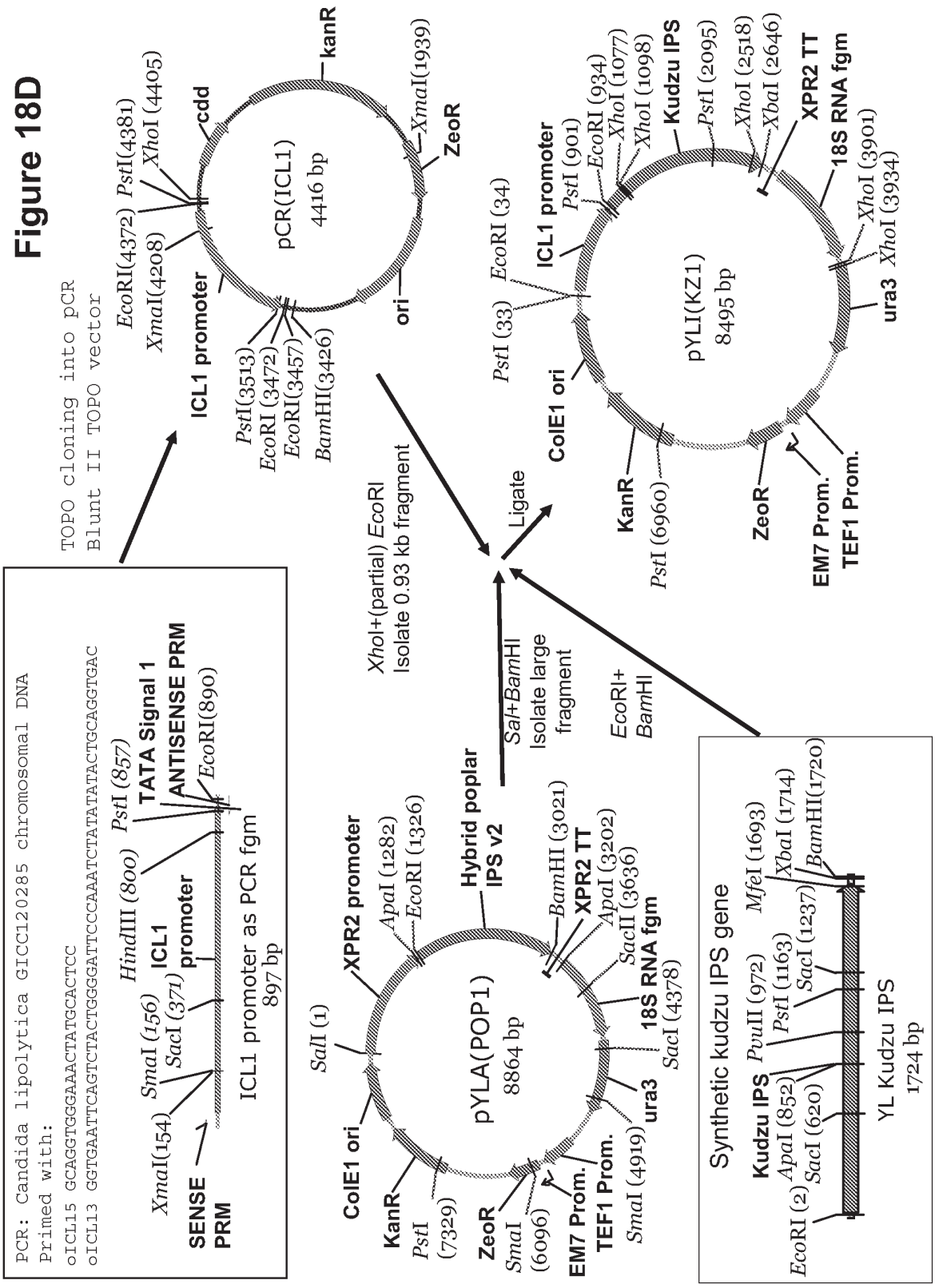
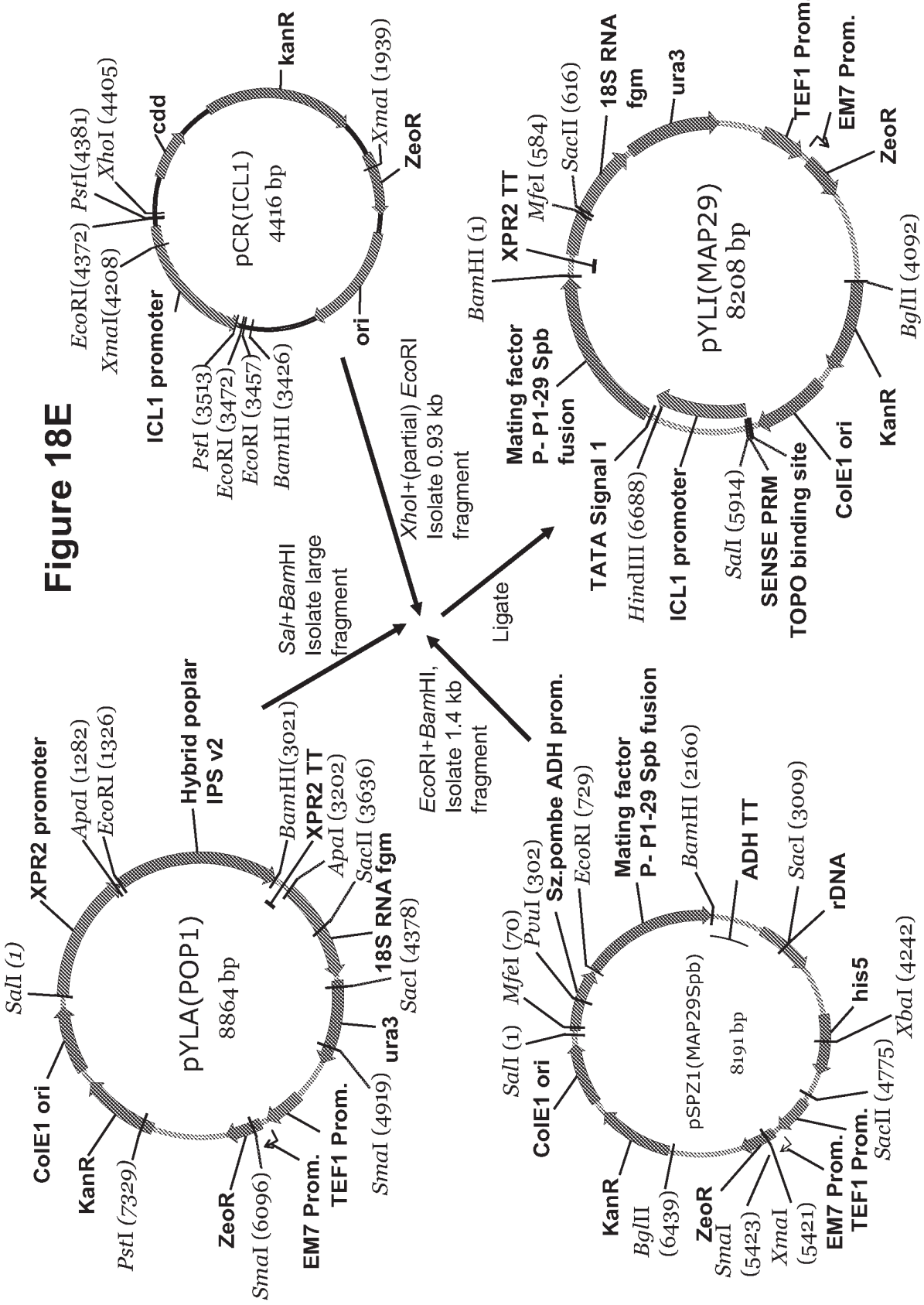

Synthetic kudzu IPS gene
Kudzu IPS
ApaI (852)
SacI (620)
EcoRI (2)
PvuII (972)
PstI (1163)
SacI (1237)
MfeI (1693)
XbaI (1714)
BamHI (1720)
YL Kudzu IPS
1724 bp
pYLA(POP1)
8864 bp
SalI (1)
XPR2 promoter
ApaI (1282)
EcoRI (1326)
Hybrid poplar IPS v2
BamHI (3021)
XPR2 TT
ApaI (3202)
SacII (3636)
18S RNA fgm
SacI (4378)
ura3
SmaI (4919)
TEF1 Prom.
EM7 Prom.
ZeoR
SmaI (6096)
PstI (7329)
ColE1 ori
KanR
BamHI+EcoRI
BamHI+EcoRI, Large fragment
Ligate
pYLA(KZ1)
8887 bp
SalI (1)
XPR2 promoter
EcoRI (1326)
Kudzu IPS
PstI(2487)
XbaI(3038)
BamHI (3044)
XPR2 TT
SacII (3659)
18S RNA fgm
ura3
SmaI (4942)
TEF1 Prom.
EM7 Prom.
SmaI (6119)
ZeoR
PstI (7352)
KanR
ColE1 ori

Figure 18C


Figure 18D
PCR: Candida lipolytica GICC120285 chromosomal DNA
Primed with:
oICL15 GCAGGTGGGAAACTATGCACTCC
oICL13 GGTGAATTCAGTCTACTGGGGATTCCCAAATCTATATATACTGCAGGTGAC
XmaI(154)
SmaI (156)
SacI (371)
HindIII (800)
PstI (857)
EcoRI(890)
SENSE PRM
ICL1 promoter
TATA Signal 1
ANTISENSE PRM
ICL1 promoter as PCR fgm
897 bp
TOPO cloning into pCR
Blunt II TOPO vector
EcoRI(4372)
XmaI(4208)
PstI(4381)
XhoI (4405)
cdd
ICL1 promoter
pCR(ICL1)
4416 bp
PstI(3513)
EcoRI (3472)
EcoRI(3457)
BamHII(3426)
kanR
ori
XmaI(1939)
ZeoR
XhoI+(partial) EcoRI
Isolate 0.93 kb fragment
Ligate
PstI (33)
EcoRI (34)
ICL1 promoter
PstI (901)
EcoRI (934)
XhoI (1077)
XhoI (1098)
Kudzu IPS
PstI (2095)
XhoI (2518)
XbaI (2646)
XPR2 TT
18S RNA fgm
XhoI (3901)
XhoI (3934)
ura3
ColE1 ori
pYLI(KZ1)
8495 bp
KanR
PstI (6960)
ZeoR
EM7 Prom.
TEF1 Prom.
SalI (1)
XPR2 promoter
ApaI (1282)
EcoRI (1326)
Hybrid poplar
IPS v2
BamHI (3021)
XPR2 TT
ApaI (3202)
SacII (3636)
18S RNA fgm
SacI (4378)
ura3
SmaI (4919)
TEF1 Prom.
EM7 Prom.
ZeoR
SmaI (6096)
PstI (7329)
KanR
ColE1 ori
pYLA(POP1)
8864 bp
Sal+BamHI
Isolate large fragment
EcoRI+ BamHI
Synthetic kudzu IPS gene
Kudzu IPS
EcoRI (2)
ApaI (852)
SacI (620)
PvuII (972)
PstI (1163)
SacI (1237)
MfeI (1693)
XbaI (1714)
BamHI(1720)
YL Kudzu IPS
1724 bp


Figure 18E
pCR(ICL1)
4416 bp
ICL1 promoter
cdd
kanR
ZeoR
ori
EcoRI(4372)
PstI(4381)
XhoI (4405)
XmaI(4208)
PstI (3513)
EcoRI (3472)
EcoRI (3457)
BamHI (3426)
XmaI (1939)
Sal+BamHI
Isolate large
fragment
XhoI+(partial) EcoRI
Isolate 0.93 kb
fragment
EcoRI+BamHI,
Isolate 1.4 kb
fragment
Ligate
pYLA(POP1)
8864 bp
ColE1 ori
KanR
ZeoR
EM7 Prom.
TEF1 Prom.
XPR2 promoter
Hybrid poplar
IPS v2
BamHII(3021)
XPR2 TT
18S RNA fgm
ura3
SalI (1)
PstI (7329)
SmaI (6096)
ApaI (1282)
EcoRI (1326)
SmaI (4919)
ApaI (3202)
SacII (3636)
SacI (4378)
pSPZ1(MAP29Spb)
8191 bp
ColE1 ori
KanR
ZeoR
EM7 Prom.
TEF1 Prom.
his5
rDNA
Sz.pombe ADH prom.
Mating factor
P- P1-29 Spb fusion
ADH TT
SalI (1)
MfeI (70)
PvuI (302)
EcoRI (729)
BamHI (2160)
SacI (3009)
BglII (6439)
SmaI (5423)
XmaI (5421)
SacII (4775)
XbaI (4242)
pYLI(MAP29)
8208 bp
Mating factor
P- P1-29 Spb
fusion
TATA Signal 1
ICL1 promoter
SENSE PRM
TOPO binding site
ColE1 ori
KanR
ZeoR
TEF1 Prom.
EM7 Prom.
18S RNA
fgm
ura3
BamHI (1)
XPR2 TT
MfeI (584)
SacII (616)
HindIII (6688)
SalI (5914)
BglII (4092)

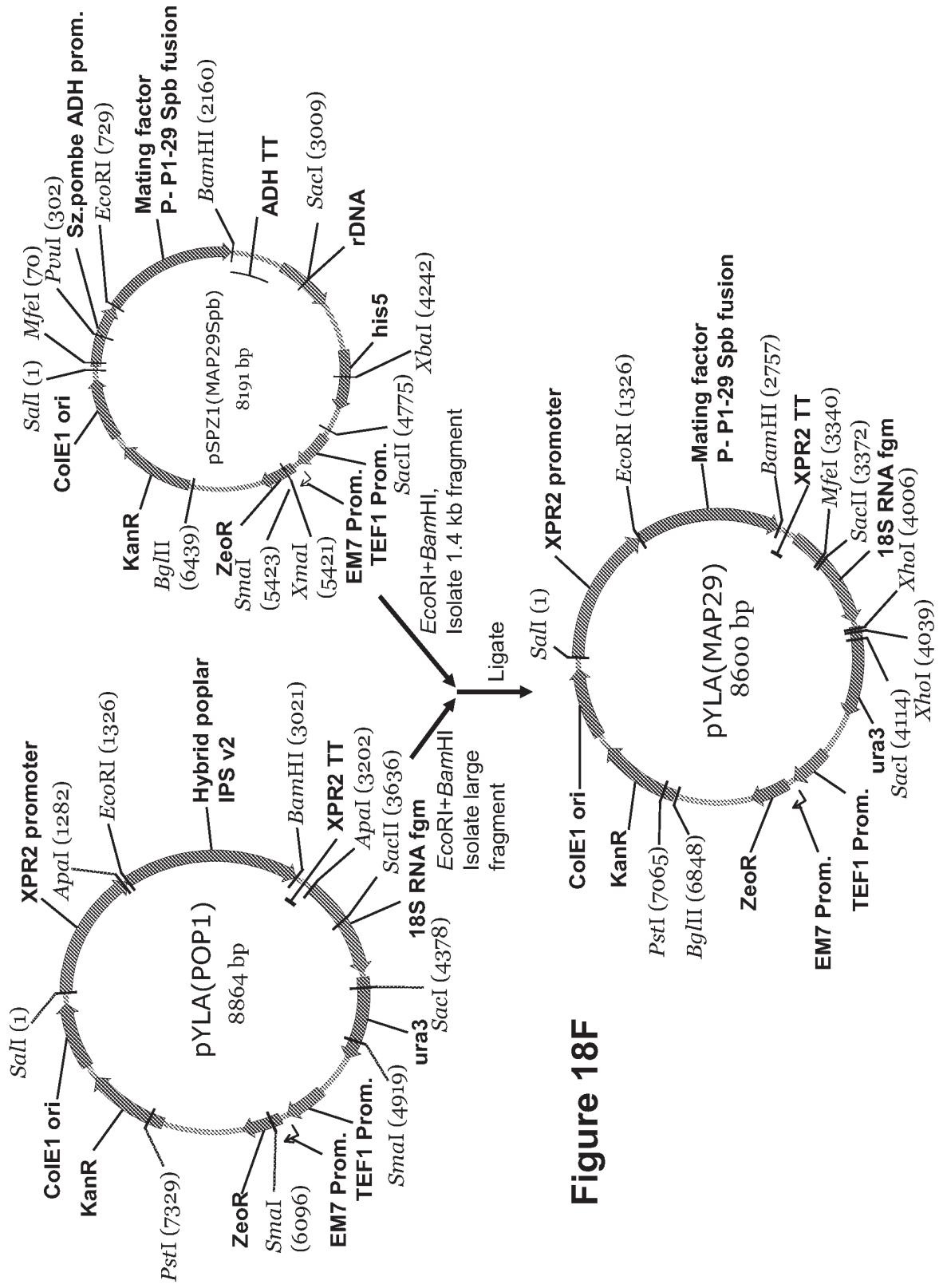

pYLA(POP1)
8864 bp
SalI (1)
ColE1 ori
KanR
PstI (7329)
ZeoR
SmaI (6096)
EM7 Prom.
TEF1 Prom.
SmaI (4919)
ura3
SacI (4378)
18S RNA fgm
EcoRI+BamHI
Isolate large fragment
SacII (3636)
ApaI (3202)
XPR2 TT
BamHI (3021)
Hybrid poplar IPS v2
EcoRI (1326)
ApaI (1282)
XPR2 promoter
EcoRI+BamHI,
Isolate 1.4 kb fragment
Ligate
pSPZ1(MAP29Spb)
8191 bp
SalI (1)
ColE1 ori
KanR
BglII (6439)
ZeoR
SmaI (5423)
XmaI (5421)
EM7 Prom.
TEF1 Prom.
SacII (4775)
XbaI (4242)
his5
rDNA
SacI (3009)
ADH TT
BamHI (2160)
Mating factor
P- P1-29 Spb fusion
EcoRI (729)
Sz.pombe ADH prom.
PvuI (302)
MfeI (70)
pYLA(MAP29)
8600 bp
SalI (1)
XPR2 promoter
EcoRI (1326)
Mating factor
P- P1-29 Spb fusion
BamHI (2757)
XPR2 TT
MfeI (3340)
SacII (3372)
18S RNA fgm
XhoI (4006)
XhoI (4039)
SacI (4114)
ura3
TEF1 Prom.
EM7 Prom.
ZeoR
BglII (6848)
PstI (7065)
KanR
ColE1 ori

Figure 18F

Figure 19A

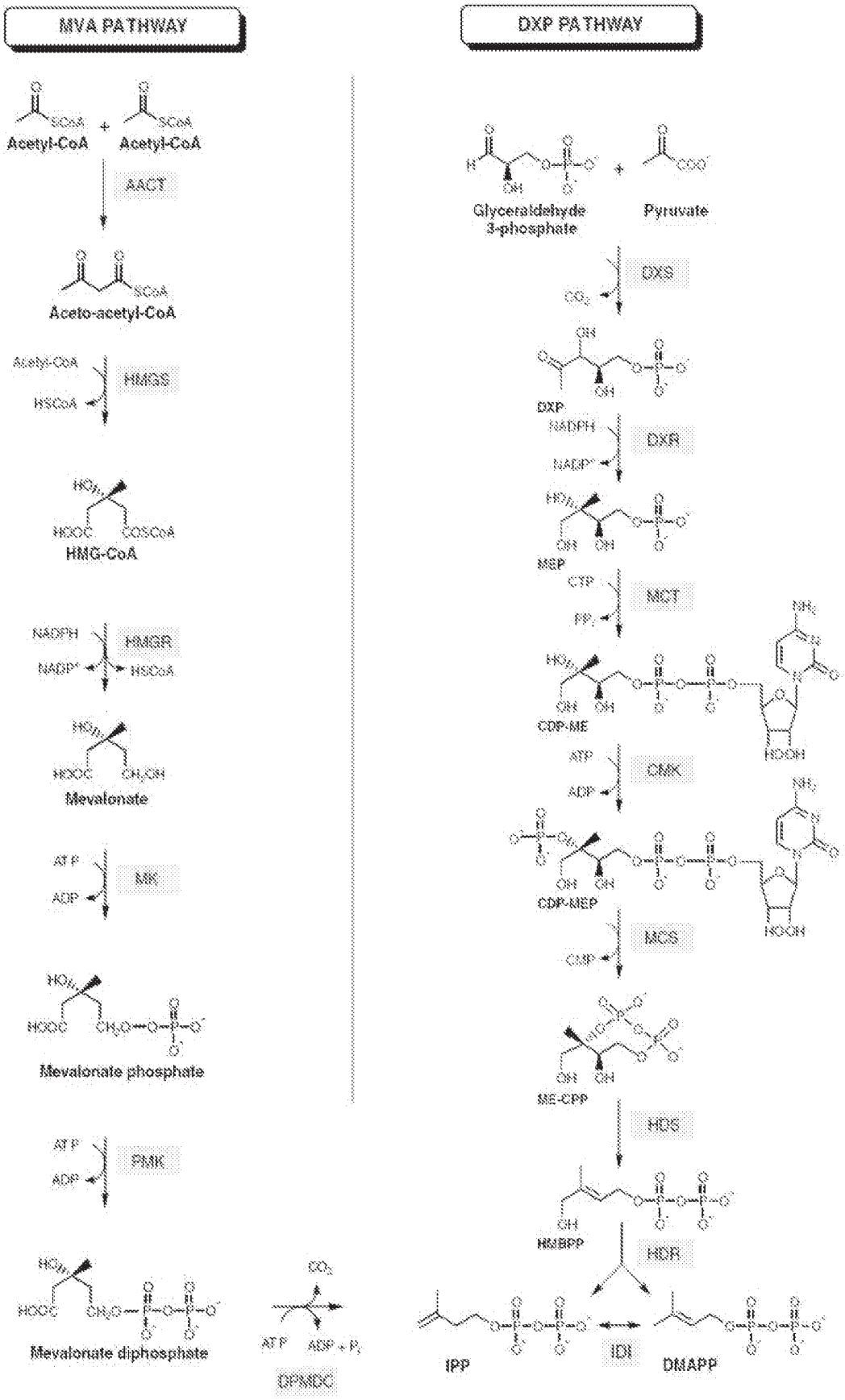

MVA PATHWAY
DXP PATHWAY
Acetyl-CoA
Acetyl-CoA
AACT
Aceto-acetyl-CoA
HMGS
HMG-CoA
HMGR
Mevalonate
MK
Mevalonate phosphate
PMK
Mevalonate diphosphate
MVD
Glyceraldehyde 3-phosphate
Pyruvate
DXS
DXP
DXR
MEP
MCT
CDP-ME
CMK
CDP-MEP
MCS
ME-CPP
HDS
HMBPP
HDR
IPP
IDI
DMAPP

Figure 19B

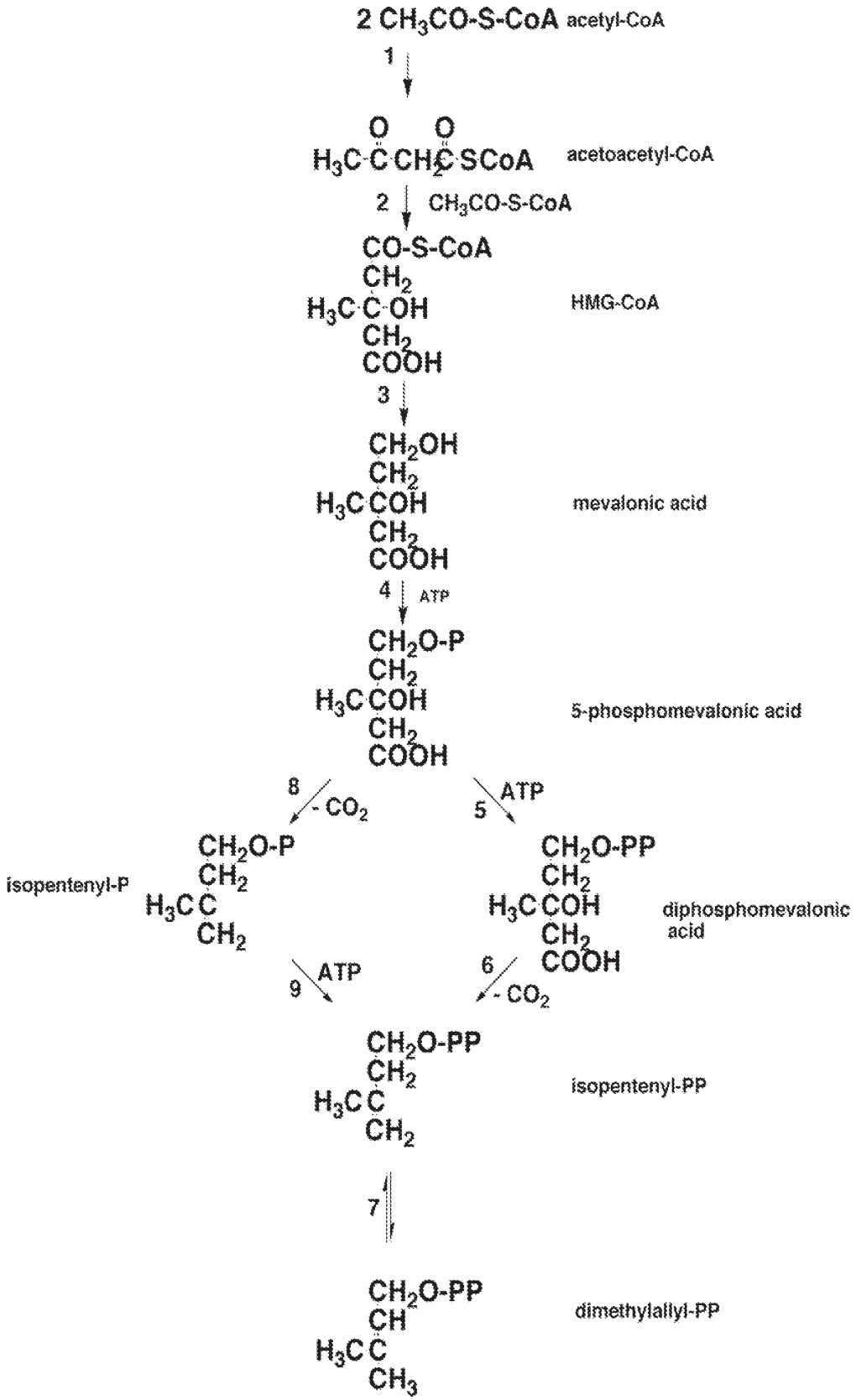

2 CH3CO-S-CoA
acetyl-CoA
1
acetoacetyl-CoA
2
CH3CO-S-CoA
HMG-CoA
3
mevalonic acid
4
ATP
5-phosphomevalonic acid
8
- CO2
ATP
5
isopentenyl-P
diphosphomevalonic acid
ATP
9
6
- CO2
isopentenyl-PP
7
dimethylallyl-PP

Figure 20A

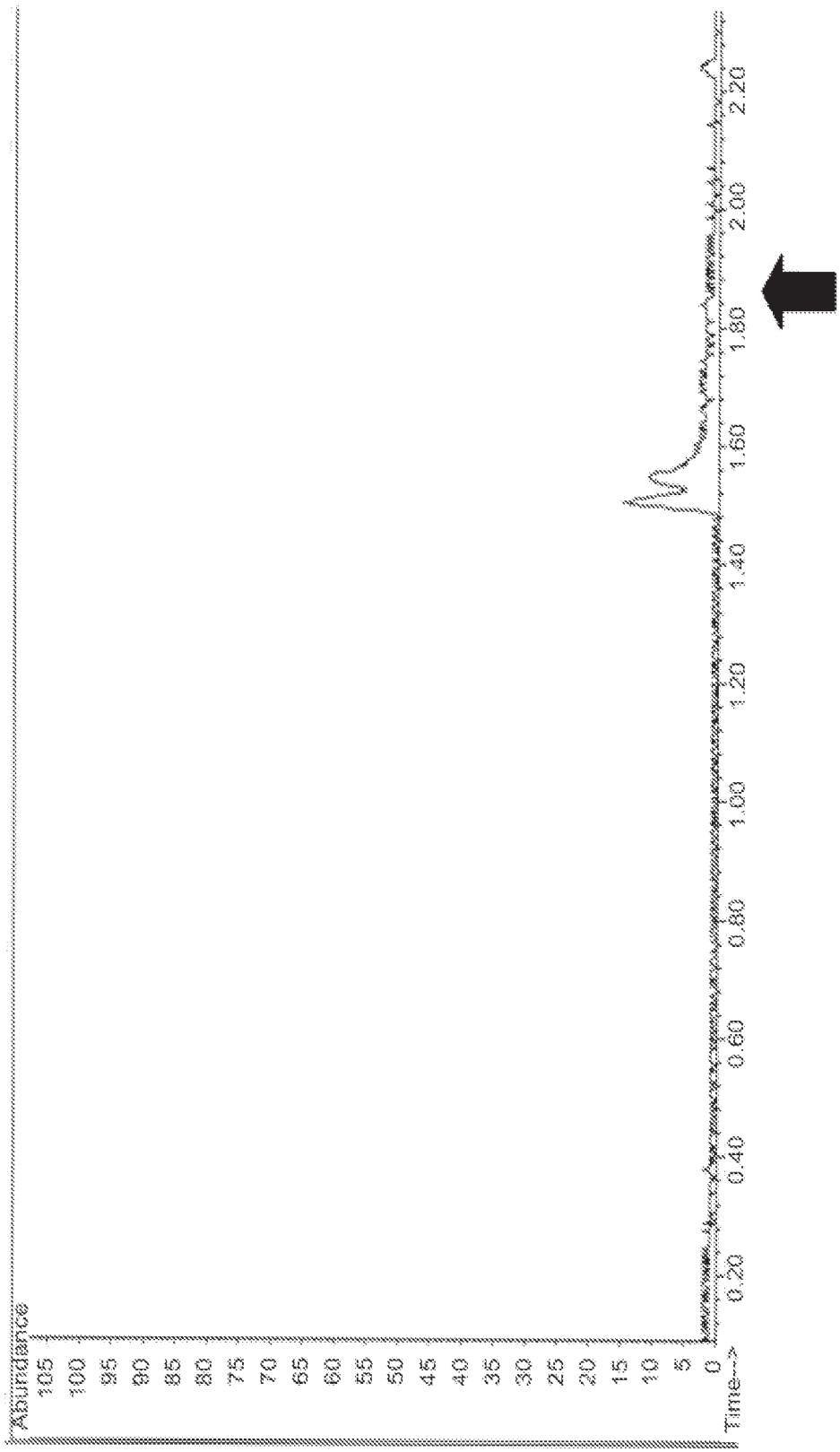

Y. lipolytica CLIB122:: pYLA(MAP29)
Abundance
Time-->
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
2.20

Figure 20B

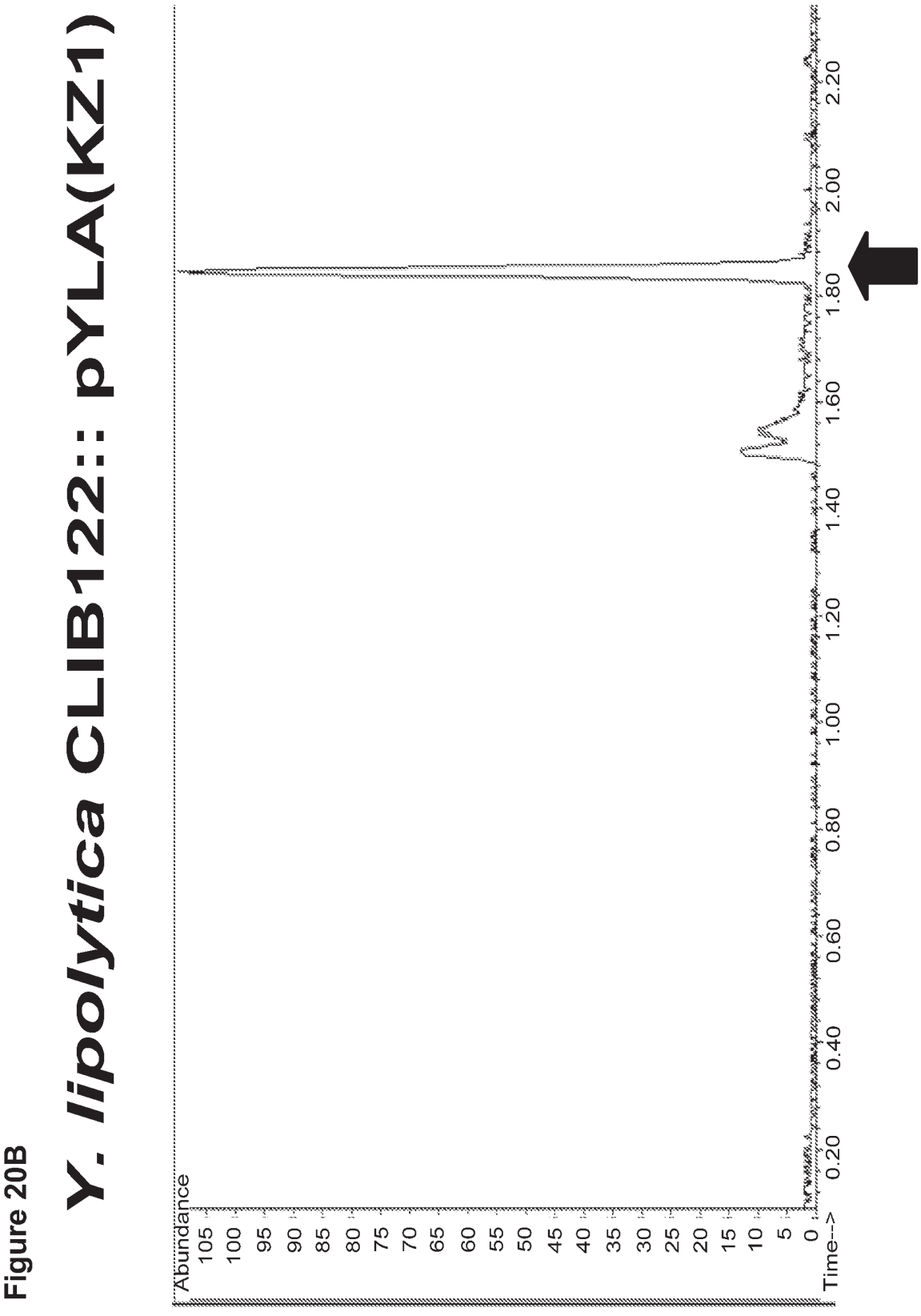

Y. lipolytica CLIB122:: pYLA(KZ1)
Abundance
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
Time-->
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
2.20

Figure 21

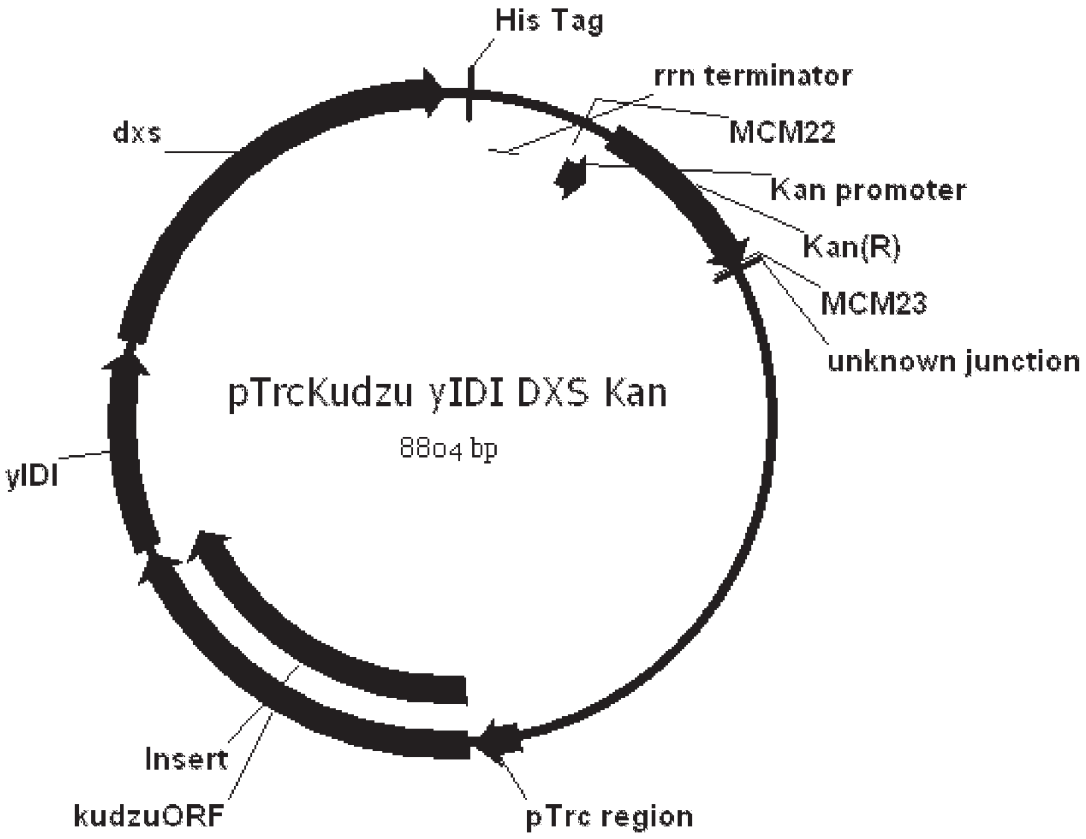

His Tag
rrn terminator
MCM22
dxs
Kan promoter
Kan(R)
MCM23
unknown junction
pTrcKudzu yIDI DXS Kan
8804 bp
yIDI
Insert
kudzuORF
pTrc region

Figure 22A

1-

gctggtaccatatgggaattcgaagctttctagaacaaaaactcatctcagaagaggatctgaatagcgccgtc
gaccatcatcatcatcattgagtttaaacggtctccagcttggctgttttggcggatgagagaagattttcagcc
tgatacagattaaatcagaacgcagaagcggtctgataaaacagaatttgcctggcggcagtagcgcggtggt
cccacctgaccccatgccgaactcagaagtgaaacgccgtagcgccgatggtagtgtggggtctccccatgcg
agagtagggaactgccaggcatcaaataaaacgaaaggctcagtcgaaagactgggcctttcgttttatctgtt
gtttgtcggtgaacgctctcctgagtaggacaaatccgccgggagcggatttgaacgttgcgaagcaacggcc
cggagggtggcgggcaggacgcccgccataaactgccaggcatcaaattaagcagaaggccatcctgacg
gatggccttttgcgtttctacaaactcttttgtttatttttctaaatacattcaaatatgtatccgcttaaccggaattgcc
agctggggcgccctctggtaaggttgggaagccctgcaaagtaaactggatggctttctcgccgccaaggatct
gatggcgcaggggatcaagctctgatcaagagacaggatgaggatcgtttcgcatgattgaacaagatggatt
gcacgcaggttctccggccgcttgggtggagaggctattcggctatgactgggcacaacagacaatcggctgct
ctgatgccgccgtgttccggctgtcagcgcaggggcgcccggttctttttgtcaagaccgacctgtccggtgccct
gaatgaactgcaagacgaggcagcgcggctatcgtggctggccacgacgggcgttccttgcgcagctgtgctc
gacgttgtcactgaagcgggaagggactggctgctattgggcgaagtgccggggcaggatctcctgtcatctca
ccttgctcctgccgagaaagtatccatcatggctgatgcaatgcggcggctgcatacgcttgatccggctacctg
cccattcgaccaccaagcgaaacatcgcatcgagcgagcacgtactcggatggaagccggtcttgtcgatca
ggatgatctggacgaagagcatcaggggctcgcgccagccgaactgttcgccaggctcaaggcgagcatgc
ccgacggcgaggatctcgtcgtgacccatggcgatgcctgcttgccgaatatcatggtggaaaatggccgctttt
ctggattcatcgactgtggccggctgggtgtggcggaccgctatcaggacatagcgttggctacccgtgatattg
ctgaagagcttggcggcgaatgggctgaccgcttcctcgtgctttacggtatcgccgctcccgattcgcagcgca
tcgccttctatcgccttcttgacgagttcttctgacatgaccaaaatcccttaacgtgagttttcgttccactgagcgtc
agaccccgtagaaaagatcaaaggatcttcttgagatccttttttttctgcgcgtaatctgctgcttgcaaacaaaaa
aaccaccgctaccagcggtggtttgtttgccggatcaagagctaccaactctttttccgaaggtaactggcttcag
cagagcgcagataccaaatactgtccttctagtgtagccgtagttaggccaccacttcaagaactctgtagcacc
gcctacatacctcgctctgctaatcctgttaccagtggctgctgccagtggcgataagtcgtgtcttaccgggttgg
actcaagacgatagttaccggataaggcgcagcggtcgggctgaacgggggttcgtgcacacagcccagct
tggagcgaacgacctacaccgaactgagatacctacagcgtgagctatgagaaagcgccacgcttcccgaa
gggagaaaggcggacaggtatccggtaagcggcagggtcggaacaggagagcgcacgagggagcttcca
gggggaaacgcctggtatctttatagtcctgtcgggtttcgccacctctgacttgagcgtcgatttttgtgatgctcgt
caggggggcggagcctatggaaaaacgccagcaacgcggccttttacggttcctggccttttgctggccttttgc
tcacatgttctttcctgcgttatcccctgattctgtggataaccgtattaccgcctttgagtgagctgataccgctcgcc
gcagccgaacgaccgagcgcagcgagtcagtgagcgaggaagcggaagagcgcctgatgcggtattttctc
cttacgcatctgtgcggtatttcacaccgcatatggtgcactctcagtacaatctgctctgatgccgcatagttaagc
cagtatacactccgctatcgctacgtgactgggtcatggctgcgccccgacacccgccaacacccgctgacgc
gccctgacgggcttgtctgctcccggcatccgcttacagacaagctgtgaccgtctccgggagctgcatgtgtca
gaggttttcaccgtcatcaccgaaacgcgcgaggcagcagatcaattcgcgcgcgaaggcgaagcggcatg
catttacgttgacaccatcgaatggtgcaaaacctttcgcggtatggcatgatagcgcccggaaga

Figure 22B

gagtcaattcagggtggtgaatgtgaaaccagtaacgttatacgatgtcgcagagtatgccggtgtctcttatc
agaccgtttcccgcgtggtgaaccaggccagccacgtttctgcgaaaacgcgggaaaaagtggaagcgg
cgatggcggagctgaattacattcccaaccgcgtggcacaacaactggcgggcaaacagtcgttgctgatt
ggcgttgccacctccagtctggccctgcacgcgccgtcgcaaattgtcgcggcgattaaatctcgcgccgat
caactgggtgccagcgtggtggtgtcgatggtagaacgaagcggcgtcgaagcctgtaaagcggcggtgc
acaatcttctcgcgcaacgcgtcagtgggctgatcattaactatccgctggatgaccaggatgccattgctgtg
gaagctgcctgcactaatgttccggcgttatttcttgatgtctctgaccagacacccatcaacagtattattttctc
ccatgaagacggtacgcgactgggcgtggagcatctggtcgcattgggtcaccagcaaatcgcgctgttag
cgggcccattaagttctgtctcggcgcgtctgcgtctggctggctggcataaatatctcactcgcaatcaaattc
agccgatagcggaacgggaaggcgactggagtgccatgtccggttttcaacaaaccatgcaaatgctgaa
tgagggcatcgttcccactgcgatgctggttgccaacgatcagatggcgctgggcgcaatgcgcgccattac
cgagtccgggctgcgcgttggtgcggatatctcggtagtgggatacgacgataccgaagacagctcatgtta
tatcccgccgtcaaccaccatcaaacaggattttcgcctgctggggcaaaccagcgtggaccgcttgctgca
actctctcagggccaggcggtgaagggcaatcagctgttgcccgtctcactggtgaaaagaaaaaccacc
ctggcgcccaatacgcaaaccgcctctccccgcgcgttggccgattcattaatgcagctggcacgacaggtt
tcccgactggaaagcgggcagtgagcgcaacgcaattaatgtgagttagcgcgaattgatctggtttgacag
cttatcatcgactgcacggtgcaccaatgcttctggcgtcaggcagccatcggaagctgtggtatggctgtgc
aggtcgtaaatcactgcataattcgtgtcgctcaaggcgcactcccgttctggataatgtttttttgcgccgacatc
ataacggttctggcaaatattctgaaatgagctgttgacaattaatcatccggctcgtataatgtgtggaattgtg
agcggataacaatttcacacaggaaacagcgccgctgagaaaaagcgaagcggcactgctctttaacaat
ttatcagacaatctgtgtgggcactcgaccggaattatcgattaactttattattaaaaattaaagaggtatatatt
aatgtatcgattaaataaggaggaataaaccatgtgtgcgacctcttctcaatttactcagattaccgagcata
attcccgtcgttccgcaaactatcagccaaacctgtggaatttcgaattcctgcaatccctggagaacgacctg
aaagtggaaaagctggaggagaaagcgaccaaactggaggaagaagttcgctgcatgatcaaccgtgt
agacacccagccgctgtccctgctggagctgatcgacgatgtgcagcgcctgggtctgacctacaaatttga
aaaagacatcattaaagccctggaaaacatcgtactgctggacgaaaacaaaaagaacaaatctgacct
gcacgcaaccgctctgtctttccgtctgctgcgtcagcacggtttcgaggtttctcaggatgtttttgagcgtttca
aggataaagaaggtggtttcagcggtgaactgaaaggtgacgtccaaggcctgctgagcctgtatgaagcg
tcttacctgggtttcgagggtgagaacctgctggaggaggcgcgtacctttccatcacccacctgaagaaca
acctgaaagaaggcattaataccaaggttgcagaacaagtgagccacgccctggaactgccatatcacca
gcgtctgcaccgtctggaggcacgttggttcctggataaatacgaaccgaaagaaccgcatcaccagctgc
tgctggagctggcgaagctggatttaacatggtacagaccctgcaccagaaagagctgcaagatctgtccc
gctggtggaccgagatgggcctggctagcaaactggattttgtacgcgaccgcctgatggaagtttatttctgg
gcactgggtatggcgccagacccgcagtttggtgaatgtcgcaaagctgttactaaaatgtttggtctggtgac
gatcatcgatgacgtgtatgacgtttatggcactctggacgaactgcaactgttcaccgatgctgtagagcgct
gggacgttaacgctattaacaccctgccggactatatgaaactgtgtttcctggcactgtacaacaccgttaac
gacacgtcctattctattctgaaagagaaaggtcataacaacctgtcctatctgacgaaaagctggcgtgaa
ctgtgcaaagcctttctgcaagaggcgaaatggtccaacaacaaaattatcccggctttctccaagtacctgg
aaaacgccagcgtttcctcctccggtgtagcgctgctggcgccgtcttacttttccgta

Figure 22C

tgccagcagcaggaagacatctccgaccacgcgctgcgttccctgaccgacttccatggtctggtgcgttctag
ctgcgttatcttccgcctgtgcaacgatctggccacctctgcggcggagctggaacgtggcgagactaccaatt
ctatcattagctacatgcacgaaaacgatggtaccagcgaggaacaggcccgcgaagaactgcgtaaactg
atcgacgccgaatggaaaaagatgaatcgtgaacgcgttagcgactccaccctgctgcctaaagcgttcatg
gaaatcgcagttaacatggcacgtgtttcccactgcacctaccagtatggcgatggtctgggtcgcccagacta
cgcgactgaaaaccgcatcaaactgctgctgattgacccttttcccgattaaccagctgatgtatgtctaactgca
tcgcccttaggaggtaaaaaaaaatgactgccgacaacaatagtatgccccatggtgcagtatctagttacgc
caaattagtgcaaaaccaaacacctgaagacattttggaagagtttcctgaaattattccattacaacaaagac
ctaatacccgatctagtgagacgtcaaatgacgaaagcggagaaacatgtttttctggtcatgatgaggagca
aattaagttaatgaatgaaaattgtattgttttggattgggacgataatgctattggtgccggtaccaagaaagttt
gtcatttaatggaaaatattgaaaagggtttactacatcgtgcattctccgtctttattttcaatgaacaaggtgaatt
acttttacaacaaagagccactgaaaaaataactttccctgatctttggactaacacatgctgctctcatccacta
tgtattgatgacgaattaggtttgaagggtaagctagacgataagattaagggcgctattactgcggcggtgag
aaaactagatcatgaattaggtattccagaagatgaaactaagacaaggggtaagtttcacttttaaacagaa
tccattacatggcaccaagcaatgaaccatggggtgaacatgaaattgattacatcctattttataagatcaacg
ctaaagaaaacttgactgtcaacccaaacgtcaatgaagttagagacttcaaatgggtttcaccaaatgatttg
aaaactatgtttgctgacccaagttacaagtttacgccttggtttaagattatttgcgagaattacttattcaactggt
gggagcaattagatgacctttctgaagtggaaaatgacaggcaaattcatagaatgctataacaacgcgtcct
gcattcgcccttaggaggtaaaaaaacatgagttttgatattgccaaatacccgaccctggcactggtcgactc
cacccaggagttacgactgttgccgaaagagagtttaccgaaactctgcgacgaactgcgccgctatttactc
gacagcgtgagccgttccagcgggcacttcgcctccgggctgggcacggtcgaactgaccgtggcgctgca
ctatgtctacaacaccccgtttgaccaattgatttgggatgtggggcatcaggcttatccgcataaaattttgacc
ggacgccgcgacaaaatcggcaccatccgtcagaaaggcggtctgcacccgttcccgtggcgcggcgaaa
gcgaatatgacgtattaagcgtcgggcattcatcaacctccatcagtgccggaattggtattgcggttgctgccg
aaaaagaaggcaaaaatcgccgcaccgtctgtgtcattggcgatggcgcgattaccgcaggcatggcgtttg
aagcgatgaatcacgcgggcgatatccgtcctgatatgctggtgattctcaacgacaatgaaatgtcgatttcc
gaaaatgtcggcgcgctcaacaaccatctggcacagctgctttccggtaagctttactcttcactgcgcgaagg
cgggaaaaaagttttctctggcgtgccgccaattaaagagctgctcaaacgcaccgaagaacatattaaagg
catggtagtgcctggcacgttgtttgaagagctgggctttaactacatcggcccggtggacggtcacgatgtgct
ggggcttatcaccacgctaaagaacatgcgcgacctgaaaggcccgcagttcctgcatatcatgaccaaaa
aaggtcgtggttatgaaccggcagaaaaagacccgatcactttccacgccgtgcctaaatttgatccctccag
cggttgtttgccgaaaagtagcggcggtttgccgagctattcaaaaatctttggcgactggttgtgcgaaacggc
agcgaaagacaacaagctgatggcgattactccggcgatgcgtgaaggttccggcatggtcgagttttcacgt
aaattcccggatcgctacttcgacgtggcaattgccgagcaacacgcggtgacctttgctgcgggtctggcgat
tggtgggtacaaacccattgtcgcgatttactccactttcctgcaacgcgcctatgatcaggtgctgcatgacgtg
gcgattcaaaagcttccggtcctgttcgccatcgaccgcgcgggcattgttggtgctgacggtcaaacccatca
gggtgcttttgatctctcttacctgcgctgcataccggaaatggtcattatgaccccgagcgatgaaaacgaatg
tcgccagatgctctataccggctatcactataacgatggcccgtcagcggtgcgctacccgcgtggcaacgcg
gtcgg

Figure 22D

cgtggaactgacgccgctggaaaaactaccaattggcaaaggcattgtgaagcgtcgtggcgagaaactgg
cgatccttaactttggtacgctgatgccagaagcggcgaaagtcgccgaatcgctgaacgccacgctggtcg
atatgcgttttgtgaaaccgcttgatgaagcgttaattctggaaatggccgccagccatgaagcgctggtcacc
gtagaagaaaacgccattatgggcggcgcaggcagcggcgtgaacgaagtgctgatggcccatcgtaaac
cagtacccgtgctgaacattggcctgccggacttctttattccgcaaggaactcaggaagaaatgcgcgccga
actcggcctcgatgccgctggtatggaagccaaaatcaaggcctggctggcataactgca

(SEQ ID NO:10)

Figure 23A

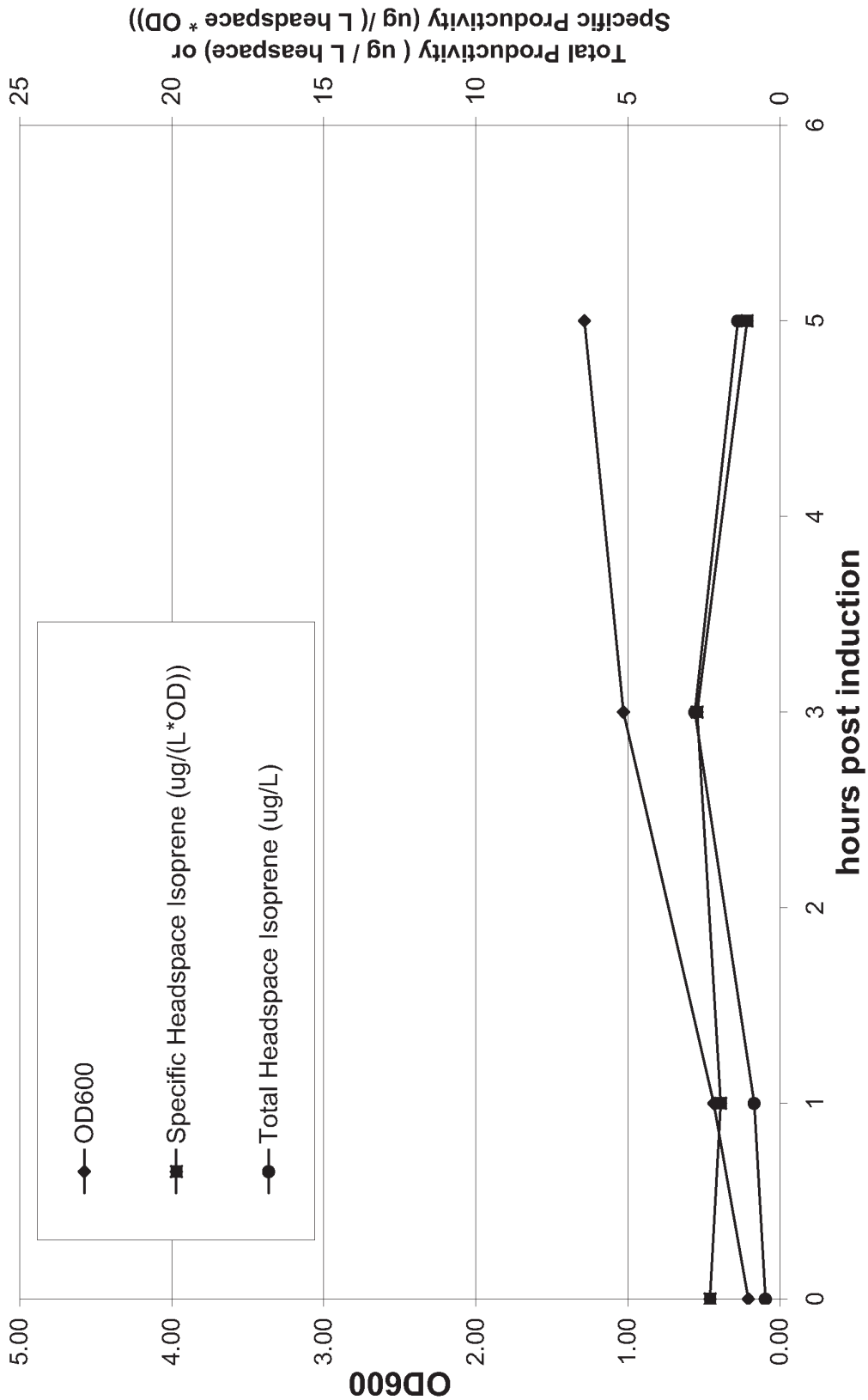

pTrcKudzu kan
OD600
Total Productivity (ug / L headspace) or Specific Productivity (ug /(L headspace * OD))
hours post induction
OD600
Specific Headspace Isoprene (ug/(L*OD))
Total Headspace Isoprene (ug/L)
0.00
1.00
2.00
3.00
4.00
5.00
0
5
10
15
20
25
0
1
2
3
4
5
6

Figure 23B

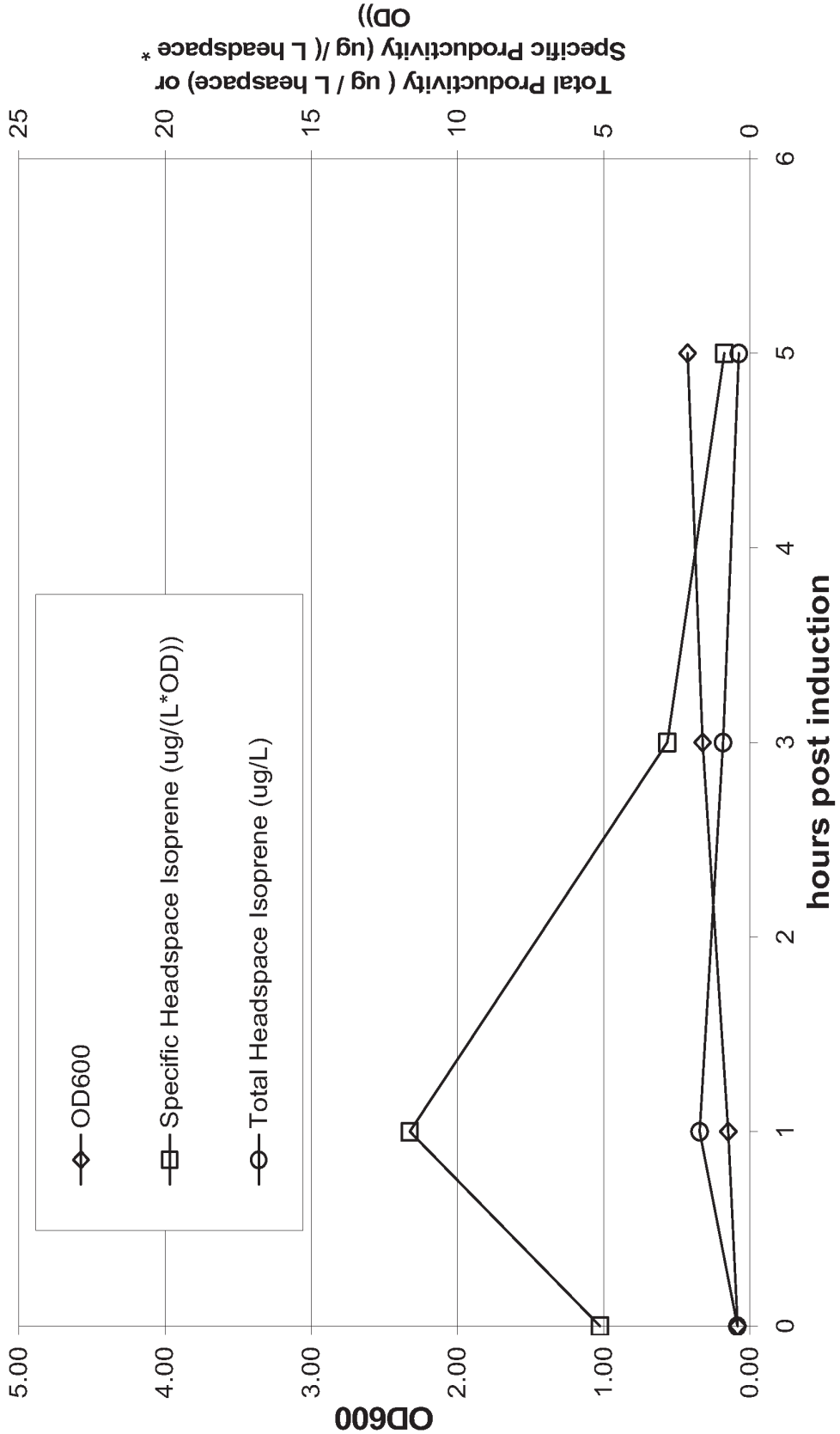

pTrcKudzu yIDI kan
OD600
Total Productivity (ug / L headspace) or Specific Productivity (ug /(L headspace * OD))
hours post induction
OD600
Specific Headspace Isoprene (ug/(L*OD))
Total Headspace Isoprene (ug/L)
0.00
1.00
2.00
3.00
4.00
5.00
0
5
10
15
20
25
0
1
2
3
4
5
6

Figure 23C

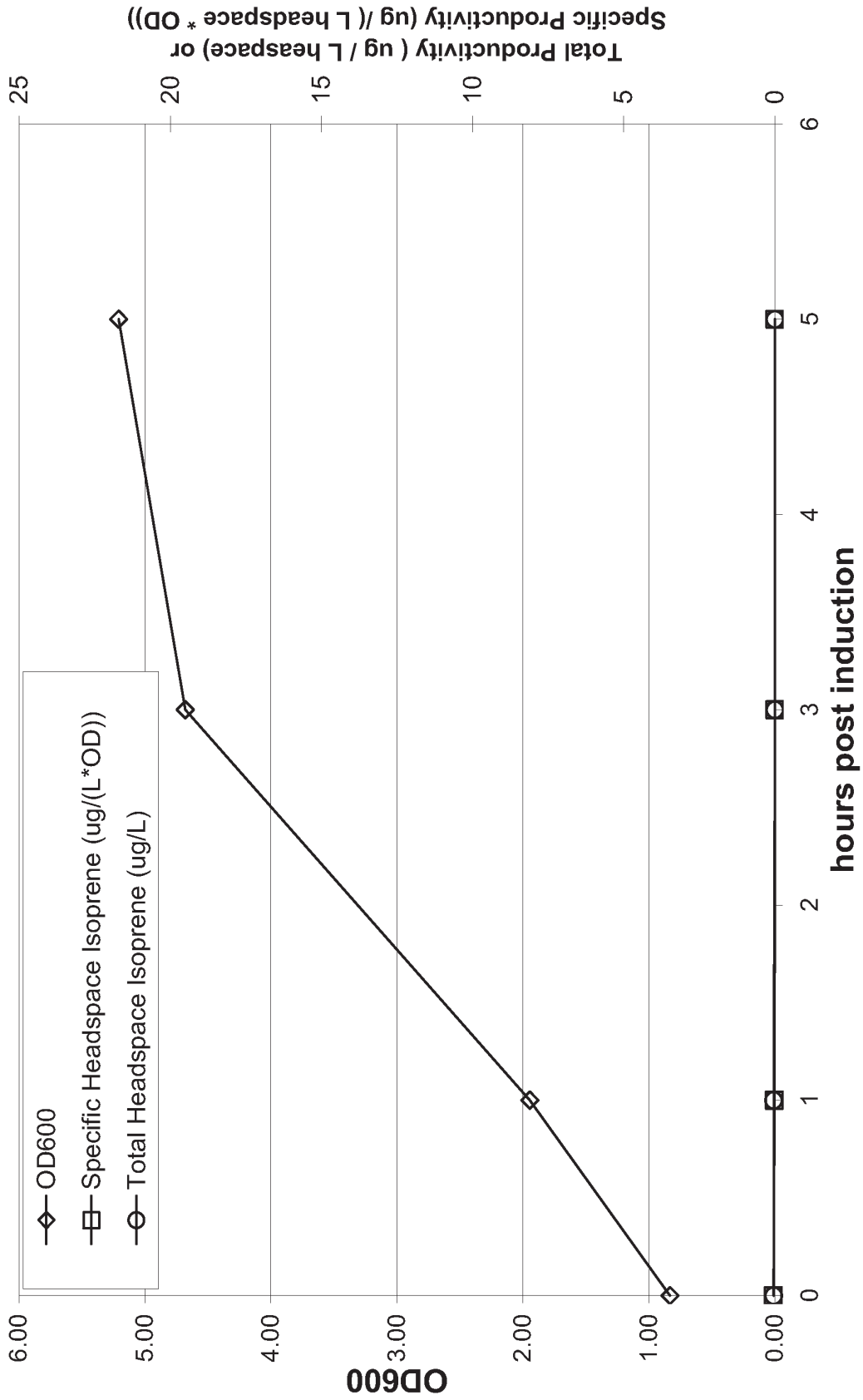

pTrcKudzu DXS kan
OD600
Total Productivity (ug / L headspace) or
Specific Productivity (ug /(L headspace * OD))
hours post induction
OD600
Specific Headspace Isoprene (ug/(L*OD))
Total Headspace Isoprene (ug/L)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
25
20
15
10
5
0
0
1
2
3
4
5
6

Figure 23D

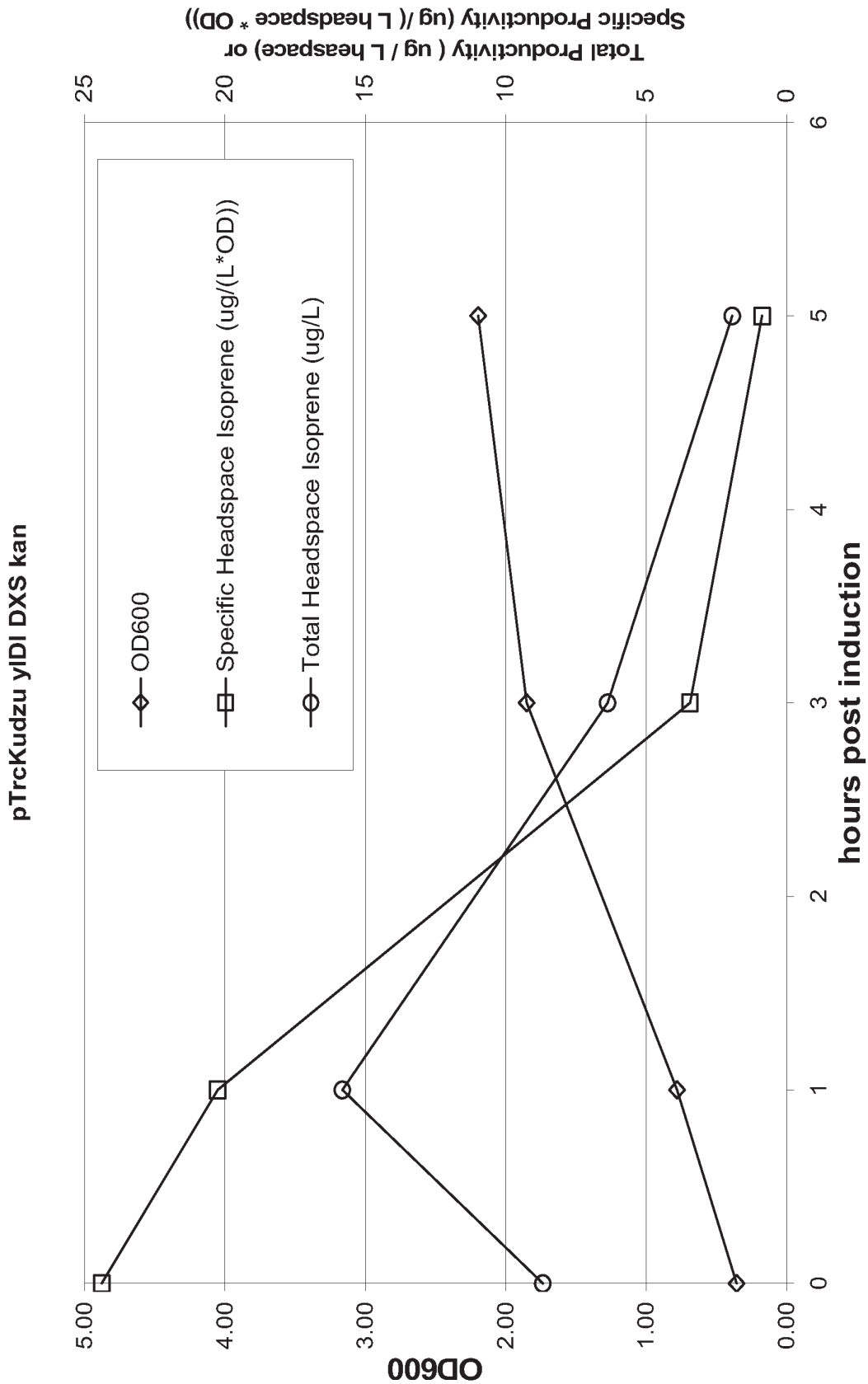

pTrcKudzu yIDI DXS kan
OD600
Specific Headspace Isoprene (ug/(L*OD))
Total Headspace Isoprene (ug/L)
OD600
Total Productivity (ug / L headspace) or
Specific Productivity (ug /(L headspace * OD))
hours post induction
5.00
4.00
3.00
2.00
1.00
0.00
25
20
15
10
5
0
0
1
2
3
4
5
6

Figure 23E

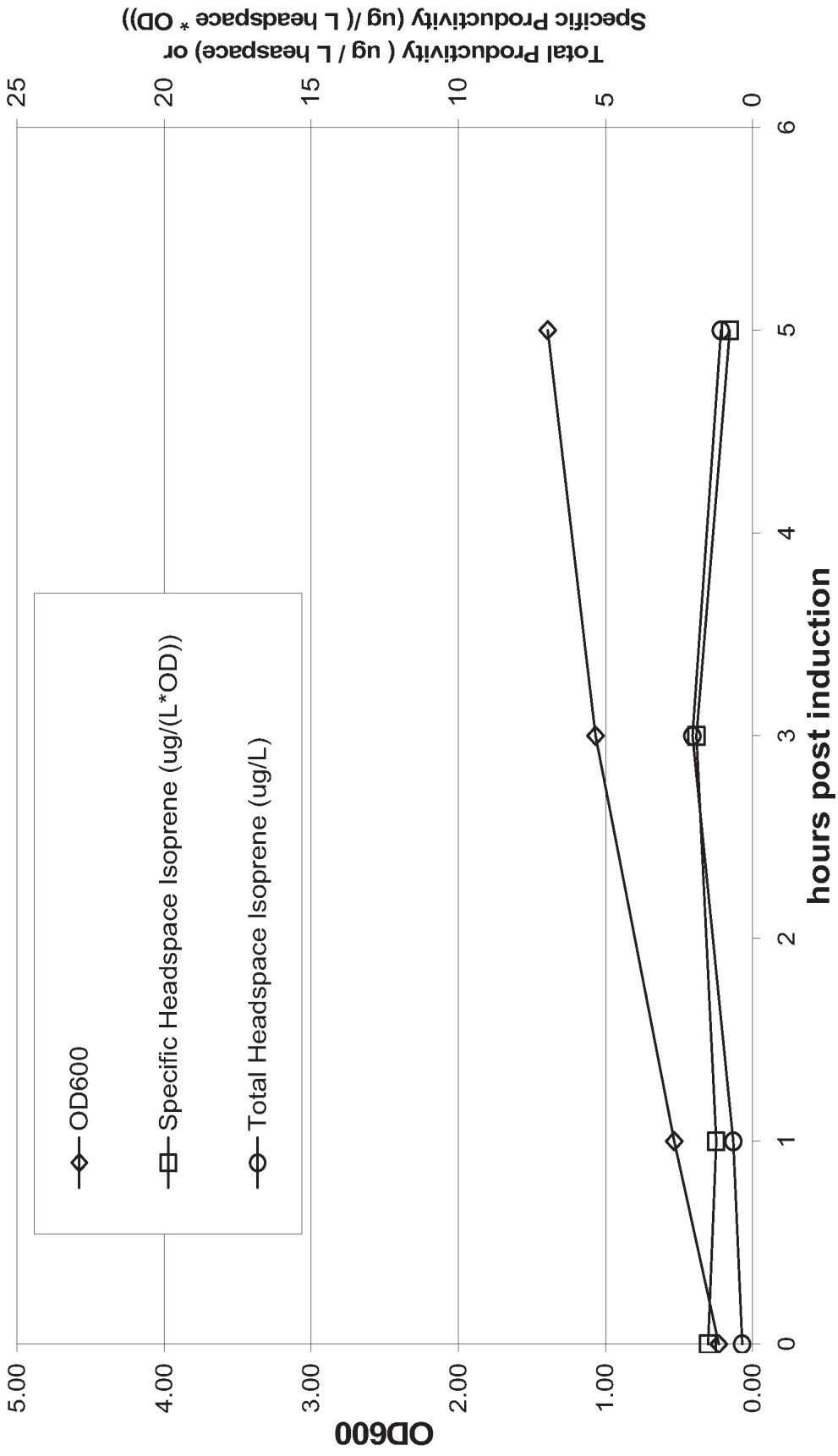

pCL PtrcKudzu
OD600
Total Productivity (ug / L headspace) or
Specific Productivity (ug /(L headspace * OD))
hours post induction
OD600
Specific Headspace Isoprene (ug/(L*OD))
Total Headspace Isoprene (ug/L)
0.00
1.00
2.00
3.00
4.00
5.00
0
5
10
15
20
25
0
1
2
3
4
5
6

Figure 23F

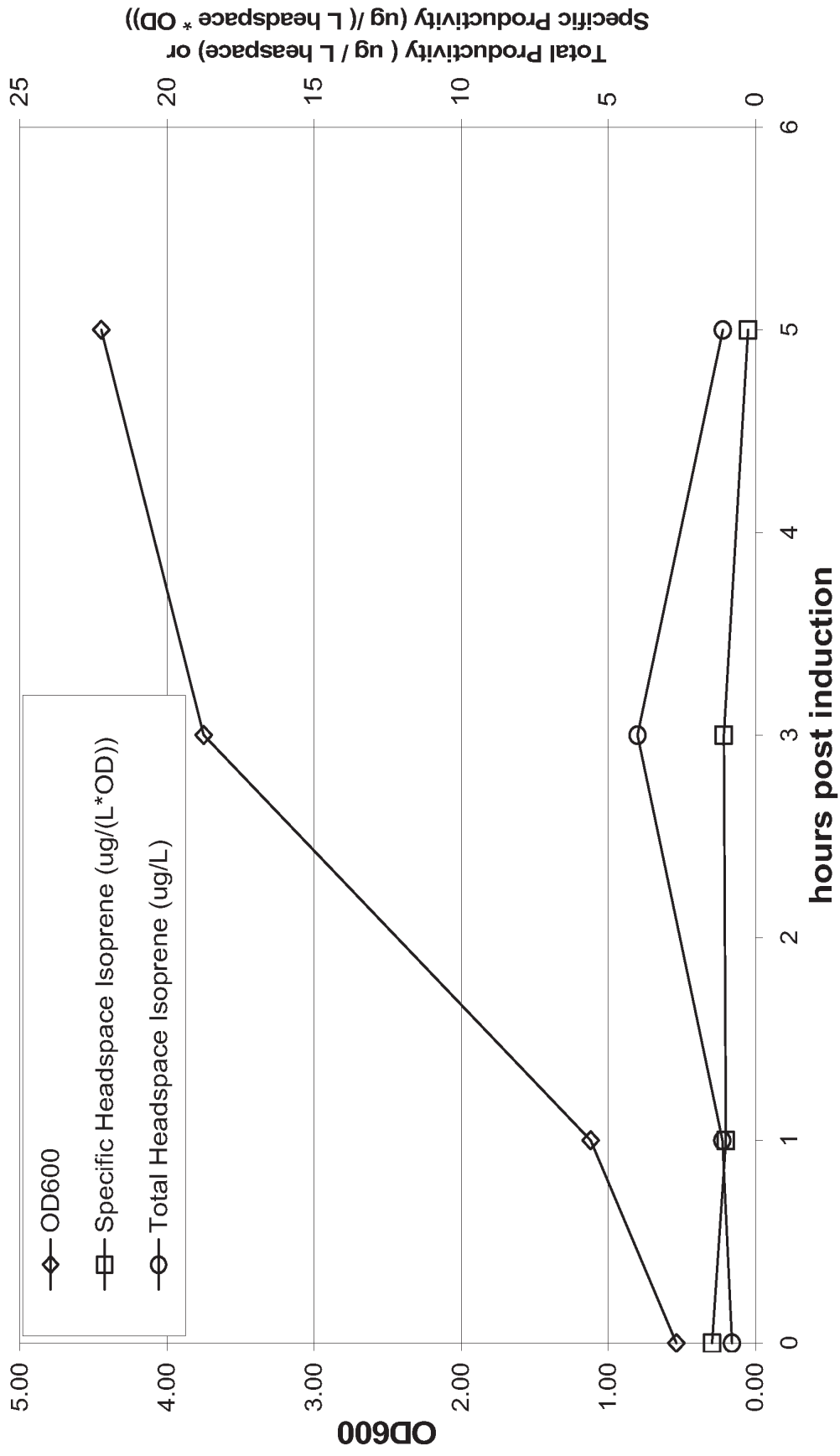
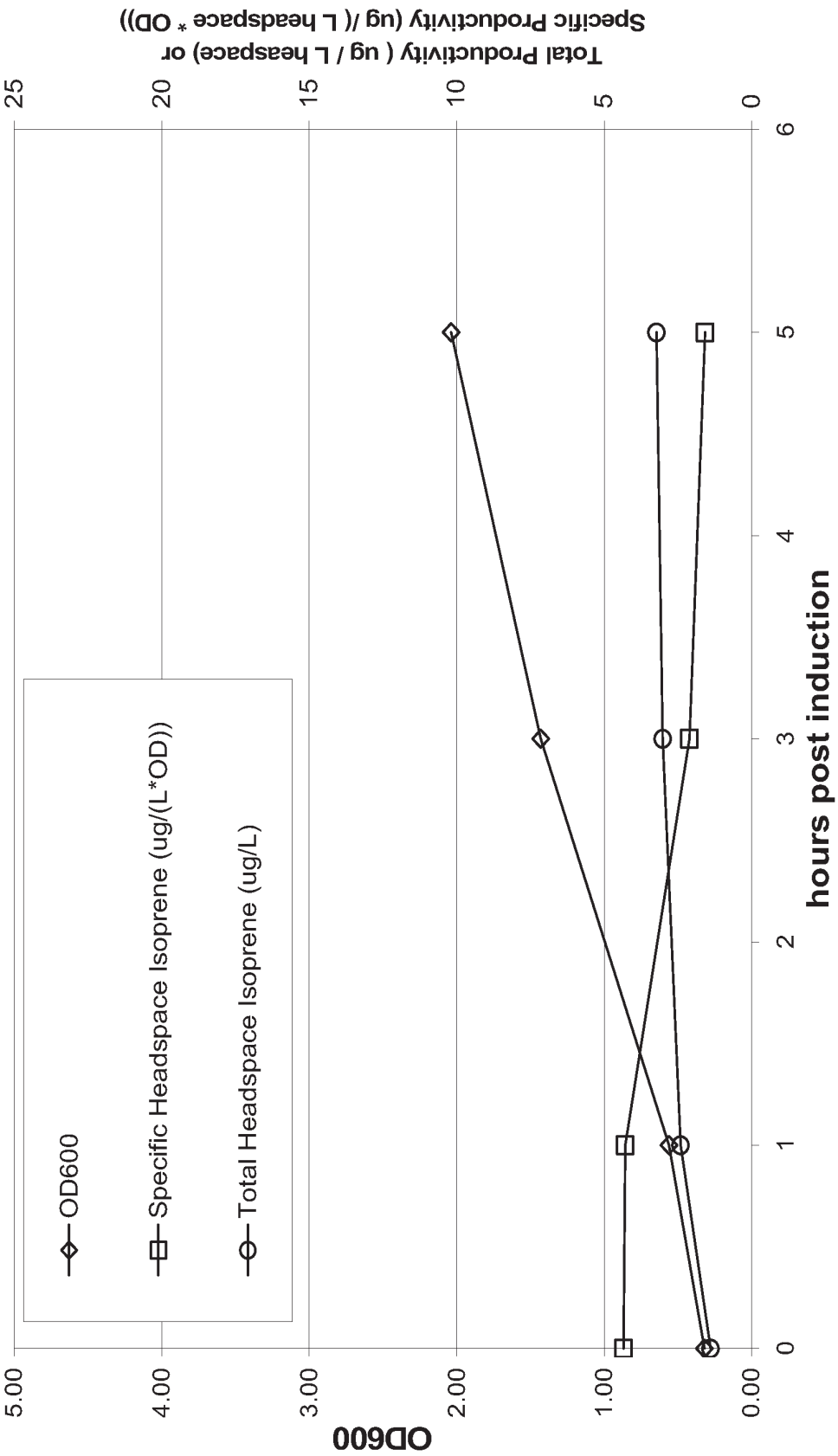

pCL PtrcKudzu yIDI
OD600
Total Productivity (ug / L headspace) or
Specific Productivity (ug /(L headspace * OD))
hours post induction
OD600
Specific Headspace Isoprene (ug/(L*OD))
Total Headspace Isoprene (ug/L)
0.00
1.00
2.00
3.00
4.00
5.00
0
5
10
15
20
25
0
1
2
3
4
5
6

Figure 23G


pCL PtrcKudzu DXS
OD600
Total Productivity (ug / L headspace) or
Specific Productivity (ug /(L headspace * OD))
hours post induction
OD600
Specific Headspace Isoprene (ug/(L*OD))
Total Headspace Isoprene (ug/L)
0.00
1.00
2.00
3.00
4.00
5.00
0
5
10
15
20
25
0
1
2
3
4
5
6

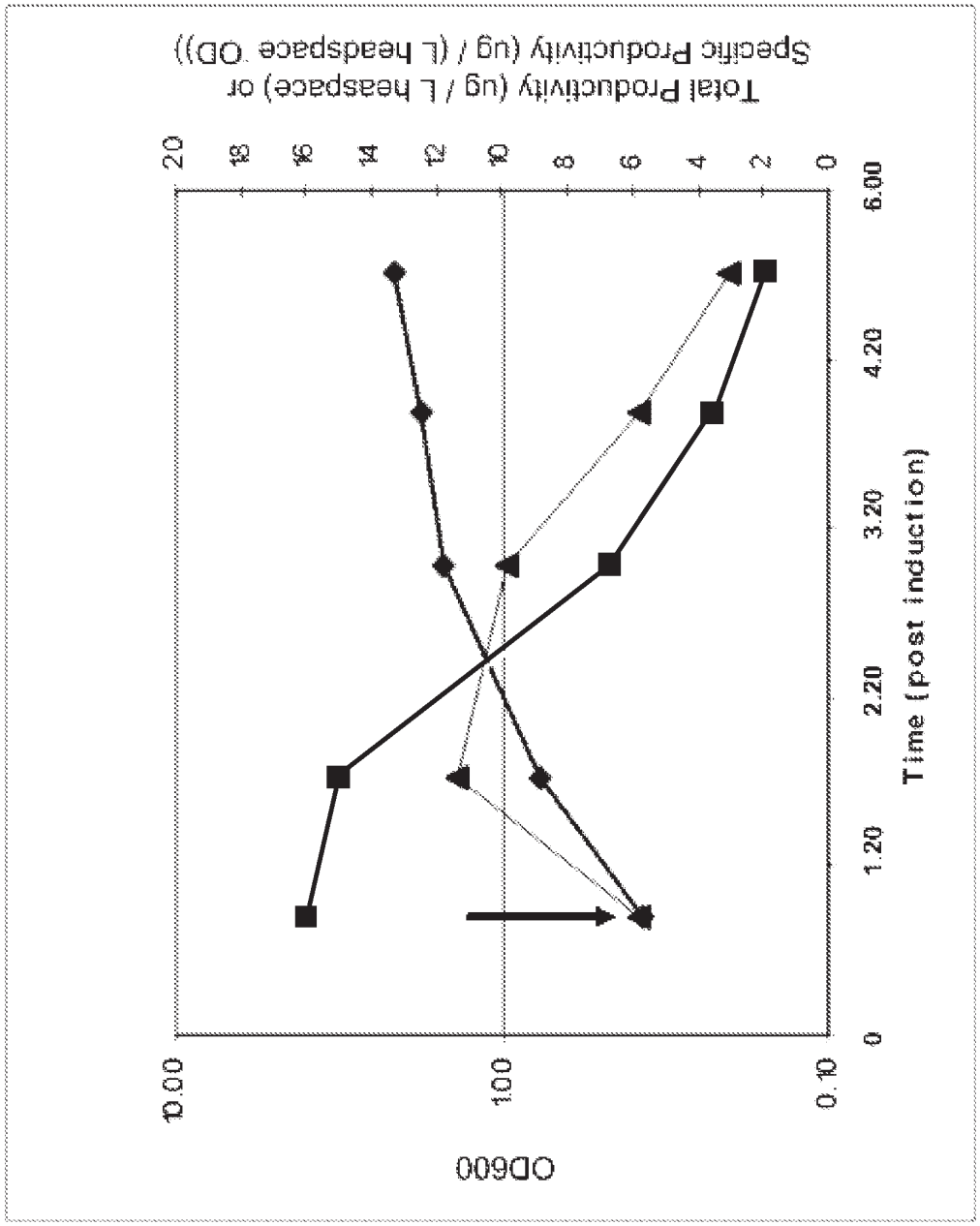

Total Productivity (ug / L headspace) or
Specific Productivity (ug / (L headspace *OD))
20
18
16
14
12
10
8
6
4
2
0
6.00
4.20
3.20
2.20
1.20
0
Time (post induction)
10.00
100
0.10
OD600

Figure 23H

Figure 24

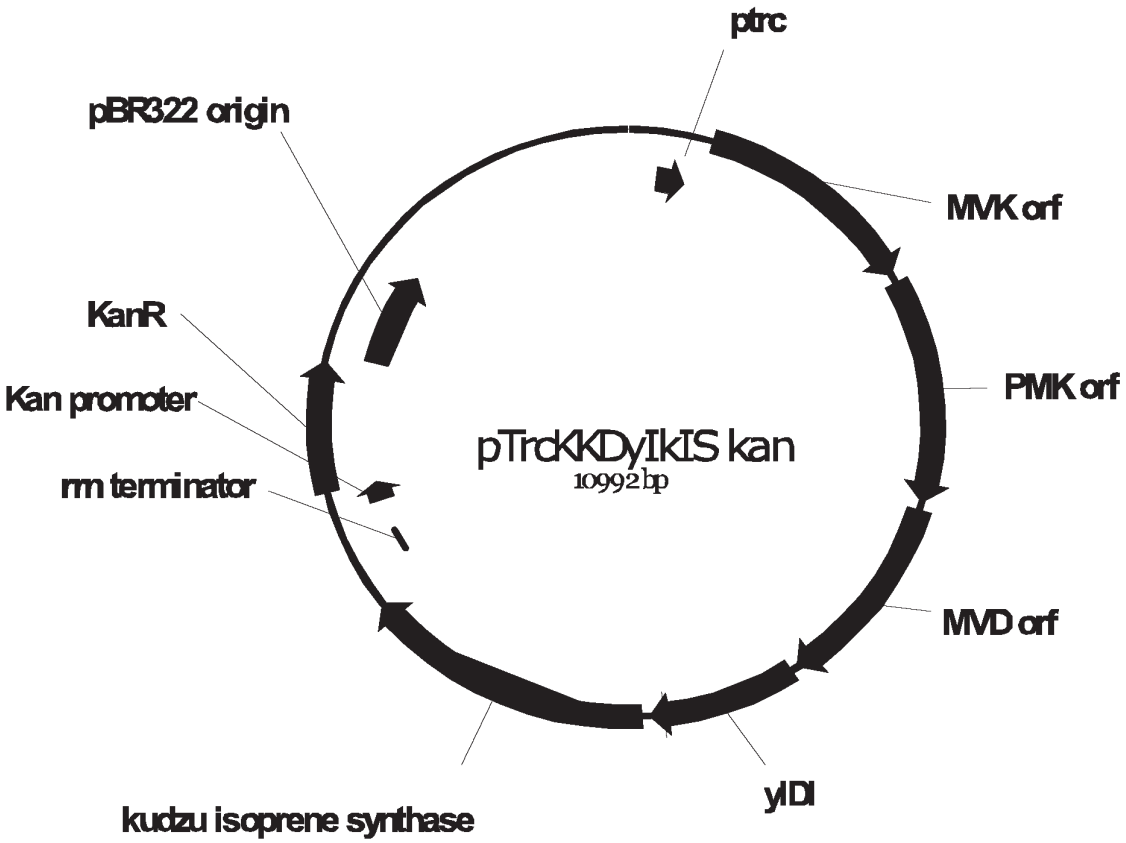

ptrc
pBR322 origin
MVK orf
KanR
PMK orf
Kan promoter
pTrcKKDyIkIS kan
10992 bp
rrn terminator
MVD orf
yIDI
kudzu isoprene synthase

Figure 25A

5'-
gtttgacagcttatcatcgactgcacggtgcaccaatgcttctggcgtcaggcagccatcggaagctgtggtatg
gctgtgcaggtcgtaaatcactgcataattcgtgtcgctcaaggcgcactcccgttctggataatgtttttgcgcc
gacatcataacggttctggcaaatattctgaaatgagctgttgacaattaatcatccggctcgtataatgtgtgga
attgtgagcggataacaatttcacacaggaaacagcgccgctgagaaaaagcgaagcggcactgctcttta
acaatttatcagacaatctgtgtgggcactcgaccggaattatcgattaactttattattaaaaattaaagaggtat
atattaatgtatcgattaaataaggaggaataaaccatggatccgagctcggatccactagtaacggccgcca
gtgtgctggaattcgcccttaggaggtaaaaaaacatgtcattaccgttcttaacttctgcaccgggaaaggttat
tatttttggtgaacactctgctgtgtacaacaagcctgccgtcgctgctagtgtgtctgcgttgagaacctacctgct
aataagcgagtcatctgcaccagatactattgaattggacttcccggacattagctttaatcataagtggtccatc
aatgatttcaatgccatcaccgaggatcaagtaaactcccaaaaattggccaaggctcaacaagccaccgat
ggcttgtctcaggaactcgttagtcttttggatccgttgttagctcaactatccgaatccttccactaccatgcagcg
ttttgtttcctgtatatgtttgtttgcctatgcccccatgccaagaatattaagttttctttaaagtctactttacccatcgg
tgctgggttgggctcaagcgcctctatttctgtatcactggccttagctatggcctacttgggggggttaataggat
ctaatgacttggaaaagctgtcagaaaacgataagcatatagtgaatcaatgggccttcataggtgaaaagtg
tattcacggtacccccttcaggaatagataacgctgtggccacttatggtaatgccctgctatttgaaaaagactc
acataatggaacaataaacacaaacaattttaagttcttagatgatttcccagccattccaatgatcctaacctat
actagaattccaaggtctacaaaagatcttgttgctcgcgttcgtgtgttggtcaccgagaaatttcctgaagttat
gaagccaattctagatgccatgggtgaatgtgccctacaaggcttagagatcatgactaagttaagtaaatgta
aaggcaccgatgacgaggctgtagaaactaataatgaactgtatgaacaactattggaattgataagaataa
atcatggactgcttgtctcaatcggtgtttctcatcctggattagaacttattaaaaatctgagcgatgatttgagaa
ttggctccacaaaacttaccggtgctggtggcggcggttgctctttgactttgttacgaagagacattactcaaga
gcaaattgacagcttcaaaaagaaattgcaagatgattttagttacgagacatttgaaacagacttgggtggga
ctggctgctgtttgttaagcgcaaaaaatttgaataaagatcttaaaatcaaatccctagtattccaattatttgaa
aataaaactaccacaaagcaacaaattgacgatctattattgccaggaaacacgaatttaccatggacttcat
aagctaatttgcgataggcctgcacccttaaggaggaaaaaaacatgtcagagttgagagccttcagtgccc
cagggaaagcgttactagctggtggatatttagttttagatacaaaatatgaagcatttgtagtcggattatcggc
aagaatgcatgctgtagcccatccttacggttcattgcaagggtctgataagtttgaagtgcgtgtgaaaagtaa
acaatttaaagatggggagtggctgtaccatataagtcctaaaagtggcttcattcctgtttcgataggcggatct
aagaaccctttcattgaaaaagttatcgctaacgtatttagctactttaaacctaacatggacgactactgcaata
gaaacttgttcgttattgatattttctctgatgatgcctaccattctcaggaggatagcgttaccgaacatcgtggca
acagaagattgagttttcattcgcacagaattgaagaagttcccaaaacagggctgggctcctcggcaggttta
gtcacagttttaactacagctttggcctccttttttgtatcggacctggaaaataatgtagacaaatatagagaagt
tattcataatttagcacaagttgctcattgtcaagctcagggtaaaattggaagcgggtttgatgtagcggcggc
agcatatggatctatcagatatagaagattcccacccgcattaatctctaatttgccagatattggaagtgctactt
acggcagtaaactggcgcatttggttgatgaagaagactggaatattacgattaaaagtaaccatttaccttcg
ggattaactttatggatgggcgatattaagaatggttcagaaacagtaaaactggtccagaaggtaaaaaaatt
ggtatgattcgcatatgccagaaagcttgaaaata

Figure 25B

tatacagaactcgatcatgcaaattctagatttatggatggactatctaaactagatcgcttacacgagactc
atgacgattacagcgatcagatatttgagtctcttgagaggaatgactgtacctgtcaaaagtatcctgaaat
cacagaagttagagatgcagttgccacaattagacgttcctttagaaaaataactaaagaatctggtgccg
atatcgaacctcccgtacaaactagcttattggatgattgccagaccttaaaaggagttcttacttgcttaatac
ctggtgctggtggttatgacgccattgcagtgattactaagcaagatgttgatcttagggctcaaaccgctaat
gacaaaagattttctaaggttcaatggctggatgtaactcaggctgactggggtgttaggaaagaaaaaga
tccggaaacttatcttgataaataacttaaggtagctgcatgcagaattcgcccttaaggaggaaaaaaaa
atgaccgtttacacagcatccgttaccgcacccgtcaacatcgcaacccttaagtattgggggaaaaggg
acacgaagttgaatctgcccaccaattcgtccatatcagtgactttatcgcaagatgacctcagaacgttga
cctctgcggctactgcacctgagtttgaacgcgacactttgtggttaaatggagaaccacacagcatcgac
aatgaaagaactcaaaattgtctgcgcgacctacgccaattaagaaaggaaatggaatcgaaggacgc
ctcattgcccacattatctcaatggaaactccacattgtctccgaaaataactttcctacagcagctggtttag
cttcctccgctgctggctttgctgcattggtctctgcaattgctaagttataccaattaccacagtcaacttcaga
aatatctagaatagcaagaaaggggtctggttcagcttgtagatcgttgtttggcggatacgtggcctggga
aatgggaaaagctgaagatggtcatgattccatggcagtacaaatcgcagacagctctgactggcctcag
atgaaagcttgtgtcctagttgtcagcgatattaaaaaggatgtgagttccactcagggtatgcaattgaccgt
ggcaacctccgaactatttaaagaaagaattgaacatgtcgtaccaaagagatttgaagtcatgcgtaaag
ccattgttgaaaaagatttcgccacctttgcaaaggaaacaatgatggattccaactctttccatgccacatgt
ttggactctttccctccaatattctacatgaatgacacttccaagcgtatcatcagttggtgccacaccattaat
cagttttacggagaaacaatcgttgcatacacgtttgatgcaggtccaaatgctgtgttgtactacttagctga
aaatgagtcgaaactctttgcatttatctataaattgtttggctctgttcctggatgggacaagaaatttactact
gagcagcttgaggctttcaaccatcaatttgaatcatctaactttactgcacgtgaattggatcttgagttgcaa
aaggatgttgccagagtgattttaactcaagtcggttcaggcccacaagaaacaaacgaatctttgattgac
gcaaagactggtctaccaaaggaataagatcaattcgctgcatcgcccttaggaggtaaaaaaaaatga
ctgccgacaacaatagtatgccccatggtgcagtatctagttacgccaaattagtgcaaaaccaaacacct
gaagacattttggaagagtttcctgaaattattccattacaacaaagacctaatacccgatctagtgagacgt
caaatgacgaaagcggagaaacatgtttttctggtcatgatgaggagcaaattaagttaatgaatgaaaatt
gtattgttttggattgggacgataatgctattggtgccggtaccaagaaagtttgtcatttaatggaaaatattga
aaagggtttactacatcgtgcattctccgtctttattttcaatgaacaaggtgaattacttttacaacaaagagc
cactgaaaaaataactttccctgatctttggactaacacatgctgctctcatccactatgtattgatgacgaatt
aggtttgaagggtaagctagacgataagattaagggcgctattactgcggcggtgagaaaactagatcat
gaattaggtattccagaagatgaaactaagacaaggggtaagtttcacttttaaacagaatccattacatg
gcaccaagcaatgaaccatggggtgaacatgaaattgattacatcctattttataagatcaacgctaaaga
aaacttgactgtcaacccaaacgtcaatgaagttagagacttcaaatgggtttcaccaaatgatttgaaaac
tatgtttgctgacccaagttacaagtttacgccttggtttaagattatttgcgagaattacttattcaactggtggg
agcaattagatgacctttctgaagtggaaaatgacaggcaaattcatagaatgctataacaacgcgtcctg
cattcgcccttaggaggtaaaaaaacatgtgtgcgacctcttctcaatttactcagattaccgagcataattcc
cgtcgttccgcaaactatcagccaaacctgtggaatttcgaattcctgcaatccctggagaacgacctgaa
agtggaaaagctggaggagaaagcgaccaaactggaggaagaagttcgctgcatg

Figure 25C

atcaaccgtgtagacacccagccgctgtccctgctggagctgatcgacgatgtgcagcgcctgggtctgacc
tacaaatttgaaaaagacatcattaaagccctggaaaacatcgtactgctggacgaaaacaaaaagaaca
aatctgacctgcacgcaaccgctctgtctttccgtctgctgcgtcagcacggtttcgaggtttctcaggatgttttt
gagcgtttcaaggataaagaaggtggtttcagcggtgaactgaaaggtgacgtccaaggcctgctgagcct
gtatgaagcgtcttacctgggtttcgagggtgagaacctgctggaggaggcgcgtacctttccatcacccac
ctgaagaacaacctgaaagaaggcattaataccaaggttgcagaacaagtgagccacgccctggaactg
ccatatcaccagcgtctgcaccgtctggaggcacgttggttcctggataaatacgaaccgaaagaaccgca
tcaccagctgctgctggagctggcgaagctggattttaacatggtacagaccctgcaccagaaagagctgc
aagatctgtcccgctggtggaccgagatgggcctggctagcaaactggattttgtacgcgaccgcctgatgg
aagtttatttctgggcactgggtatggcgccagacccgcagtttggtgaatgtcgcaaagctgttactaaaatgt
ttggtctggtgacgatcatcgatgacgtgtatgacgtttatggcactctggacgaactgcaactgttcaccgatg
ctgtagagcgctgggacgttaacgctattaacaccctgccggactatatgaaactgtgtttcctggcactgtac
aacaccgttaacgacacgtcctattctattctgaaagagaaaggtcataacaacctgtcctatctgacgaaaa
gctggcgtgaactgtgcaaagcctttctgcaagaggcgaaatggtccaacaacaaaattatcccggctttctc
caagtacctggaaaacgccagcgtttcctcctccggtgtagcgctgctggcgccgtcttacttttccgtatgcca
gcagcaggaagacatctccgaccacgcgctgcgttccctgaccgacttccatggtctggtgcgttctagctgc
gttatcttccgcctgtgcaacgatctggccacctctgcggcggagctggaacgtggcgagactaccaattcta
tcattagctacatgcacgaaaacgatggtaccagcgaggaacaggcccgcgaagaactgcgtaaactgat
cgacgccgaatggaaaaagatgaatcgtgaacgcgttagcgactccaccctgctgcctaaagcgttcatgg
aaatcgcagttaacatggcacgtgtttcccactgcacctaccagtatggcgatggtctgggtcgcccagacta
cgcgactgaaaaccgcatcaaactgctgctgattgacccttcccgattaaccagctgatgtatgtctaactgc
agctggtaccatatgggaattcgaagctttctagaacaaaaactcatctcagaagaggatctgaatagcgcc
gtcgaccatcatcatcatcatcattgagtttaaacggtctccagcttggctgttttggcggatgagagaagatttt
cagcctgatacagattaaatcagaacgcagaagcggtctgataaaacagaatttgcctggcggcagtagc
gcggtggtcccacctgaccccatgccgaactcagaagtgaaacgccgtagcgccgatggtagtgtggggt
ctccccatgcgagagtagggaactgccaggcatcaaataaaacgaaaggctcagtcgaaagactgggcc
tttcgttttatctgttgtttgtcggtgaacgctctcctgagtaggacaaatccgccgggagcggatttgaacgttgc
gaagcaacggcccggagggtggcgggcaggacgcccgccataaactgccaggcatcaaattaagcag
aaggccatcctgacggatggccttttgcgtttctacaaactcttttgtttatttttctaaatacattcaaatatgtatc
cgcttaaccggaattgccagctggggcgccctctggtaaggttgggaagccctgcaaagtaaactggatgg
ctttctcgccgccaaggatctgatggcgcaggggatcaagctctgatcaagagacaggatgaggatcgtttc
gcatgattgaacaagatggattgcacgcaggttctccggccgcttgggtggagaggctattcggctatgactg
ggcacaacagacaatcggctgctctgatgccgccgtgttccggctgtcagcgcaggggcgcccggttctttttt
gtcaagaccgacctgtccggtgccctgaatgaactgcaagacgaggcagcgcggctatcgtggctggcca
cgacgggcgttccttgcgcagctgtgctcgacgttgtcactgaagcgggaagggactggctgctattgggcg
aagtgccggggcaggatctcctgtcatctcaccttgctcctgccgagaaagtatccatcatggctgatgcaat
gcggcggctgcatacgcttgatccggctacctgcccattcgaccaccaagcgaaacatcgcatcgagcga
gcacgtactcggatggaagccggtcttgtcgatcaggatgatctggacgaagagcatcaggggctcgcgcc
agccgaactgttcgccaggctcaaggcgagcatgcccgacggcgaggatctcgtcgtgacccat

Figure 25D

ggcgatgcctgcttgccgaatatcatggtggaaaatggccgcttttctggattcatcgactgtggccggctgg
gtgtggcggaccgctatcaggacatagcgttggctacccgtgatattgctgaagagcttggcggcgaatgg
gctgaccgcttcctcgtgctttacggtatcgccgctcccgattcgcagcgcatcgccttctatcgccttcttgac
gagttcttctgacgcatgaccaaaatcccttaacgtgagttttcgttccactgagcgtcagaccccgtagaaa
agatcaaaggatcttcttgagatccttttttttctgcgcgtaatctgctgcttgcaaacaaaaaaaccaccgcta
ccagcggtggtttgtttgccggatcaagagctaccaactctttttccgaaggtaactggcttcagcagagcgc
agataccaaatactgtccttctagtgtagccgtagttaggccaccacttcaagaactctgtagcaccgcctac
atacctcgctctgctaatcctgttaccagtggctgctgccagtggcgataagtcgtgtcttaccgggttggact
caagacgatagttaccggataaggcgcagcggtcgggctgaacgggggggttcgtgcacacagcccagc
ttggagcgaacgacctacaccgaactgagatacctacagcgtgagctatgagaaagcgccacgcttccc
gaagggagaaaggcggacaggtatccggtaagcggcagggtcggaacaggagagcgcacgaggga
gcttccagggggaaacgcctggtatctttatagtcctgtcgggtttcgccacctctgacttgagcgtcgatttttg
tgatgctcgtcaggggggcggagcctatggaaaaacgccagcaacgcggccttttacggttcctggccttt
tgctggccttttgctcacatgttctttcctgcgttatcccctgattctgtggataaccgtattaccgcctttgagtga
gctgataccgctcgccgcagccgaacgaccgagcgcagcgagtcagtgagcgaggaagcggaagag
cgcctgatgcggtattttctccttacgcatctgtgcggtatttcacaccgcatatggtgcactctcagtacaatct
gctctgatgccgcatagttaagccagtatacactccgctatcgctacgtgactgggtcatggctgcgccccg
acacccgccaacacccgctgacgcgccctgacgggcttgtctgctcccggcatccgcttacagacaagct
gtgaccgtctccgggagctgcatgtgtcagaggttttcaccgtcatcaccgaaacgcgcgaggcagcaga
tcaattcgcgcgcgaaggcgaagcggcatgcatttacgttgacaccatcgaatggtgcaaaacctttcgcg
gtatggcatgatagcgcccggaagagagtcaattcagggtggtgaatgtgaaaccagtaacgttatacgat
gtcgcagagtatgccggtgtctcttatcagaccgtttcccgcgtggtgaaccaggccagccacgtttctgcga
aaacgcgggaaaaagtggaagcggcgatggcggagctgaattacattcccaaccgcgtggcacaaca
actggcgggcaaacagtcgttgctgattggcgttgccacctccagtctggccctgcacgcgccgtcgcaaa
ttgtcgcggcgattaaatctcgcgccgatcaactgggtgccagcgtggtggtgtcgatggtagaacgaagc
ggcgtcgaagcctgtaaagcggcggtgcacaatcttctcgcgcaacgcgtcagtgggctgatcattaacta
tccgctggatgaccaggatgccattgctgtggaagctgcctgcactaatgttccggcgttatttcttgatgtctct
gaccagacacccatcaacagtattattttctcccatgaagacggtacgcgactgggcgtggagcatctggt
cgcattgggtcaccagcaaatcgcgctgttagcgggcccattaagttctgtctcggcgcgtctgcgtctggct
ggctggcataaatatctcactcgcaatcaaattcagccgatagcggaacgggaaggcgactggagtgcc
atgtccggttttcaacaaaccatgcaaatgctgaatgagggcatcgttcccactgcgatgctggttgccaac
gatcagatggcgctgggcgcaatgcgcgccattaccgagtccgggctgcgcgttggtgcggatatctcggt
agtgggatacgacgataccgaagacagctcatgttatatcccgccgtcaaccaccatcaaacaggattttc
gcctgctggggcaaaccagcgtggaccgcttgctgcaactctctcagggccaggcggtgaagggcaatc
agctgttgcccgtctcactggtgaaaagaaaaaccaccctggcgcccaatacgcaaaccgcctctccccg
cgcgttggccgattcattaatgcagctggcacgacaggtttcccgactggaaagcgggcagtgagcgcaa
cgcaattaatgtgagttagcgcgaattgatctg

(SEQ ID NO:11)

Figure 26

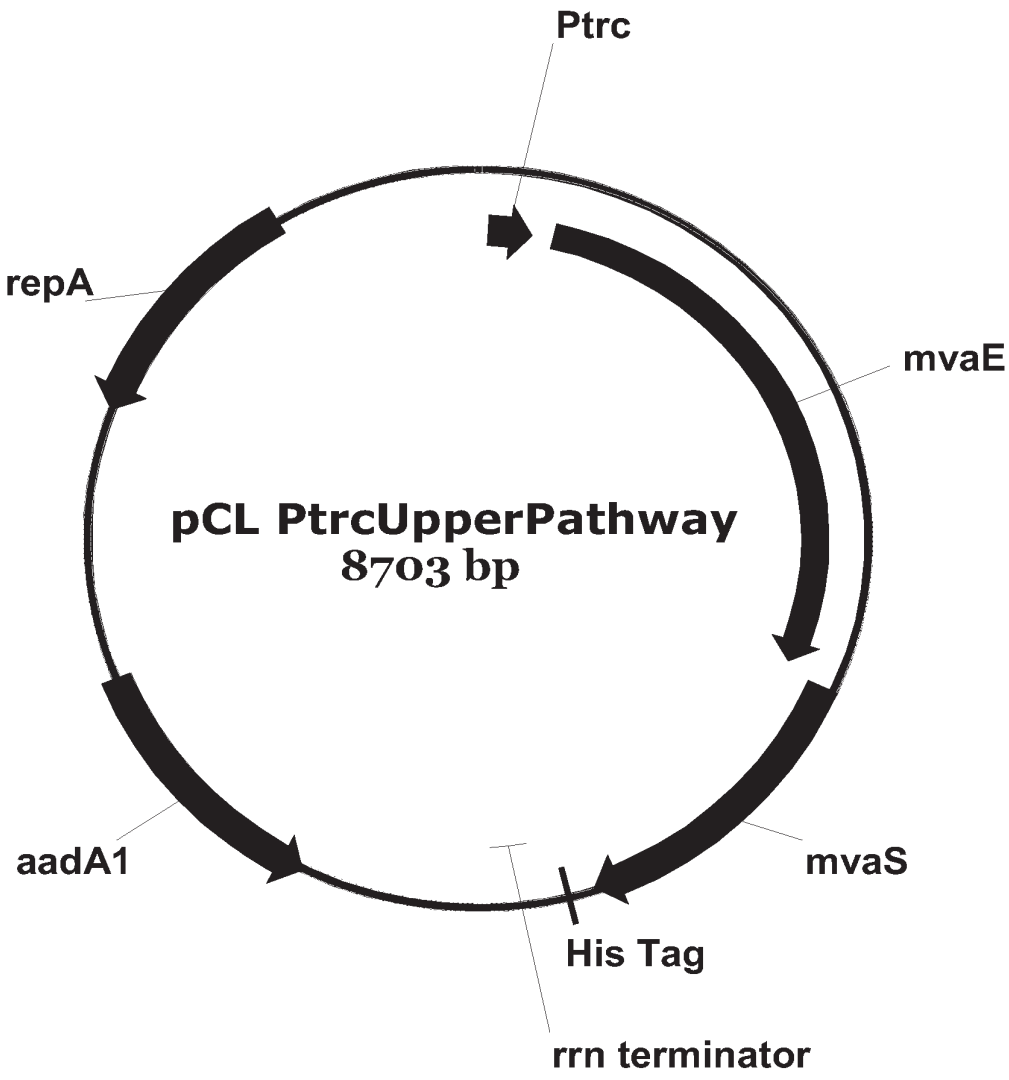

Ptrc
repA
mvaE
pCL PtrcUpperPathway
8703 bp
aadA1
mvaS
His Tag
rrn terminator

Figure 27A

5'-
cccgtcttactgtcgggaattcgcgttggccgattcattaatgcagattctgaaatgagctgttgacaattaatcatc
cggctcgtataatgtgtggaattgtgagcggataacaatttcacacaggaaacagcgccgctgagaaaaagcg
aagcggcactgctctttaacaatttatcagacaatctgtgtgggcactcgaccggaattatcgattaactttattatta
aaaattaaagaggtatatattaatgtatcgattaaataaggaggaataaaccatggatccgagctcaggaggta
aaaaaacatgaaaacagtagttattattgatgcattacgaacaccaattggaaaatataaaggcagcttaagtc
aagtaagtgccgtagacttaggaacacatgttacaacacaacttttaaaaagacattccactatttctgaagaaa
ttgatcaagtaatctttggaaatgttttacaagctggaaatggccaaaatcccgcacgacaaatagcaataaac
agcggtttgtctcatgaaattcccgcaatgacggttaatgaggtctgcggatcaggaatgaaggccgttattttgg
cgaaacaattgattcaattaggagaagcggaagttttaattgctggcgggattgagaatatgtcccaagcaccta
aattacaacgttttaattacgaaacagaaagctacgatgcgccttttctagtatgatgtatgatggattaacggatg
cctttagtggtcaggcaatgggcttaactgctgaaaatgtggccgaaaagtatcatgtaactagagaagagcaa
gatcaattttctgtacattcacaattaaaagcagctcaagcacaagcagaagggatattcgctgacgaaatagc
cccattagaagtatcaggaacgcttgtggagaaagatgaagggattcgccctaattcgagcgttgagaagcta
ggaacgcttaaaacagtttttaaagaagacggtactgtaacagcagggaatgcatcaaccattaatgatgggg
cttctgctttgattattgcttcacaagaatatgccgaagcacacggtcttccttatttagctattattcgagacagtgtg
gaagtcggtattgatccagcctatatgggaatttcgccgattaaagccattcaaaaactgttagcgcgcaatcaa
cttactacggaagaaattgatctgtatgaaatcaacgaagcatttgcagcaacttcaatcgtggtccaaagaga
actggctttaccagaggaaaaggtcaacatttatggtggcggtatttcattaggtcatgcgattggtgccacaggt
gctcgtttattaacgagtttaagttatcaattaaatcaaaaagaaaagaaatatggagtggcttctttatgtatcggc
ggtggcttaggactcgctatgctactagagagacctcagcaaaaaaaaaacagccgattttatcaaatgagtcc
tgaggaacgcctggcttctcttcttaatgaaggccagatttctgctgatacaaaaaaagaatttgaaaatacggct
ttatcttcgcagattgccaatcatatgattgaaaatcaaatcagtgaaacagaagtgccgatgggcgttggcttac
atttaacagtggacgaaactgattatttggtaccaatggcgacagaagagccctcagttattgcggctttgagtaa
tggtgcaaaaatagcacaaggatttaaaacagtgaatcaacaacgcttaatgcgtggacaaatcgtttttttacga
tgttgcagatcccgagtcattgattgataaactacaagtaagagaagcggaagtttttcaacaagcagagttaag
ttatccatctatcgttaaacggggcggcggcttaagagatttgcaatatcgtacttttgatgaatcatttgtatctgtcg
actttttagtagatgttaaggatgcaatgggggcaaatatcgttaacgctatgttggaaggtgtggccgagttgttcc
gtgaatggtttgcggagcaaaagattttattcagtattttaagtaattatgccacggagtcggttgttacgatgaaaa
cggctattccagtttcacgtttaagtaaggggagcaatggccgggaaattgctgaaaaaattgttttagcttcacg
ctatgcttcattagatccttatcgggcagtcacgcataacaaaggaatcatgaatggcattgaagctgtagttttag
ctacaggaaatgatacacgcgctgttagcgcttcttgtcatgcttttgcggtgaaggaaggtcgctaccaaggctt
gactagttggacgctggatggcgaacaactaattggtgaaatttcagttccgcttgctttagccacggttggcggtg
ccacaaaagtcttacctaaatctcaagcagctgctgatttgttagcagtgacggatgcaaaagaactaagtcga
gtagtagcggctgttggtttggcacaaaatttagcggcgttacgggccttagtctctgaaggaattcaaaaagga
cacatggctctacaagcacgttctttagcgatgacggtcggagctactggtaaagaagttgaggcagtcgctca
acaattaaaacgtcaaaaaacgatgaaccaagaccgagccatggctattttaaatgatttaagaaaacaataa
aggaggtaaaaaaacatgacaattgggat

Figure 27B

tgataaaattagttttttgtgccccttattatattgatatgacggcactggctgaagccagaaatgtagaccctgg
aaaatttcatattggtattgggcaagaccaaatggcggtgaacccaatcagccaagatattgtgacatttgcag
ccaatgccgcagaagcgatcttgaccaaagaagataaagaggccattgatatggtgattgtcgggactgagt
ccagtatcgatgagtcaaaagcggccgcagttgtcttacatcgtttaatggggattcaacctttcgctcgctctttc
gaaatcaaggaagcttgttacggagcaacagcaggcttacagttagctaagaatcacgtagccttacatcca
gataaaaaagtcttggtcgtagcggcagatattgcaaaatatggcttaaattctggcggtgagcctacacaag
gagctggggcggttgcaatgttagttgctagtgaaccgcgcattttggctttaaaagaggataatgtgatgctga
cgcaagatatctatgacttttggcgtccaacaggccacccgtatcctatggtcgatggtcctttgtcaaacgaaa
cctacatccaatcttttgcccaagtctgggatgaacataaaaaacgaaccggtcttgattttgcagattatgatgc
tttagcgttccatattccttacacaaaaatgggcaaaaaagccttattagcaaaaatctccgaccaaactgaag
cagaacaggaacgaattttagcccgttatgaagaaagtatcgtctatagtcgtcgcgtaggaaacttgtatacg
ggttcactttatctgggactcatttccctttagaaaatgcaacgactttaaccgcaggcaatcaaattggtttattc
agttatggttctggtgctgtcgctgaatttttcactggtgaattagtagctggttatcaaaatcatttacaaaaagaa
actcatttagcactgctggataatcggacagaactttctatcgctgaatatgaagccatgtttgcagaaactttag
acacagacattgatcaaacgttagaagatgaattaaaatatagtatttctgctattaataataccgttcgttcttatc
gaaactaagagatctgcagctggtaccatatgggaattcgaagcttgggcccgaacaaaaactcatctcaga
agaggatctgaatagcgccgtcgaccatcatcatcatcatcattgagtttaaacggtctccagcttggctgttttg
gcggatgagagaagattttcagcctgatacagattaaatcagaacgcagaagcggtctgataaaacagaatt
tgcctggcggcagtagcgcggtggtcccacctgaccccatgccgaactcagaagtgaaacgccgtagcgcc
gatggtagtgtggggtctccccatgcgagagtagggaactgccaggcatcaaataaaacgaaaggctcagt
cgaaagactgggcctttcgttttatctgttgtttgtcggtgaacgctctcctgagtaggacaaatccgccgggagc
ggatttgaacgttgcgaagcaacggcccggagggtggcgggcaggacgcccgccataaactgccaggcat
caaattaagcagaaggccatcctgacggatggccttttgcgtttctacaaactctttttgtttatttttctaaatacatt
caaatatgtatccgctcatgagacaataaccctgataaatgcttcaataatctggcgtaatagcgaagaggcc
cgcaccgatcgcccttcccaacagttgcgcagcctgaatggcgaatggcgcctgatgcggtattttctccttacg
catctgtgcggtatttcacaccgcatatggtgcactctcagtacaatctgctctgatgccgcatagttaagccagc
cccgacacccgccaacacccgctgacgagcttagtaaagccctcgctagattttaatgcggatgttgcgattac
ttcgccaactattgcgataacaagaaaaagccagcctttcatgatatatctcccaatttgtgtagggcttattatgc
acgcttaaaaataataaaagcagacttgacctgatagtttggctgtgagcaattatgtgcttagtgcatctaacg
cttgagttaagccgcgccgcgaagcggcgtcggcttgaacgaattgttagacattatttgccgactaccttggtg
atctcgcctttcacgtagtggacaaattcttccaactgatctgcgcgcgaggccaagcgatcttcttcttgtccaa
gataagcctgtctagcttcaagtatgacgggctgatactgggccggcaggcgctccattgcccagtcggcagc
gacatccttcggcgcgattttgccggttactgcgctgtaccaaatgcgggacaacgtaagcactacatttcgctc
atcgccagcccagtcgggcggcgagttccatagcgttaaggtttcatttagcgcctcaaatagatcctgttcagg
aaccggatcaaagagttcctccgccgctggacctaccaaggcaacgctatgttctcttgcttttgtcagcaagat
agccagatcaatgtcgatcgtggctggctcgaagatacctgcaagaatgtcattgcgctgccattctccaaattg
cagttcgcgcttagctggataacgccacggaatgatgtcgtcgtgcacaacaatggtgacttctacagcgcgg
agaatctcgctctctccaggggaagccgaagtttccaaaaggtcgttgat

Figure 27C

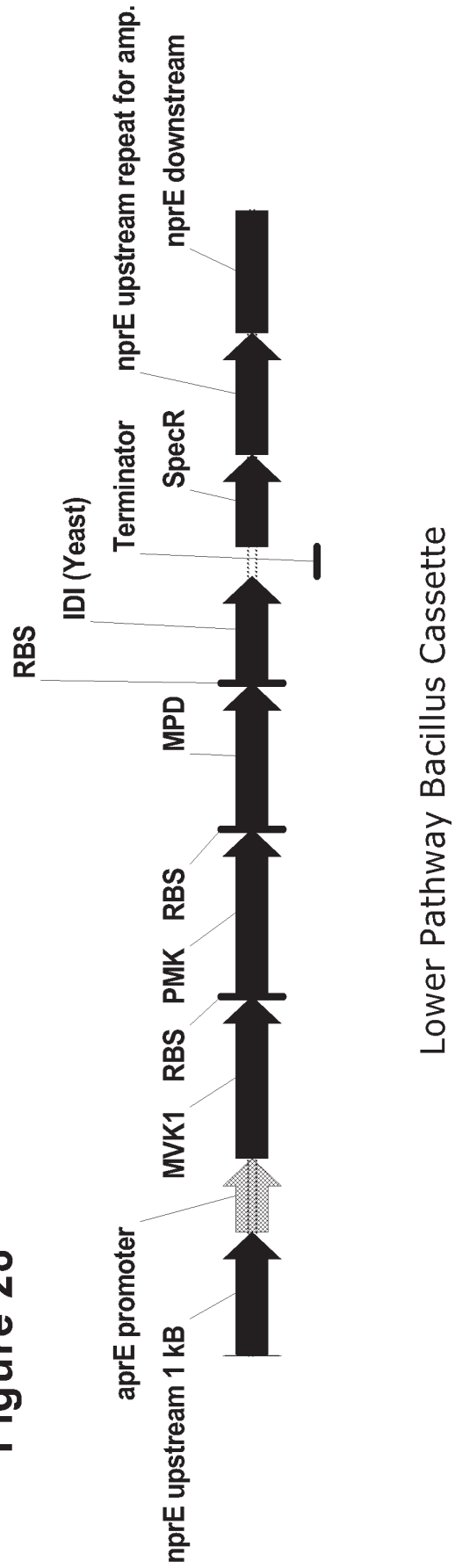
caaagctcgccgcgttgtttcatcaagccttacggtcaccgtaaccagcaaatcaatatcactgtgtggcttca
ggccgccatccactgcggagccgtacaaatgtacggccagcaacgtcggttcgagatggcgctcgatgac
gccaactacctctgatagttgagtcgatacttcggcgatcaccgcttccctcatgatgtttaactttgttttagggc
gactgccctgctgcgtaacatcgttgctgctccataacatcaaacatcgacccacggcgtaacgcgcttgctg
cttggatgcccgaggcatagactgtaccccaaaaaaacagtcataacaagccatgaaaaccgccactgc
gccgttaccaccgctgcgttcggtcaaggttctggaccagttgcgtgagcgcatacgctacttgcattacagct
tacgaaccgaacaggcttatgtccactgggttcgtgccttcatccgtttccacggtgtgcgtcacccggcaacc
ttgggcagcagcgaagtcgaggcatttctgtcctggctggcgaacgagcgcaaggtttcggtctccacgcat
cgtcaggcattggcggccttgctgttcttctacggcaaggtgctgtgcacggatctgccctggcttcaggagat
cggaagacctcggccgtcgcggcgcttgccggtggtgctgaccccggatgaagtggttcgcatcctcggtttt
ctggaaggcgagcatcgtttgttcgcccagcttctgtatggaacgggcatgcggatcagtgagggtttgcaac
tgcgggtcaaggatctggatttcgatcacggcacgatcatcgtgcgggagggcaagggctccaaggatcg
ggccttgatgttacccgagagcttggcacccagcctgcgcgagcaggggaattaattcccacgggttttgctg
cccgcaaacgggctgttctggtgttgctagtttgttatcagaatcgcagatccggcttcagccggtttgccggct
gaaagcgctatttcttccagaattgccatgatttttttccccacgggaggcgtcactggctcccgtgttgtcggca
gctttgattcgataagcagcatcgcctgtttcaggctgtctatgtgtgactgttgagctgtaacaagttgtctcagg
tgttcaatttcatgttctagttgctttgttttactggtttcacctgttctattaggtgttacatgctgttcatctgttacattgt
cgatctgttcatggtgaacagctttgaatgcaccaaaaactcgtaaaagctctgatgtatctatctttttacacc
gttttcatctgtgcatatggacagttttccctttgatatgtaacggtgaacagttgttctacttttgtttgttagtcttgat
gcttcactgatagatacaagagccataagaacctcagatccttccgtatttagccagtatgttctctagtgtggtt
cgttgtttttgcgtgagccatgagaacgaaccattgagatcatacttactttgcatgtcactcaaaaattttgcctc
aaaactggtgagctgaatttttgcagttaaagcatcgtgtagtgtttttcttagtccgttatgtaggtaggaatctga
tgtaatggttgttggtattttgtcaccattcatttttatctggttgttctcaagttcggttacgagatccatttgtctatcta
gttcaacttggaaaatcaacgtatcagtcgggcggcctcgcttatcaaccaccaatttcatattgctgtaagtgtt
taaatctttacttattggtttcaaaacccattggttaagccttttaaactcatggtagttatttttcaagcattaacatg
aacttaaattcatcaaggctaatctctatatttgccttgtgagttttcttttgtgttagttcttttaataaccactcataaa
tcctcatagagtatttgttttcaaaagacttaacatgttccagattatattttatgaatttttttaactggaaaagataa
ggcaatatctcttcactaaaaactaattctaatttttcgcttgagaacttggcatagtttgtccactggaaaatctc
aaagcctttaaccaaaggattcctgatttccacagttctcgtcatcagctctctggttgctttagctaatacaccat
aagcattttccctactgatgttcatcatctgagcgtattggttataagtgaacgataccgtccgttctttccttgtag
ggttttcaatcgtggggttgagtagtgccacacagcataaaattagcttggtttcatgctccgttaagtcatagcg
actaatcgctagttcatttgctttgaaaacaactaattcagacatacatctcaattggtctaggtgattttaatcact
ataccaattgagatgggctagtcaatgataattactagtccttttcctttgagttgtgggtatctgtaaattctgcta
gacctttgctggaaaacttgtaaattctgctagaccctctgtaaattccgctagacctttgtgtgttttttttgtttatatt
caagtggttataatttatagaataaagaaagaataaaaaaagataaaaagaatagatcccagccctgtgtat
aactcactactttagtcagttccgcagtattacaaaaggatgtcgcaaacgctgtttgctcctctacaaaacag
accttaaaaccctaaaggcttaagtagcaccctcgcaagctcgggcaaatcgctgaatattccttttgtctccg
acc

Figure 27D

Atcaggcacctgagtcgctgtctttttcgtgacattcagttcgctgcgctcacggctctggcagtgaatgggg
gtaaatggcactacaggcgccttttatggattcatgcaaggaaactacccataatacaagaaaagcccgt
cacgggcttctcagggcgttttatggcgggtctgctatgtggtgctatctgactttttgctgttcagcagttcctg
ccctctgattttccagtctgaccacttcggattatcccgtgacaggtcattcagactggctaatgcacccagt
aaggcagcggtatcatcaacaggctta

(SEQ ID NO:12)

Figure 28



Lower Pathway Bacillus Cassette

9371 bp

Figure 29A

5'-
tgtaacctttgctttcaaatgagtagaaataatgcacatccatgtttgtatcgtgcaaataaagtgtttcatccgtag
gaaaaaatgactttagtatctgttccgctttttctgatgaaatgtgctccccgacaaaattgaatgaatcatggaca
tttgctggctttgatacagcgaaagcagccgttcctatgttatatatcggatttaacagcaggacaaaaaacacc
atgacagccatcgtcacccacttattcacacgcacataaacctttcctgacttttggaacagatgatagctcatc
aaaaatcccgccattgccaaataaatcgtatatggcattactgcaccataatcttttgagatttgattgggatatgg
cgcaagcagcaagacaagcagtccgataatcagcgtataaaataagcctagtaagatcttatccgttctcca
atacagcttgaaaaacactacattcaacgcaatgggaagagtgatgatgaaaaacagaaacacgaatgca
atcggctccatcccatccgggtattccttccaatacgaaaagaaactaaaaatcatttgtacgatcggcaaact
gacaacagcaaggtcgaacgtataaaacttacccttccgccatgatcacgcggcatcagcatatagtgaaa
agccgtcagcagcacatatccgtataacaaaaaatgcagcagcggcagcagttcttttccgtcctctcttaagt
aagcgctggtgaagtttgttgattgcacctggtgaataagttcaacagacactcccgccagcagcacaatccg
caatataacacccgccaagaacattgtgcgctgccggtttattttgggatgatgcaccaaaagatataagccc
gccagaacaacaattgaccattgaatcagcagggtgctttgtctgcttaatataaaataacgttcgaaatgcaat
acataatgactgaataactccaacacgaacaacaactccattttcttctgctatcaaaataacagactcgtgattt
tccaaacgagctttcaaaaaagcctctgccccttgcaaatcggatgcctgtctataaaattcccgatattggttaa
acagcggcgcaatggcggccgcatctgatgtctttgcttggcgaatgttcatcttatttcttcctccctctcaataatt
ttttcattctatccctttctgtaaagtttatttttcagaatacttttatcatcatgctttgaaaaaatatcacgataatatc
cattgttctcacggaagcacacgcaggtcatttgaacgaatttttcgacaggaatttgccgggactcaggagc
atttaacctaaaaaagcatgacatttcagcataatgaacatttactcatgtctattttcgttcttttctgtatgaaaata
gttatttcgagtctctacggaaatagcgagagatgatatacctaaatagagataaaatcatctcaaaaaaatgg
gtctactaaaatattattccatctattacaataaattcacagaatagtcttttaagtaagtctactctgaatttttttaaa
aggagagggtaaagagtgtcattaccgttcttaacttctgcaccgggaaaggttattatttttggtgaacactctg
ctgtgtacaacaagcctgccgtcgctgctagtgtgtctgcgttgagaacctacctgctaataagcgagtcatctg
caccagatactattgaattggacttcccggacattagctttaatcataagtggtccatcaatgatttcaatgccatc
accgaggatcaagtaaactcccaaaaattggccaaggctcaacaagccaccgatggcttgtctcaggaact
cgttagtcttttggatccgttgttagctcaactatccgaatccttccactaccatgcagcgttttgtttcctgtatatgttt
gtttgcctatgcccccatgccaagaatattaagttttctttaaagtctactttacccatcggtgctgggttgggctca
agcgcctctatttctgtatcactggccttagctatggcctacttgggggggttaataggatctaatgacttggaaaa
gctgtcagaaaacgataagcatatagtgaatcaatgggccttcataggtgaaaagtgtattcacggtacccctt
caggaatagataacgctgtggccacttatggtaatgccctgctatttgaaaaagactcacataatggaacaata
aacacaaacaattttaagttcttagatgatttcccagccattccaatgatcctaacctatactagaattccaaggtc
tacaaaagatcttgttgctcgcgttcgtgtgttggtcaccgagaaatttcctgaagttatgaagccaattctagatg
ccatgggtgaatgtgccctacaaggcttagagatcatgactaagttaagtaaatgtaaaggcaccgatgacga
ggctgtagaaactaataatgaactgtatgaacaactattggaattgataagaataaatcatggactgcttgtctc
aatcggtgtttctcatcctggattagaacttattaaaaatctgagcgatgatttgagaattggctccacaaaactta
ccggtgctggtggcggcggttgctctttgactttgttacgaagagacattactcaagagcaaattgacagcttca
aaaagaaattgcaagatgattttagt

Figure 29B

tacgagacatttgaaacagacttgggtgggactggctgctgtttgttaagcgcaaaaaatttgaataaagat
cttaaaatcaaatccctagtattccaattatttgaaaataaaactaccacaaagcaacaaattgacgatctat
tattgccaggaaacacgaatttaccatggacttcataaaaggagagggtgtcagagttgagagccttcagt
gccccagggaaagcgttactagctggtggatatttagttttagatacaaaatatgaagcatttgtagtcggatt
atcggcaagaatgcatgctgtagcccatccttacggttcattgcaagggtctgataagtttgaagtgcgtgtg
aaaagtaaacaatttaaagatggggagtggctgtaccatataagtcctaaaagtggcttcattcctgtttcga
taggcggatctaagaacccttttcattgaaaaagttatcgctaacgtatttagctactttaaacctaacatggac
gactactgcaatagaaacttgttcgttattgatattttctctgatgatgcctaccattctcaggaggatagcgtta
ccgaacatcgtggcaacagaagattgagttttcattcgcacagaattgaagaagttcccaaaacagggct
gggctcctcggcaggtttagtcacagttttaactacagctttggcctccttttttgtatcggacctggaaaataat
gtagacaaatatagagaagttattcataatttagcacaagttgctcattgtcaagctcagggtaaaattggaa
gcgggtttgatgtagcggcggcagcatatggatctatcagatatagaagattcccacccgcattaatctcta
atttgccagatattggaagtgctacttacggcagtaaactggcgcatttggttgatgaagaagactggaatat
tacgattaaaagtaaccatttaccttcgggattaactttatggatgggcgatattaagaatggttcagaaaca
gtaaaactggtccagaaggtaaaaaattggtatgattcgcatatgccagaaagcttgaaaatatatacaga
actcgatcatgcaaattctagatttatggatggactatctaaactagatcgcttacacgagactcatgacgatt
acagcgatcagatatttgagtctcttgagaggaatgactgtacctgtcaaaagtatcctgaaatcacagaag
ttagagatgcagttgccacaattagacgttcctttagaaaaataactaaagaatctggtgccgatatcgaac
ctcccgtacaaactagcttattggatgattgccagaccttaaaaggagttcttacttgcttaatacctggtgctg
gtggttatgacgccattgcagtgattactaagcaagatgttgatcttagggctcaaaccgctaatgacaaaa
gattttctaaggttcaatggctggatgtaactcaggctgactggggtgttaggaaagaaaaagatccggaa
acttatcttgataaataaaaggagagggtgaccgtttacacagcatccgttaccgcacccgtcaacatcgc
aacccttaagtattgggggaaaagggacacgaagttgaatctgcccaccaattcgtccatatcagtgacttt
atcgcaagatgacctcagaacgttgacctctgcggctactgcacctgagtttgaacgcgacactttgtggtta
aatggagaaccacacagcatcgacaatgaaagaactcaaaattgtctgcgcgacctacgccaattaaga
aaggaaatggaatcgaaggacgcctcattgcccacattatctcaatggaaactccacattgtctccgaaaa
taactttcctacagcagctggtttagcttcctccgctgctggctttgctgcattggtctctgcaattgctaagttata
ccaattaccacagtcaacttcagaaatatctagaatagcaagaaaggggtctggttcagcttgtagatcgtt
gtttggcggatacgtggcctgggaaatgggaaaagctgaagatggtcatgattccatggcagtacaaatcg
cagacagctctgactggcctcagatgaaagcttgtgtcctagttgtcagcgatattaaaaaggatgtgagttc
cactcagggtatgcaattgaccgtggcaacctccgaactatttaaagaaagaattgaacatgtcgtaccaa
agagatttgaagtcatgcgtaaagccattgttgaaaaagatttcgccacctttgcaaaggaaacaatgatg
gattccaactctttccatgccacatgtttggactctttccctccaatattctacatgaatgacacttccaagcgtat
catcagttggtgccacaccattaatcagttttacggagaaacaatcgttgcatacacgtttgatgcaggtcca
aatgctgtgttgtactacttagctgaaaatgagtcgaaactctttgcatttatctataaattgtttggctctgttcctg
gatgggacaagaaatttactactgagcagcttgaggctttcaaccatcaatttgaatcatctaactttactgca
cgtgaattggatcttgagttgcaaaaggatgttgccagagtgattttaactcaagtcggttcaggcccacaag
aaacaaacgaatctttgattgacgcaaagactggtctaccaaaggaataaaaggagagggtgactgccg
acaacaatagtatgccccatggtgcagtatctagttacgccaaattagt

Figure 29C

gcaaaaccaaacacctgaagacattttggaagagtttcctgaaattattccattacaacaaagacctaatac
ccgatctagtgagacgtcaaatgacgaaagcggagaaacatgtttttctggtcatgatgaggagcaaattaa
gttaatgaatgaaaattgtattgttttggattgggacgataatgctattggtgccggtaccaagaaagtttgtcatt
taatggaaaatattgaaaagggtttactacatcgtgcattctccgtctttattttcaatgaacaaggtgaattacttt
tacaacaaagagccactgaaaaaataactttccctgatctttggactaacacatgctgctctcatccactatgt
attgatgacgaattaggtttgaagggtaagctagacgataagattaagggcgctattactgcggcggtgaga
aaactagatcatgaattaggtattccagaagatgaaactaagacaaggggtaagtttcacttttaaacagaa
tccattacatggcaccaagcaatgaaccatggggtgaacatgaaattgattacatcctattttataagatcaac
gctaaagaaaacttgactgtcaacccaaacgtcaatgaagttagagacttcaaatgggtttcaccaaatgatt
tgaaaactatgtttgctgacccaagttacaagtttacgccttggtttaagattatttgcgagaattacttattcaact
ggtgggagcaattagatgacctttctgaagtggaaaatgacaggcaaattcatagaatgctataaaaaaaaa
ccggccttggccccgccggttttttattatttttcttcctccgcatgttcaatccgctccataatcgacggatggctc
cctctgaaaattttaacgagaaacggcgggttgacccggctcagtcccgtaacggccaagtcctgaaacgt
ctcaatcgccgcttcccggtttccggtcagctcaatgccgtaacggtcggcggcgttttcctgataccgggaga
cggcattcgtaatttgaatacatacgaacaaattaataaagtgaaaaaaatacttcggaaacatttaaaaaat
aaccttattggtacttacatgtttggatcaggagttgagagtggactaaaaccaaatagtgatcttgacttttagt
cgtcgtatctgaaccattgacagatcaaagtaaagaaatacttatacaaaaaattagacctatttcaaaaaa
aataggagataaaagcaacttacgatatattgaattaacaattattattcagcaagaaatggtaccgtggaat
catcctcccaaacaagaatttatttatggagaatggttacaagagctttatgaacaaggatacattcctcagaa
ggaattaaattcagatttaaccataatgctttaccaagcaaaacgaaaaaataaaagaatatacggaaatta
tgacttagaggaattactacctgatattccattttctgatgtgagaagagccattatggattcgtcagaggaatta
atagataattatcaggatgatgaaaccaactctatattaactttatgccgtatgattttaactatggacacgggta
aaatcataccaaaagatattgcgggaaatgcagtggctgaatcttctccattagaacatagggagagaatttt
gttagcagttcgtagttatcttggagagaatattgaatggactaatgaaaatgtaaatttaactataaactattta
aataacagattaaaaaaattataatgtaacctttgctttcaaatgagtagaaataatgcacatccatgtttgtatc
gtgcaaataaagtgtttcatccgtaggaaaaaatgactttagtatctgttccgctttttctgatgaaatgtgctccc
cgacaaaattgaatgaatcatggacatttgctggctttgatacagcgaaagcagccgttcctatgttatatatcg
gatttaacagcaggacaaaaaacaccatgacagccatcgtcacccacttattcacacgcacataaacctttc
ctgacttttggaacagatgatagctcatcaaaaatcccgccattgccaaataaatcgtatatggcattactgca
ccataatcttttgagatttgattgggatatggcgcaagcagcaagacaagcagtccgataatcagcgtataaa
ataagcctagtaagatcttatccgttctccaatacagcttgaaaaacactacattcaacgcaatgggaagagt
gatgatgaaaaacagaaacacgaatgcaatcggctccatcccatccgggtattccttccaatacgaaaaga
aactaaaaatcatttgtacgatcggcaaactgacaacagcaaggtcgaacgtataaaacttacccttccgc
catgatcacgcggcatcagcatatagtgaaaagccgtcagcagcacatatccgtataacaaaaaatgcag
cagcggcagcagttcttttccgtcctctcttaagtaagcgctggtgaagtttgttgattgcacctggtgaataagtt
caacagacactcccgccagcagcacaatccgcaatataacacccgccaagaacattgtgcgctgccggtt
tattttgggatgatgcaccaaaagatataagcccgccagaacaacaattgaccattgaatcagcagggtgct
ttgtctgcttaatataaaataacgttcgaaatgcaatacataatgactgaataactccaacacgaacaacaaa
agtgcgcatttt

Figure 29D

Ataaaagctaatgattcagtccacataattgatagacgaattctgctacaggtcacgtggctatgtgaagg
atcgcgcgtccagttaagagcaaaaacattgacaaaaaaatttatttatgctaaaatttactattaatatattt
gtatgtataataagattctcctggccaggggaatcttatttttgtggaggatcatttcatgaggaaaaatgag
tccagcttaacgtctctaatttcagcttttgcccgtgcatatcacagccgatatgacacacctcttatttttgatg
attttatcgcaaaagatctcattaacgaaaaagagtttatcgacatcagtaaaaatatgattcaagaaatat
cgtttttcaacaaagagatcgccgaacgtcttcaaaatgatcctgaaaaaatattaaaatgggttgcacaa
atccagctgtctccaacgcccctagcacgtgcttcttattgtgaaaaagtcttgcacaacgaattaatcctgg
gggcaaaacagtatgtcattcttggagcgggactggatactttctgctttcggcatccagaattagaaaac
agcttacaggttttcgaggttgatcatccggccacacagcaattgaaaaaaaataagctgaaggatgca
aatctgacaattccgggtcatcttcattttgttcctatggatttcaccaaaacgttttcgtatgatcctctcttagat
gaaggatttaaaaacacaaaaacattcttcagccttctcggagtgtcttattatgtaacacgggaagaaaa
tgcaagcttgatcagcaatttatttctcatgtcccgcctggaagctctattgtttttgattatgcggacgaaac
acttttacagcaaaagggacgtcgaatcgagttgaacatatggtgaagatggctgccgcaagcgggga
accgatgaaatcatgtttcacttatcaagagattgaacatctg

(SEQ ID NO:13)

Figure 30

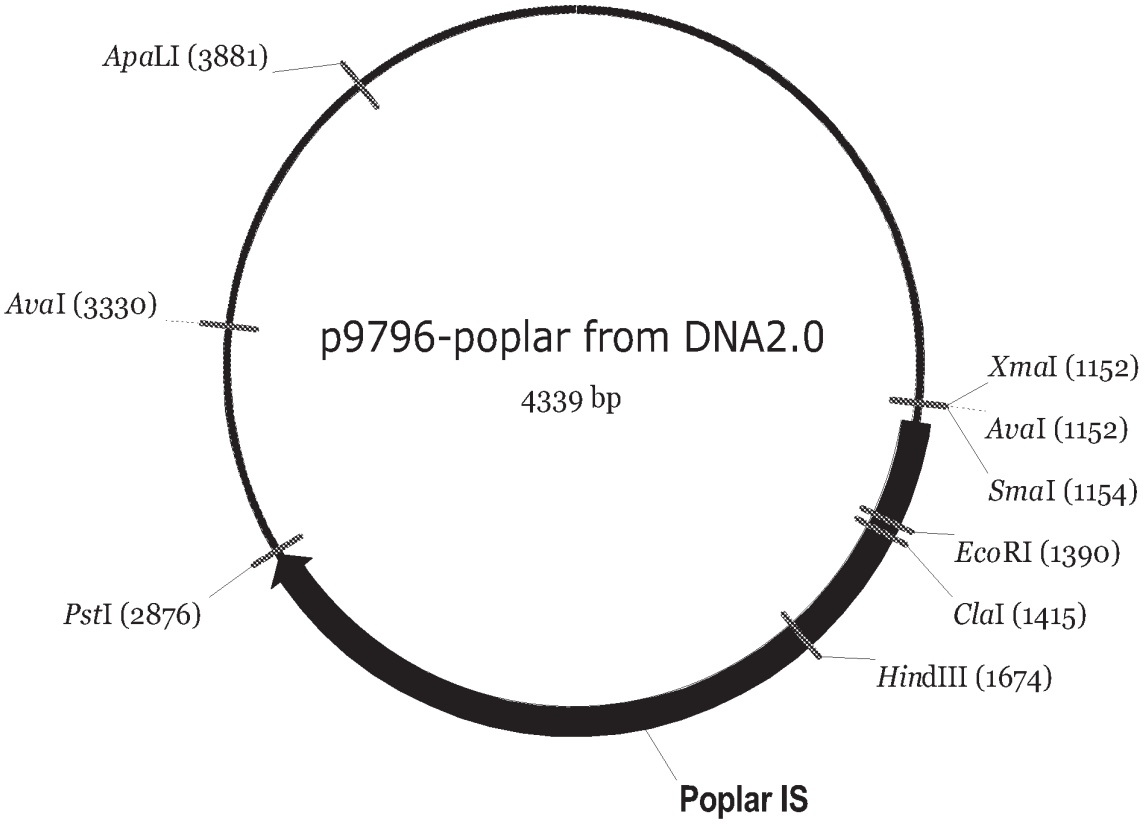

ApaLI (3881)
AvaI (3330)
PstI (2876)
p9796-poplar from DNA2.0
4339 bp
XmaI (1152)
AvaI (1152)
SmaI (1154)
EcoRI (1390)
ClaI (1415)
HindIII (1674)
Poplar IS

Figure 31A

5'-
tagaaaaactcatcgagcatcaaatgaaactgcaatttattcatatcaggattatcaataccatatttttgaaaa
agccgtttctgtaatgaaggagaaaactcaccgaggcagttccataggatggcaagatcctggtatcggtct
gcgattccgactcgtccaacatcaatacaacctattaatttcccctcgtcaaaaataaggttatcaagtgagaa
atcaccatgagtgacgactgaatccggtgagaatggcaaaagtttatgcatttctttccagacttgttcaacag
gccagccattacgctcgtcatcaaaatcactcgcatcaaccaaaccgttattcattcgtgattgcgcctgagcg
aggcgaaatacgcgatcgctgttaaaaggacaattacaaacaggaatcgagtgcaaccggcgcaggaa
cactgccagcgcatcaacaatattttcacctgaatcaggatattcttctaatacctggaacgctgtttttccgggg
atcgcagtggtgagtaaccatgcatcatcaggagtacggataaaatgcttgatggtcggaagtggcataaat
tccgtcagccagtttagtctgaccatctcatctgtaacatcattggcaacgctacctttgccatgtttcagaaaca
actctggcgcatcgggcttcccatacaagcgatagattgtcgcacctgattgcccgacattatcgcgagccca
tttatacccatataaatcagcatccatgttggaatttaatcgcggcctcgacgtttcccgttgaatatggctcatat
tcttcctttttcaatattattgaagcatttatcagggttattgtctcatgagcggatacatatttgaatgtatttagaaa
aataaacaaataggggtcagtgttacaaccaattaaccaattctgaacattatcgcgagcccatttatacctg
aatatggctcataacacccttgtttgcctggcggcagtagcgcggtggtcccacctgaccccatgccgaact
cagaagtgaaacgccgtagcgccgatggtagtgtggggactccccatgcgagagtagggaactgccagg
catcaaataaaacgaaaggctcagtcgaaagactgggcctttcgcccgggctaattagggggtgtcgccctt
tagtcgctgaacatgtgctctgtttctaccgagaacgtttccttcactgagacggaaaccgaggcacgtcgtag
cgcgaactacgagccgaatagctgggactacgatttcctgctgtcttccgatactgacgaatctattgaggtgt
acaaagacaaagcaaagaaactggaggctgaagtgcgccgcgaaattaacaacgagaaagctgaattc
ctgactctgctggagctgatcgataacgtacagcgcctgggtctgggttaccgcttcgaatctgatatccgtcg
cgcactggatcgtttcgtaagcagcggcggtttcgatggcgtgaccaaaacgagcctgcacgctaccgcgc
tgtccttccgtctgctgcgtcagcacggcttcgaagtttctcaggaagcattctccggtttcaaagatcaaaacg
gtaacttcctggaaaacctgaaagaagacactaaggcgatcctgagcctgtatgaggcaagctttctggccc
tggagggtgagaacatcctggatgaggcgcgcgtattcgccatctcccatctgaaagagctgtctgaagag
aaaatcggtaaggaactggcagagcaggttaatcacgcactggaactgccgctgcatcgtcgtacccagc
gtctggaggcggtttggtccatcgaagcgtaccgcaaaaaggaggatgctaaccaggttctgctggaactg
gccatcctggactacaacatgatccagtccgtttaccagcgtgatctgcgtgaaacctcccgttggtggcgcc
gtgtgggcctggcgaccaaactgcacttcgctaaggaccgcctgattgagtctttttactgggcagtcggcgtt
gcgttcgaacctcagtattctgactgccgtaacagcgttgcgaaaatgttcagcttcgttactattatcgacgac
atctacgacgtttacggtactctggacgagctggaactgtttaccgacgctgtcgaacgttgggatgttaacgc
catcaacgatctgcctgactacatgaaactgtgcttcctggcactgtataacacgatcaacgaaattgcatac
gacaacctgaaagacaaaggtgaaaacatcctgccgtacctgactaaagcgtgggcggatctgtgtaacg
cttttctgcaagaagcgaaatggctgtataacaaatccactccgacctttgacgattatttcggcaatgcctgga
aatccagctctggcccgctgcaactgatcttcgcttattttgcggttgtccaaaacatcaaaaaggaggaaatt
gaaaacctgcaaaaataccacgatatcattagccgtccttctcatatctttcgcctgtgcaacgacctggcaa
gcgcgtccgcagagatcgcacgtggcgaaaccgctaactctgtttcctgctacatgcgcaccaagggcattt
ccgaagagctggcaaccgagagcgtaatgaatctgatcgacgaaacctgtaagaaaatgaacaaagaa
aaactgggtggctccctgttcgctaaaccgttcgtagagactgctattaacct

Figure 31B

ggcacgtcagagccactgcacctaccacaatggtgacgcacatactagcccggatgaactgactcg
taaacgtgtactgtctgttatcaccgaaccgattctgccgttcgaacgttaactgcagcgtcaatcgaaa
gggcgacacaaaatttattctaaatgcataataaatactgataacatcttatagtttgtattatattttgtatt
atcgttgacatgtataattttgatatcaaaaactgattttccctttattattttcgagatttattttcttaattctctttt
aacaaactagaaatattgtatatacaaaaaatcataaataatagatgaatagtttaattataggtgttcat
caatcgaaaaagcaacgtatcttatttaaagtgcgttgctttttctcatttataaggttaaataattctcatat
atcaagcaaagtgacaggcgcccttaaatattctgacaaatgctctttccctaaactccccccataaaa
aaacccgccgaagcgggtttttacgttatttgcggattaacgattactcgttatcagaaccgcccaggg
ggcccgagcttaagactggccgtcgttttacaacacagaaagagtttgtagaaacgcaaaaaggcc
atccgtcaggggccttctgcttagtttgatgcctggcagttccctactctcgccttccgcttcctcgctcact
gactcgctgcgctcggtcgttcggctgcggcgagcggtatcagctcactcaaaggcggtaatacggtt
atccacagaatcaggggataacgcaggaaagaacatgtgagcaaaaggccagcaaaaggccag
gaaccgtaaaaaggccgcgttgctggcgtttttccataggctccgccccccctgacgagcatcacaaa
aatcgacgctcaagtcagaggtggcgaaacccgacaggactataaagataccaggcgtttccccct
ggaagctccctcgtgcgctctcctgttccgaccctgccgcttaccggatacctgtccgcctttctcccttcg
ggaagcgtggcgctttctcatagctcacgctgtaggtatctcagttcggtgtaggtcgttcgctccaagct
gggctgtgtgcacgaaccccccgttcagcccgaccgctgcgccttatccggtaactatcgtcttgagtc
caacccggtaagacacgacttatcgccactggcagcagccactggtaacaggattagcagagcga
ggtatgtaggcggtgctacagagttcttgaagtggtgggctaactacggctacactagaagaacagta
tttggtatctgcgctctgctgaagccagttaccttcggaaaaagagttggtagctcttgatccggcaaac
aaaccaccgctggtagcggtggtttttttgtttgcaagcagcagattacgcgcagaaaaaaggatctc
aagaagatcctttgatcttttctacggggtctgacgctcagtggaacgacgcgcgcgtaactcacgtta
agggattttggtcatgagcttgcgccgtcccgtcaagtcagcgtaatgctctgcttt

(SEQ ID NO:14)

Figure 32

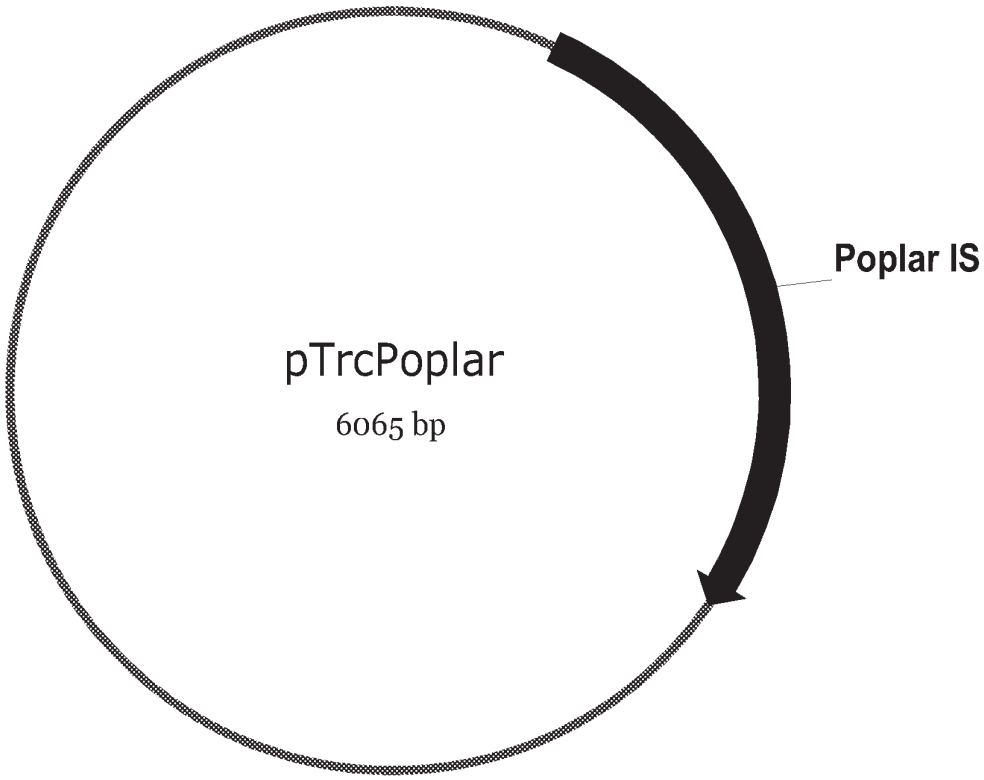


Figure 33A

5'-
gtttgacagcttatcatcgactgcacggtgcaccaatgcttctggcgtcaggcagccatcggaagctgtgg
tatggctgtgcaggtcgtaaatcactgcataattcgtgtcgctcaaggcgcactcccgttctggataatgttttt
tgcgccgacatcataacggttctggcaaatattctgaaatgagctgttgacaattaatcatccggctcgtata
atgtgtggaattgtgagcggataacaatttcacacaggaaacagcgccgctgagaaaaagcgaagcg
gcactgctctttaacaatttatcagacaatctgtgtgggcactcgaccggaattatcgattaactttattattaa
aaattaaagaggtatatattaatgtatcgattaaataaggaggaataaaccatgtgctctgtttctaccgag
aacgtttccttcactgagacggaaaccgaggcacgtcgtagcgcgaactacgagccgaatagctggga
ctacgatttcctgctgtcttccgatactgacgaatctattgaggtgtacaaagacaaagcaaagaaactgg
aggctgaagtgcgccgcgaaattaacaacgagaaagctgaattcctgactctgctggagctgatcgata
acgtacagcgcctgggtctgggttaccgcttcgaatctgatatccgtcgcgcactggatcgtttcgtaagca
gcggcggtttcgatggcgtgaccaaaacgagcctgcacgctaccgcgctgtccttccgtctgctgcgtca
gcacggcttcgaagtttctcaggaagcattctccggtttcaaagatcaaaacggtaacttcctggaaaacc
tgaaagaagacactaaggcgatcctgagcctgtatgaggcaagctttctggccctggagggtgagaac
atcctggatgaggcgcgcgtattcgccatctcccatctgaaagagctgtctgaagagaaaatcggtaagg
aactggcagagcaggttaatcacgcactggaactgccgctgcatcgtcgtacccagcgtctggaggcg
gtttggtccatcgaagcgtaccgcaaaaaggaggatgctaaccaggttctgctggaactggccatcctgg
actacaacatgatccagtccgtttaccagcgtgatctgcgtgaaacctcccgttggtggcgccgtgtgggc
ctggcgaccaaactgcacttcgctaaggaccgcctgattgagtctttttactgggcagtcggcgttgcgttc
gaacctcagtattctgactgccgtaacagcgttgcgaaaatgttcagcttcgttactattatcgacgacatct
acgacgtttacggtactctggacgagctggaactgtttaccgacgctgtcgaacgttgggatgttaacgcc
atcaacgatctgcctgactacatgaaactgtgcttcctggcactgtataacacgatcaacgaaattgcata
cgacaacctgaaagacaaaggtgaaaacatcctgccgtacctgactaaagcgtgggcggatctgtgta
acgcttttctgcaagaagcgaaatggctgtataacaaatccactccgacctttgacgattatttcggcaatg
cctggaaatccagctctggcccgctgcaactgatcttcgcttattttgcggttgtccaaaacatcaaaaagg
aggaaattgaaaacctgcaaaaataccacgatatcattagccgtccttctcatatctttcgcctgtgcaacg
acctggcaagcgcgtccgcagagatcgcacgtggcgaaaccgctaactctgtttcctgctacatgcgca
ccaagggcatttccgaagagctggcaaccgagagcgtaatgaatctgatcgacgaaacctgtaagaaa
atgaacaaagaaaaactgggtggctccctgttcgctaaaccgttcgtagagactgctattaacctggcac
gtcagagccactgcacctaccacaatggtgacgcacatactagcccggatgaactgactcgtaaacgtg
tactgtctgttatcaccgaaccgattctgccgttcgaacgttaactgcagctggtaccatatgggaattcgaa
gctttctagaacaaaaactcatctcagaagaggatctgaatagcgccgtcgaccatcatcatcatcatcat
tgagtttaaacggtctccagcttggctgttttggcggatgagagaagattttcagcctgatacagattaaatc
agaacgcagaagcggtctgataaaacagaatttgcctggcggcagtagcgcggtggtcccacctgacc
ccatgccgaactcagaagtgaaacgccgtagcgccgatggtagtgtggggtctccccatgcgagagta
gggaactgccaggcatcaaataaaacgaaaggctcagtcgaaagactgggcctttcgttttatctgttgttt
gtcggtgaacgctctcctgagtaggacaaatccgccgggagcggatttgaacgttgcgaagcaacggc
ccggagggtggcgggcaggacgcccgccataaactgccaggcatcaaattaagcagaaggccatcct
gacggatggccttttgcgtttctacaaactcttttgtttatttttctaaatacattcaaatatgtatccgctcatga
gacaataaccctgataaatgcttcaataatattgaaaaaggaagagtatgagtattcaacatttc

Figure 33B

cgtgtcgcccttattccctttttgcggcattttgccttcctgtttttgctcacccagaaacgctggtgaaagtaa
aagatgctgaagatcagttgggtgcacgagtgggttacatcgaactggatctcaacagcggtaagatc
cttgagagttttcgccccgaagaacgttttccaatgatgagcacttttaaagttctgctatgtggcgcggtat
tatcccgtgttgacgccgggcaagagcaactcggtcgccgcatacactattctcagaatgacttggttga
gtactcaccagtcacagaaaagcatcttacggatggcatgacagtaagagaattatgcagtgctgccat
aaccatgagtgataacactgcggccaacttacttctgacaacgatcggaggaccgaaggagctaacc
gcttttttgcacaacatgggggatcatgtaactcgccttgatcgttgggaaccggagctgaatgaagccat
accaaacgacgagcgtgacaccacgatgcctgtagcaatggcaacaacgttgcgcaaactattaact
ggcgaactacttactctagcttcccggcaacaattaatagactggatggaggcggataaagttgcagg
accacttctgcgctcggcccttccggctggctggtttattgctgataaatctggagccggtgagcgtgggtc
tcgcggtatcattgcagcactggggccagatggtaagccctcccgtatcgtagttatctacacgacggg
gagtcaggcaactatggatgaacgaaatagacagatcgctgagataggtgcctcactgattaagcatt
ggtaactgtcagaccaagtttactcatatatactttagattgatttaaaacttcatttttaatttaaaaggatct
aggtgaagatccttttttgataatctcatgaccaaaatcccttaacgtgagttttcgttccactgagcgtcaga
ccccgtagaaaagatcaaaggatcttcttgagatcctttttttctgcgcgtaatctgctgcttgcaaacaaa
aaaaccaccgctaccagcggtggtttgtttgccggatcaagagctaccaactctttttccgaaggtaact
ggcttcagcagagcgcagataccaaatactgtccttctagtgtagccgtagttaggccaccacttcaag
aactctgtagcaccgcctacatacctcgctctgctaatcctgttaccagtggctgctgccagtggcgataa
gtcgtgtcttaccgggttggactcaagacgatagttaccggataaggcgcagcggtcgggctgaacgg
ggggttcgtgcacacagcccagcttggagcgaacgacctacaccgaactgagatacctacagcgtga
gctatgagaaagcgccacgcttcccgaagggagaaaggcggacaggtatccggtaagcggcaggg
tcggaacaggagagcgcacgagggagcttccagggggaaacgcctggtatctttatagtcctgtcggg
tttcgccacctctgacttgagcgtcgatttttgtgatgctcgtcaggggggcggagcctatggaaaaacgc
cagcaacgcggccttttttacggttcctggccttttgctggccttttgctcacatgttctttcctgcgttatcccct
gattctgtggataaccgtattaccgcctttgagtgagctgataccgctcgccgcagccgaacgaccgag
cgcagcgagtcagtgagcgaggaagcggaagagcgcctgatgcggtattttctccttacgcatctgtgc
ggtatttcacaccgcatatggtgcactctcagtacaatctgctctgatgccgcatagttaagccagtatac
actccgctatcgctacgtgactgggtcatggctgcgccccgacacccgccaacacccgctgacgcgcc
ctgacgggcttgtctgctcccggcatccgcttacagacaagctgtgaccgtctccgggagctgcatgtgt
cagaggttttcaccgtcatcaccgaaacgcgcgaggcagcagatcaattcgcgcgcgaaggcgaag
cggcatgcatttacgttgacaccatcgaatggtgcaaaacctttcgcggtatggcatgatagcgcccgg
aagagagtcaattcagggtggtgaatgtgaaaccagtaacgttatacgatgtcgcagagtatgccggtg
tctcttatcagaccgtttcccgcgtggtgaaccaggccagccacgtttctgcgaaaacgcgggaaaaag
tggaagcggcgatggcggagctgaattacattcccaaccgcgtggcacaacaactggcgggcaaac
agtcgttgctgattggcgttgccacctccagtctggccctgcacgcgccgtcgcaaattgtcgcggcgatt
aaatctcgcgccgatcaactgggtgccagcgtggtggtgtcgatggtagaacgaagcggcgtcgaag
cctgtaaagcggcggtgcacaatcttctcgcgcaacgcgtcagtgggctgatcattaactatccgctgga
tgaccaggatgccattgctgtggaagctgcctgcactaatgttccggcgttatttcttgatgtctctgaccag
acacccatcaacagtattattttctcccatgaagacggtacgcgactgggcgtggagcatctggtcgcat
tgggtcaccagcaaatcgcgctgttagcgggcccattaagttctgtctcggcgcgtctgcgtctggctggc
tggcataaatatctcactcgcaatc

Figure 33C

aaattcagccgatagcggaacgggaaggcgactggagtgccatgtccggttttcaacaaaccatgca
aatgctgaatgagggcatcgttcccactgcgatgctggttgccaacgatcagatggcgctgggcgcaat
gcgcgccattaccgagtccgggctgcgcgttggtgcggatatctcggtagtgggatacgacgataccg
aagacagctcatgttatatcccgccgtcaaccaccatcaaacaggattttcgcctgctggggcaaacca
gcgtggaccgcttgctgcaactctctcagggccaggcggtgaagggcaatcagctgttgcccgtctcac
tggtgaaaagaaaaaccaccctggcgcccaatacgcaaaccgcctctccccgcgcgttggccgattc
attaatgcagctggcacgacaggtttcccgactggaaagcgggcagtgagcgcaacgcaattaatgtg
agttagcgcgaattgatctg

(SEQ ID NO:15)

Figure 34

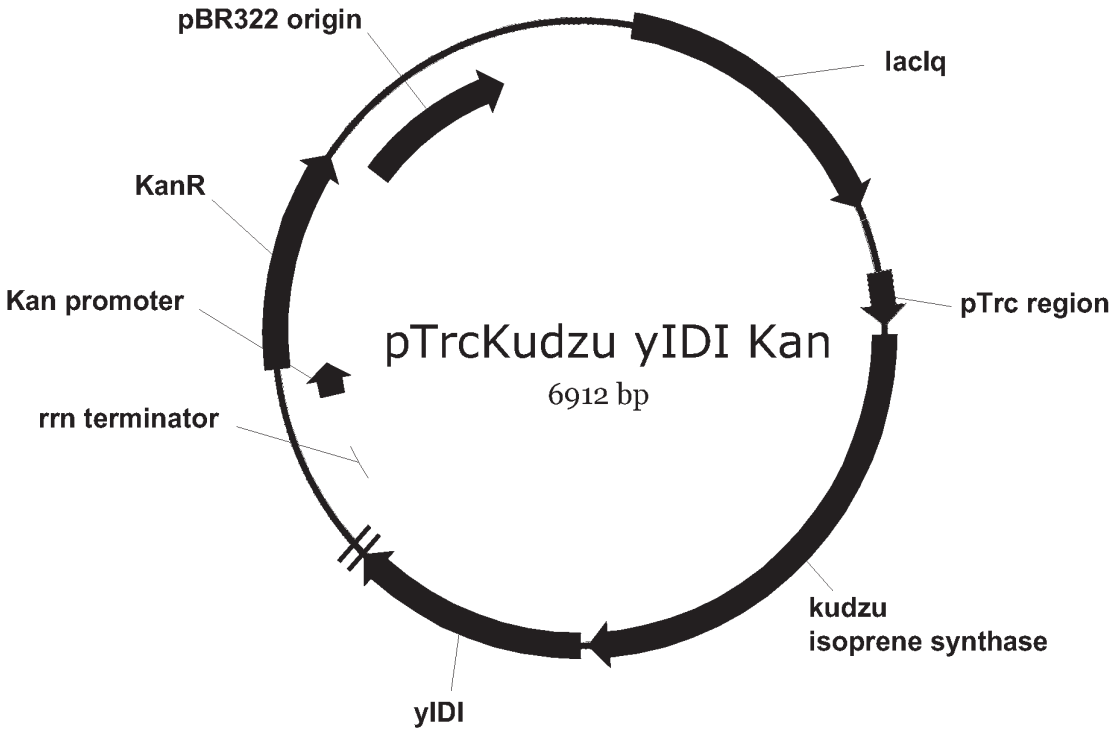

pBR322 origin
laclq
KanR
pTrc region
Kan promoter
pTrcKudzu yIDI Kan
6912 bp
rrn terminator
kudzu
isoprene synthase
yIDI

Figure 35A

5'-
ttgtctgctcccggcatccgcttacagacaagctgtgaccgtctccgggagctgcatgtgtcagaggttttca
ccgtcatcaccgaaacgcgcgaggcagcagatcaattcgcgcgcgaaggcgaagcggcatgcattta
cgttgacaccatcgaatggtgcaaaacctttcgcggtatggcatgatagcgcccggaagagagtcaattc
agggtggtgaatgtgaaaccagtaacgttatacgatgtcgcagagtatgccggtgtctcttatcagaccgtt
tcccgcgtggtgaaccaggccagccacgtttctgcgaaaacgcgggaaaaagtggaagcggcgatgg
cggagctgaattacattcccaaccgcgtggcacaacaactggcgggcaaacagtcgttgctgattggcg
ttgccacctccagtctggccctgcacgcgccgtcgcaaattgtcgcggcgattaaatctcgcgccgatcaa
ctgggtgccagcgtggtggtgtcgatggtagaacgaagcggcgtcgaagcctgtaaagcggcggtgca
caatcttctcgcgcaacgcgtcagtgggctgatcattaactatccgctggatgaccaggatgccattgctgt
ggaagctgcctgcactaatgttccggcgttatttcttgatgtctctgaccagacacccatcaacagtattatttt
ctcccatgaagacggtacgcgactgggcgtggagcatctggtcgcattgggtcaccagcaaatcgcgct
gttagcgggcccattaagttctgtctcggcgcgtctgcgtctggctggctggcataaatatctcactcgcaat
caaattcagccgatagcggaacgggaaggcgactggagtgccatgtccggttttcaacaaaccatgca
aatgctgaatgagggcatcgttcccactgcgatgctggttgccaacgatcagatggcgctgggcgcaatg
cgcgccattaccgagtccgggctgcgcgttggtgcggatatctcggtagtgggatacgacgataccgaa
gacagctcatgttatatcccgccgtcaaccaccatcaaacaggattttcgcctgctggggcaaaccagcg
tggaccgcttgctgcaactctctcagggccaggcggtgaagggcaatcagctgttgcccgtctcactggtg
aaaagaaaaaccaccctggcgcccaatacgcaaaccgcctctccccgcgcgttggccgattcattaat
gcagctggcacgacaggtttcccgactggaaagcgggcagtgagcgcaacgcaattaatgtgagttag
cgcgaattgatctggtttgacagcttatcatcgactgcacggtgcaccaatgcttctggcgtcaggcagcc
atcggaagctgtggtatggctgtgcaggtcgtaaatcactgcataattcgtgtcgctcaaggcgcactccc
gttctggataatgtttttttgcgccgacatcataacggttctggcaaatattctgaaatgagctgttgacaattaa
tcatccggctcgtataatgtgtggaattgtgagcggataacaatttcacacaggaaacagcgccgctgag
aaaaagcgaagcggcactgctctttaacaatttatcagacaatctgtgtgggcactcgaccggaattatcg
attaactttattattaaaaattaaagaggtatatattaatgtatcgattaaataaggaggaataaaccatgtgt
gcgacctcttctcaatttactcagattaccgagcataattcccgtcgttccgcaaactatcagccaaacctgt
ggaatttcgaattcctgcaatccctggagaacgacctgaaagtggaaaagctggaggagaaagcgac
caaactggaggaagaagttcgctgcatgatcaaccgtgtagacacccagccgctgtccctgctggagct
gatcgacgatgtgcagcgcctgggtctgacctacaaatttgaaaaagacatcattaaagccctggaaaa
catcgtactgctggacgaaaacaaaaagaacaaatctgacctgcacgcaaccgctctgtctttccgtctg
ctgcgtcagcacggtttcgaggtttctcaggatgtttttgagcgtttcaaggataaagaaggtggtttcagcg
gtgaactgaaaggtgacgtccaaggcctgctgagcctgtatgaagcgtcttacctgggtttcgagggtga
gaacctgctggaggaggcgcgtacctttccatcacccacctgaagaacaacctgaaagaaggcatta
ataccaaggttgcagaacaagtgagccacgccctggaactgccatatcaccagcgtctgcaccgtctgg
aggcacgttggttcctggataaatacgaaccgaaagaaccgcatcaccagctgctgctggagctggcg
aagctggattttaacatggtacagaccctgcaccagaaagagctgcaagatctgtcccgctggtggacc
gagatgggcctggctagcaaactggattttgtacgcgaccgcctgatggaagtttatttctgggcactgggt
atggcgccagacccgcagtttggtgaatgtcgcaaagctgttactaaaatgtttggtctggtgacgatcatc
gatgacgtgtatgacgt

Figure 35B

ttatggcactctggacgaactgcaactgttcaccgatgctgtagagcgctgggacgttaacgctattaacac
cctgccggactatatgaaactgtgtttcctggcactgtacaacaccgttaacgacacgtcctattctattctga
aagagaaaggtcataacaacctgtcctatctgacgaaaagctggcgtgaactgtgcaaagcctttctgca
agaggcgaaatggtccaacaacaaaattatcccggctttctccaagtacctggaaaacgccagcgtttcct
cctccggtgtagcgctgctggcgccgtcttacttttccgtatgccagcagcaggaagacatctccgaccacg
cgctgcgttccctgaccgacttccatggtctggtgcgttctagctgcgttatcttccgcctgtgcaacgatctgg
ccacctctgcggcggagctggaacgtggcgagactaccaattctatcattagctacatgcacgaaaacga
tggtaccagcgaggaacaggcccgcgaagaactgcgtaaactgatcgacgccgaatggaaaaagatg
aatcgtgaacgcgttagcgactccaccctgctgcctaaagcgttcatggaaatcgcagttaacatggcacg
tgtttcccactgcacctaccagtatggcgatggtctgggtcgcccagactacgcgactgaaaaccgcatca
aactgctgctgattgacccttcccgattaaccagctgatgtatgtctaactgcatcgcccttaggaggtaaaa
aaaaatgactgccgacaacaatagtatgccccatggtgcagtatctagttacgccaaattagtgcaaaacc
aaacacctgaagacattttggaagagtttcctgaaattattccattacaacaaagacctaatacccgatcta
gtgagacgtcaaatgacgaaagcggagaaacatgtttttctggtcatgatgaggagcaaattaagttaatg
aatgaaaattgtattgttttggattgggacgataatgctattggtgccggtaccaagaaagtttgtcatttaatgg
aaaatattgaaaagggtttactacatcgtgcattctccgtctttattttcaatgaacaaggtgaattacttttaca
acaaagagccactgaaaaaataacttttccctgatctttggactaacacatgctgctctcatccactatgtattg
atgacgaattaggtttgaagggtaagctagacgataagattaagggcgctattactgcggcggtgagaaa
actagatcatgaattaggtattccagaagatgaaactaagacaaggggtaagtttcacttttaaacagaat
ccattacatggcaccaagcaatgaaccatggggtgaacatgaaattgattacatcctatttttataagatcaa
cgctaaagaaaacttgactgtcaacccaaacgtcaatgaagttagagacttcaaatgggtttcaccaaatg
atttgaaaactatgtttgctgacccaagttacaagtttacgccttggtttaagattatttgcgagaattacttattc
aactggtgggagcaattagatgacctttctgaagtggaaaatgacaggcaaattcatagaatgctataaca
acgcgtcctgcagctggtaccatatgggaattcgaagctttctagaacaaaaactcatctcagaagaggat
ctgaatagcgccgtcgaccatcatcatcatcatcattgagtttaaacggtctccagcttggctgttttggcggat
gagagaagattttcagcctgatacagattaaatcagaacgcagaagcggtctgataaaacagaatttgcct
ggcggcagtagcgcggtggtcccacctgaccccatgccgaactcagaagtgaaacgccgtagcgccga
tggtagtgtggggtctccccatgcgagagtagggaactgccaggcatcaaataaaacgaaaggctcagt
cgaaagactgggcctttcgttttatctgttgtttgtcggtgaacgctctcctgagtaggacaaatccgccgggga
gcggatttgaacgttgcgaagcaacggcccggagggtggcgggcaggacgcccgccataaactgcca
ggcatcaaattaagcagaaggccatcctgacggatggccttttgcgtttctacaaactcttttgtttatttttcta
aatacattcaaatatgtatccgcttaaccggaattgccagctggggcgccctctggtaaggttgggaagccc
tgcaaagtaaactggatggctttctcgccgccaaggatctgatggcgcaggggatcaagctctgatcaag
agacaggatgaggatcgtttcgcatgattgaacaagatggattgcacgcaggttctccggccgcttgggtg
gagaggctattcggctatgactgggcacaacagacaatcggctgctctgatgccgccgtgttccggctgtc
agcgcaggggcgcccggttctttttgtcaagaccgacctgtccggtgccctgaatgaactgcaagacgag
gcagcgcggctatcgtggctggccacgacgggcgttccttgcgcagctgtgctcgacgttgtcactgaagc
gggaagggactggctgctattgggcgaagtgccggggcaggatctcctgtcatctcaccttgctcctgccg
agaaagtatccatcatggctgat

Figure 35C

gcaatgcggcggctgcatacgcttgatccggctacctgcccattcgaccaccaagcgaaacatcgca
tcgagcgagcacgtactcggatggaagccggtcttgtcgatcaggatgatctggacgaagagcatca
ggggctcgcgccagccgaactgttcgccaggctcaaggcgagcatgcccgacggcgaggatctcg
tcgtgacccatggcgatgcctgcttgccgaatatcatggtggaaaatggccgcttttctggattcatcga
ctgtggccggctgggtgtggcggaccgctatcaggacatagcgttggctacccgtgatattgctgaag
agcttggcggcgaatgggctgaccgcttcctcgtgctttacggtatcgccgctcccgattcgcagcgca
tcgccttctatcgccttcttgacgagttcttctgacatgaccaaaatcccttaacgtgagttttcgttccactg
agcgtcagaccccgtagaaaagatcaaaggatcttcttgagatccttttttttctgcgcgtaatctgctgctt
gcaaacaaaaaaaccaccgctaccagcggtggtttgtttgccggatcaagagctaccaactctttttcc
gaaggtaactggcttcagcagagcgcagataccaaatactgtccttctagtgtagccgtagttaggcc
accacttcaagaactctgtagcaccgcctacatacctcgctctgctaatcctgttaccagtggctgctgc
cagtggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccggataaggcgcagcggt
cgggctgaacgggggttcgtgcacacagcccagcttggagcgaacgacctacaccgaactgaga
tacctacagcgtgagctatgagaaagcgccacgcttcccgaagggagaaaggcggacaggtatcc
ggtaagcggcagggtcggaacaggagagcgcacgagggagcttccagggggaaacgcctggtat
ctttatagtcctgtcgggtttcgccacctctgacttgagcgtcgatttttgtgatgctcgtcaggggggcgg
agcctatggaaaaacgccagcaacgcggccttttacggttcctggccttttgctggccttttgctcacat
gttctttcctgcgttatcccctgattctgtggataaccgtattaccgcctttgagtgagctgataccgctcgc
cgcagccgaacgaccgagcgcagcgagtcagtgagcgaggaagcggaagagcgcctgatgcg
gtattttctccttacgcatctgtgcggtatttcacaccgcatatggtgcactctcagtacaatctgctctgatg
ccgcatagttaagccagtatacactccgctatcgctacgtgactgggtcatggctgcgccccgacacc
cgccaacacccgctgacgcgccctgacgggc

(SEQ ID NO:16)

Figure 36

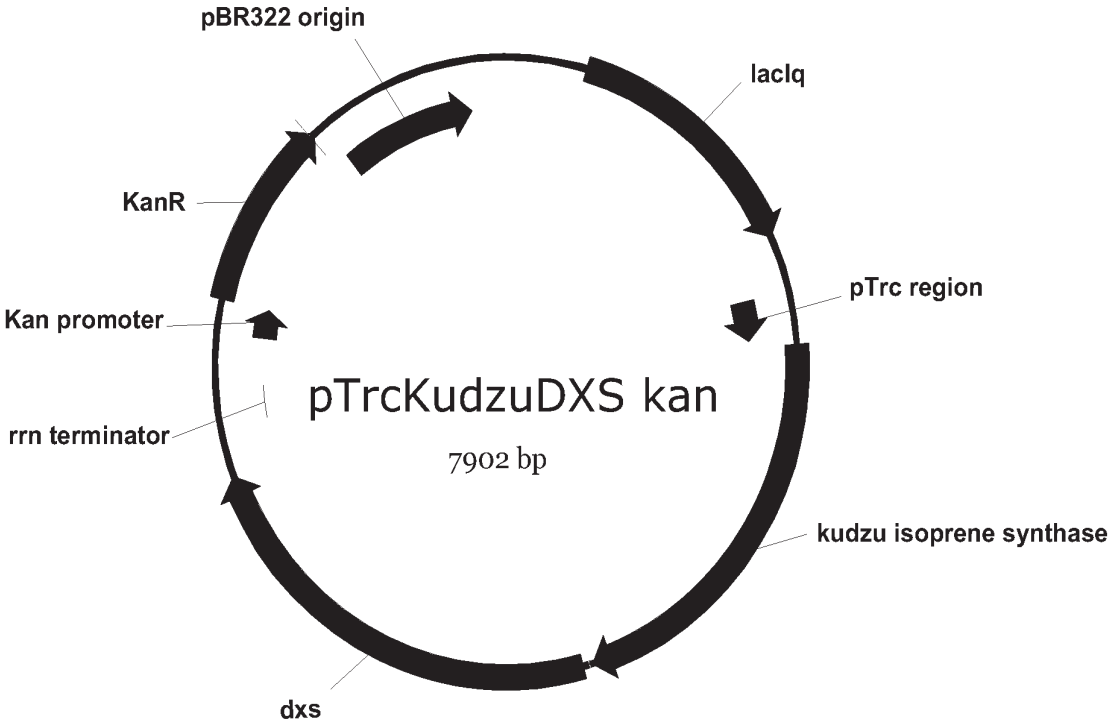

pBR322 origin
laclq
KanR
pTrc region
Kan promoter
pTrcKudzuDXS kan
7902 bp
rrn terminator
kudzu isoprene synthase
dxs

Figure 37A

5'-
ttgtctgctcccggcatccgcttacagacaagctgtgaccgtctccgggagctgcatgtgtcagaggttttca
ccgtcatcaccgaaacgcgcgaggcagcagatcaattcgcgcgcgaaggcgaagcggcatgcattta
cgttgacaccatcgaatggtgcaaaacctttcgcggtatggcatgatagcgcccggaagagagtcaattc
agggtggtgaatgtgaaaccagtaacgttatacgatgtcgcagagtatgccggtgtctcttatcagaccgtt
tcccgcgtggtgaaccaggccagccacgtttctgcgaaaacgcgggaaaaagtggaagcggcgatgg
cggagctgaattacattcccaaccgcgtggcacaacaactggcgggcaaacagtcgttgctgattggcg
ttgccacctccagtctggccctgcacgcgccgtcgcaaattgtcgcggcgattaaatctcgcgccgatcaa
ctgggtgccagcgtggtggtgtcgatggtagaacgaagcggcgtcgaagcctgtaaagcggcggtgca
caatcttctcgcgcaacgcgtcagtgggctgatcattaactatccgctggatgaccaggatgccattgctgt
ggaagctgcctgcactaatgttccggcgttatttcttgatgtctctgaccagacacccatcaacagtattatttt
ctcccatgaagacggtacgcgactgggcgtggagcatctggtcgcattgggtcaccagcaaatcgcgct
gttagcgggcccattaagttctgtctcggcgcgtctgcgtctggctggctggcataaatatctcactcgcaat
caaattcagccgatagcggaacgggaaggcgactggagtgccatgtccggttttcaacaaaccatgca
aatgctgaatgagggcatcgttcccactgcgatgctggttgccaacgatcagatggcgctgggcgcaatg
cgcgccattaccgagtccgggctgcgcgttggtgcggatatctcggtagtgggatacgacgataccgaa
gacagctcatgttatatcccgccgtcaaccaccatcaaacaggattttcgcctgctggggcaaaccagcg
tggaccgcttgctgcaactctctcagggccaggcggtgaagggcaatcagctgttgcccgtctcactggtg
aaaagaaaaaccaccctggcgcccaatacgcaaaccgcctctccccgcgcgttggccgattcattaat
gcagctggcacgacaggtttcccgactggaaagcgggcagtgagcgcaacgcaattaatgtgagttag
cgcgaattgatctggtttgacagcttatcatcgactgcacggtgcaccaatgcttctggcgtcaggcagcc
atcggaagctgtggtatggctgtgcaggtcgtaaatcactgcataattcgtgtcgctcaaggcgcactccc
gttctggataatgtttttttgcgccgacatcataacggttctggcaaatattctgaaatgagctgttgacaattaa
tcatccggctcgtataatgtgtggaattgtgagcggataacaatttcacacaggaaacagcgccgctgag
aaaaagcgaagcggcactgctctttaacaatttatcagacaatctgtgtgggcactcgaccggaattatcg
attaactttattattaaaaattaaagaggtatatattaatgtatcgattaaataaggaggaataaaccatgtgt
gcgacctcttctcaatttactcagattaccgagcataattcccgtcgttccgcaaactatcagccaaacctgt
ggaatttcgaattcctgcaatccctggagaacgacctgaaagtggaaaagctggaggagaaagcgac
caaactggaggaagaagttcgctgcatgatcaaccgtgtagacacccagccgctgtccctgctggagct
gatcgacgatgtgcagcgcctgggtctgacctacaaatttgaaaaagacatcattaaagccctggaaaa
catcgtactgctggacgaaaacaaaaagaacaaatctgacctgcacgcaaccgctctgtctttccgtctg
ctgcgtcagcacggtttcgaggtttctcaggatgtttttgagcgtttcaaggataaagaaggtggtttcagcg
gtgaactgaaaggtgacgtccaaggcctgctgagcctgtatgaagcgtcttacctgggtttcgagggtga
gaacctgctggaggaggcgcgtacctttccatcacccacctgaagaacaacctgaaagaaggcatta
ataccaaggttgcagaacaagtgagccacgccctggaactgccatatcaccagcgtctgcaccgtctgg
aggcacgttggttcctggataaatacgaaccgaaagaaccgcatcaccagctgctgctggagctggcg
aagctggattttaacatggtacagaccctgcaccagaaagagctgcaagatctgtcccgctggtggacc
gagatgggcctggctagcaaactggattttgtacgcgaccgcctgatggaagtttatttctgggcactgggt
atggcgccagacccgcagtttggtgaatgtcgcaaagctgttactaaaatgtttggtctggtgacgatcatc
gatgacgtgtatgacgtttatggcactctggacgaactgcaactgttcaccgatgctgtagagcgctggga
cgttaacgct

Figure 37B

attaacaccctgccggactatatgaaactgtgtttcctggcactgtacaacaccgttaacgacacgtccta
ttctattctgaaagagaaaggtcataacaacctgtcctatctgacgaaaagctggcgtgaactgtgcaa
agcctttctgcaagaggcgaaatggtccaacaacaaaattatcccggctttctccaagtacctggaaaa
cgccagcgtttcctcctccggtgtagcgctgctggcgccgtcttacttttccgtatgccagcagcaggaag
acatctccgaccacgcgctgcgttccctgaccgacttccatggtctggtgcgttctagctgcgttatcttccg
cctgtgcaacgatctggccacctctgcggcggagctggaacgtggcgagactaccaattctatcattag
ctacatgcacgaaaacgatggtaccagcgaggaacaggcccgcgaagaactgcgtaaactgatcg
acgccgaatggaaaaagatgaatcgtgaacgcgttagcgactccaccctgctgcctaaagcgttcatg
gaaatcgcagttaacatggcacgtgtttcccactgcacctaccagtatggcgatggtctgggtcgcccag
actacgcgactgaaaaccgcatcaaactgctgctgattgacccttcccgattaaccagctgatgtatgtc
taactgcattcgcccttaggaggtaaaaaaacatgagttttgatattgccaaatacccgaccctggcact
ggtcgactccacccaggagttacgactgttgccgaaagagagtttaccgaaactctgcgacgaactgc
gccgctatttactcgacagcgtgagccgttccagcgggcacttcgcctccgggctgggcacggtcgaa
ctgaccgtggcgctgcactatgtctacaacaccccgtttgaccaattgatttgggatgtggggcatcagg
cttatccgcataaaattttgaccggacgccgcgacaaaatcggcaccatccgtcagaaaggcggtctg
cacccgttcccgtggcgcggcgaaagcgaatatgacgtattaagcgtcgggcattcatcaacctccatc
agtgccggaattggtattgcggttgctgccgaaaaagaaggcaaaaatcgccgcaccgtctgtgtcatt
ggcgatggcgcgattaccgcaggcatggcgtttgaagcgatgaatcacgcgggcgatatccgtcctga
tatgctggtgattctcaacgacaatgaaatgtcgatttccgaaaatgtcggcgcgctcaacaaccatctg
gcacagctgctttccggtaagctttactcttcactgcgcgaaggcgggaaaaaagttttctctggcgtgcc
gccaattaaagagctgctcaaacgcaccgaagaacatattaaaggcatggtagtgcctggcacgttgtt
tgaagagctgggctttaactacatcggcccggtggacggtcacgatgtgctggggcttatcaccacgct
aaagaacatgcgcgacctgaaaggcccgcagttcctgcatatcatgaccaaaaaaggtcgtggttatg
aaccggcagaaaaagacccgatcactttccacgccgtgcctaaatttgatccctccagcggttgtttgcc
gaaaagtagcggcggtttgccgagctattcaaaaatctttggcgactggttgtgcgaaacggcagcga
aagacaacaagctgatggcgattactccggcgatgcgtgaaggttccggcatggtcgagttttcacgta
aattcccggatcgctacttcgacgtggcaattgccgagcaacacgcggtgacctttgctgcgggtctggc
gattggtgggtacaaacccattgtcgcgatttactccactttcctgcaacgcgcctatgatcaggtgctgca
tgacgtggcgattcaaaagcttccggtcctgttcgccatcgaccgcgcgggcattgttggtgctgacggtc
aaacccatcagggtgcttttgatctctcttacctgcgctgcataccggaaatggtcattatgaccccgagc
gatgaaaacgaatgtcgccagatgctctataccggctatcactataacgatggcccgtcagcggtgcg
ctacccgcgtggcaacgcggtcggcgtggaactgacgccgctggaaaaactaccaattggcaaagg
cattgtgaagcgtcgtggcgagaaactggcgatccttaactttggtacgctgatgccagaagcggcgaa
agtcgccgaatcgctgaacgccacgctggtcgatatgcgttttgtgaaaccgcttgatgaagcgttaattc
tggaaatggccgccagccatgaagcgctggtcaccgtagaagaaaacgccattatgggcggcgcag
gcagcggcgtgaacgaagtgctgatggcccatcgtaaaccagtacccgtgctgaacattggcctgccg
gacttctttattccgcaaggaactcaggaagaaatgcgcgccgaactcggcctcgatgccgctggtatg
gaagccaaaatcaaggcctggctggcataactgcagctggtaccatatgggaattcgaagctttctaga
acaaaaactcatctcagaagaggatctgaatagcgccgtcgaccatcatcatcatcattgagtttaa
acggtctccagcttggctgttttggcggatgagagaagattttcagcctgatacagattaaatcagaacg
cagaagcggtctgataaaacagaatttgcctggcggcagtagcgcg

Figure 37C

gtggtcccacctgaccccatgccgaactcagaagtgaaacgccgtagcgccgatggtagtgtggggtct
ccccatgcgagagtagggaactgccaggcatcaaataaaacgaaaggctcagtcgaaagactgggc
ctttcgttttatctgttgtttgtcggtgaacgctctcctgagtaggacaaatccgccgggagcggatttgaacg
ttgcgaagcaacggcccggagggtggcgggcaggacgcccgccataaactgccaggcatcaaatta
agcagaaggccatcctgacggatggccttttgcgtttctacaaactctttttgtttatttttctaaatacattcaa
atatgtatccgcttaaccggaattgccagctggggcgccctctggtaaggttgggaagccctgcaaagta
aactggatggctttctcgccgccaaggatctgatggcgcaggggatcaagctctgatcaagagacagga
tgaggatcgtttcgcatgattgaacaagatggattgcacgcaggttctccggccgcttgggtggagaggct
attcggctatgactgggcacaacagacaatcggctgctctgatgccgccgtgttccggctgtcagcgcag
gggcgcccggttctttttgtcaagaccgacctgtccggtgccctgaatgaactgcaagacgaggcagcgc
ggctatcgtggctggccacgacgggcgttccttgcgcagctgtgctcgacgttgtcactgaagcgggaag
ggactggctgctattgggcgaagtgccggggcaggatctcctgtcatctcaccttgctcctgccgagaaa
gtatccatcatggctgatgcaatgcggcggctgcatacgcttgatccggctacctgcccattcgaccacca
agcgaaacatcgcatcgagcgagcacgtactcggatggaagccggtcttgtcgatcaggatgatctgga
cgaagagcatcaggggctcgcgccagccgaactgttcgccaggctcaaggcgagcatgcccgacgg
cgaggatctcgtcgtgacccatggcgatgcctgcttgccgaatatcatggtggaaaatggccgcttttctgg
attcatcgactgtggccggctgggtgtggcggaccgctatcaggacatagcgttggctacccgtgatattg
ctgaagagcttggcggcgaatgggctgaccgcttcctcgtgctttacggtatcgccgctcccgattcgcag
cgcatcgccttctatcgccttcttgacgagttcttctgacgcatgaccaaaatcccttaacgtgagttttcgttc
cactgagcgtcagaccccgtagaaaagatcaaaggatcttcttgagatcctttttttctgcgcgtaatctgct
gcttgcaaacaaaaaaaccaccgctaccagcggtggtttgtttgccggatcaagagctaccaactcttttt
ccgaaggtaactggcttcagcagagcgcagataccaaatactgtccttctagtgtagccgtagttaggcc
accacttcaagaactctgtagcaccgcctacatacctcgctctgctaatcctgttaccagtggctgctgcca
gtggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccggataaggcgcagcggtcgg
gctgaacgggggttcgtgcacacagcccagcttggagcgaacgacctacaccgaactgagataccta
cagcgtgagctatgagaaagcgccacgcttcccgaagggagaaaggcggacaggtatccggtaagc
ggcagggtcggaacaggagagcgcacgagggagcttccagggggaaacgcctggtatctttatagtcc
tgtcgggtttcgccacctctgacttgagcgtcgatttttgtgatgctcgtcaggggggcggagcctatggaaa
aacgccagcaacgcggccttttacggttcctggccttttgctggccttttgctcacatgttctttcctgcgttatc
ccctgattctgtggataaccgtattaccgcctttgagtgagctgataccgctcgccgcagccgaacgaccg
agcgcagcgagtcagtgagcgaggaagcggaagagcgcctgatgcggtattttctccttacgcatctgtg
cggtatttcacaccgcatatggtgcactctcagtacaatctgctctgatgccgcatagttaagccagtatac
actccgctatcgctacgtgactgggtcatggctgcgccccgacacccgccaacacccgctgacgcgccc
tgacgggc

(SEQ ID NO:17)

Figure 38

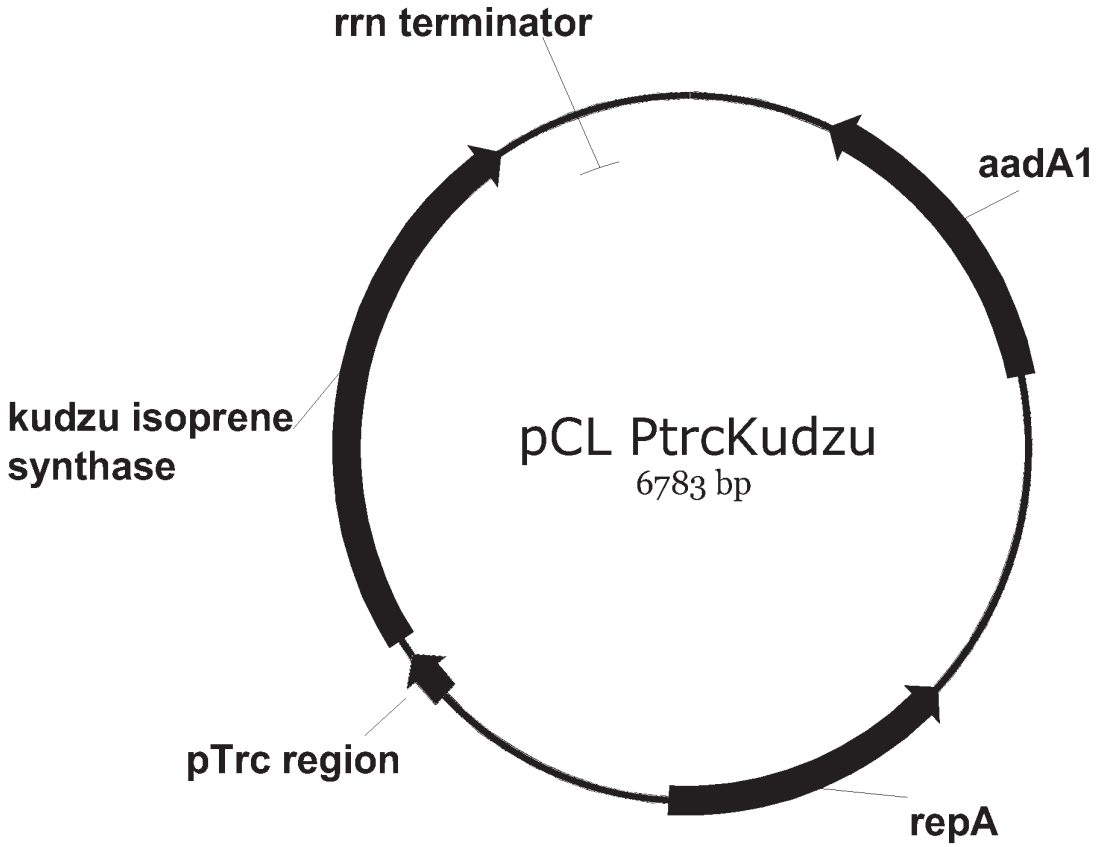

rrn terminator
aadA1
kudzu isoprene synthase
pCL PtrcKudzu
6783 bp
pTrc region
repA

Figure 39A

5'-
ctggcgtaatagcgaagaggcccgcaccgatcgcccttcccaacagttgcgcagcctgaatggcgaa
tggcgcctgatgcggtattttctccttacgcatctgtgcggtatttcacaccgcatatggtgcactctcagtac
aatctgctctgatgccgcatagttaagccagccccgacacccgccaacacccgctgacgagcttagta
aagccctcgctagattttaatgcggatgttgcgattacttcgccaactattgcgataacaagaaaaagcc
agcctttcatgatatatctcccaatttgtgtagggcttattatgcacgcttaaaaataataaaagcagacttg
acctgatagtttggctgtgagcaattatgtgcttagtgcatctaacgcttgagttaagccgcgccgcgaag
cggcgtcggcttgaacgaattgttagacattatttgccgactaccttggtgatctcgcctttcacgtagtgga
caaattcttccaactgatctgcgcgcgaggccaagcgatcttcttcttgtccaagataagcctgtctagctt
caagtatgacgggctgatactgggccggcaggcgctccattgcccagtcggcagcgacatccttcggc
gcgattttgccggttactgcgctgtaccaaatgcgggacaacgtaagcactacatttcgctcatcgccag
cccagtcgggcggcgagttccatagcgttaaggtttcatttagcgcctcaaatagatcctgttcaggaac
cggatcaaagagttcctccgccgctggacctaccaaggcaacgctatgttctcttgcttttgtcagcaaga
tagccagatcaatgtcgatcgtggctggctcgaagatacctgcaagaatgtcattgcgctgccattctcc
aaattgcagttcgcgcttagctggataacgccacggaatgatgtcgtcgtgcacaacaatggtgacttct
acagcgcggagaatctcgctctctccaggggaagccgaagtttccaaaaggtcgttgatcaaagctcg
ccgcgttgtttcatcaagccttacggtcaccgtaaccagcaaatcaatatcactgtgtggcttcaggccgc
catccactgcggagccgtacaaatgtacggccagcaacgtcggttcgagatggcgctcgatgacgcc
aactacctctgatagttgagtcgatacttcggcgatcaccgcttccctcatgatgtttaactttgttttagggc
gactgccctgctgcgtaacatcgttgctgctccataacatcaaacatcgacccacggcgtaacgcgctt
gctgcttggatgcccgaggcatagactgtaccccaaaaaaacagtcataacaagccatgaaaaccgc
cactgcgccgttaccaccgctgcgttcggtcaaggttctggaccagttgcgtgagcgcatacgctacttg
cattacagcttacgaaccgaacaggcttatgtccactgggttcgtgccttcatccgtttccacggtgtgcgt
cacccggcaaccttgggcagcagcgaagtcgaggcatttctgtcctggctggcgaacgagcgcaagg
tttcggtctccacgcatcgtcaggcattggcggccttgctgttcttctacggcaaggtgctgtgcacggatct
gccctggcttcaggagatcggaagacctcggccgtcgcggcgcttgccggtggtgctgaccccggatg
aagtggttcgcatcctcggttttctggaaggcgagcatcgtttgttcgcccagcttctgtatggaacgggca
tgcggatcagtgagggtttgcaactgcgggtcaaggatctggatttcgatcacggcacgatcatcgtgcg
ggagggcaagggctccaaggatcgggccttgatgttacccgagagcttggcacccagcctgcgcgag
caggggaattaattcccacgggttttgctgcccgcaaacgggctgttctggtgttgctagtttgttatcagaa
tcgcagatccggcttcagccggtttgccggctgaaagcgctatttcttccagaattgccatgatttttttcccc
acgggaggcgtcactggctcccgtgttgtcggcagctttgattcgataagcagcatcgcctgtttcaggct
gtctatgtgtgactgttgagctgtaacaagttgtctcaggtgttcaatttcatgttctagttgctttgttttactggtt
tcacctgttctattaggtgttacatgctgttcatctgttacattgtcgatctgttcatggtgaacagctttgaatg
caccaaaaactcgtaaaagctctgatgtatctatctttttacaccgttttcatctgtgcatatggacagttttc
cctttgatatgtaacggtgaacagttgttctacttttgtttgttagtcttgatgcttcactgatagatacaagagc
cataagaacctcagatccttccgtatttagccagtatgttctctagtgtggttcgttgtttttgcgtgagccatg
agaacgaaccattgagatcatacttactttgcatgtcactcaaaaattttgcctcaaaactggtgagctga
atttttgcagttaaagcatcgtgtagtgtttttcttagtccgttatgtaggtaggaatctgatgtaatggttgttgg
tattttgtcaccattcatttttatctggttgttctcaagttcgg

Figure 39B

ttacgagatccatttgtctatctagttcaacttggaaaatcaacgtatcagtcgggcggcctcgcttatcaacc
accaatttcatattgctgtaagtgtttaaatctttacttattggtttcaaaacccattggttaagccttttaaactcat
ggtagttatttttcaagcattaacatgaacttaaattcatcaaggctaatctctatatttgccttgtgagttttcttttgt
gttagttcttttaataaccactcataaatcctcatagagtatttgttttcaaaagacttaacatgttccagattatatt
ttatgaatttttttaactggaaaagataaggcaatatctcttcactaaaaactaattctaatttttcgcttgagaac
ttggcatagtttgtccactggaaaatctcaaagcctttaaccaaaggattcctgatttccacagttctcgtcatc
agctctctggttgctttagctaatacaccataagcattttccctactgatgttcatcatctgagcgtattggttata
agtgaacgataccgtccgttctttccttgtagggttttcaatcgtggggttgagtagtgccacacagcataaaa
ttagcttggtttcatgctccgttaagtcatagcgactaatcgctagttcatttgctttgaaaacaactaattcaga
catacatctcaattggtctaggtgattttaatcactataccaattgagatgggctagtcaatgataattactagtc
cttttcctttgagttgtgggtatctgtaaattctgctagacctttgctggaaaacttgtaaattctgctagaccctct
gtaaattccgctagacctttgtgtgttttttttgtttatattcaagtggttataatttatagaataaagaaagaataa
aaaaagataaaaagaatagatcccagccctgtgtataactcactactttagtcagttccgcagtattacaaa
aggatgtcgcaaacgctgtttgctcctctacaaaacagaccttaaaaccctaaaggcttaagtagcaccct
cgcaagctcgggcaaatcgctgaatattccttttgtctccgaccatcaggcacctgagtcgctgtctttttcgtg
acattcagttcgctgcgctcacggctctggcagtgaatgggggtaaatggcactacaggcgccttttatggat
tcatgcaaggaaactacccataatacaagaaaagcccgtcacgggcttctcagggcgttttatggcgggtc
tgctatgtggtgctatctgactttttgctgttcagcagttcctgccctctgattttccagtctgaccacttcggattat
cccgtgacaggtcattcagactggctaatgcacccagtaaggcagcggtatcatcaacaggcttacccgtc
ttactgtcgggaattcgcgttggccgattcattaatgcagattctgaaatgagctgttgacaattaatcatccgg
ctcgtataatgtgtggaattgtgagcggataacaatttcacacaggaaacagcgccgctgagaaaaagcg
aagcggcactgctctttaacaatttatcagacaatctgtgtgggcactcgaccggaattatcgattaactttatt
attaaaaattaaagaggtatatattaatgtatcgattaaataaggaggaataaaccatgtgtgcgacctcttct
caatttactcagattaccgagcataattcccgtcgttccgcaaactatcagccaaacctgtggaatttcgaatt
cctgcaatccctggagaacgacctgaaagtggaaaagctggaggagaaagcgaccaaactggagga
agaagttcgctgcatgatcaaccgtgtagacacccagccgctgtccctgctggagctgatcgacgatgtgc
agcgcctgggtctgacctacaaatttgaaaaagacatcattaaagccctggaaaacatcgtactgctggac
gaaaacaaaaagaacaaatctgacctgcacgcaaccgctctgtctttccgtctgctgcgtcagcacggtttc
gaggtttctcaggatgtttttgagcgtttcaaggataaagaaggtggtttcagcggtgaactgaaaggtgacg
tccaaggcctgctgagcctgtatgaagcgtcttacctgggtttcgagggtgagaacctgctggaggaggcg
cgtacctttccatcacccacctgaagaacaacctgaaagaaggcattaataccaaggttgcagaacaag
tgagccacgccctggaactgccatatcaccagcgtctgcaccgtctggaggcacgttggttcctggataaat
acgaaccgaaagaaccgcatcaccagctgctgctggagctggcgaagctggattttaacatggtacaga
ccctgcaccagaaagagctgcaagatctgtcccgctggtggaccgagatgggcctggctagcaaactgg
attttgtacgcgaccgcctgatggaagtttatttctgggcactgggtatggcgccagacccgcagtttggtga
atgtcgcaaagctgttactaaaatgtttggtctggtgacgatcatcgatgacgtgtatgacgtttatggcactct
ggacgaactgcaactgttcaccgatgctgtagagcgctgggacgttaacgctattaacaccctgccggact
atatgaaactgtgtttcctggcactgtacaacaccgttaacgacacgtcctattctattctgaaagagaaagg
tcataacaacctgtcct

Figure 39C

atctgacgaaaagctggcgtgaactgtgcaaagcctttctgcaagaggcgaaatggtccaacaaca
aaattatcccggctttctccaagtacctggaaaacgccagcgtttcctcctccggtgtagcgctgctggc
gccgtcttacttttccgtatgccagcagcaggaagacatctccgaccacgcgctgcgttccctgaccga
cttccatggtctggtgcgttctagctgcgttatcttccgcctgtgcaacgatctggccacctctgcggcgg
agctggaacgtggcgagactaccaattctatcattagctacatgcacgaaaacgatggtaccagcga
ggaacaggcccgcgaagaactgcgtaaactgatcgacgccgaatggaaaaagatgaatcgtgaa
cgcgttagcgactccaccctgctgcctaaagcgttcatggaaatcgcagttaacatggcacgtgtttcc
cactgcacctaccagtatggcgatggtctgggtcgcccagactacgcgactgaaaaccgcatcaaa
ctgctgctgattgacccttcccgattaaccagctgatgtatgtctaactgcagctggtaccatatgggaa
ttcgaagctttctagaacaaaaactcatctcagaagaggatctgaatagcgccgtcgaccatcatcat
catcatcattgagtttaaacggtctccagcttggctgttttggcggatgagagaagattttcagcctgatac
agattaaatcagaacgcagaagcggtctgataaaacagaatttgcctggcggcagtagcgcggtgg
tcccacctgaccccatgccgaactcagaagtgaaacgccgtagcgccgatggtagtgtggggtctcc
ccatgcgagagtagggaactgccaggcatcaaataaaacgaaaggctcagtcgaaagactgggc
ctttcgttttatctgttgtttgtcggtgaacgctctcctgagtaggacaaatccgccgggagcggatttgaa
cgttgcgaagcaacggcccggagggtggcgggcaggacgcccgccataaactgccaggcatcaa
attaagcagaaggccatcctgacggatggccttttgcgtttctacaaactctttttgtttatttttctaaatac
attcaaatatgtatccgctcatgagacaataaccctgataaatgcttcaataat

(SEQ ID NO:18)

Figure 40

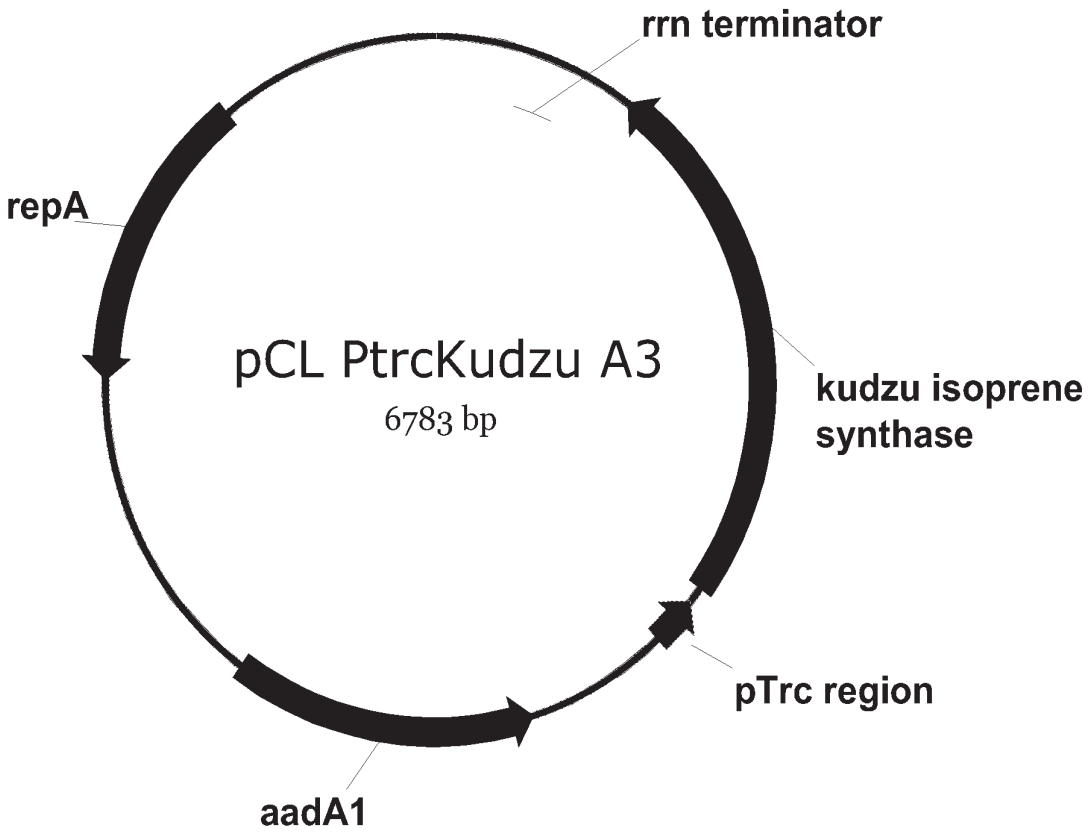

rrn terminator
repA
pCL PtrcKudzu A3
6783 bp
kudzu isoprene synthase
pTrc region
aadA1

Figure 41A

5'-

cccgtcttactgtcgggaattcgcgttggccgattcattaatgcagattattgaagcatttatcagggttattgtctc
atgagcggatacatatttgaatgtatttagaaaaataaacaaaaagagtttgtagaaacgcaaaaaggccat
ccgtcaggatggccttctgcttaatttgatgcctggcagtttatggcgggcgtcctgcccgccaccctccgggc
cgttgcttcgcaacgttcaaatccgctcccggcggatttgtcctactcaggagagcgttcaccgacaaacaac
agataaaacgaaaggcccagtctttcgactgagcctttcgttttatttgatgcctggcagttccctactctcgcat
ggggagaccccacactaccatcggcgctacggcgtttcacttctgagttcggcatggggtcaggtgggacc
accgcgctactgccgccaggcaaattctgttttatcagaccgcttctgcgttctgatttaatctgtatcaggctga
aaatcttctctcatccgccaaaacagccaagctggagaccgtttaaactcaatgatgatgatgatgatggtcg
acggcgctattcagatcctcttctgagatgagtttttgttctagaaagcttcgaattcccatatggtaccagctgc
agttagacatacatcagctggttaatcgggaaagggtcaatcagcagcagtttgatgcggttttcagtcgcgta
gtctgggcgacccagaccatcgccatactggtaggtgcagtgggaaacacgtgccatgttaactgcgatttc
catgaacgctttaggcagcagggtggagtcgctaacgcgttcacgattcatctttttccattcggcgtcgatcag
tttacgcagttcttcgcgggcctgttcctcgctggtaccatcgttttcgtgcatgtagctaatgatagaattggtagt
ctcgccacgttccagctccgccgcagaggtggccagatcgttgcacaggcggaagataacgcagctagaa
cgcaccagaccatggaagtcggtcagggaacgcagcgcgtggtcggagatgtcttcctgctgctggcatac
ggaaaagtaagacggcgccagcagcgctacaccggaggaggaaacgctggcgttttccaggtacttgga
gaaagccgggataattttgttgttggaccatttcgcctcttgcagaaaggctttgcacagttcacgccagcttttc
gtcagataggacaggttgttatgacctttctctttcagaatagaataggacgtgtcgttaacggtgttgtacagtg
ccaggaaacacagtttcatatagtccggcagggtgttaatagcgttaacgtcccagcgctctacagcatcggt
gaacagttgcagttcgtccagagtgccataaacgtcatacacgtcatcgatgatcgtcaccagaccaaacat
tttagtaacagctttgcgacattcaccaaactgcgggtctggcgccatacccagtgcccagaaataaacttcc
atcaggcggtcgcgtacaaaatccagtttgctagccaggcccatctcggtccaccagcgggacagatcttgc
agctctttctggtgcagggtctgtaccatgttaaaatccagcttcgccagctccagcagcagctggtgatgcgg
ttctttcggttcgtatttatccaggaaccaacgtgcctccagacggtgcagacgctggtgatatggcagttccag
ggcgtggctcacttgttctgcaaccttggtattaatgccttctttcaggttgttcttcaggtgggtgatggaaaaggt
acgcgcctcctccagcaggttctcaccctcgaaacccaggtaagacgcttcatacaggctcagcaggcctt
ggacgtcacctttcagttcaccgctgaaaccaccttctttatccttgaaacgctcaaaaacatcctgagaaacc
tcgaaaccgtgctgacgcagcagacggaaagacagagcggttgcgtgcaggtcagatttgttctttttgttttc
gtccagcagtacgatgttttccagggctttaatgatgtctttttcaaatttgtaggtcagacccaggcgctgcaca
tcgtcgatcagctccagcagggacagcggctgggtgtctacacggttgatcatgcagcgaacttcttcctcca
gtttggtcgctttctcctccagcttttccactttcaggtcgttctccagggattgcaggaattcgaaattccacaggt
ttggctgatagtttgcggaacgacgggaattatgctcggtaatctgagtaaattgagaagaggtcgcacacat
ggtttattcctccttatttaatcgatacattaatatatacctctttaatttttaataataaagttaatcgataattccggt
cgagtgcccacacagattgtctgataaattgttaaagagcagtgccgcttcgctttttctcagcggcgctgtttcc
tgtgtgaaattgttatccgctcacaattccacacattatacgagccggatgattaattgtcaacagctcatttcag
aatctggcgtaatagcgaagaggcccgcaccgatcgcccttcccaacagttgcgcagcctgaatggcgaa
tggcgcctgatgcggtattttctccttacgcatctgtgcggtatttcacaccgcatatggtgcactctcagtacaat
ctgctc

Figure 41B

tgatgccgcatagttaagccagccccgacacccgccaacacccgctgacgagcttagtaaagccctcg
ctagattttaatgcggatgttgcgattacttcgccaactattgcgataacaagaaaaagccagcctttcatg
atatatctcccaatttgtgtagggcttattatgcacgcttaaaaataataaaagcagacttgacctgatagttt
ggctgtgagcaattatgtgcttagtgcatctaacgcttgagttaagccgcgccgcgaagcggcgtcggctt
gaacgaattgttagacattatttgccgactaccttggtgatctcgcctttcacgtagtggacaaattcttccaa
ctgatctgcgcgcgaggccaagcgatcttcttcttgtccaagataagcctgtctagcttcaagtatgacggg
ctgatactgggccggcaggcgctccattgcccagtcggcagcgacatccttcggcgcgattttgccggtta
ctgcgctgtaccaaatgcgggacaacgtaagcactacatttcgctcatcgccagcccagtcgggcggcg
agttccatagcgttaaggtttcatttagcgcctcaaatagatcctgttcaggaaccggatcaaagagttcctc
cgccgctggacctaccaaggcaacgctatgttctcttgcttttgtcagcaagatagccagatcaatgtcgat
cgtggctggctcgaagatacctgcaagaatgtcattgcgctgccattctccaaattgcagttcgcgcttagc
tggataacgccacggaatgatgtcgtcgtgcacaacaatggtgacttctacagcgcggagaatctcgctc
tctccaggggaagccgaagtttccaaaaggtcgttgatcaaagctcgccgcgttgtttcatcaagccttac
ggtcaccgtaaccagcaaatcaatatcactgtgtggcttcaggccgccatccactgcggagccgtacaa
atgtacggccagcaacgtcggttcgagatggcgctcgatgacgccaactacctctgatagttgagtcgat
acttcggcgatcaccgcttccctcatgatgtttaactttgttttagggcgactgccctgctgcgtaacatcgttg
ctgctccataacatcaaacatcgacccacggcgtaacgcgcttgctgcttggatgcccgaggcatagact
gtaccccaaaaaaacagtcataacaagccatgaaaaccgccactgcgccgttaccaccgctgcgttcg
gtcaaggttctggaccagttgcgtgagcgcatacgctacttgcattacagcttacgaaccgaacaggctta
tgtccactgggttcgtgccttcatccgtttccacggtgtgcgtcacccggcaaccttgggcagcagcgaagt
cgaggcatttctgtcctggctggcgaacgagcgcaaggtttcggtctccacgcatcgtcaggcattggcg
gccttgctgttcttctacggcaaggtgctgtgcacggatctgccctggcttcaggagatcggaagacctcg
gccgtcgcggcgcttgccggtggtgctgaccccggatgaagtggttcgcatcctcggttttctggaaggcg
agcatcgtttgttcgcccagcttctgtatggaacgggcatgcggatcagtgagggtttgcaactgcgggtca
aggatctggatttcgatcacggcacgatcatcgtgcgggagggcaagggctccaaggatcgggccttga
tgttacccgagagcttggcacccagcctgcgcgagcaggggaattaattcccacgggttttgctgcccgc
aaacgggctgttctggtgttgctagtttgttatcagaatcgcagatccggcttcagccggtttgccggctgaa
agcgctatttcttccagaattgccatgatttttttccccacgggaggcgtcactggctcccgtgttgtcggcagc
tttgattcgataagcagcatcgcctgtttcaggctgtctatgtgtgactgttgagctgtaacaagttgtctcagg
tgttcaatttcatgttctagttgctttgttttactggtttcacctgttctattaggtgttacatgctgttcatctgttacatt
gtcgatctgttcatggtgaacagctttgaatgcaccaaaaactcgtaaaagctctgatgtatctatctttttttac
accgttttcatctgtgcatatggacagttttcccttgatatgtaacggtgaacagttgttctacttttgtttgttagt
cttgatgcttcactgatagatacaagagccataagaacctcagatccttccgtatttagccagtatgttctcta
gtgtggttcgttgtttttgcgtgagccatgagaacgaaccattgagatcatacttactttgcatgtcactcaaa
aattttgcctcaaaactggtgagctgaatttttgcagttaaagcatcgtgtagtgtttttcttagtccgttatgtag
gtaggaatctgatgtaatggttgttggtattttgtcaccattcatttttatctggttgttctcaagttcggttacgag
atccatttgtctatctagttcaacttggaaaatcaacgtatcagtcgggcggcctcgcttatcaaccaccaat
ttcatattgctgtaagtgtttaaatctttacttattggtttcaaaacccattggttaagccttttaaactcatggtagt
tattttcaagcattaacatgaacttaaattcatcaaggctaatctctatatttgc

Figure 41C

cttgtgagttttcttttgtgttagttcttttaataaccactcataaatcctcatagagtatttgttttcaaaagacttaa
catgttccagattatattttatgaatttttttaactggaaaagataaggcaatatctcttcactaaaaactaattc
taatttttcgcttgagaacttggcatagtttgtccactggaaaatctcaaagcctttaaccaaaggattcctga
tttccacagttctcgtcatcagctctctggttgctttagctaatacaccataagcattttccctactgatgttcatc
atctgagcgtattggttataagtgaacgataccgtccgttctttccttgtagggttttcaatcgtggggttgagta
gtgccacacagcataaaattagcttggtttcatgctccgttaagtcatagcgactaatcgctagttcatttgctt
tgaaaacaactaattcagacatacatctcaattggtctaggtgattttaatcactataccaattgagatgggc
tagtcaatgataattactagtccttttcctttgagttgtgggtatctgtaaattctgctagacctttgctggaaaac
ttgtaaattctgctagaccctctgtaaattccgctagacctttgtgtgttttttttgtttatattcaagtggttataattt
atagaataaagaaagaataaaaaaaagataaaaagaatagatcccagccctgtgtataactcactactttt
agtcagttccgcagtattacaaaaggatgtcgcaaacgctgtttgctcctctacaaaacagaccttaaaac
cctaaaggcttaagtagcaccctcgcaagctcgggcaaatcgctgaatattccttttgtctccgaccatcag
gcacctgagtcgctgtctttttcgtgacattcagttcgctgcgctcacggctctggcagtgaatgggggtaaa
tggcactacaggcgccttttatggattcatgcaaggaaactacccataatacaagaaaagcccgtcacg
ggcttctcagggcgttttatggcgggtctgctatgtggtgctatctgactttttgctgttcagcagttcctgccctc
tgattttccagtctgaccacttcggattatcccgtgacaggtcattcagactggctaatgcacccagtaagg
cagcggtatcatcaacaggctta

(SEQ ID NO:19)

Figure 42

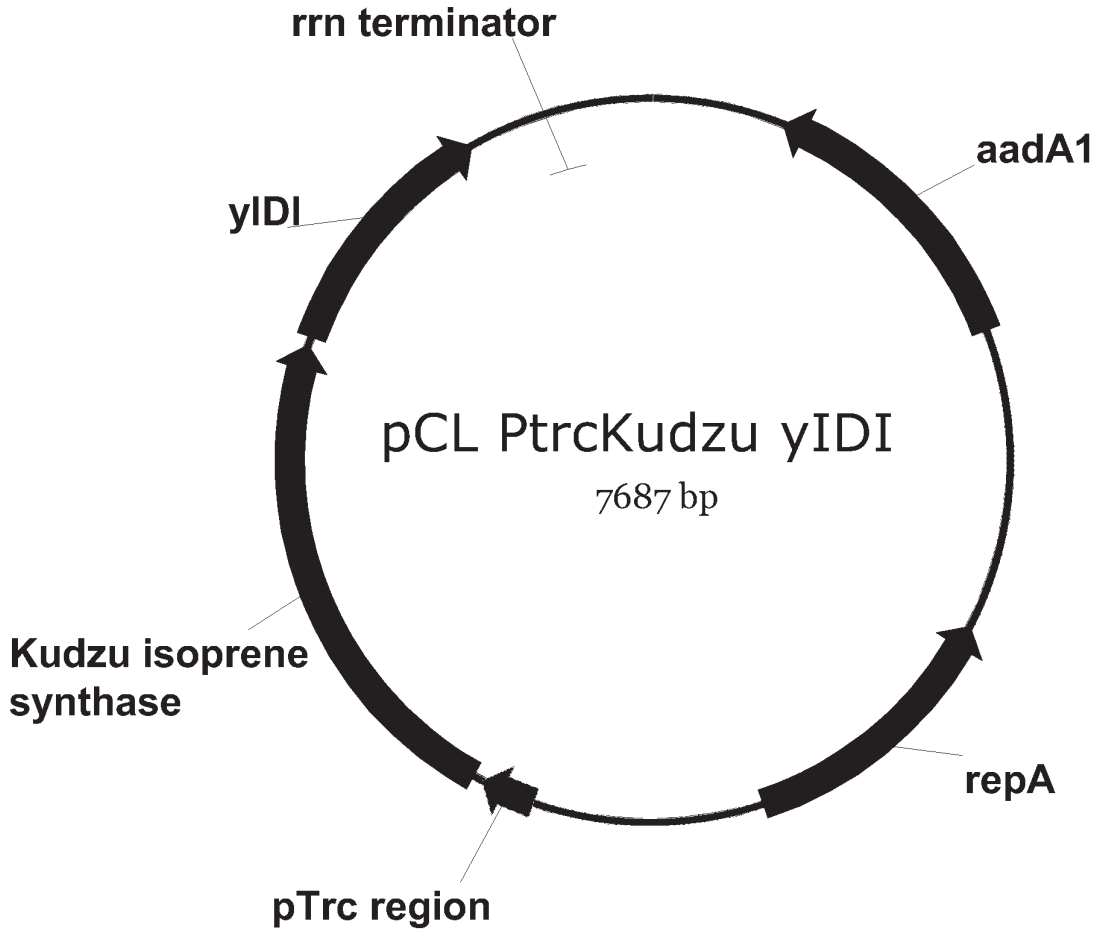

rrn terminator
aadA1
yIDI
pCL PtrcKudzu yIDI
7687 bp
Kudzu isoprene synthase
repA
pTrc region

Figure 43A

5'-

ctggcgtaatagcgaagaggcccgcaccgatcgcccttcccaacagttgcgcagcctgaatggcgaa
tggcgcctgatgcggtattttctccttacgcatctgtgcggtatttcacaccgcatatggtgcactctcagtac
aatctgctctgatgccgcatagttaagccagccccgacacccgccaacacccgctgacgagcttagta
aagccctcgctagattttaatgcggatgttgcgattacttcgccaactattgcgataacaagaaaaagcc
agcctttcatgatatatctcccaatttgtgtagggcttattatgcacgcttaaaaataataaaagcagacttg
acctgatagtttggctgtgagcaattatgtgcttagtgcatctaacgcttgagttaagccgcgccgcgaag
cggcgtcggcttgaacgaattgttagacattatttgccgactaccttggtgatctcgcctttcacgtagtgga
caaattcttccaactgatctgcgcgcgaggccaagcgatcttcttcttgtccaagataagcctgtctagctt
caagtatgacgggctgatactgggccggcaggcgctccattgcccagtcggcagcgacatccttcggc
gcgattttgccggttactgcgctgtaccaaatgcgggacaacgtaagcactacatttcgctcatcgccag
cccagtcgggcggcgagttccatagcgttaaggtttcatttagcgcctcaaatagatcctgttcaggaac
cggatcaaagagttcctccgccgctggacctaccaaggcaacgctatgttctcttgcttttgtcagcaaga
tagccagatcaatgtcgatcgtggctggctcgaagatacctgcaagaatgtcattgcgctgccattctcc
aaattgcagttcgcgcttagctggataacgccacggaatgatgtcgtcgtgcacaacaatggtgacttct
acagcgcggagaatctcgctctctccaggggaagccgaagtttccaaaaggtcgttgatcaaagctcg
ccgcgttgtttcatcaagccttacggtcaccgtaaccagcaaatcaatatcactgtgtggcttcaggccgc
catccactgcggagccgtacaaatgtacggccagcaacgtcggttcgagatggcgctcgatgacgcc
aactacctctgatagttgagtcgatacttcggcgatcaccgcttccctcatgatgtttaactttgttttagggc
gactgccctgctgcgtaacatcgttgctgctccataacatcaaacatcgacccacggcgtaacgcgctt
gctgcttggatgcccgaggcatagactgtaccccaaaaaaacagtcataacaagccatgaaaaccgc
cactgcgccgttaccaccgctgcgttcggtcaaggttctggaccagttgcgtgagcgcatacgctacttg
cattacagcttacgaaccgaacaggcttatgtccactgggttcgtgccttcatccgtttccacggtgtgcgt
cacccggcaaccttgggcagcagcgaagtcgaggcatttctgtcctggctggcgaacgagcgcaagg
tttcggtctccacgcatcgtcaggcattggcggccttgctgttcttctacggcaaggtgctgtgcacggatct
gccctggcttcaggagatcggaagacctcggccgtcgcggcgcttgccggtggtgctgaccccggatg
aagtggttcgcatcctcggttttctggaaggcgagcatcgtttgttcgcccagcttctgtatggaacgggca
tgcggatcagtgagggtttgcaactgcgggtcaaggatctggatttcgatcacggcacgatcatcgtgcg
ggagggcaagggctccaaggatcgggccttgatgttacccgagagcttggcacccagcctgcgcgag
caggggaattaattcccacgggttttgctgcccgcaaacgggctgttctggtgttgctagtttgttatcagaa
tcgcagatccggcttcagccggtttgccggctgaaagcgctatttcttccagaattgccatgatttttcccc
acgggaggcgtcactggctcccgtgttgtcggcagctttgattcgataagcagcatcgcctgtttcaggct
gtctatgtgtgactgttgagctgtaacaagttgtctcaggtgttcaatttcatgttctagttgctttgttttactggtt
tcacctgttctattaggtgttacatgctgttcatctgttacattgtcgatctgttcatggtgaacagctttgaatg
caccaaaaactcgtaaaagctctgatgtatctatctttttacaccgttttcatctgtgcatatggacagttttc
cctttgatatgtaacggtgaacagttgttctacttttgtttgttagtcttgatgcttcactgatagatacaagagc
cataagaacctcagatccttccgtatttagccagtatgttctctagtgtggttcgttgtttttgcgtgagccatg
agaacgaaccattgagatcatacttactttgcatgtcactcaaaaattttgcctcaaaactggtgagctga
atttttgcagttaaagcatcgtgtagtgtttttcttagtccgttatgtaggtaggaatctgatgtaatggttgttgg
tattttgtcaccattcatttttatctggttgttctcaagttcgg

Figure 43B

ttacgagatccatttgtctatctagttcaacttggaaaatcaacgtatcagtcgggcggcctcgcttatcaa
ccaccaatttcatattgctgtaagtgtttaaatctttacttattggtttcaaaacccattggttaagccttttaaa
ctcatggtagttattttcaagcattaacatgaacttaaattcatcaaggctaatctctatatttgccttgtgagtt
ttcttttgtgttagttcttttaataaccactcataaatcctcatagagtatttgttttcaaaagacttaacatgttcc
agattatattttatgaatttttttaactggaaaagataaggcaatatctcttcactaaaaactaattctaatttttt
cgcttgagaacttggcatagtttgtccactggaaaatctcaaagcctttaaccaaaggattcctgatttcca
cagttctcgtcatcagctctctggttgctttagctaatacaccataagcattttccctactgatgttcatcatctg
agcgtattggttataagtgaacgataccgtccgttctttccttgtagggttttcaatcgtggggttgagtagtg
ccacacagcataaaattagcttggtttcatgctccgttaagtcatagcgactaatcgctagttcatttgctttg
aaaacaactaattcagacatacatctcaattggtctaggtgattttaatcactataccaattgagatgggct
agtcaatgataattactagtccttttccttgagttgtgggtatctgtaaattctgctagacctttgctggaaaa
cttgtaaattctgctagaccctctgtaaattccgctagacctttgtgtgttttttttgtttatattcaagtggttataa
tttatagaataaagaaagaataaaaaaagataaaaagaatagatcccagccctgtgtataactcacta
ctttagtcagttccgcagtattacaaaaggatgtcgcaaacgctgtttgctcctctacaaaacagacctta
aaaccctaaaggcttaagtagcaccctcgcaagctcgggcaaatcgctgaatattccttttgtctccgac
catcaggcacctgagtcgctgtctttttcgtgacattcagttcgctgcgctcacggctctggcagtgaatgg
gggtaaatggcactacaggcgcctttatggattcatgcaaggaaactacccataatacaagaaaagc
ccgtcacgggcttctcagggcgttttatggcgggtctgctatgtggtgctatctgactttttgctgttcagcagt
tcctgccctctgattttccagtctgaccacttcggattatcccgtgacaggtcattcagactggctaatgcac
ccagtaaggcagcggtatcatcaacaggcttacccgtcttactgtcgggaattcgcgttggccgattcatt
aatgcagattctgaaatgagctgttgacaattaatcatccggctcgtataatgtgtggaattgtgagcggat
aacaatttcacacaggaaacagcgccgctgagaaaaagcgaagcggcactgctctttaacaatttatc
agacaatctgtgtgggcactcgaccggaattatcgattaactttattattaaaaattaaagaggtatatatt
aatgtatcgattaaataaggaggaataaaccatgtgtgcgacctcttctcaatttactcagattaccgagc
ataattcccgtcgttccgcaaactatcagccaaacctgtggaatttcgaattcctgcaatccctggagaac
gacctgaaagtggaaaagctggaggagaaagcgaccaaactggaggaagaagttcgctgcatgat
caaccgtgtagacacccagccgctgtccctgctggagctgatcgacgatgtgcagcgcctgggtctga
cctacaaatttgaaaaagacatcattaaagccctggaaaacatcgtactgctggacgaaaacaaaaa
gaacaaatctgacctgcacgcaaccgctctgtctttccgtctgctgcgtcagcacggtttcgaggtttctca
ggatgtttttgagcgtttcaaggataaagaaggtggtttcagcggtgaactgaaaggtgacgtccaagg
cctgctgagcctgtatgaagcgtcttacctgggtttcgagggtgagaacctgctggaggaggcgcgtac
cttttccatcacccacctgaagaacaacctgaaagaaggcattaataccaaggttgcagaacaagtga
gccacgccctggaactgccatatcaccagcgtctgcaccgtctggaggcacgttggttcctggataaat
acgaaccgaaagaaccgcatcaccagctgctgctggagctggcgaagctggattttaacatggtaca
gaccctgcaccagaaagagctgcaagatctgtcccgctggtggaccgagatgggcctggctagcaaa
ctggattttgtacgcgaccgcctgatggaagtttatttctgggcactgggtatggcgccagacccgcagttt
ggtgaatgtcgcaaagctgttactaaaatgtttggtctggtgacgatcatcgatgacgtgtatgacgtttatg
gcactctggacgaactgcaactgttcaccgatgctgtagagcgctgggacgttaacgctattaacaccct
gccggactatatgaaactgtgtttcctggcactgtacaacaccgttaacgacacgtcctattctattctgaa
agagaaaggtcataacaacctgtcct

Figure 43C

atctgacgaaaagctggcgtgaactgtgcaaagcctttctgcaagaggcgaaatggtccaacaa
caaaattatcccggctttctccaagtacctggaaaacgccagcgtttcctcctccggtgtagcgctgc
tggcgccgtcttacttttccgtatgccagcagcaggaagacatctccgaccacgcgctgcgttccct
gaccgacttccatggtctggtgcgttctagctgcgttatcttccgcctgtgcaacgatctggccacctct
gcggcggagctggaacgtggcgagactaccaattctatcattagctacatgcacgaaaacgatg
gtaccagcgaggaacaggcccgcgaagaactgcgtaaactgatcgacgccgaatggaaaaa
gatgaatcgtgaacgcgttagcgactccaccctgctgcctaaagcgttcatggaaatcgcagttaa
catggcacgtgtttcccactgcacctaccagtatggcgatggtctgggtcgcccagactacgcgact
gaaaaccgcatcaaactgctgctgattgacccttcccgattaaccagctgatgtatgtctaactgca
tcgcccttaggaggtaaaaaaaaatgactgccgacaacaatagtatgccccatggtgcagtatct
agttacgccaaattagtgcaaaaccaaacacctgaagacattttggaagagtttcctgaaattattc
cattacaacaaagacctaatacccgatctagtgagacgtcaaatgacgaaagcggagaaacat
gtttttctggtcatgatgaggagcaaattaagttaatgaatgaaaattgtattgttttggattgggacgat
aatgctattggtgccggtaccaagaaagtttgtcatttaatggaaaatattgaaaagggtttactacat
cgtgcattctccgtctttattttcaatgaacaaggtgaattacttttacaacaaagagccactgaaaaa
ataactttccctgatctttggactaacacatgctgctctcatccactatgtattgatgacgaattaggttt
gaagggtaagctagacgataagattaagggcgctattactgcggcggtgagaaaactagatcat
gaattaggtattccagaagatgaaactaagacaaggggtaagtttcacttttaaacagaatccatt
acatggcaccaagcaatgaaccatggggtgaacatgaaattgattacatcctattttataagatcaa
cgctaaagaaaacttgactgtcaacccaaacgtcaatgaagttagagacttcaaatgggtttcacc
aaatgatttgaaaactatgtttgctgacccaagttacaagtttacgccttggtttaagattatttgcgag
aattacttattcaactggtgggagcaattagatgacctttctgaagtggaaaatgacaggcaaattc
atagaatgctataacgacgcgtcctgcagctggtaccatatgggaattcgaagctttctagaacga
aaactcatctcagaagaggatctgaatagcgccgtcgaccatcatcatcatcatcattgagtttaaa
cggtctccagcttggctgttttggcggatgagagaagattttcagcctgatacagattaaatcagaac
gcagaagcggtctgataaaacagaatttgcctggcggcagtagcgcggtggtcccacctgaccc
catgccgaactcagaagtgaaacgccgtagcgccgatggtagtgtggggtctccccatgcgaga
gtagggaactgccaggcatcaaataaaacgaaaggctcagtcgaaagactgggcctttcgttttat
ctgttgtttgtcggtgaacgctctcctgagtaggacaaatccgccgggagcggatttgaacgttgcg
aagcaacggcccggagggtggcgggcaggacgcccgccataaactgccaggcatcaaattaa
gcagaaggccatcctgacggatggccttttgcgtttctacaaactctttttgtttatttttctaaatacatt
caaatatgtatccgctcatgagacaataaccctgataaatgcttcaataat

(SEQ ID NO:20)

Figure 44

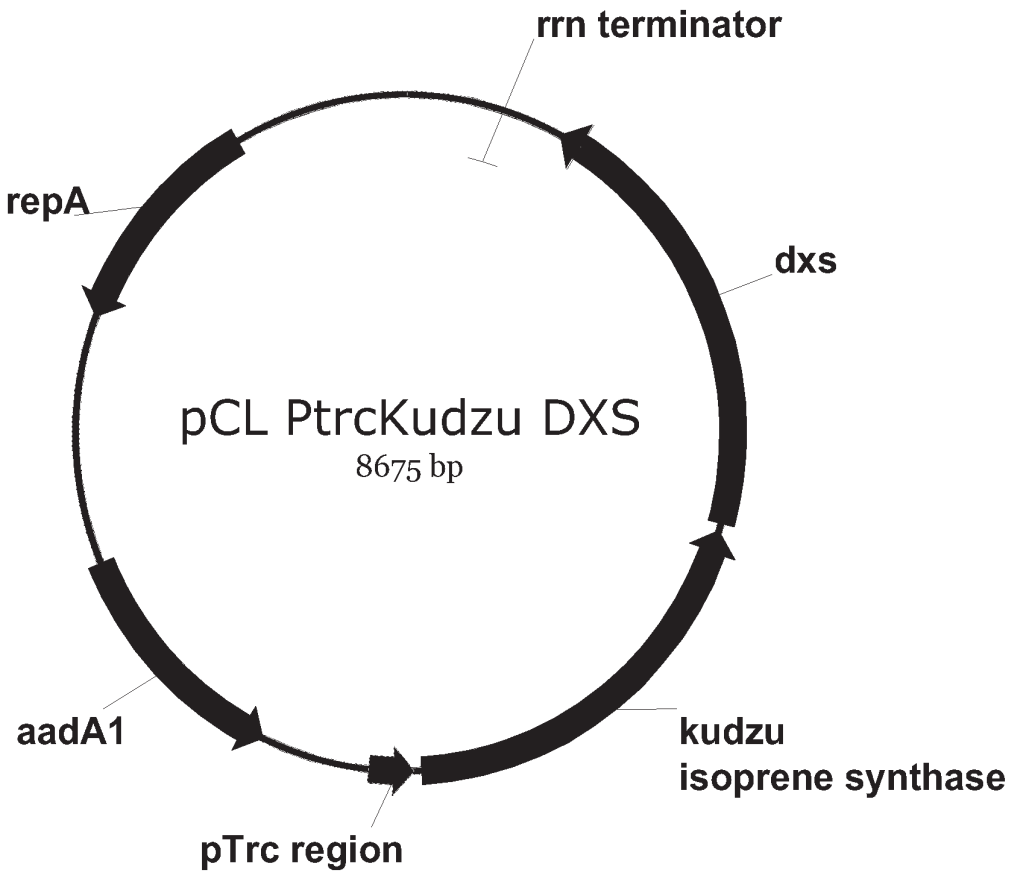

rrn terminator
repA
dxs
pCL PtrcKudzu DXS
8675 bp
aadA1
kudzu
isoprene synthase
pTrc region

Figure 45A

5'-

cccgtcttactgtcgggaattcgcgttggccgattcattaatgcagattattgaagcatttatcagggttattgt
ctcatgagcggatacatatttgaatgtatttagaaaaataaacaaaaagagtttgtagaaacgcaaaaag
gccatccgtcaggatggccttctgcttaatttgatgcctggcagtttatggcgggcgtcctgcccgccaccct
ccgggccgttgcttcgcaacgttcaaatccgctcccggcggatttgtcctactcaggagagcgttcaccga
caaacaacagataaaacgaaaggcccagtctttcgactgagcctttcgttttatttgatgcctggcagttcc
ctactctcgcatggggagaccccacactaccatcggcgctacggcgtttcacttctgagttcggcatgggg
tcaggtgggaccaccgcgctactgccgccaggcaaattctgttttatcagaccgcttctgcgttctgatttaa
tctgtatcaggctgaaaatcttctctcatccgccaaaacagccaagctggagaccgtttaaactcaatgat
gatgatgatgatggtcgacggcgctattcagatcctcttctgagatgagtttttgttctagaaagcttcgaattc
ccatatggtaccagctgcagttatgccagccaggccttgattttggcttccataccagcggcatcgaggcc
gagttcggcgcgcatttcttcctgagttccttgcggaataaagaagtccggcaggccaatgttcagcacgg
gtactggtttacgatgggccatcagcacttcgttcacgccgctgcctgcgccgcccataatggcgttttcttct
acggtgaccagcgcttcatggctggcggccatttccagaattaacgcttcatcaagcggtttcacaaaac
gcatatcgaccagcgtggcgttcagcgattcggcgactttcgccgcttctggcatcagcgtaccaaagtta
aggatcgccagtttctcgccacgacgcttcacaatgcctttgccaattggtagtttttccagcggcgtcagttc
cacgccgaccgcgttgccacgcgggtagcgcaccgctgacgggccatcgttatagtgatagccggtata
gagcatctggcgacattcgttttcatcgctcggggtcataatgaccatttccggtatgcagcgcaggtaaga
gagatcaaaagcaccctgatgggtttgaccgtcagcaccaacaatgcccgcgcggtcgatggcgaaca
ggaccggaagcttttgaatcgccacgtcatgcagcacctgatcataggcgcgttgcaggaaagtggagt
aaatcgcgacaatgggtttgtacccaccaatcgccagacccgcagcaaaggtcaccgcgtgttgctcgg
caattgccacgtcgaagtagcgatccgggaatttacgtgaaaactcgaccatgccggaaccttcacgca
tcgccggagtaatcgccatcagcttgttgtctttcgctgccgtttcgcacaaccagtcgccaaagatttttga
atagctcggcaaaccgccgctacttttcggcaaacaaccgctggagggatcaaatttaggcacggcgtg
gaaagtgatcgggtctttttctgccggttcataaccacgacctttttttggtcatgatatgcaggaactgcgggc
ctttcaggtcgcgcatgttctttagcgtggtgataagccccagcacatcgtgaccgtccaccgggccgatgt
agttaaagcccagctcttcaaacaacgtgccaggcactaccatgcctttaatatgttcttcggtgcgtttgag
cagctctttaattggcggcacgccagagaaaacttttttcccgccttcgcgcagtgaagagtaaagcttac
cggaaagcagctgtgccagatggttgttgagcgcgccgacattttcggaaatcgacatttcattgtcgttga
gaatcaccagcatatcaggacggatatcgcccgcgtgattcatcgcttcaaacgccatgcctgcggtaat
cgcgccatcgccaatgacacagacggtgcggcgatttttgccttctttttcggcagcaaccgcaataccaa
ttccggcactgatggaggttgatgaatgcccgacgcttaatacgtcatattcgctttcgccgcgccacggg
aacgggtgcagaccgcctttctgacggatggtgccgattttgtcgcggcgtccggtcaaaattttatgcgga
taagcctgatgccccacatcccaaatcaattggtcaaacggggtgttgtagacatagtgcagcgccacg
gtcagttcgaccgtgcccagcccggaggcgaagtgcccgctggaacggctcacgctgtcgagtaaata
gcggcgcagttcgtcgcagagtttcggtaaactctctttcggcaacagtcgtaactcctgggtggagtcga
ccagtgccagggtcgggtatttggcaatatcaaaactcatgtttttttacctcctaagggcgaatgcagttag
acatacatcagctggttaatcgggaaagggtcaatcagcagcagtttgatgcggttttcagtcgcgtagtct
gggcgacccagaccatcgccatactggtaggtgcagtgggaaacacgtgccatgttaactgcgatttcc
atgaacgctttaggcagcagggtggagtcgctaacgcgttcacg

Figure 45B

attcatctttttccattcggcgtcgatcagtttacgcagttcttcgcgggcctgttcctcgctggtaccatcgttttc
gtgcatgtagctaatgatagaattggtagtctcgccacgttccagctccgccgcagaggtggccagatcgt
tgcacaggcggaagataacgcagctagaacgcaccagaccatggaagtcggtcagggaacgcagc
gcgtggtcggagatgtcttcctgctgctggcatacggaaaagtaagacggcgccagcagcgctacacc
ggaggaggaaacgctggcgttttccaggtacttggagaaagccgggataattttgttgttggaccatttcgc
ctcttgcagaaaggctttgcacagttcacgccagcttttcgtcagataggacaggttgttatgacctttctctttt
cagaatagaataggacgtgtcgttaacggtgttgtacagtgccaggaaacacagtttcatatagtccggc
agggtgttaatagcgttaacgtcccagcgctctacagcatcggtgaacagttgcagttcgtccagagtgcc
ataaacgtcatacacgtcatcgatgatcgtcaccagaccaaacattttagtaacagctttgcgacattcac
caaactgcgggtctggcgccatacccagtgcccagaaataaacttccatcaggcggtcgcgtacaaaat
ccagtttgctagccaggcccatctcggtccaccagcgggacagatcttgcagctctttctggtgcagggtct
gtaccatgttaaaatccagcttcgccagctccagcagcagctggtgatgcggttctttcggttcgtatttatcc
aggaaccaacgtgcctccagacggtgcagacgctggtgatatggcagttccagggcgtggctcacttgtt
ctgcaaccttggtattaatgccttctttcaggttgttcttcaggtgggtgatggaaaaggtacgcgcctcctcc
agcaggttctcaccctcgaaacccaggtaagacgcttcatacaggctcagcaggccttggacgtcacctt
tcagttcaccgctgaaaccaccttctttatccttgaaacgctcaaaaacatcctgagaaacctcgaaaccg
tgctgacgcagcagacggaaagacagagcggttgcgtgcaggtcagatttgttctttttgttttcgtccagc
agtacgatgttttccagggctttaatgatgtctttttcaaatttgtaggtcagacccaggcgctgcacatcgtc
gatcagctccagcagggacagcggctgggtgtctacacggttgatcatgcagcgaacttcttcctccagtt
tggtcgctttctcctccagcttttccactttcaggtcgttctccagggattgcaggaattcgaaattccacaggt
ttggctgatagtttgcggaacgacgggaattatgctcggtaatctgagtaaattgagaagaggtcgcacac
atggtttattcctccttatttaatcgatacattaatatatacctctttaatttttaataataaagttaatcgataattcc
ggtcgagtgcccacacagattgtctgataaattgttaaagagcagtgccgcttcgctttttctcagcggcgct
gtttcctgtgtgaaattgttatccgctcacaattccacacattatacgagccggatgattaattgtcaacagct
catttcagaatctggcgtaatagcgaagaggcccgcaccgatcgcccttcccaacagttgcgcagcctg
aatggcgaatggcgcctgatgcggtattttctccttacgcatctgtgcggtatttcacaccgcatatggtgca
ctctcagtacaatctgctctgatgccgcatagttaagccagccccgacacccgccaacacccgctgacg
agcttagtaaagccctcgctagattttaatgcggatgttgcgattacttcgccaactattgcgataacaaga
aaaagccagcctttcatgatatatctcccaatttgtgtagggcttattatgcacgcttaaaaataataaaagc
agacttgacctgatagtttggctgtgagcaattatgtgcttagtgcatctaacgcttgagttaagccgcgccg
cgaagcggcgtcggcttgaacgaattgttagacattatttgccgactaccttggtgatctcgcctttcacgta
gtggacaaattcttccaactgatctgcgcgcgaggccaagcgatcttcttcttgtccaagataagcctgtct
agcttcaagtatgacgggctgatactgggccggcaggcgctccattgcccagtcggcagcgacatccttc
ggcgcgattttgccggttactgcgctgtaccaaatgcgggacaacgtaagcactacatttcgctcatcgcc
agcccagtcgggcggcgagttccatagcgttaaggtttcatttagcgcctcaaatagatcctgttcaggaa
ccggatcaaagagttcctccgccgctggacctaccaaggcaacgctatgttctcttgcttttgtcagcaaga
tagccagatcaatgtcgatcgtggctggctcgaagatacctgcaagaatgtcattgcgctgccattctcca
aattgcagttcgcgcttagctggataacgccacggaatgatgtcgtcgtgcacaacaatggtgacttctac
agcgcggagaatctcgctctctccaggggaagccgaagtttccaaaaggtcgttgatcaaagctcgccg
cgttgtttcatcaagc

Figure 45C

cttacggtcaccgtaaccagcaaatcaatatcactgtgtggcttcaggccgccatccactgcggagccg
tacaaatgtacggccagcaacgtcggttcgagatggcgctcgatgacgccaactacctctgatagttga
gtcgatacttcggcgatcaccgcttccctcatgatgtttaactttgttttagggcgactgccctgctgcgtaac
atcgttgctgctccataacatcaaacatcgacccacggcgtaacgcgcttgctgcttggatgcccgagg
catagactgtaccccaaaaaaacagtcataacaagccatgaaaaccgccactgcgccgttaccacc
gctgcgttcggtcaaggttctggaccagttgcgtgagcgcatacgctacttgcattacagcttacgaacc
gaacaggcttatgtccactgggttcgtgccttcatccgtttccacggtgtgcgtcacccggcaaccttggg
cagcagcgaagtcgaggcatttctgtcctggctggcgaacgagcgcaaggtttcggtctccacgcatcg
tcaggcattggcggccttgctgttcttctacggcaaggtgctgtgcacggatctgccctggcttcaggaga
tcggaagacctcggccgtcgcggcgcttgccggtggtgctgaccccggatgaagtggttcgcatcctcg
gttttctggaaggcgagcatcgtttgttcgcccagcttctgtatggaacgggcatgcggatcagtgagggt
ttgcaactgcgggtcaaggatctggatttcgatcacggcacgatcatcgtgcgggagggcaagggctc
caaggatcgggccttgatgttacccgagagcttggcacccagcctgcgcgagcaggggaattaattcc
cacgggttttgctgcccgcaaacgggctgttctggtgttgctagtttgttatcagaatcgcagatccggcttc
agccggtttgccggctgaaagcgctatttcttccagaattgccatgatttttttccccacgggaggcgtcact
ggctcccgtgttgtcggcagctttgattcgataagcagcatcgcctgtttcaggctgtctatgtgtgactgttg
agctgtaacaagttgtctcaggtgttcaatttcatgttctagttgctttgttttactggtttcacctgttctattaggt
gttacatgctgttcatctgttacattgtcgatctgttcatggtgaacagctttgaatgcaccaaaaactcgta
aaagctctgatgtatctatctttttttacaccgttttcatctgtgcatatggacagttttccctttgatatgtaacgg
tgaacagttgttctacttttgtttgttagtcttgatgcttcactgatagatacaagagccataagaacctcaga
tccttccgtatttagccagtatgttctctagtgtggttcgttgtttttgcgtgagccatgagaacgaaccattga
gatcatacttactttgcatgtcactcaaaaattttgcctcaaaactggtgagctgaatttttgcagttaaagc
atcgtgtagtgtttttcttagtccgttatgtaggtaggaatctgatgtaatggttgttggtattttgtcaccattcat
ttttatctggttgttctcaagttcggttacgagatccatttgtctatctagttcaacttggaaaatcaacgtatca
gtcgggcggcctcgcttatcaaccaccaatttcatattgctgtaagtgtttaaatctttacttattggtttcaaa
acccattggttaagccttttaaactcatggtagttatttttcaagcattaacatgaacttaaattcatcaaggct
aatctctatatttgccttgtgagttttcttttgtgttagttcttttaataaccactcataaatcctcatagagtatttgt
tttcaaaagacttaacatgttccagattatattttatgaatttttttaactggaaaagataaggcaatatctctt
cactaaaaactaattctaatttttcgcttgagaacttggcatagtttgtccactggaaaatctcaaagccttt
aaccaaaggattcctgatttccacagttctcgtcatcagctctctggttgctttagctaatacaccataagc
attttccctactgatgttcatcatctgagcgtattggttataagtgaacgataccgtccgttctttccttgtaggg
ttttcaatcgtggggttgagtagtgccacacagcataaaattagcttggtttcatgctccgttaagtcatagc
gactaatcgctagttcatttgctttgaaaacaactaattcagacatacatctcaattggtctaggtgattttaa
tcactataccaattgagatgggctagtcaatgataattactagtccttttcctttgagttgtgggtatctgtaaa
ttctgctagacctttgctggaaaacttgtaaattctgctagaccctctgtaaattccgctagacctttgtgtgttt
tttttgtttatattcaagtggttataatttatagaataaagaaagaataaaaaaagataaaaagaatagatc
ccagccctgtgtataactcactactttagtcagttccgcagtattacaaaaggatgtcgcaaacgctgtttg
ctcctctacaaaacagaccttaaaaccctaaaggcttaagtagcaccctcgcaagctcgggcaaatcg
ctgaatattccttttgtctccgaccatcaggcacctgagtcgctgtctttttc

Figure 45D

Gtgacattcagttcgctgcgctcacggctctggcagtgaatgggggtaaatggcactacaggcgcctttt
atggattcatgcaaggaaactacccataatacaagaaaagcccgtcacgggcttctcagggcgttttat
ggcgggtctgctatgtggtgctatctgactttttgctgttcagcagttcctgccctctgattttccagtctgacc
acttcggattatcccgtgacaggtcattcagactggctaatgcacccagtaaggcagcggtatcatcaa
caggctta

(SEQ ID NO:21)

Figure 46A

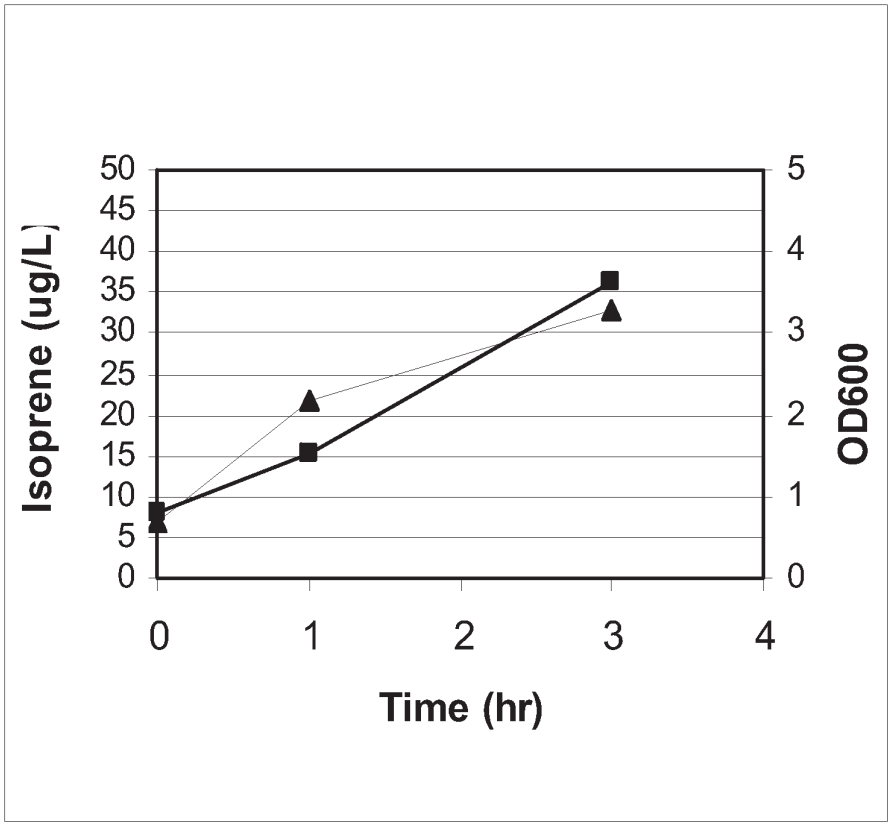

Isoprene (ug/L)
50
45
40
35
30
25
20
15
10
5
0
OD600
5
4
3
2
1
0
0
1
2
3
4
Time (hr)

Figure 46B

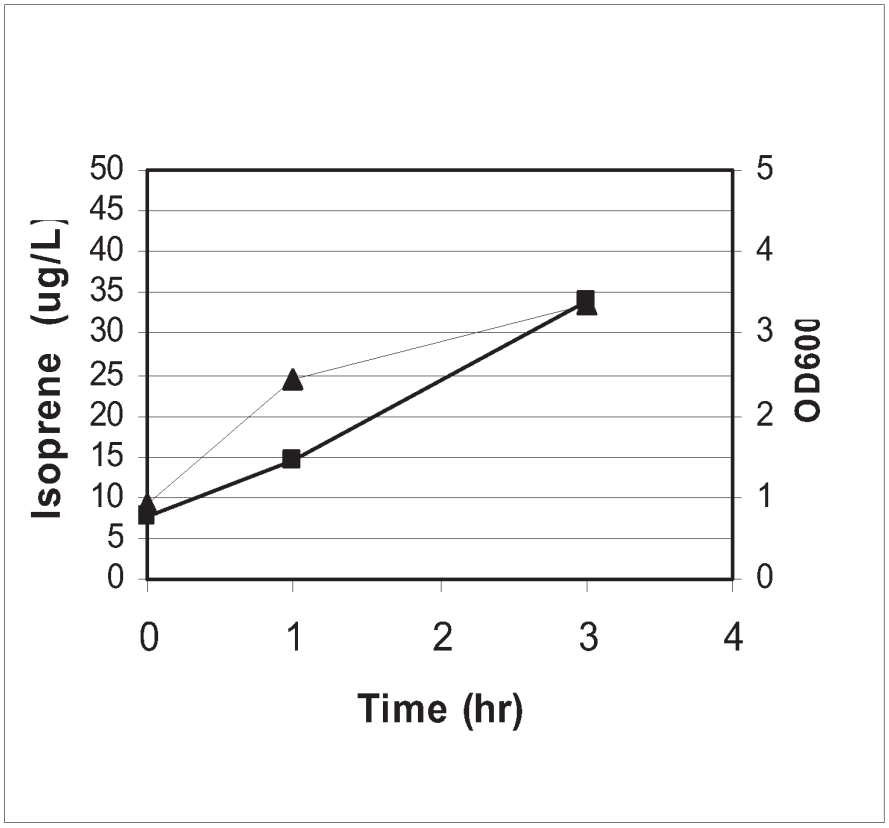

Isoprene (ug/L)
50
45
40
35
30
25
20
15
10
5
0
OD600
5
4
3
2
1
0
0
1
2
3
4
Time (hr)

Figure 46C

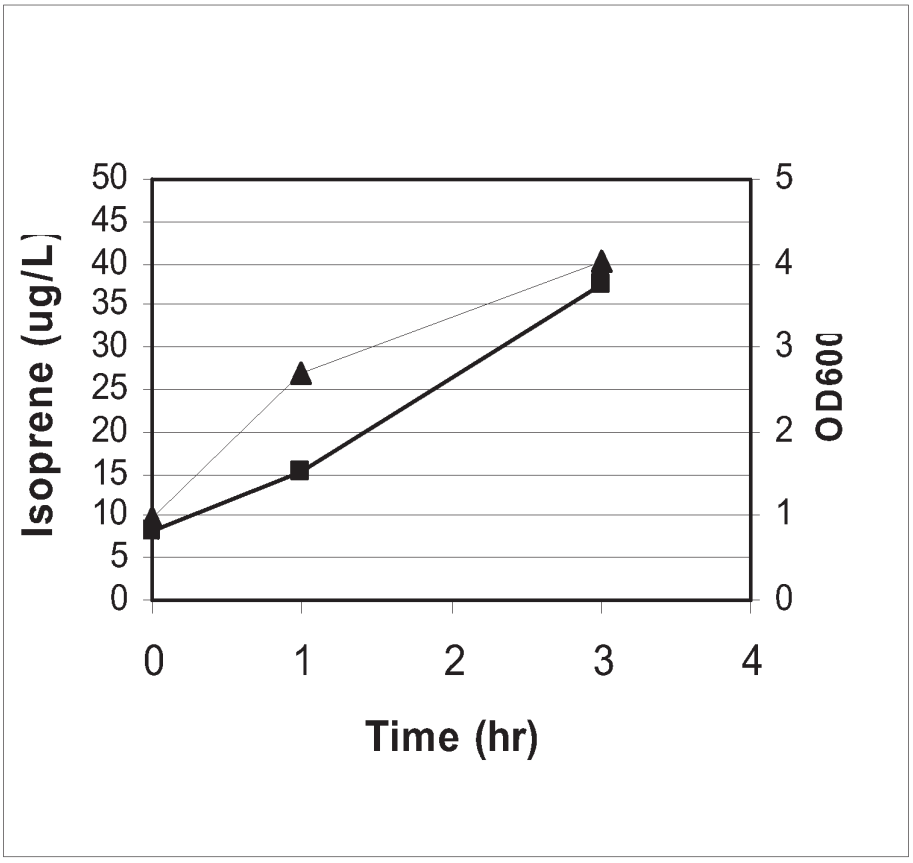

Isoprene (ug/L)
50
45
40
35
30
25
20
15
10
5
0
OD600
5
4
3
2
1
0
0
1
2
3
4
Time (hr)

Figure 46D

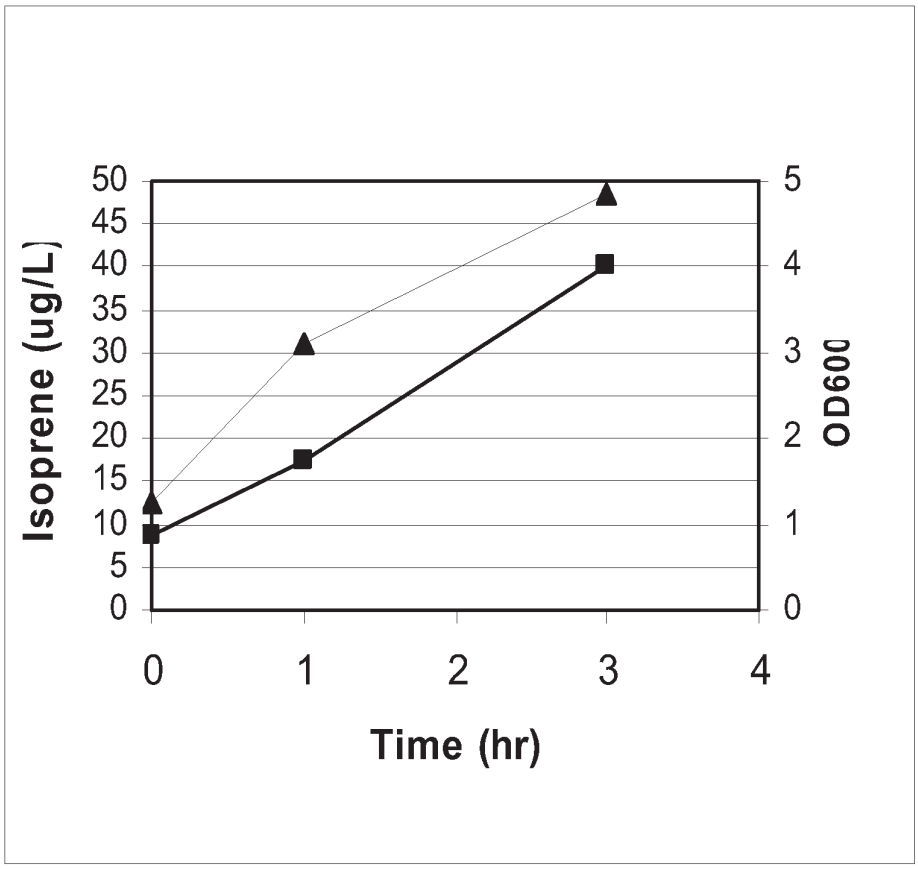

Isoprene (ug/L)
50
45
40
35
30
25
20
15
10
5
0
OD600
5
4
3
2
1
0
0
1
2
3
4
Time (hr)

Figure 46E

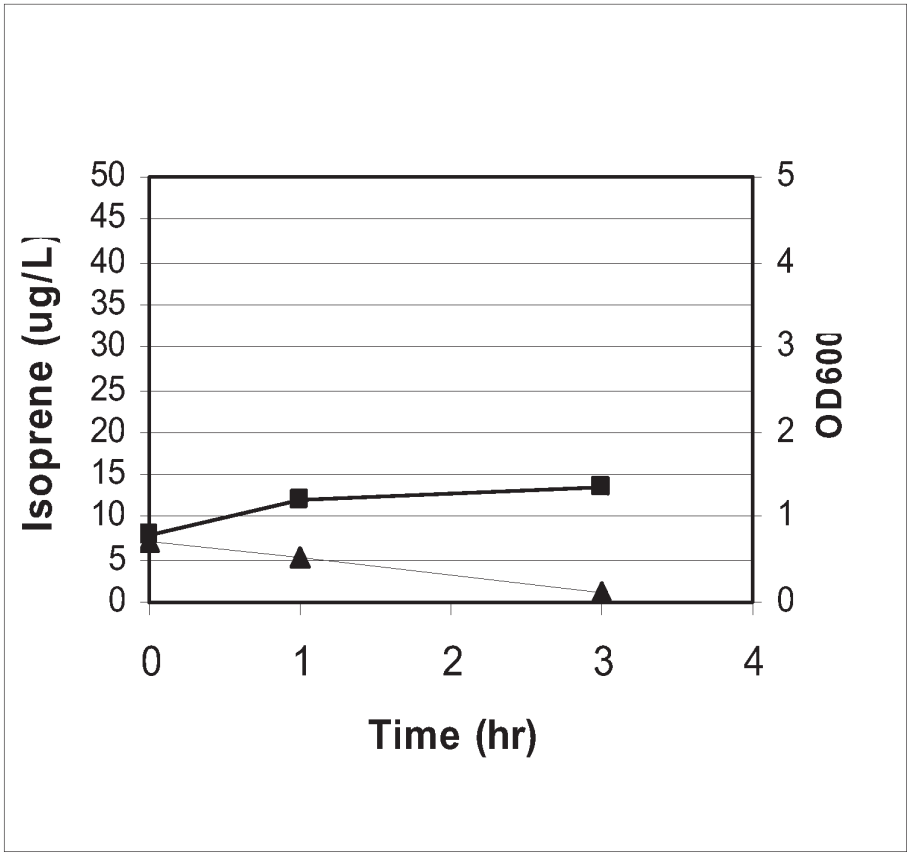

Isoprene (ug/L)
50
45
40
35
30
25
20
15
10
5
0
OD600
5
4
3
2
1
0
0
1
2
3
4
Time (hr)

Figure 47A

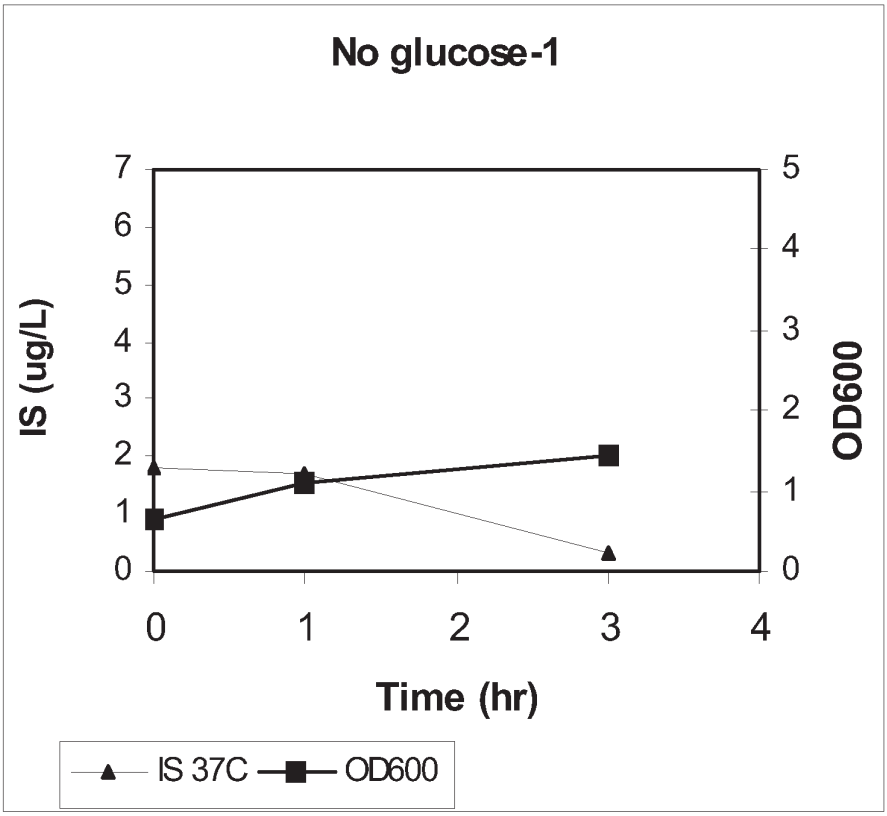


Figure 47B

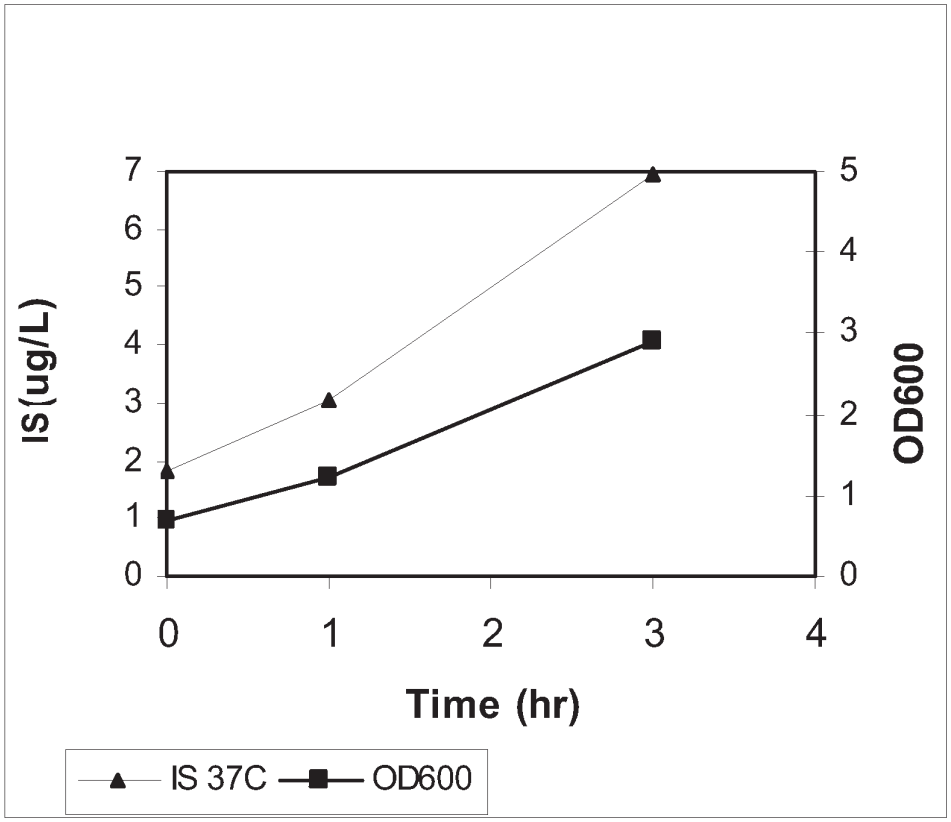


Figure 47C

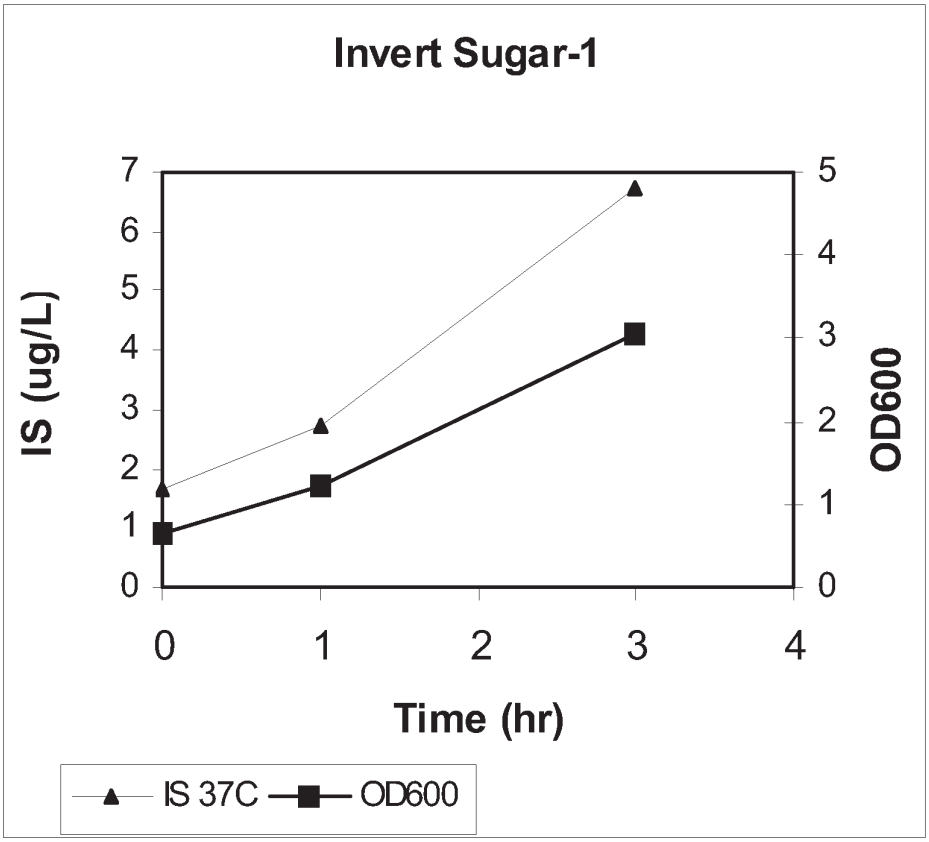


Figure 47D

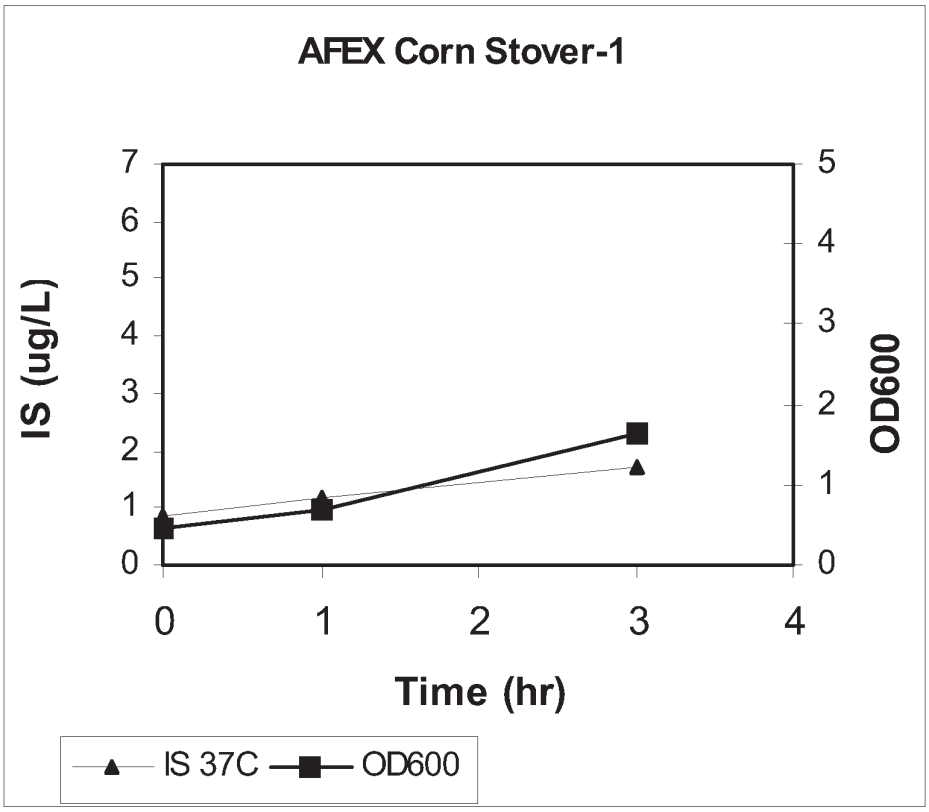


Figure 48A

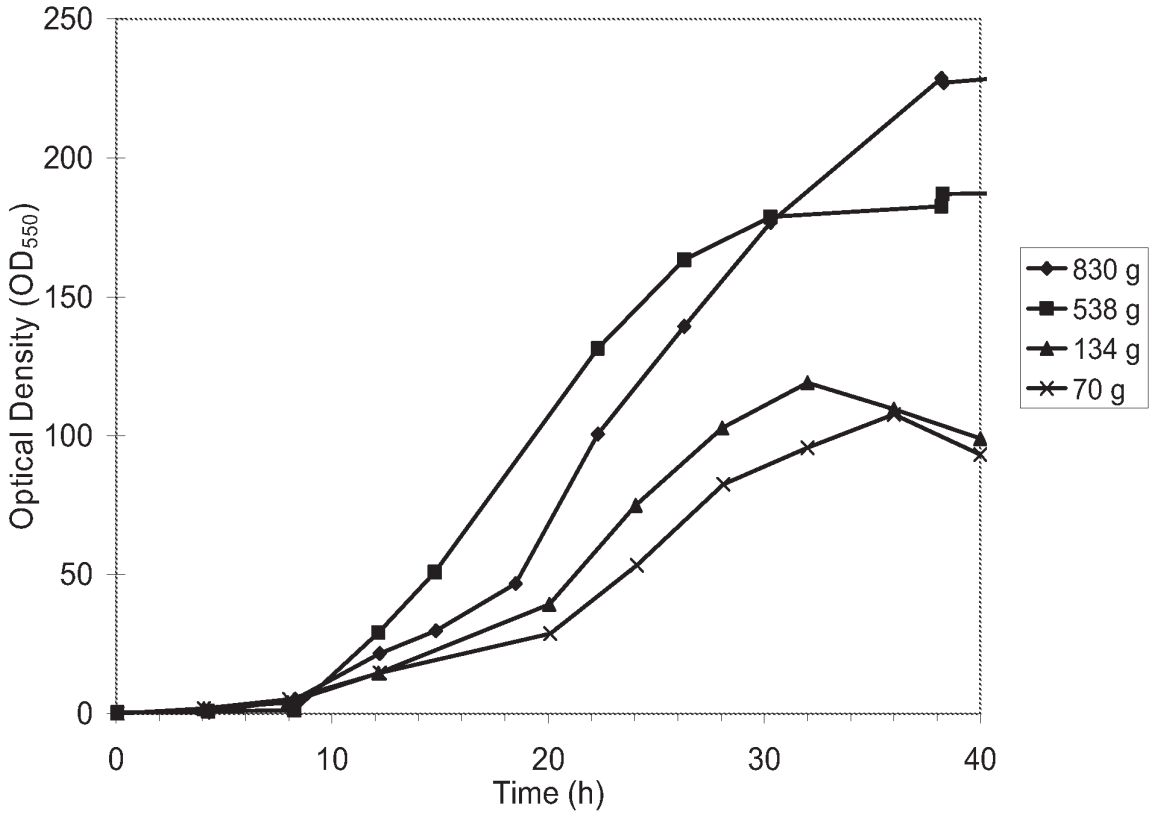

250
200
150
100
50
0
Optical Density (OD550)
0
10
20
30
40
Time (h)
830 g
538 g
134 g
70 g

Figure 48B

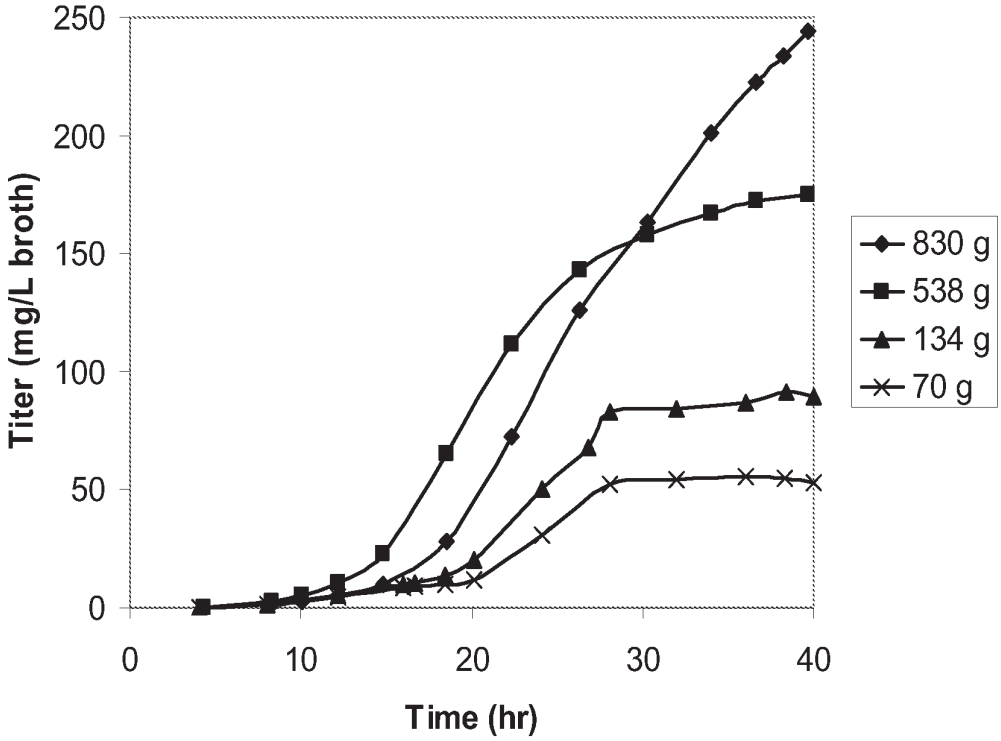

250
200
150
100
50
0
Titer (mg/L broth)
0
10
20
30
40
Time (hr)
830 g
538 g
134 g
70 g

Figure 48C

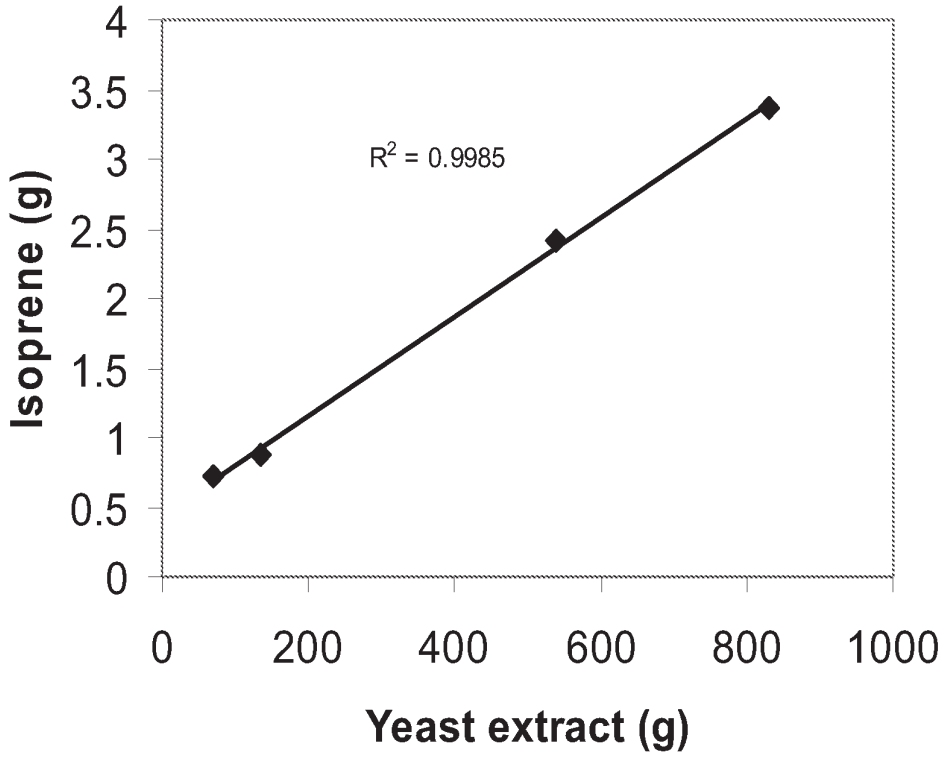

Isoprene (g)
Yeast extract (g)
R^2 = 0.9985
0
0.5
1
1.5
2
2.5
3
3.5
4
0
200
400
600
800
1000

Figure 49A

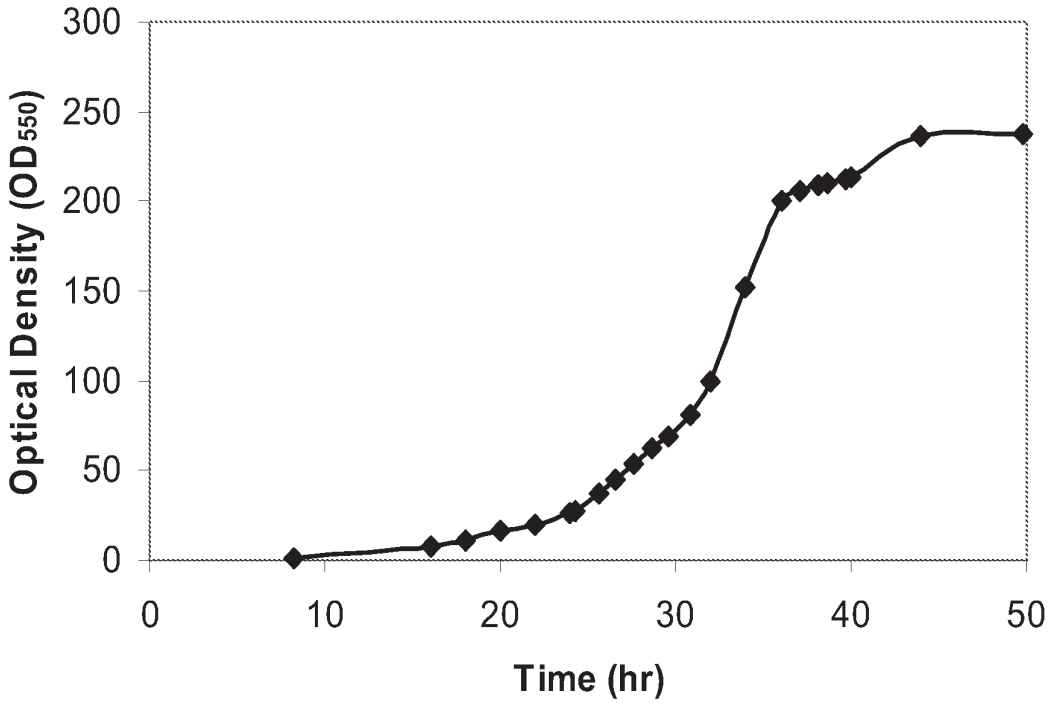

Optical Density (OD550)
300
250
200
150
100
50
0
0
10
20
30
40
50
Time (hr)

Figure 49B

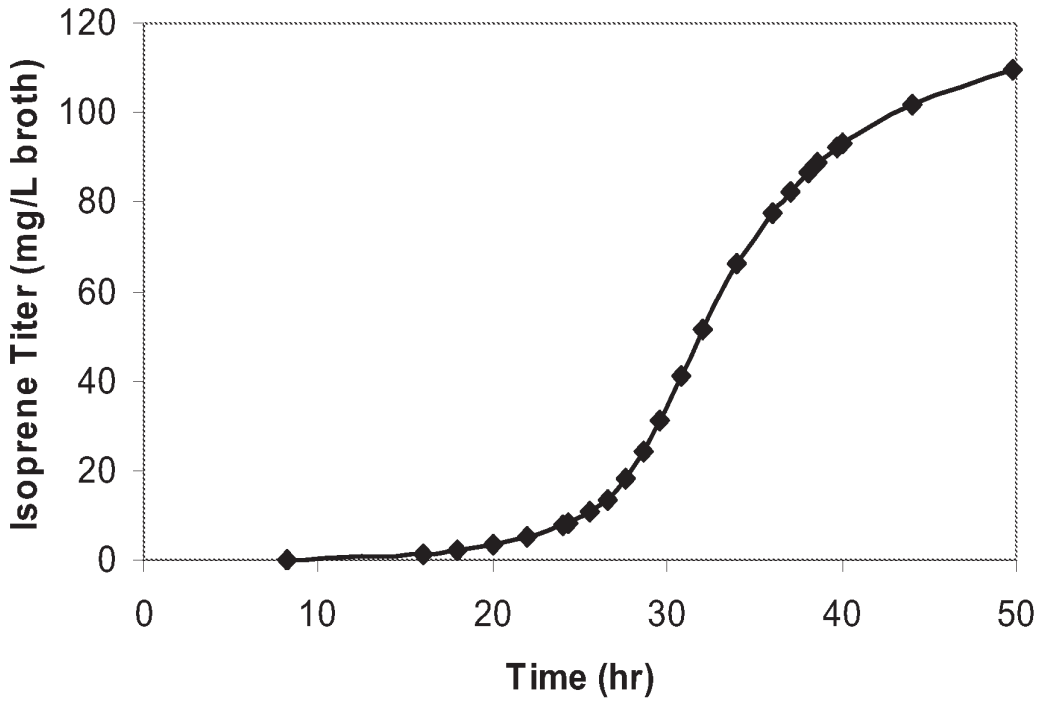

Isoprene Titer (mg/L broth)
120
100
80
60
40
20
0
0
10
20
30
40
50
Time (hr)

Figure 49C

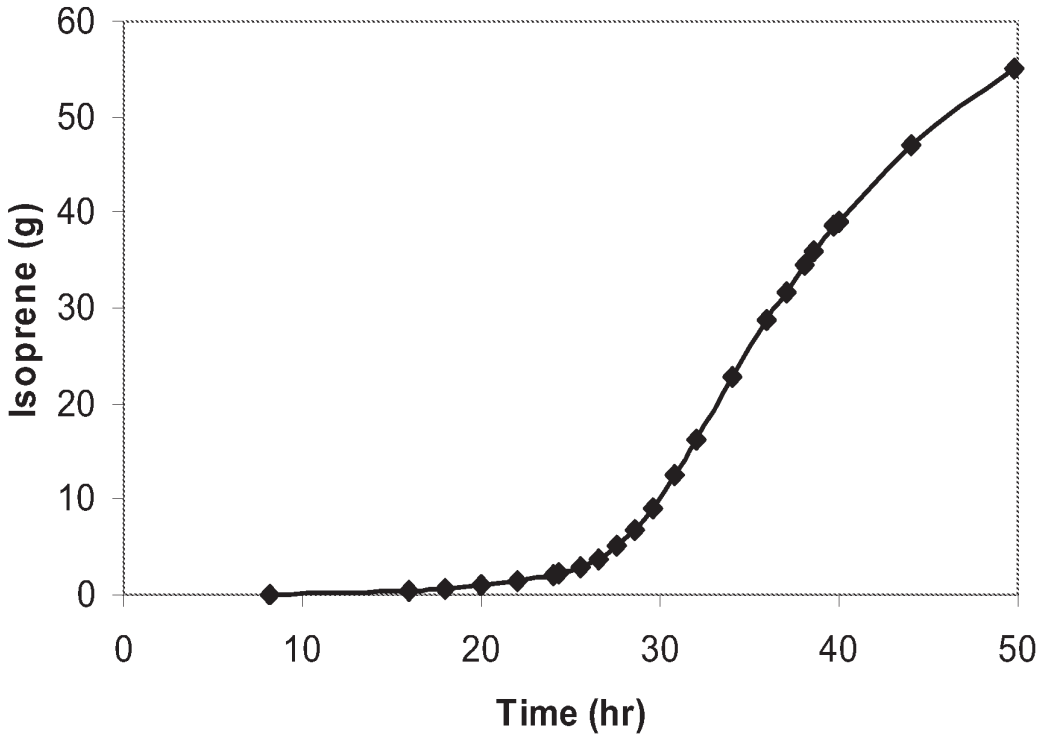


Figure 50

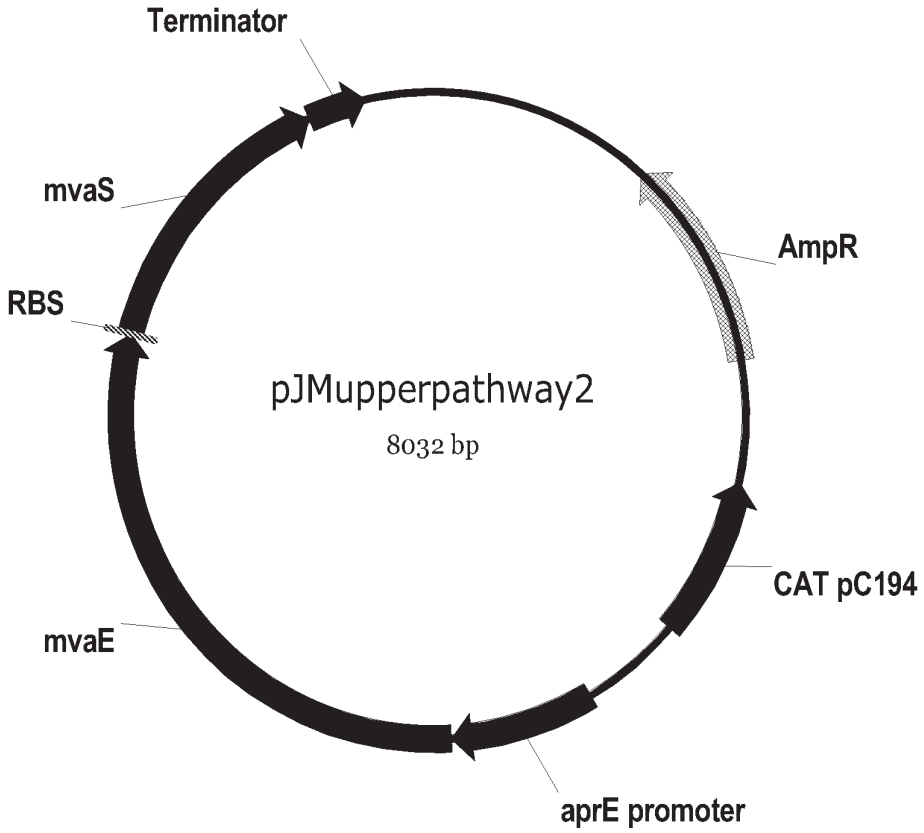

Terminator
mvaS
AmpR
RBS
pJMupperpathway2
8032 bp
CAT pC194
mvaE
aprE promoter

Figure 51A

5'-

tcgctgcgctcggtcgttcggctgcggcgagcggtatcagctcactcaaaggcggtaatacggttatcca
cagaatcaggggataacgcaggaaagaacatgtgagcaaaaggccagcaaaaggccaggaacc
gtaaaaaggccgcgttgctggcgtttttccataggctccgccccctgacgagcatcacaaaaatcgac
gctcaagtcagaggtggcgaaacccgacaggactataaagataccaggcgtttcccccctggaagctc
cctcgtgcgctctcctgttccgaccctgccgcttaccggatacctgtccgcctttctcccttcgggaagcgt
ggcgctttctcatagctcacgctgtaggtatctcagttcggtgtaggtcgttcgctccaagctgggctgtgtg
cacgaaccccccgttcagcccgaccgctgcgccttatccggtaactatcgtcttgagtccaacccggta
agacacgacttatcgccactggcagcagccactggtaacaggattagcagagcgaggtatgtaggcg
gtgctacagagttcttgaagtggtggcctaactacggctacactagaagaacagtatttggtatctgcgct
ctgctgaagccagttaccttcggaaaaagagttggtagctcttgatccggcaaacaaaccaccgctggt
agcggtggtttttttgtttgcaagcagcagattacgcgcagaaaaaaaggatctcaagaagatcctttgat
cttttctacggggtctgacgctcagtggaacgaaaactcacgttaagggattttggtcatgagattatcaa
aaaggatcttcacctagatccttttaaattaaaaatgaagttttaaatcaatctaaagtatatatgagtaaa
cttggtctgacagttaccaatgcttaatcagtgaggcacctatctcagcgatctgtctatttcgttcatccata
gttgcctgactccccgtcgtgtagataactacgatacgggagggcttaccatctggccccagtgctgcaa
tgataccgcgagacccacgctcaccggctccagatttatcagcaataaaccagccagccggaaggg
ccgagcgcagaagtggtcctgcaactttatccgcctccatccagtctattaattgttgccgggaagctaga
gtaagtagttcgccagttaatagtttgcgcaacgttgttgccattgctacaggcatcgtggtgtcacgctcgt
cgtttggtatggcttcattcagctccggttcccaacgatcaaggcgagttacatgatcccccatgttgtgca
aaaaagcggttagctccttcggtcctccgatcgttgtcagaagtaagttggccgcagtgttatcactcatg
gttatggcagcactgcataattctcttactgtcatgccatccgtaagatgcttttctgtgactggtgagtactc
aaccaagtcattctgagaatagtgtatgcggcgaccgagttgctcttgcccggcgtcaatacgggataat
accgcgccacatagcagaactttaaaagtgctcatcattggaaaacgttcttcggggcgaaaactctca
aggatcttaccgctgttgagatccagttcgatgtaacccactcgtgcacccaactgatcttcagcatcttta
ctttcaccagcgtttctgggtgagcaaaaacaggaaggcaaaatgccgcaaaaaagggaataaggg
cgacacggaaatgttgaatactcatactcttccttttcaatattattgaagcatttatcagggttattgtctcat
gagcggatacatatttgaatgtatttagaaaaataaacaaatagggttccgcgcacatttccccgaaa
agtgccacctgacgtctaagaaaccattattatcatgacattaacctataaaaataggcgtatcacgagg
ccctttcgtctcgcgcgtttcggtgatgacggtgaaaacctctgacacatgcagctcccggagacggtca
cagcttgtctgtaagcggatgccgggagcagacaagcccgtcagggcgcgtcagcgggtgttggcgg
gtgtcggggctggcttaactatgcggcatcagagcagattgtactgagagtgcaccatagatctggagc
tgtaatataaaaaccttcttcaactaacggggcaggttagtgacattagaaaaccgactgtaaaaagta
cagtcggcattatctcatattataaaagccagtcattaggcctatctgacaattcctgaatagagttcataa
acaatcctgcatgataaccatcacaaacagaatgatgtacctgtaaagatagcggtaaatatattgaatt
acctttattaatgaattttcctgctgtaataatgggtagaaggtaattactattattattgatatttaagttaaac
ccagtaaatgaagtccatggaataatagaaagagaaaaagcattttcaggtataggtgttttgggaaac
aatttccccgaaccattatatttctctacatcagaaaggtataaatcataaaactctttgaagtcattctttac
aggagtccaaataccagagaatgttttagatacaccatcaaaaattgtataaagtggctctaacttatcc
caataacctaactctccgtcgctattgtaaccagttctaaaagctgtatttgagtttatcacccttgtcactaa
gaaaataaatgcagggtaaaatttatatccttcttgttttatgtttc

Figure 51B

ggtataaaacactaatatcaatttctgtggttatactaaaagtcgtttgttggttcaaataatgattaaatatctc
ttttctcttccaattgtctaaatcaattttattaaagttcatttgatatgcctcctaaatttttatctaaagtgaattta
ggaggcttacttgtctgctttcttcattagaatcaatccttttttaaaagtcaatattactgtaacataaatatatat
tttaaaaatatcccactttatccaattttcgtttgttgaactaatgggtgctttagttgaagaataaaagacctat
gcggtgtgaaataccgcacagatgcgtaaggagaaaataccgcatcaggcgccattcgccattcaggc
tgcgcaactgttgggaagggcgatcggtgcgggcctcttcgctattacgccagctggcgaaaggggat
gtgctgcaaggcgattaagttgggtaacgccagggttttcccagtcacgacgttgtaaaacgacggccag
tgccaagcttgcatgcctgcactccatttttcttctgctatcaaaataacagactcgtgattttccaaacgagct
ttcaaaaaagcctctgccccttgcaaatcggatgcctgtctataaaattcccgatattggttaaacagcggc
gcaatggcggccgcatctgatgtctttgcttggcgaatgttcatcttatttcttcctccctctcaataatttttttcatt
ctatccctttttctgtaaagtttatttttcagaatacttttatcatcatgctttgaaaaaatatcacgataatatccatt
gttctcacggaagcacacgcaggtcatttgaacgaatttttttcgacaggaatttgccgggactcaggagca
tttaacctaaaaaagcatgacatttcagcataatgaacatttactcatgtctattttcgttcttttctgtatgaaaa
tagttatttcgagtctctacggaaatagcgagagatgatatacctaaatagagataaaatcatctcaaaaa
aatgggtctactaaaatattattccatctattacaataaattcacagaatagtcttttaagtaagtctactctga
attttttttaaaaggagagggtaaagagtgaaaacagtagttattattgatgcattacgaacaccaattggaa
aatataaaggcagcttaagtcaagtaagtgccgtagacttaggaacacatgttacaacacaacttttaaa
aagacattccactatttctgaagaaattgatcaagtaatctttggaaatgttttacaagctggaaatggccaa
aatcccgcacgacaaatagcaataaacagcggtttgtctcatgaaattcccgcaatgacggttaatgagg
tctgcggatcaggaatgaaggccgttatttttggcgaaacaattgattcaattaggagaagcggaagtttta
attgctggcgggattgagaatatgtcccaagcacctaaattacaacgttttaattacgaaacagaaagcta
cgatgcgccttttctagtatgatgtatgatggattaacggatgcctttagtggtcaggcaatgggcttaactg
ctgaaaatgtggccgaaaagtatcatgtaactagagaagagcaagatcaattttctgtacattcacaatta
aaagcagctcaagcacaagcagaagggatattcgctgacgaaatagccccattagaagtatcaggaa
cgcttgtggagaaagatgaagggattcgccctaattcgagcgttgagaagctaggaacgcttaaaacag
tttttaaagaagacggtactgtaacagcagggaatgcatcaaccattaatgatggggcttctgctttgattatt
gcttcacaagaatatgccgaagcacacggtcttccttatttagctattattcgagacagtgtggaagtcggt
attgatccagcctatatgggaatttcgccgattaaagccattcaaaaactgttagcgcgcaatcaacttact
acggaagaaattgatctgtatgaaatcaacgaagcatttgcagcaacttcaatcgtggtccaaagagaa
ctggctttaccagaggaaaaggtcaacatttatggtggcggtatttcattaggtcatgcgattggtgccaca
ggtgctcgtttattaacgagtttaagttatcaattaaatcaaaaagaaaagaaatatggagtggcttctttatg
tatcggcggtggcttaggactcgctatgctactagagagacctcagcaaaaaaaaaacagccgattttat
caaatgagtcctgaggaacgcctggcttctcttcttaatgaaggccagatttctgctgatacaaaaaaaga
atttgaaaatacggctttatcttcgcagattgccaatcatatgattgaaaatcaaatcagtgaaacagaagt
gccgatgggcgttggcttacatttaacagtggacgaaactgattatttggtaccaatggcgacagaagag
ccctcagttattgcggctttgagtaatggtgcaaaaatagcacaaggatttaaaacagtgaatcaacaac
gcttaatgcgtggacaaatcgtttttttacgatgttgcagatcccgagtcattgattgataaactacaagtaag
agaagcggaagtttttcaacaagcagagttaagttatccatctatcgttaaacggggcggcggcttaaga
gatttgcaatatcgtacttttgatgaatcatttgtatctgtcgacttttagtagatgttaaggatgcaatggggg
caaatatcgttaacgctatgttggaaggtgtg

Figure 51C

gccgagttgttccgtgaatggtttgcggagcaaaagattttattcagtattttaagtaattatgccacggag
tcggttgttacgatgaaaacggctattccagtttcacgtttaagtaaggggagcaatggccgggaaatt
gctgaaaaaattgttttagcttcacgctatgcttcattagatccttatcgggcagtcacgcataacaaagg
aatcatgaatggcattgaagctgtagttttagctacaggaaatgatacacgcgctgttagcgcttcttgtc
atgcttttgcggtgaaggaaggtcgctaccaaggcttgactagttggacgctggatggcgaacaacta
attggtgaaatttcagttccgcttgctttagccacggttggcggtgccacaaaagtcttacctaaatctca
agcagctgctgatttgttagcagtgacggatgcaaaagaactaagtcgagtagtagcggctgttggttt
ggcacaaaatttagcggcgttacgggccttagtctctgaaggaattcaaaaaggacacatggctctac
aagcacgttctttagcgatgacggtcggagctactggtaaagaagttgaggcagtcgctcaacaatta
aaacgtcaaaaaacgatgaaccaagaccgagccatggctattttaaatgatttaagaaaacaataa
aaggagagggtgacaattgggattgataaaattagtttttttgtgccccttattatattgatatgacggca
ctggctgaagccagaaatgtagaccctggaaaatttcatattggtattgggcaagaccaaatggcggt
gaacccaatcagccaagatattgtgacatttgcagccaatgccgcagaagcgatcttgaccaaaga
agataaagaggccattgatatggtgattgtcgggactgagtccagtatcgatgagtcaaaagcggcc
gcagttgtcttacatcgtttaatggggattcaacctttcgctcgctctttcgaaatcaaggaagcttgttacg
gagcaacagcaggcttacagttagctaagaatcacgtagccttacatccagataaaaaagtcttggtc
gtagcggcagatattgcaaaatatggcttaaattctggcggtgagcctacacaaggagctggggcgg
ttgcaatgttagttgctagtgaaccgcgcattttggctttaaaagaggataatgtgatgctgacgcaagat
atctatgacttttggcgtccaacaggccacccgtatcctatggtcgatggtcctttgtcaaacgaaaccta
catccaatcttttgcccaagtctgggatgaacataaaaaacgaaccggtcttgattttgcagattatgatg
ctttagcgttccatattccttacacaaaaatgggcaaaaaagccttattagcaaaaatctccgaccaaa
ctgaagcagaacaggaacgaattttagcccgttatgaagaaagtatcgtctatagtcgtcgcgtagga
aacttgtatacgggttcactttatctgggactcatttccctttagaaaatgcaacgactttaaccgcaggc
aatcaaattggtttattcagttatggttctggtgctgtcgctgaatttttcactggtgaattagtagctggttatc
aaaatcatttacaaaaagaaactcatttagcactgctggataatcggacagaactttctatcgctgaat
atgaagccatgtttgcagaaactttagacacagacattgatcaaacgttagaagatgaattaaaatata
gtatttctgctattaataataccgttcgttcttatcgaaactaaaaaaaaccggccttggccccgccggttt
tttattatttttcttcctccgcatgttcaatccgctccataatcgacggatggctccctctgaaaattttaacga
gaaacggcgggttgacccggctcagtcccgtaacggccaagtcctgaaacgtctcaatcgccgcttc
ccggtttccggtcagctcaatgccgtaacggtcggcggcgttttcctgataccgggagacggcattcgt
aatcgggatccccgggtaccgagctcgaattcgtaatcatgtcatagctgtttcctgtgtgaaattgttatc
cgctcacaattccacacaacatacgagccggaagcataaagtgtaaagcctggggtgcctaatgag
tgagctaactcacattaattgcgttgcgctcactgcccgctttccagtcgggaaacctgtcgtgccagct
gcattaatgaatcggccaacgcgcggggagaggcggtttgcgtattgggcgctcttccgcttcctcgct
cactgac

(SEQ ID NO:22)

Figure 52

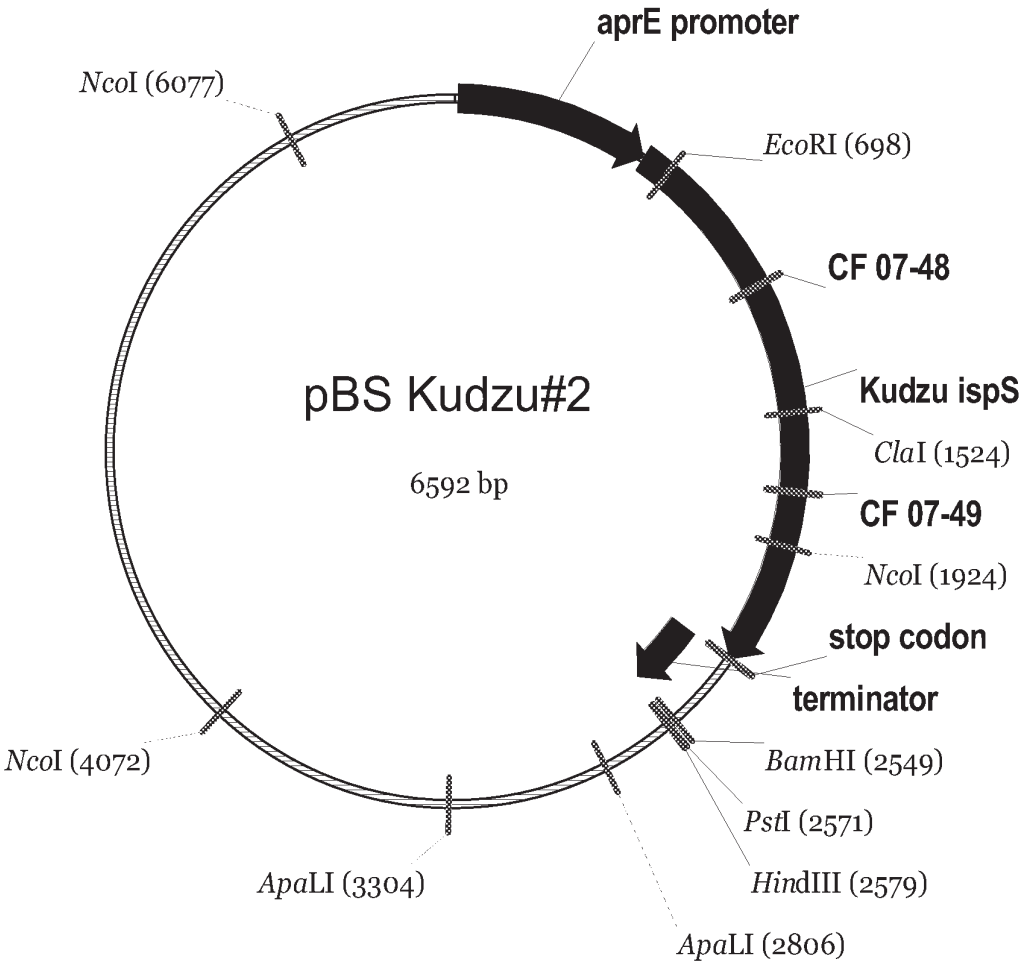

aprE promoter
NcoI (6077)
EcoRI (698)
CF 07-48
pBS Kudzu#2
6592 bp
Kudzu ispS
ClaI (1524)
CF 07-49
NcoI (1924)
stop codon
terminator
NcoI (4072)
BamHI (2549)
PstI (2571)
HindIII (2579)
ApaLI (3304)
ApaLI (2806)

Figure 53A

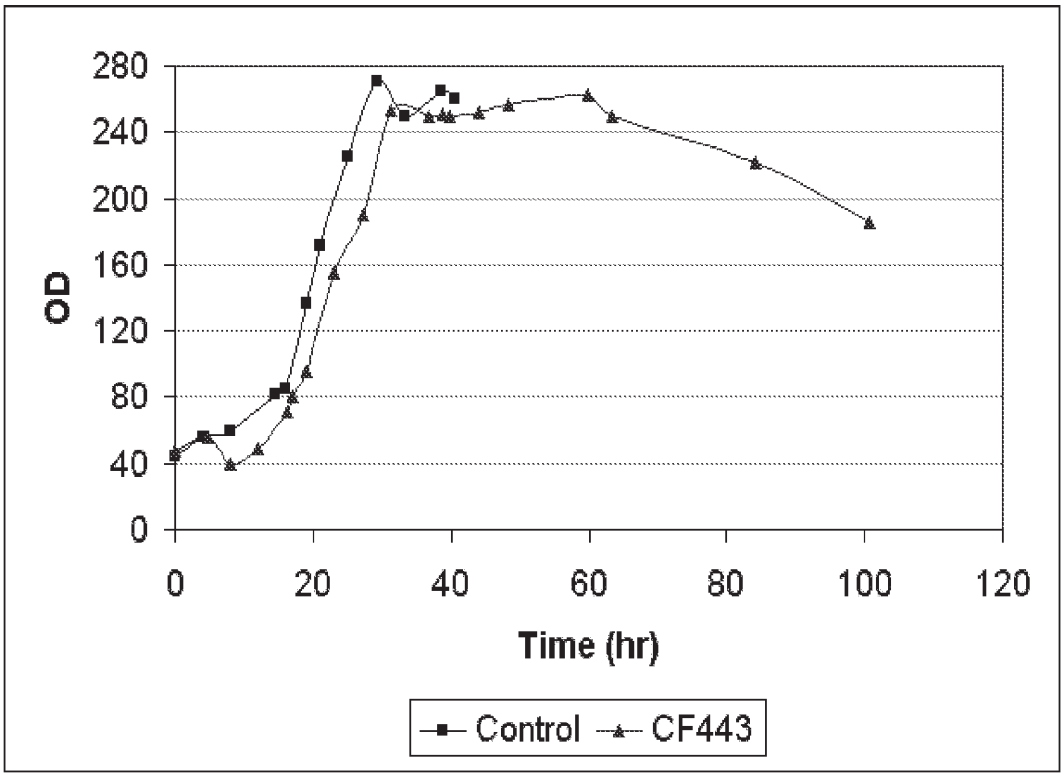

280
240
200
160
120
80
40
0
OD
0
20
40
60
80
100
120
Time (hr)
Control
CF443

Figure 53B

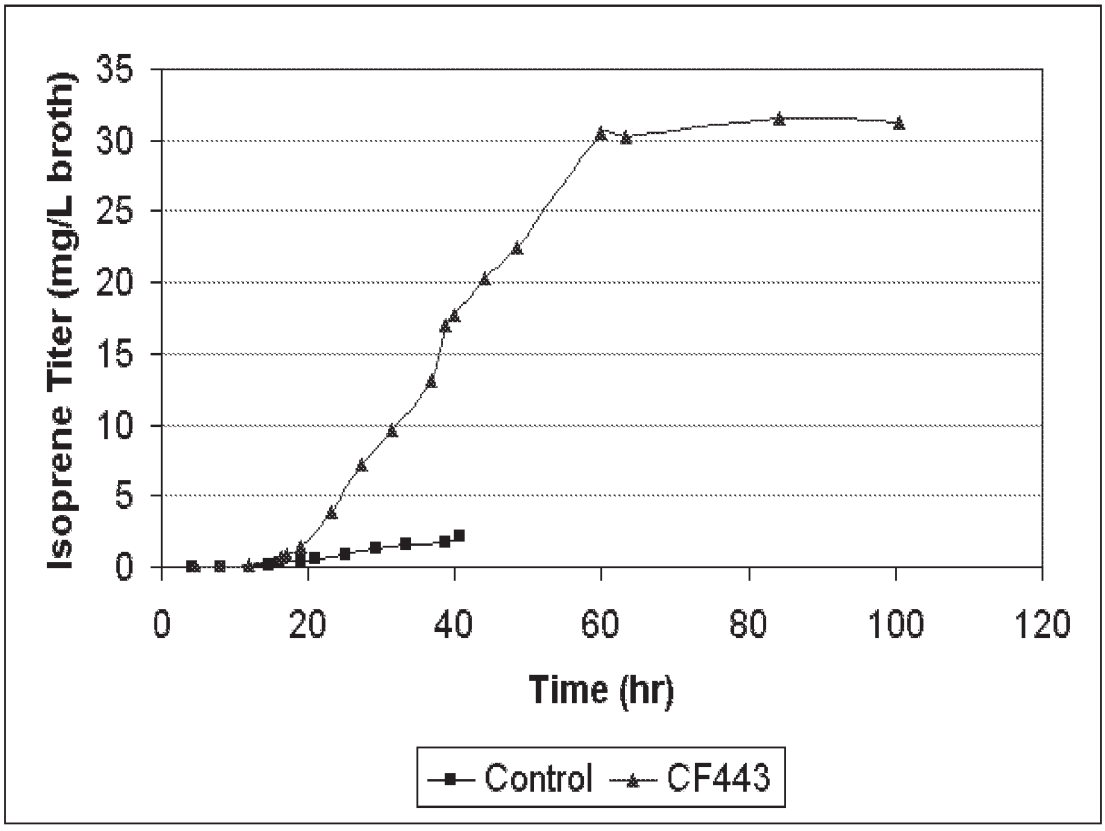

Isoprene Titer (mg/L broth)
35
30
25
20
15
10
5
0
0
20
40
60
80
100
120
Time (hr)
Control
CF443

Figure 54

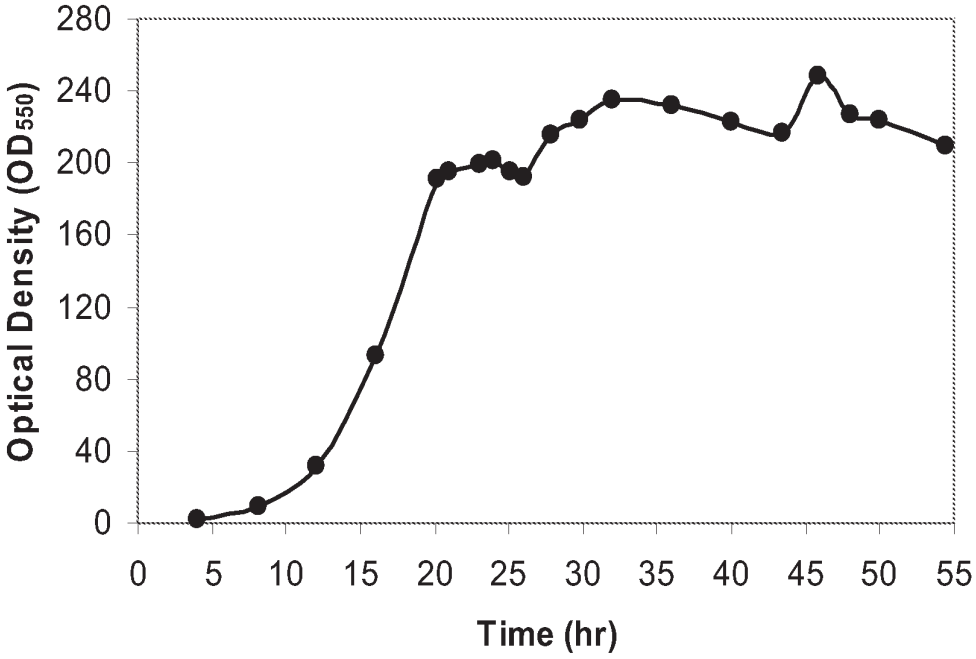

Optical Density (OD550)
280
240
200
160
120
80
40
0
0
5
10
15
20
25
30
35
40
45
50
55
Time (hr)

Figure 55

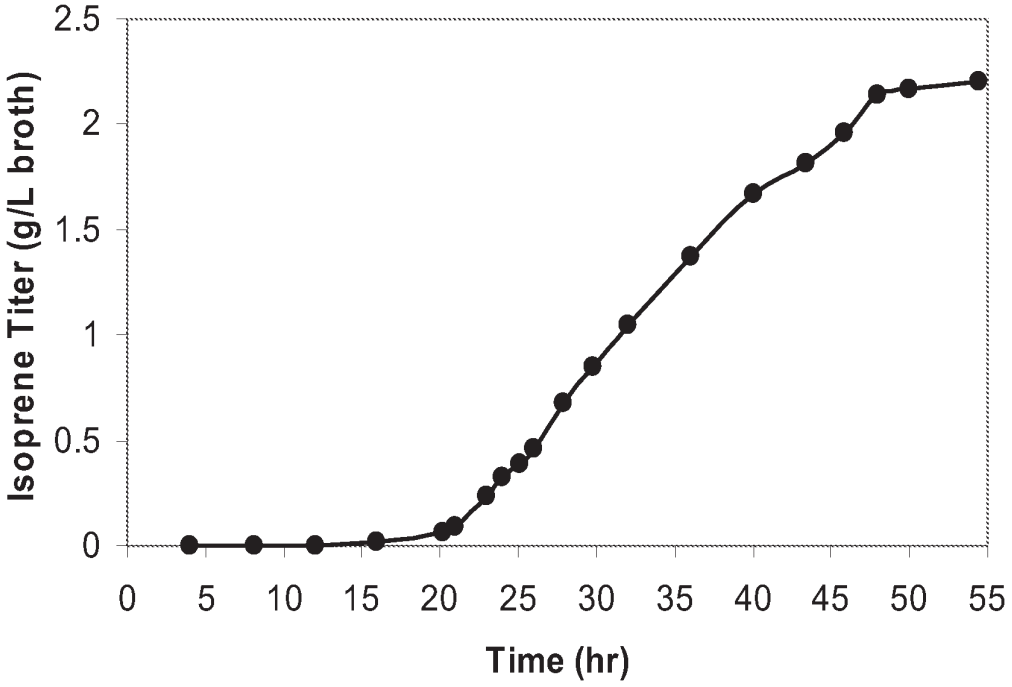

Isoprene Titer (g/L broth)
2.5
2
1.5
1
0.5
0
0 5 10 15 20 25 30 35 40 45 50 55
Time (hr)

Figure 56

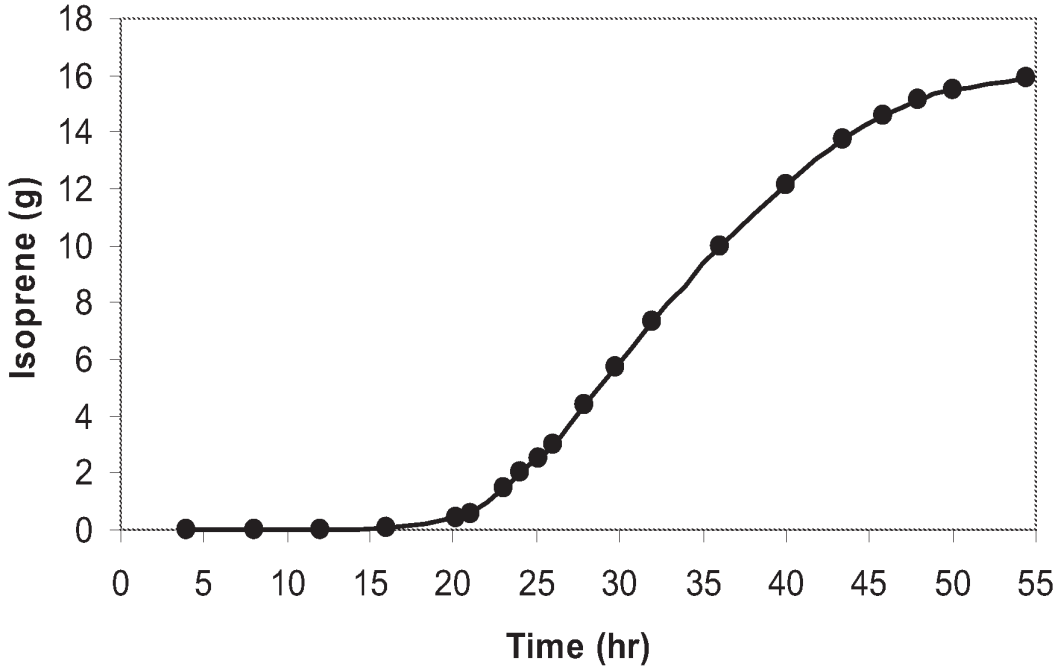

Isoprene (g)
18
16
14
12
10
8
6
4
2
0
0
5
10
15
20
25
30
35
40
45
50
55
Time (hr)

Figure 57

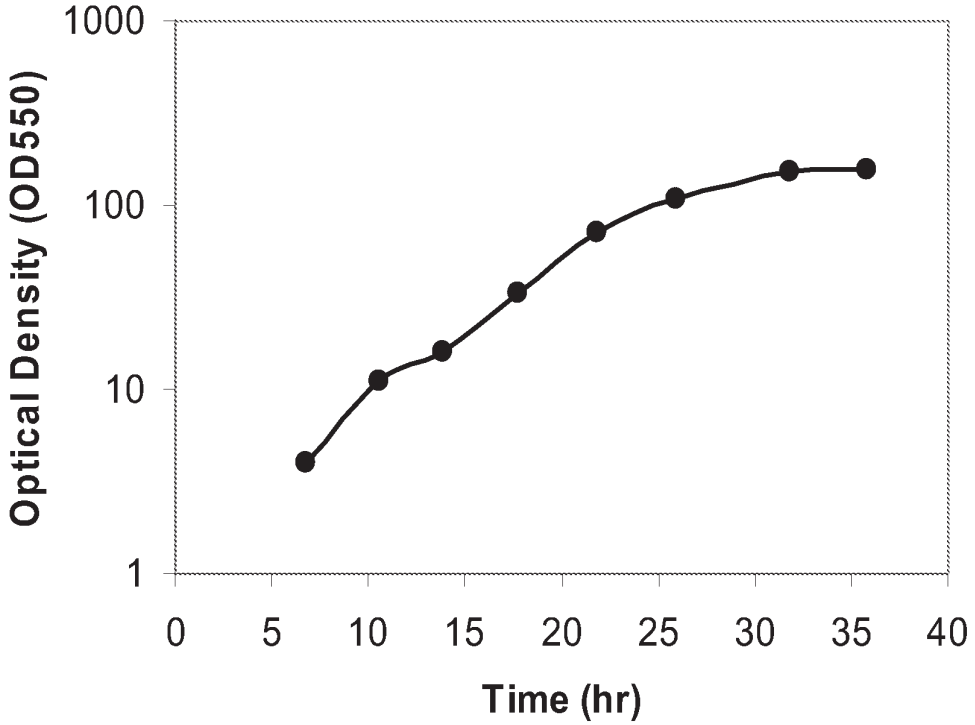

1000
100
10
1
Optical Density (OD550)
0
5
10
15
20
25
30
35
40
Time (hr)

Figure 58

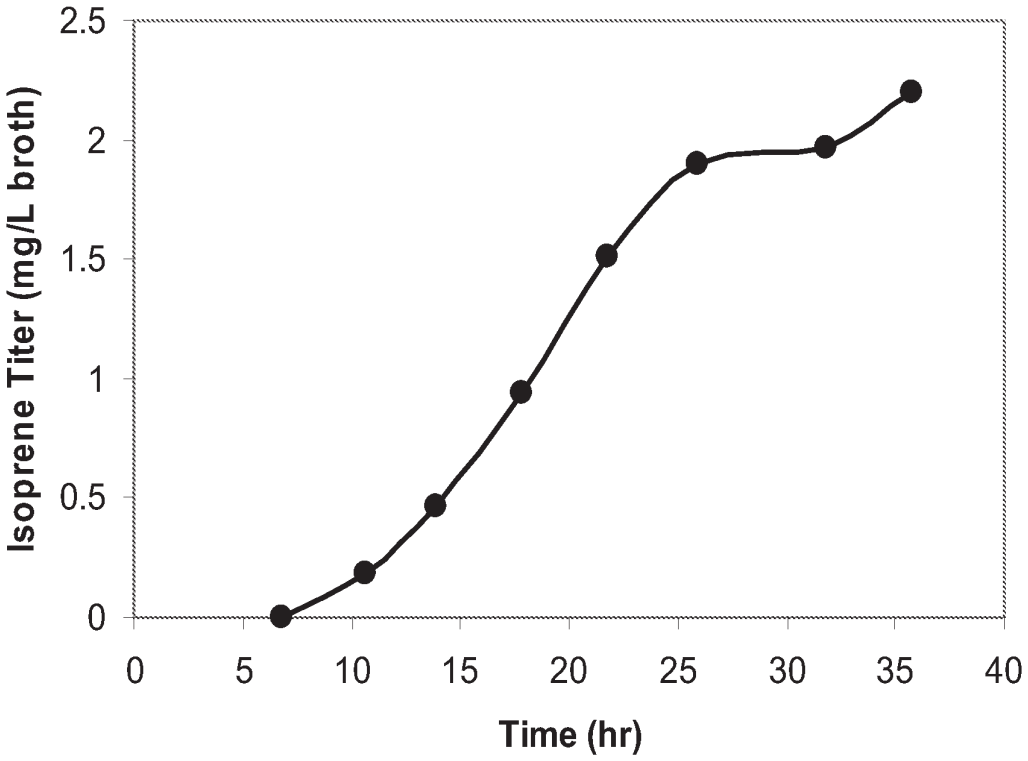

Isoprene Titer (mg/L broth)
2.5
2
1.5
1
0.5
0
0
5
10
15
20
25
30
35
40
Time (hr)

Figure 59

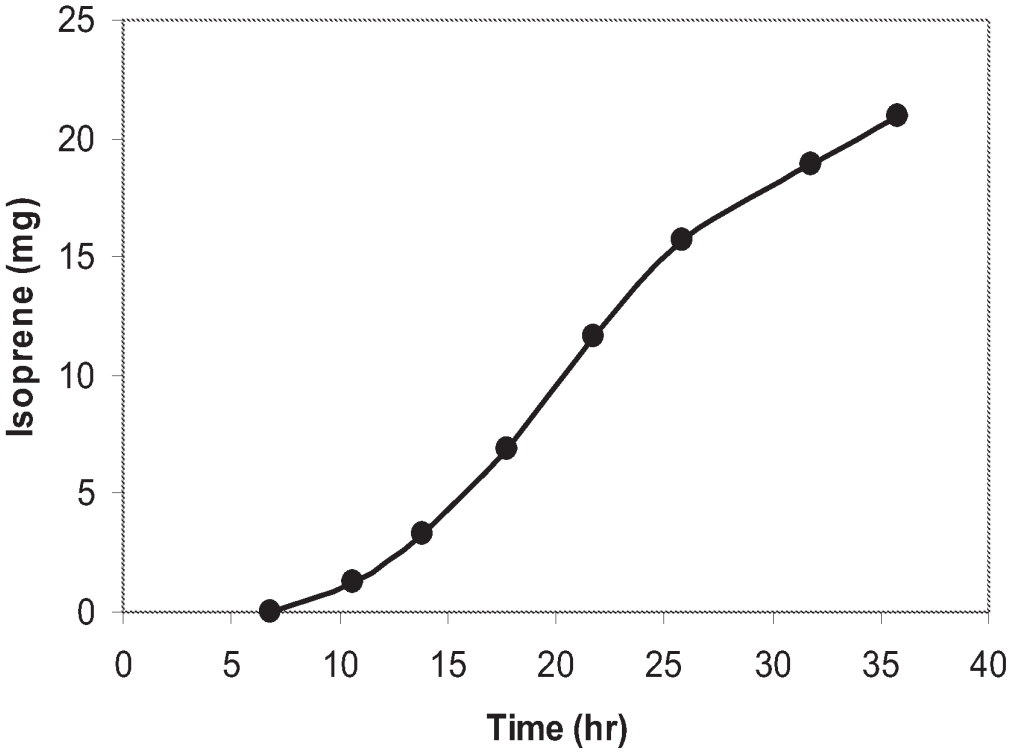


Figure 60A

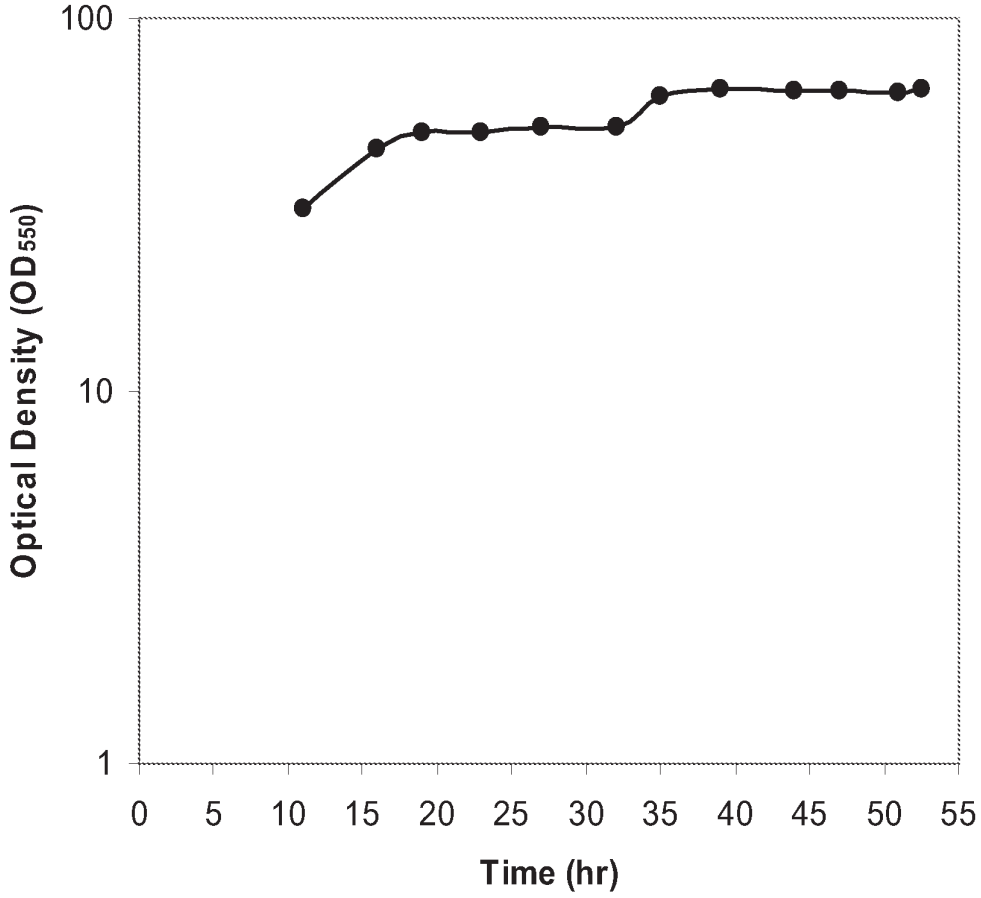

100
10
1
Optical Density (OD550)
0
5
10
15
20
25
30
35
40
45
50
55
Time (hr)

Figure 60B

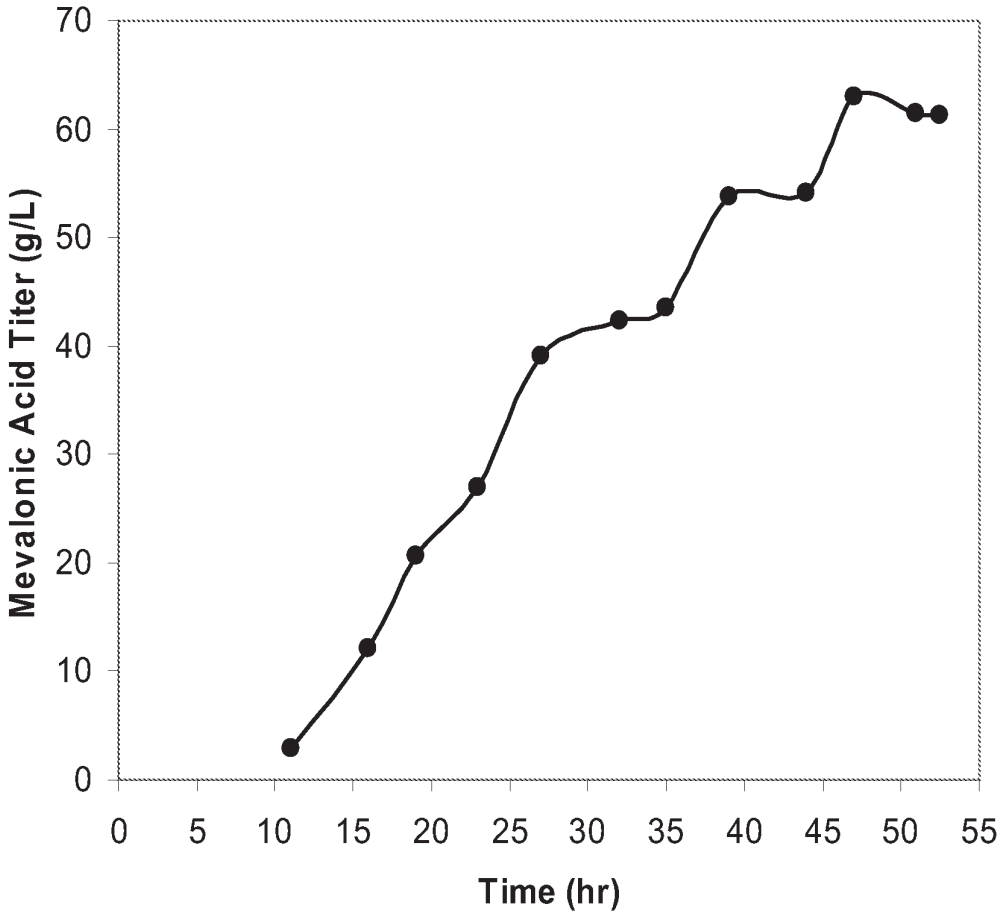

Mevalonic Acid Titer (g/L)
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
35
40
45
50
55
Time (hr)

Figure 60C

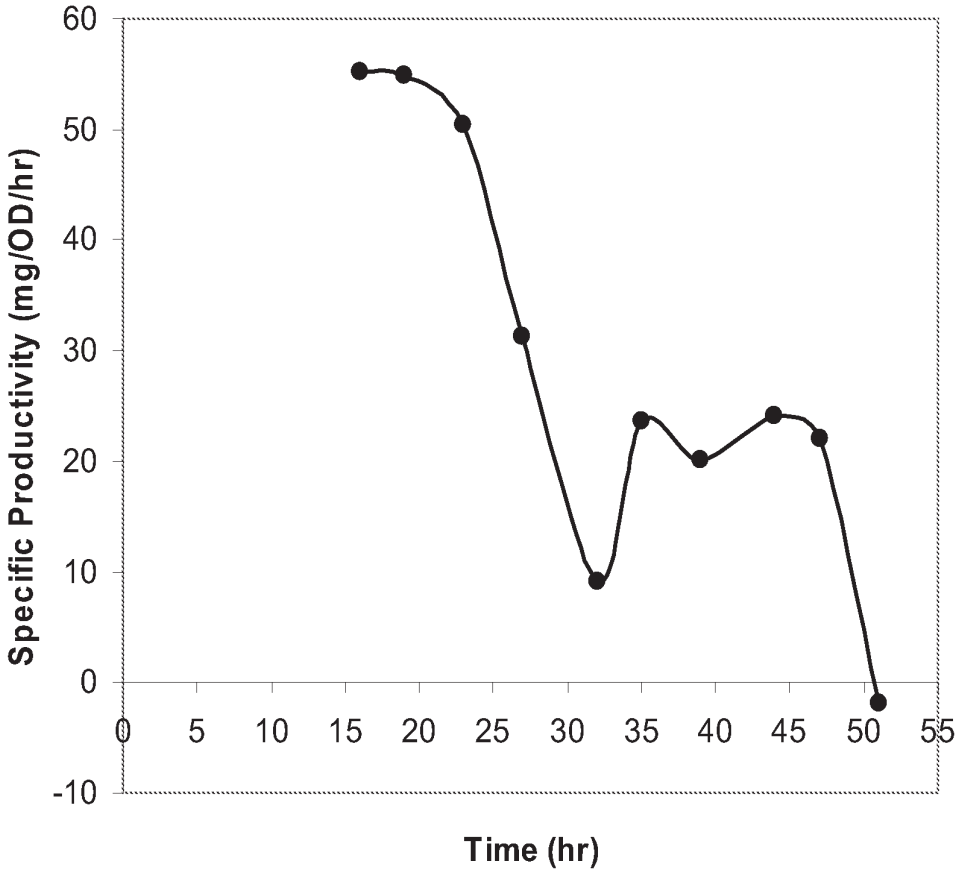

Specific Productivity (mg/OD/hr)
60
50
40
30
20
10
0
-10
0
5
10
15
20
25
30
35
40
45
50
55
Time (hr)

Figure 61A

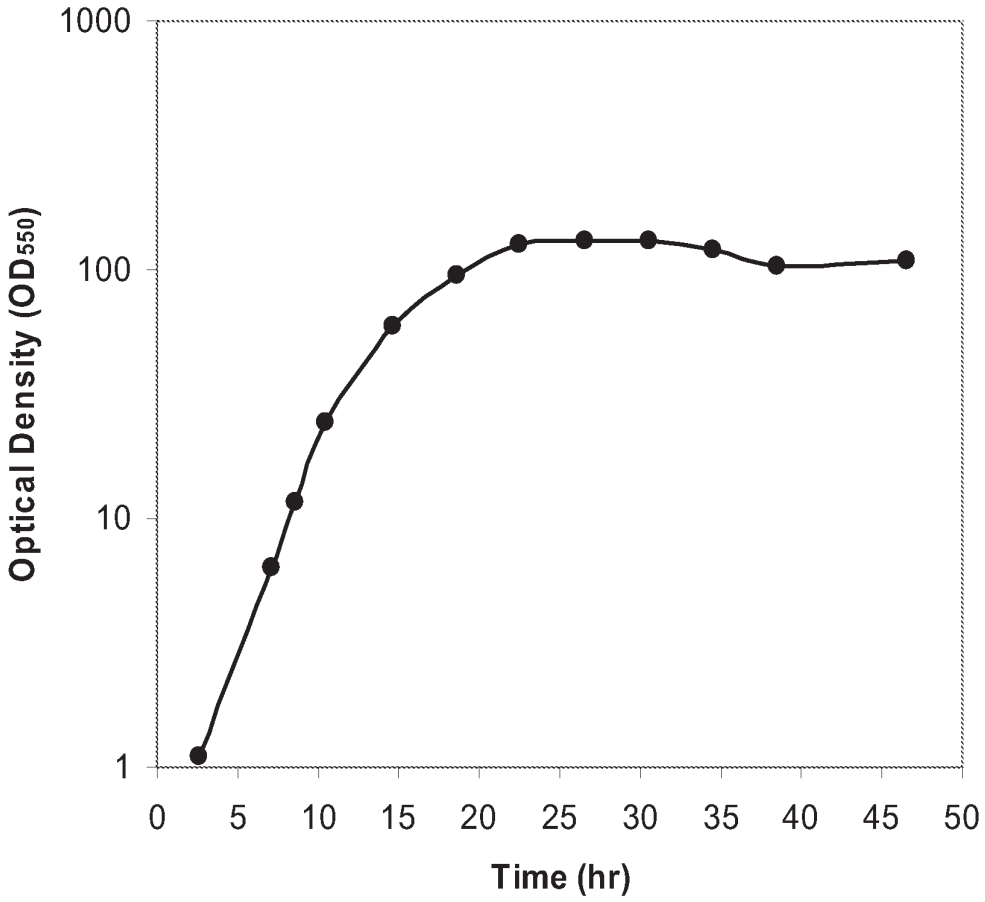

1000
100
10
1
Optical Density (OD550)
0
5
10
15
20
25
30
35
40
45
50
Time (hr)

Figure 61B

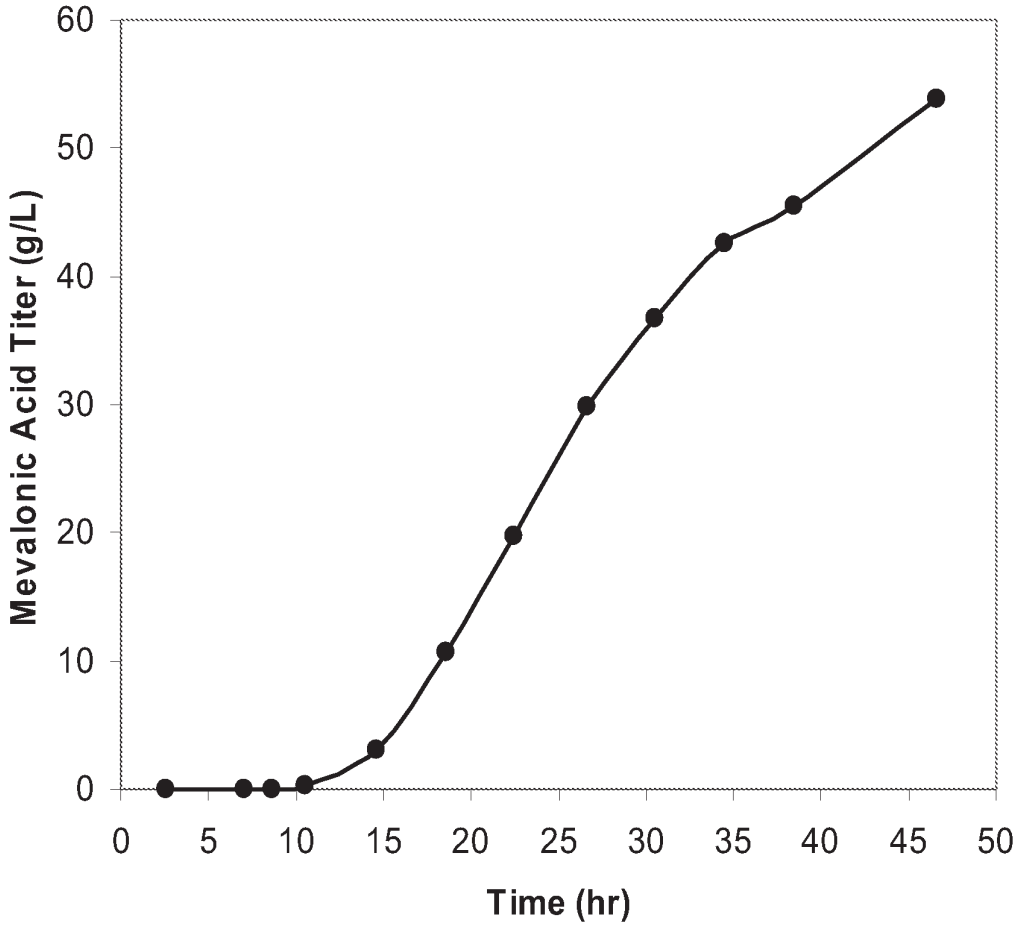

Mevalonic Acid Titer (g/L)
60
50
40
30
20
10
0
0
5
10
15
20
25
30
35
40
45
50
Time (hr)

Figure 61C

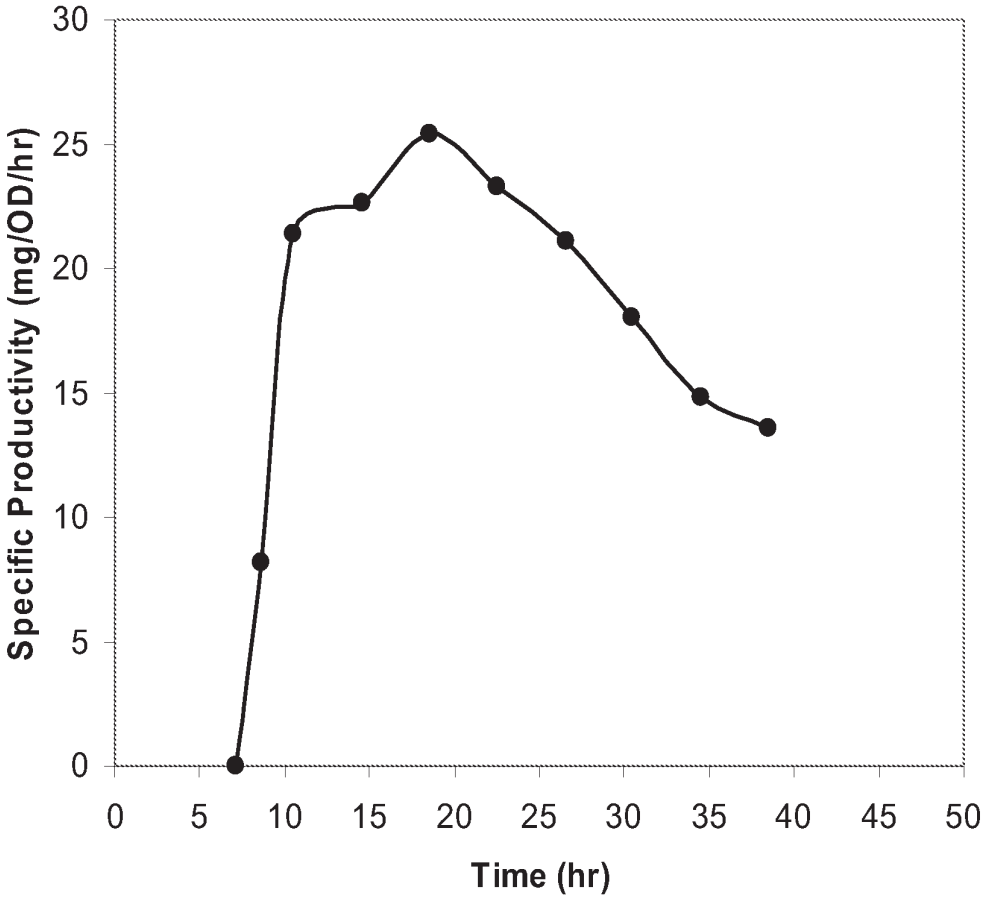

Specific Productivity (mg/OD/hr)
30
25
20
15
10
5
0
0
5
10
15
20
25
30
35
40
45
50
Time (hr)

Figure 62A

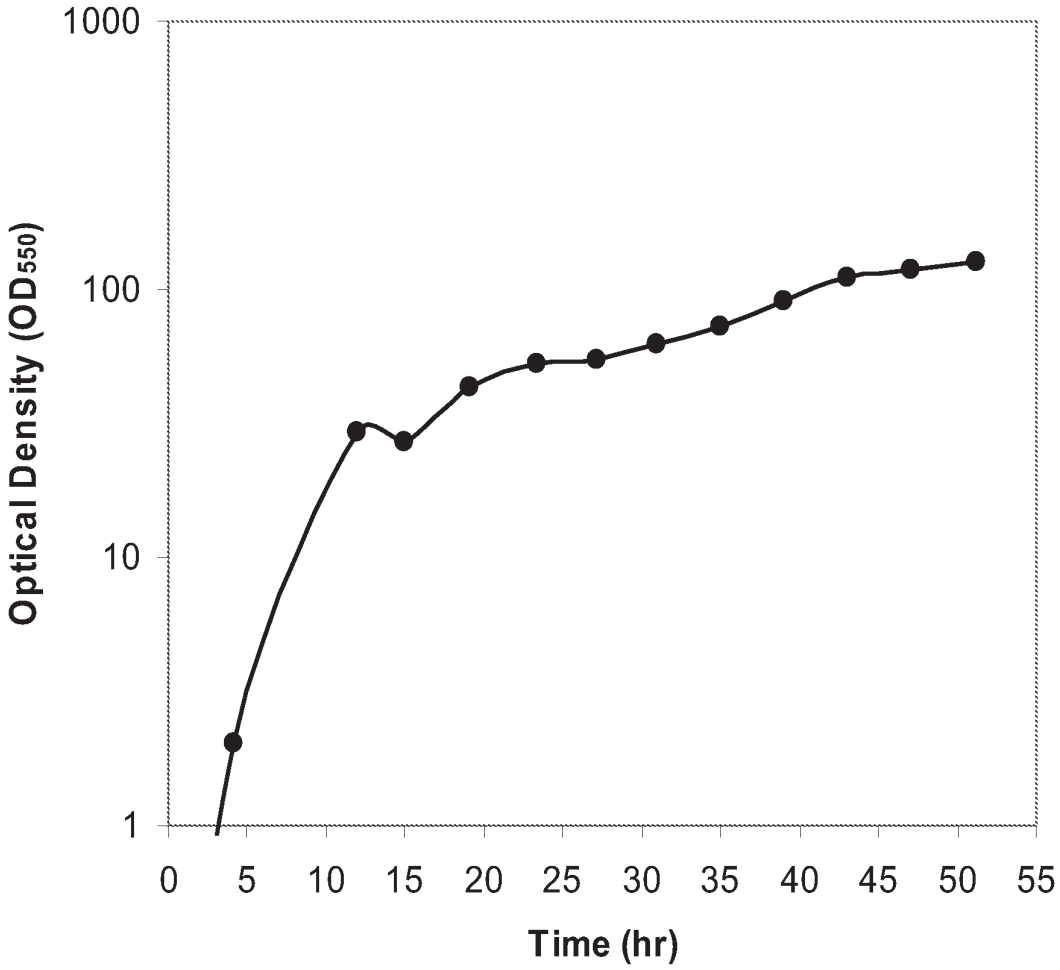

1000
100
10
1
Optical Density (OD550)
0
5
10
15
20
25
30
35
40
45
50
55
Time (hr)

Figure 62B

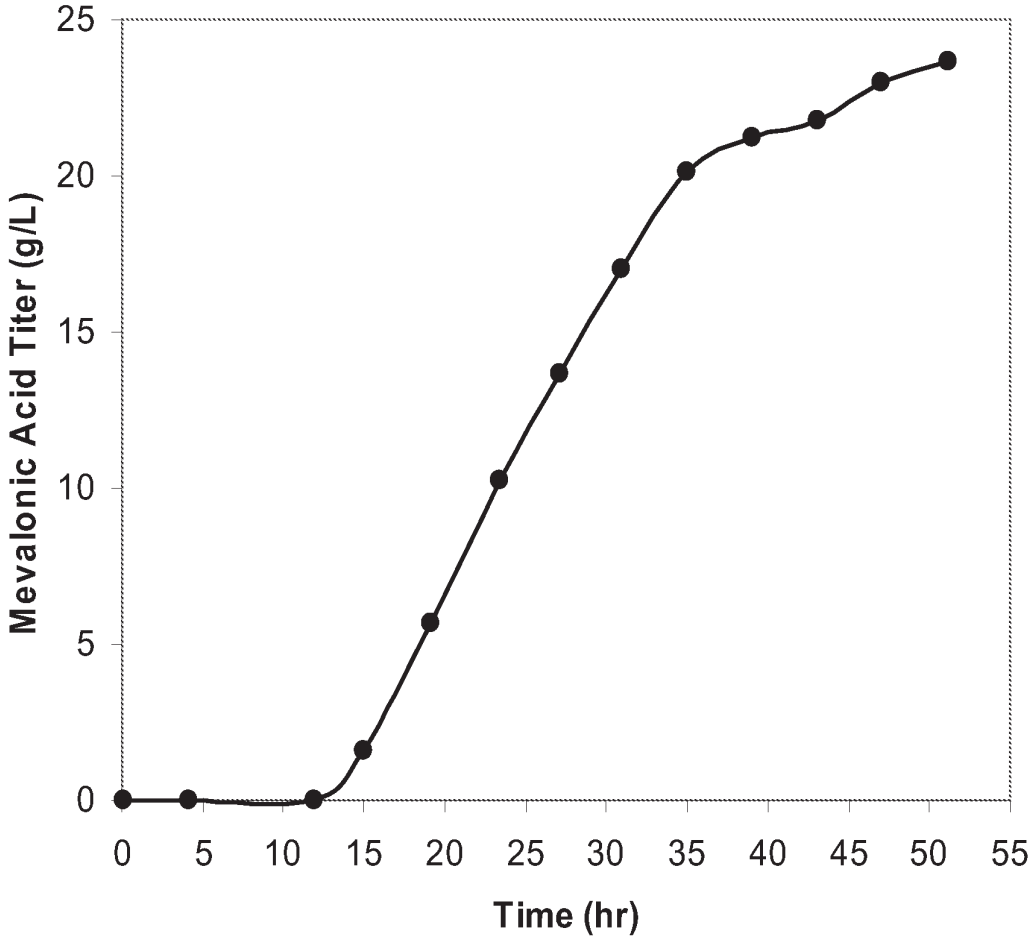

Mevalonic Acid Titer (g/L)
25
20
15
10
5
0
0
5
10
15
20
25
30
35
40
45
50
55
Time (hr)

Figure 62C

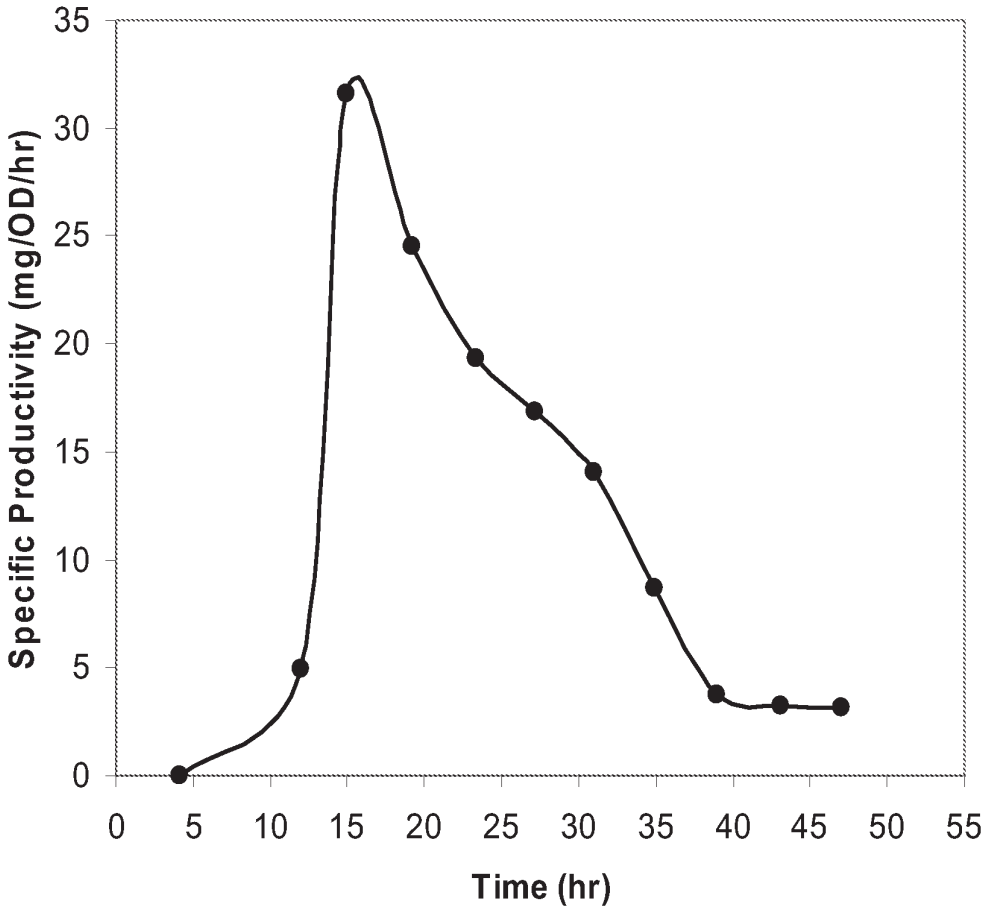

Specific Productivity (mg/OD/hr)
35
30
25
20
15
10
5
0
0
5
10
15
20
25
30
35
40
45
50
55
Time (hr)

Figure 63A

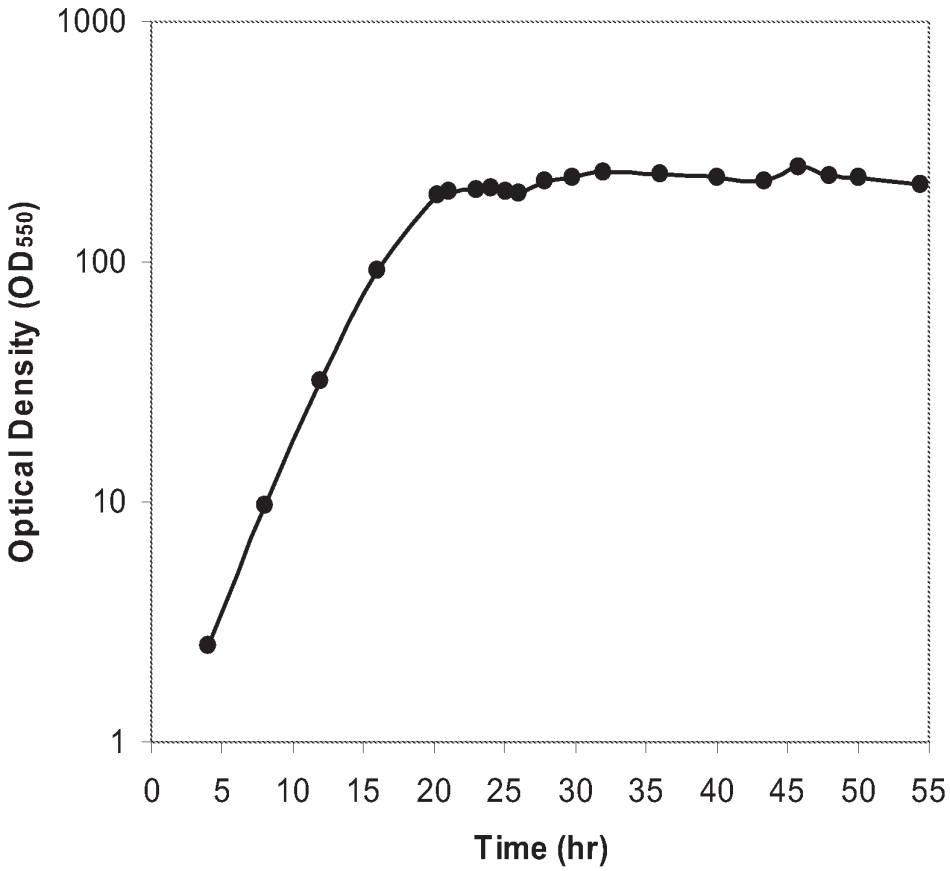

1000
100
10
1
Optical Density (OD550)
0
5
10
15
20
25
30
35
40
45
50
55
Time (hr)

Figure 63B

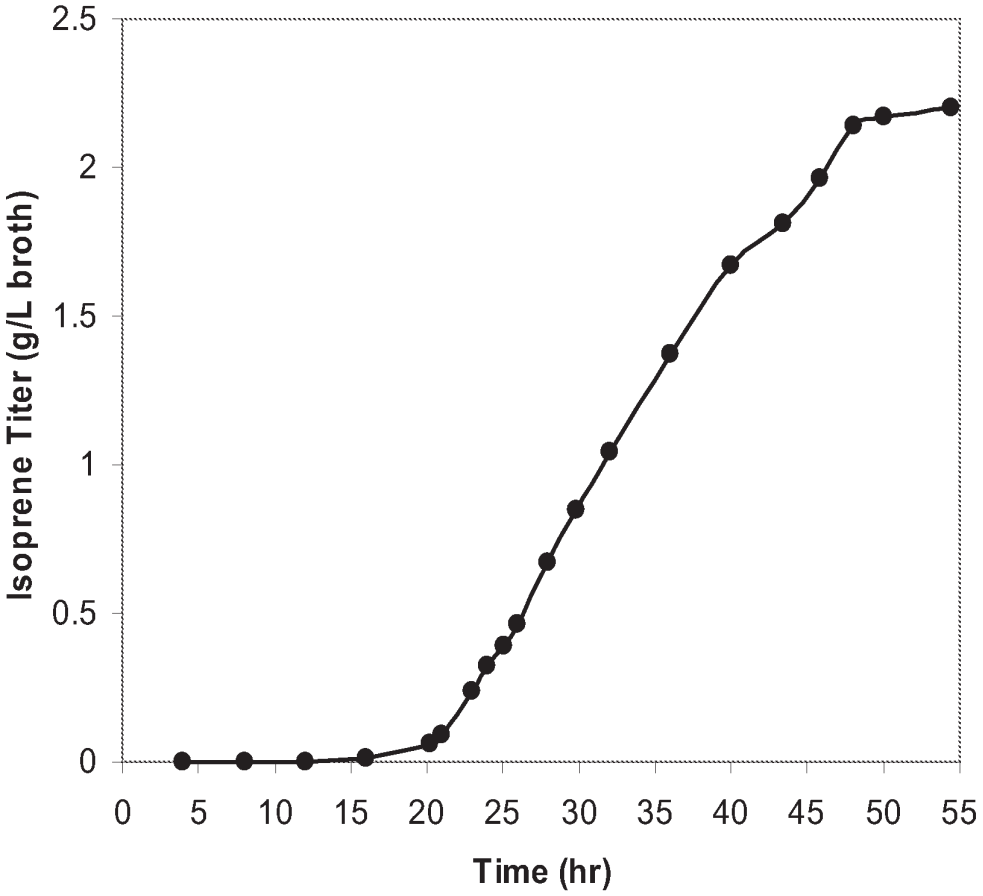

Isoprene Titer (g/L broth)
2.5
2
1.5
1
0.5
0
0 5 10 15 20 25 30 35 40 45 50 55
Time (hr)

Figure 63C

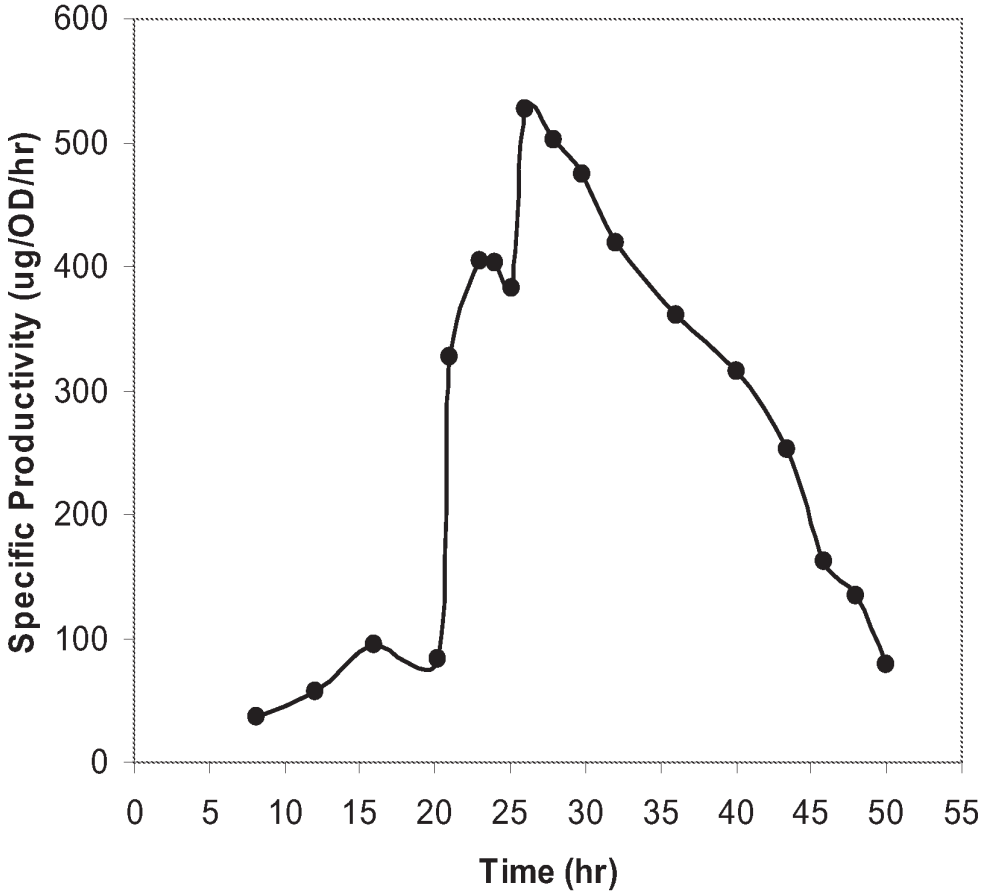

Specific Productivity (ug/OD/hr)
600
500
400
300
200
100
0
0
5
10
15
20
25
30
35
40
45
50
55
Time (hr)

Figure 64A

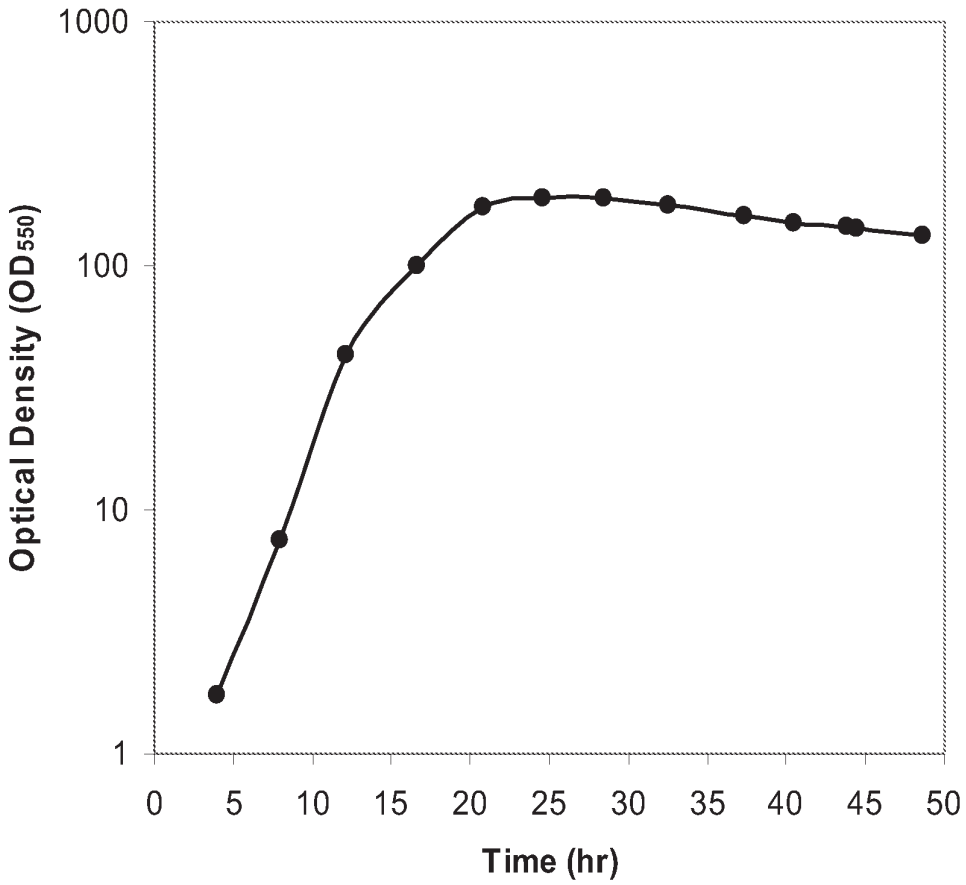

1000
100
10
1
Optical Density (OD550)
0
5
10
15
20
25
30
35
40
45
50
Time (hr)

Figure 64B

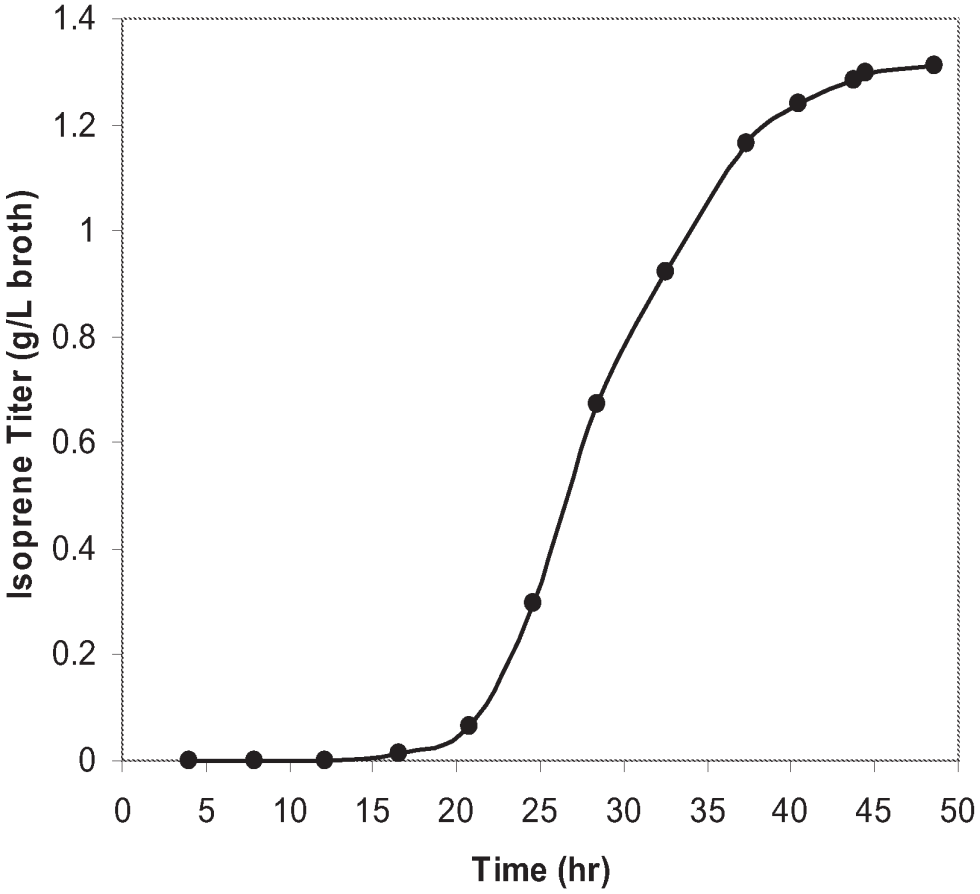

Isoprene Titer (g/L broth)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
30
35
40
45
50
Time (hr)

Figure 64C

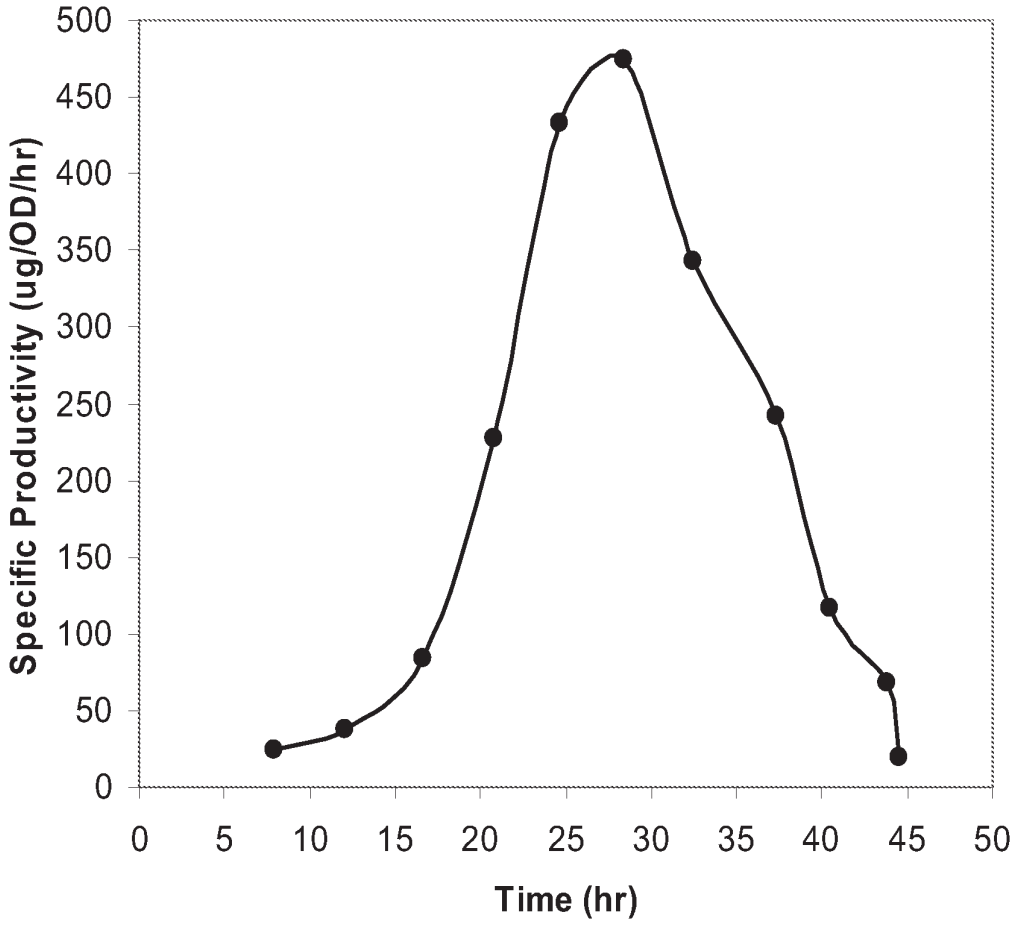

Specific Productivity (ug/OD/hr)
500
450
400
350
300
250
200
150
100
50
0
0
5
10
15
20
25
30
35
40
45
50
Time (hr)

Figure 65A

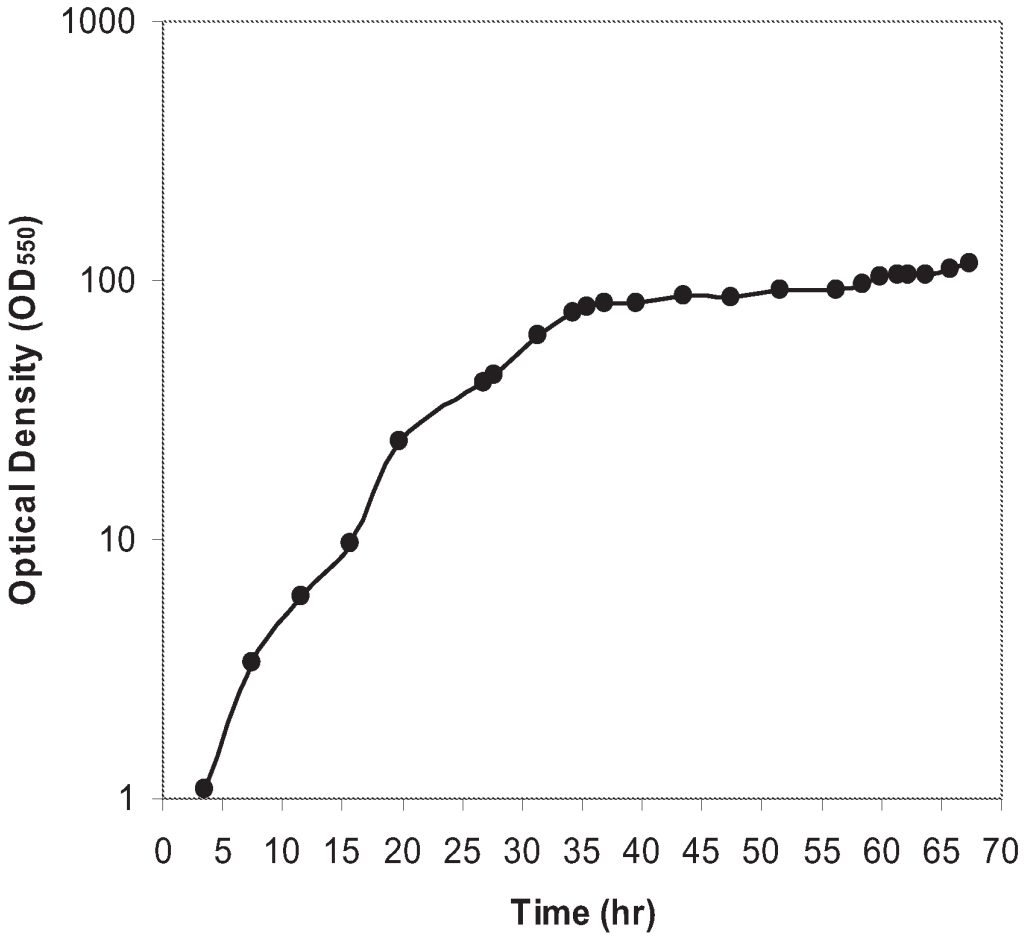

1000
100
10
1
Optical Density (OD550)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70
Time (hr)

Figure 65B

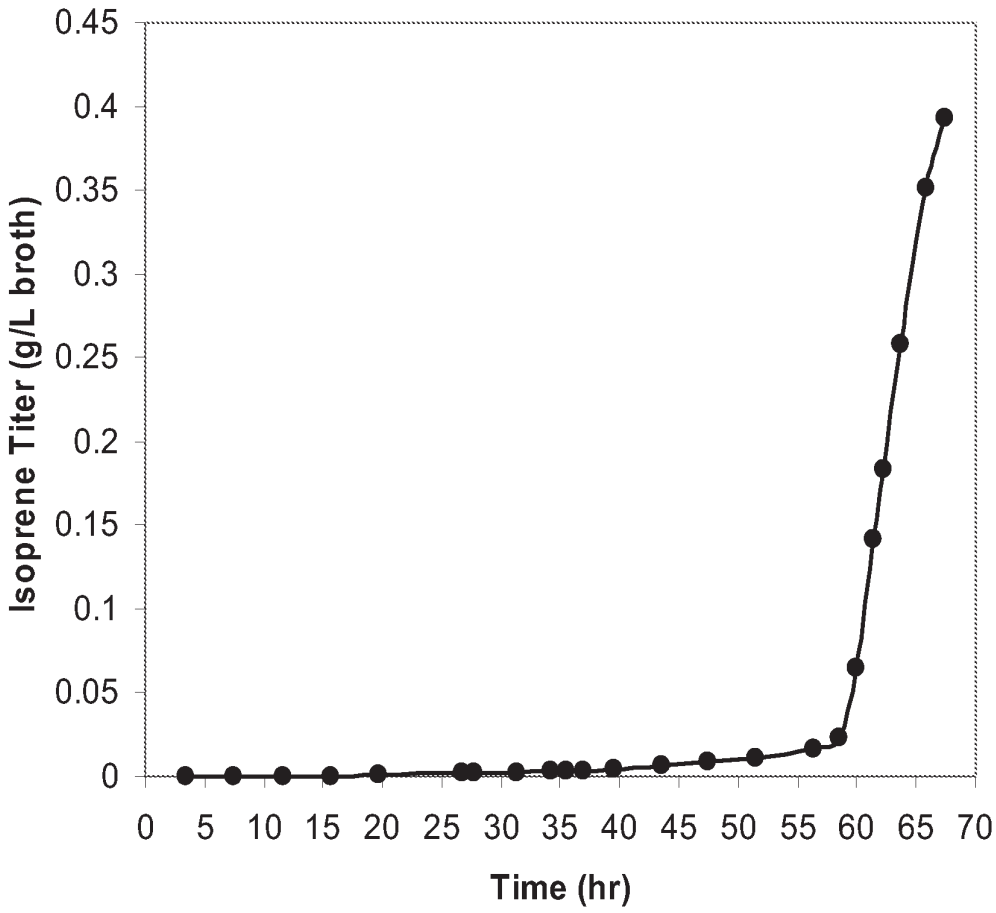

Isoprene Titer (g/L broth)
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70
Time (hr)

Figure 65C

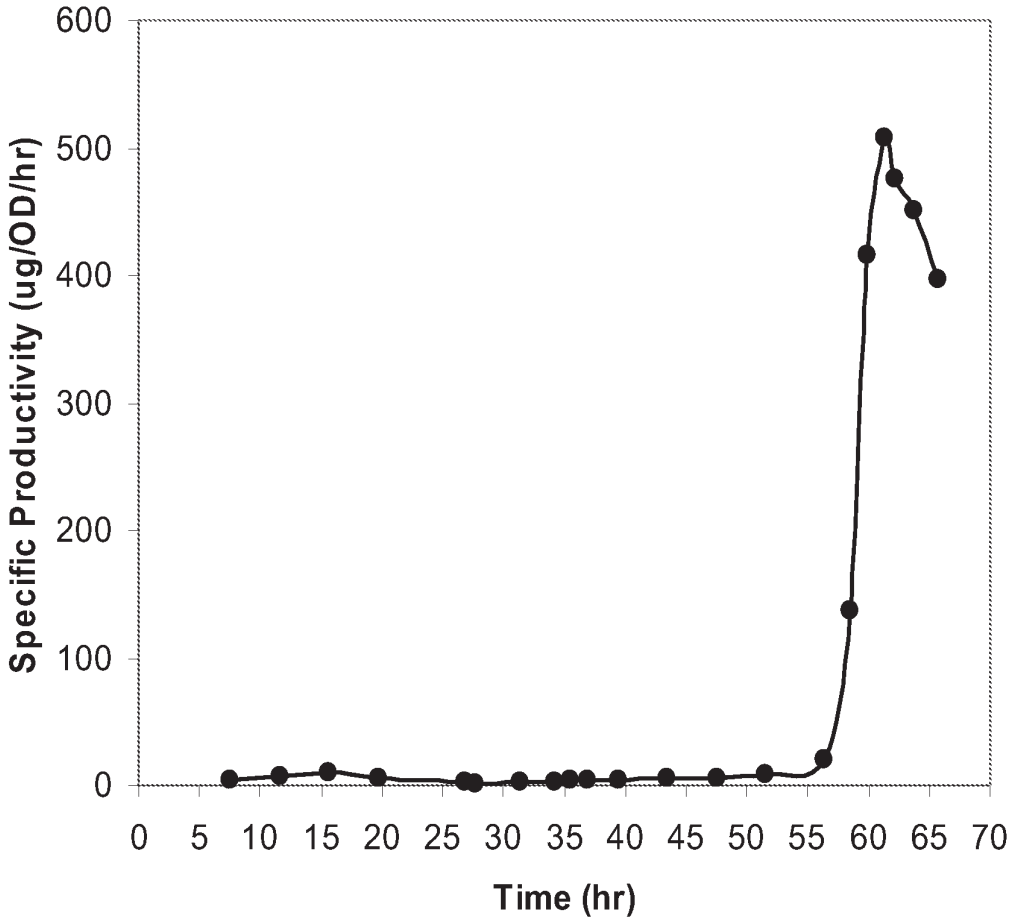

Specific Productivity (ug/OD/hr)
600
500
400
300
200
100
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70
Time (hr)

Figure 66A

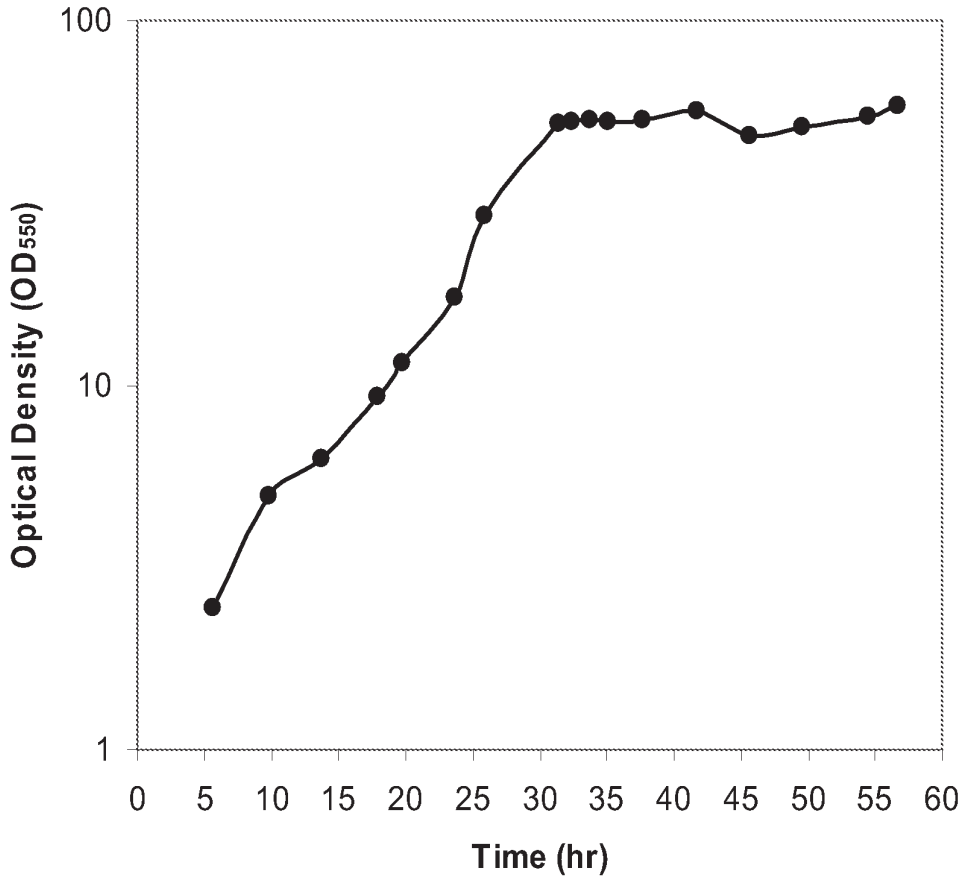

100
10
1
Optical Density (OD550)
0
5
10
15
20
25
30
35
40
45
50
55
60
Time (hr)

Figure 66B

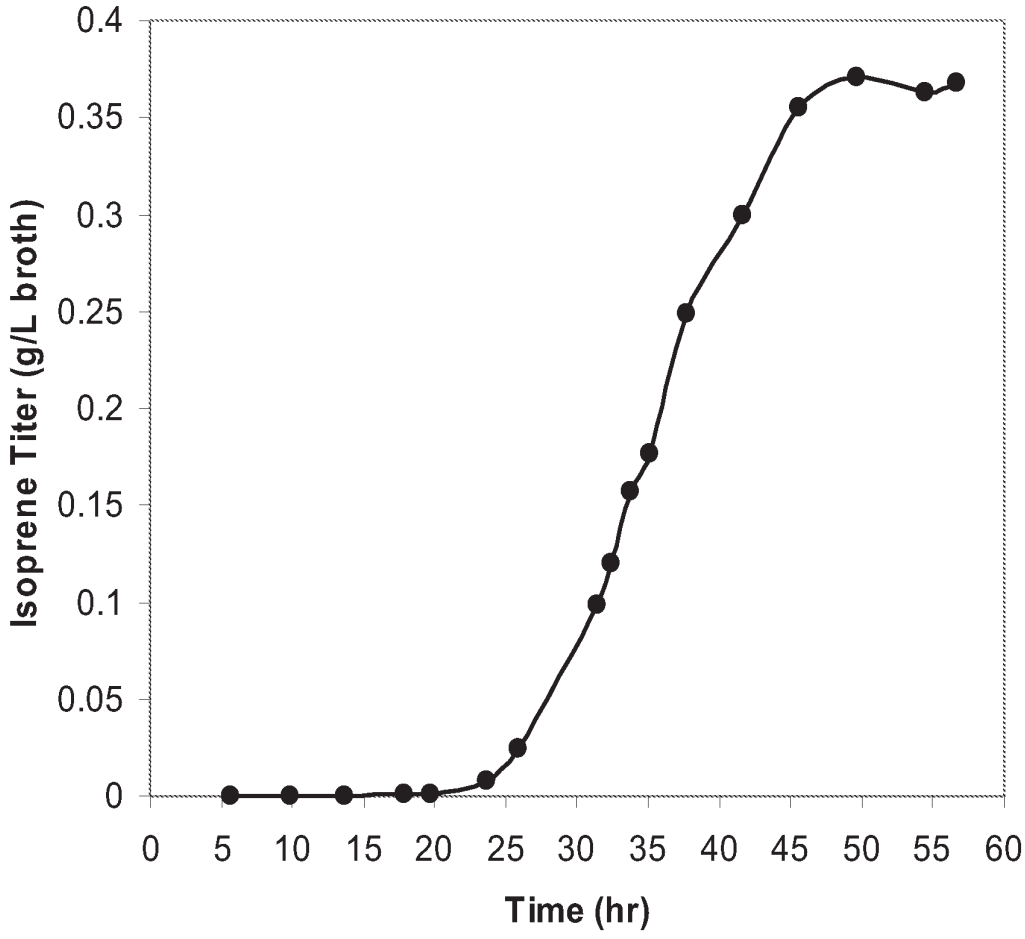

Isoprene Titer (g/L broth)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0 5 10 15 20 25 30 35 40 45 50 55 60
Time (hr)

Figure 66C

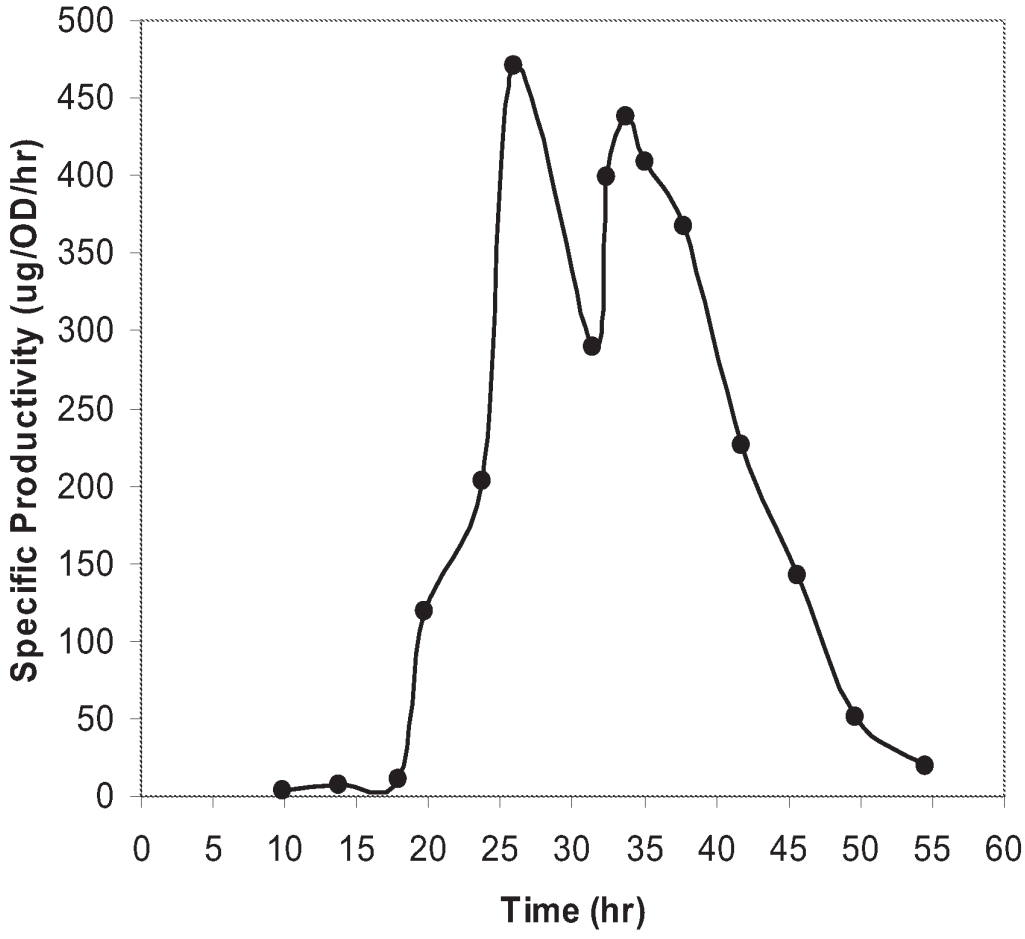

Specific Productivity (ug/OD/hr)
500
450
400
350
300
250
200
150
100
50
0
0 5 10 15 20 25 30 35 40 45 50 55 60
Time (hr)

Figure 67A

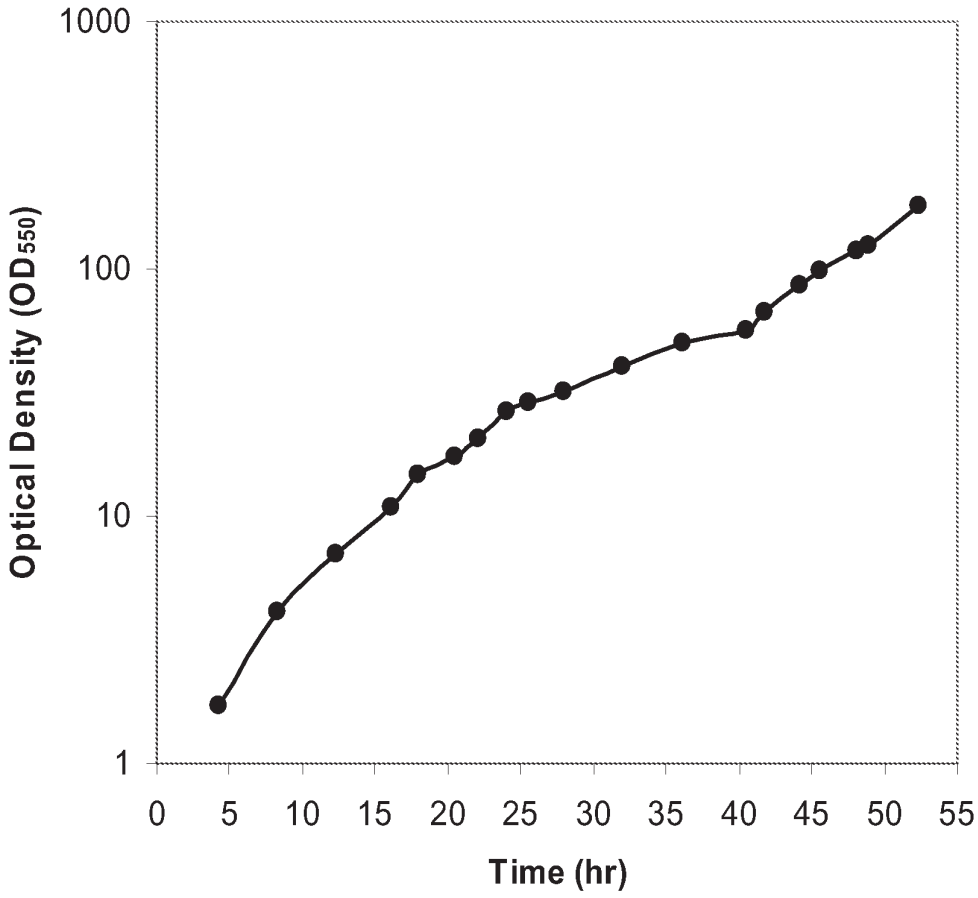

1000
100
10
1
Optical Density (OD550)
0
5
10
15
20
25
30
35
40
45
50
55
Time (hr)

Figure 67B

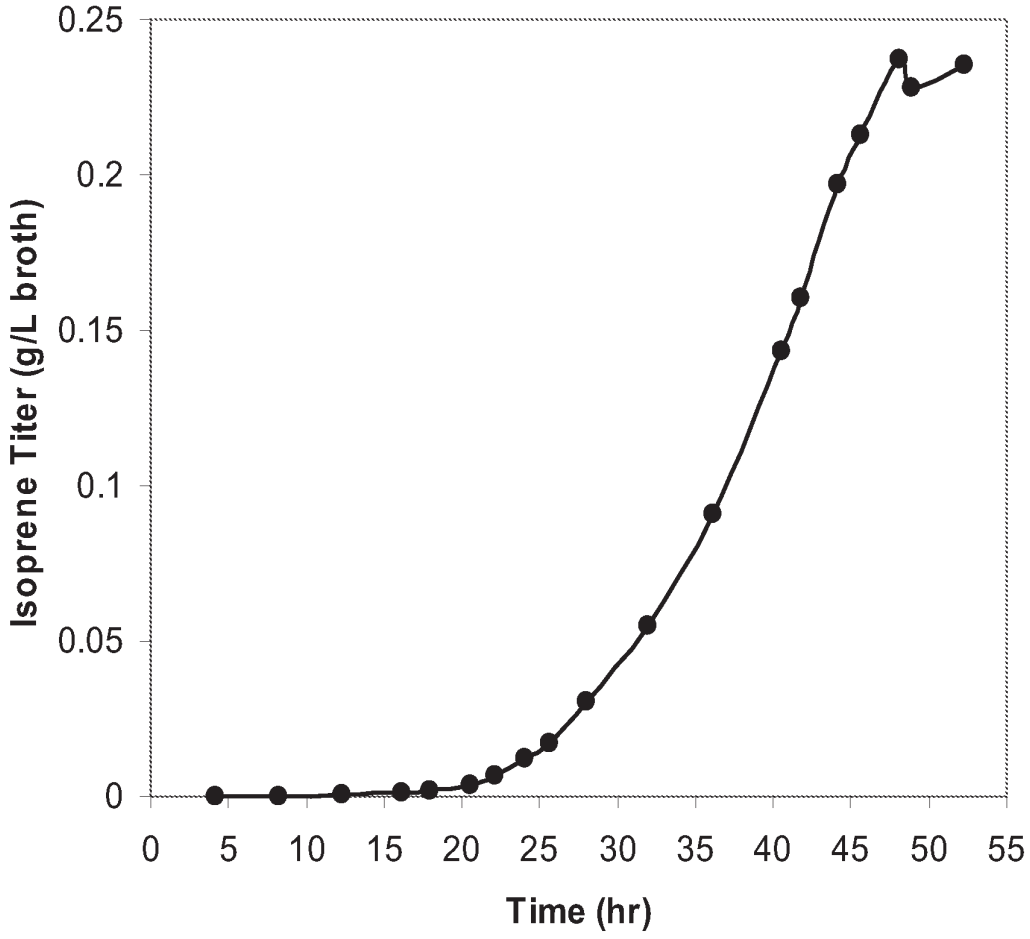

0.25
0.2
0.15
0.1
0.05
0
Isoprene Titer (g/L broth)
0
5
10
15
20
25
30
35
40
45
50
55
Time (hr)

Figure 67C

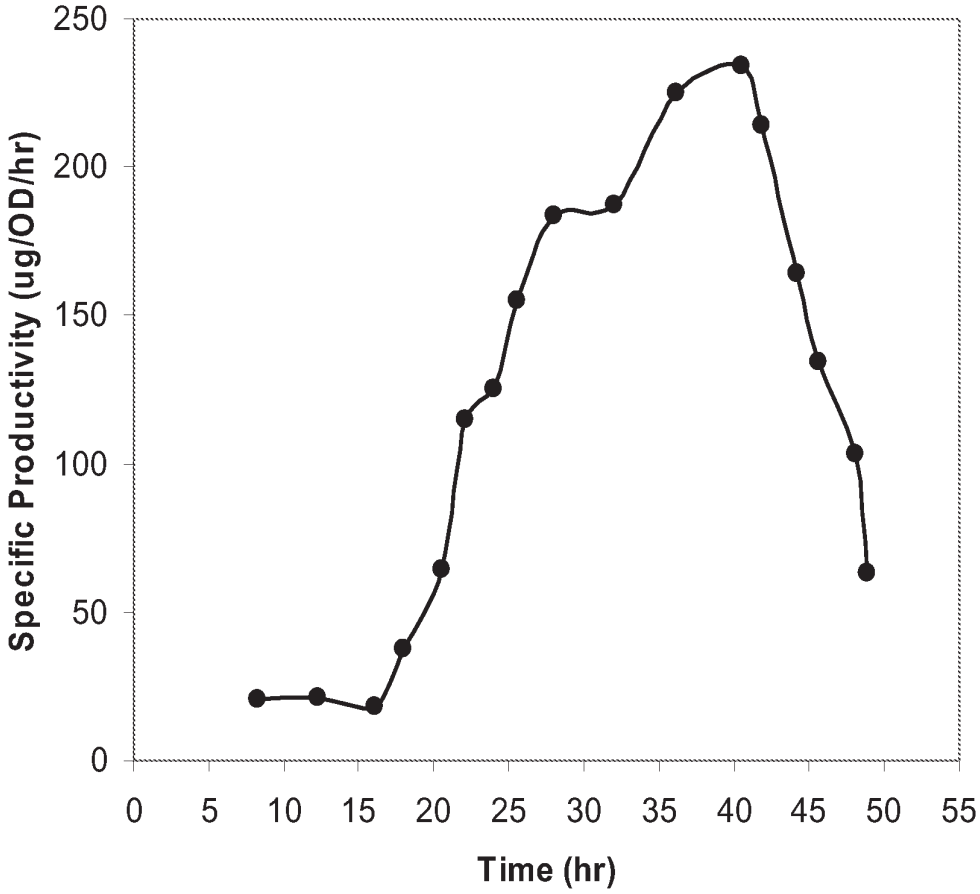

Specific Productivity (ug/OD/hr)
250
200
150
100
50
0
0
5
10
15
20
25
30
35
40
45
50
55
Time (hr)

Figure 68

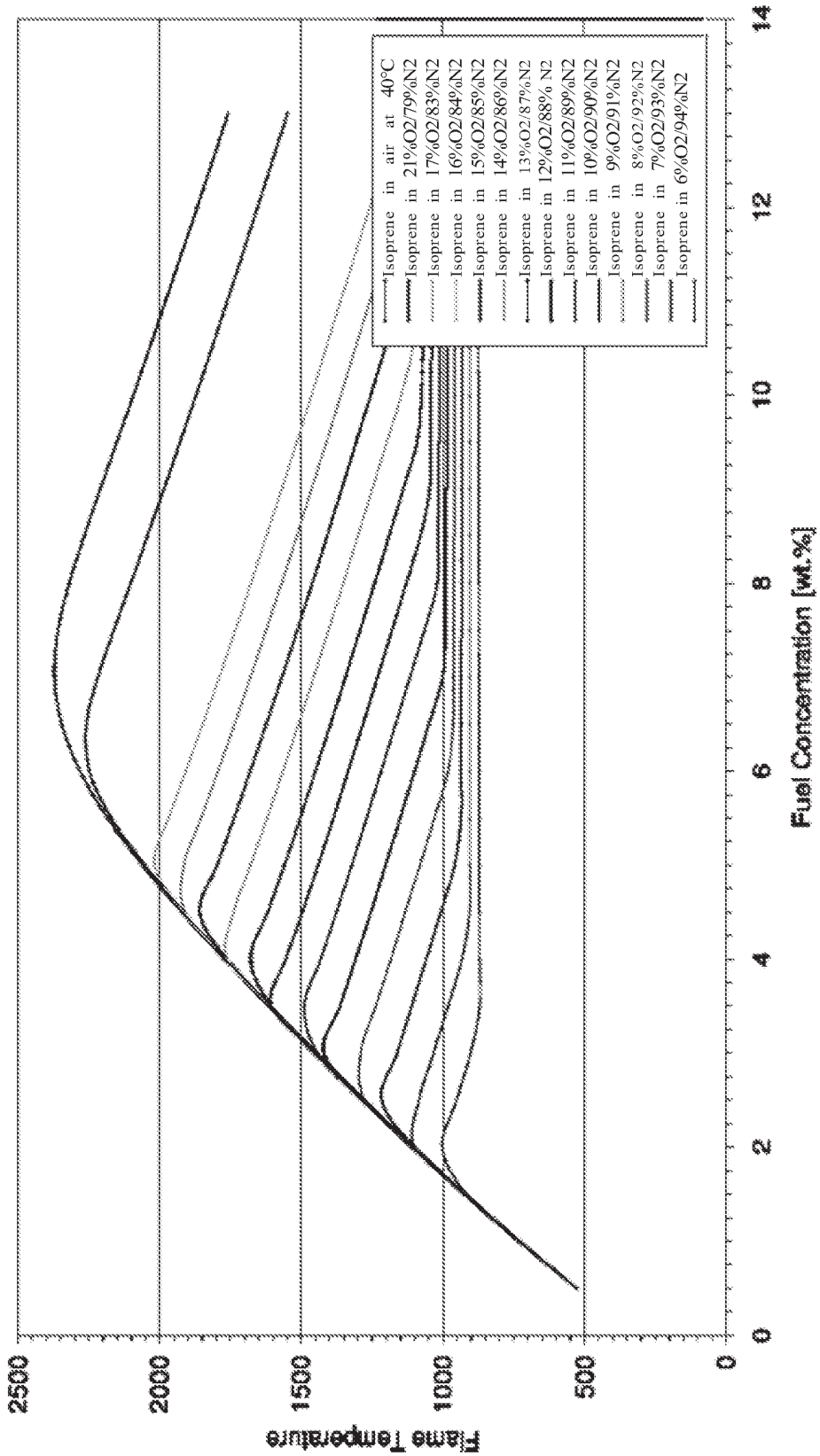

Isoprene in Oxygen/Nitrogen Environments
Flame Temperature
Fuel Concentration [wt.%]
2500
2000
1500
1000
500
0
0
2
4
6
8
10
12
14
Isoprene in air at 40°C
Isoprene in 21%O2/79%N2
Isoprene in 17%O2/83%N2
Isoprene in 16%O2/84%N2
Isoprene in 15%O2/85%N2
Isoprene in 14%O2/86%N2
Isoprene in 13%O2/87%N2
Isoprene in 12%O2/88% N2
Isoprene in 11%O2/89%N2
Isoprene in 10%O2/90%N2
Isoprene in 9%O2/91%N2
Isoprene in 8%O2/92%N2
Isoprene in 7%O2/93%N2
Isoprene in 6%O2/94%N2

Figure 69

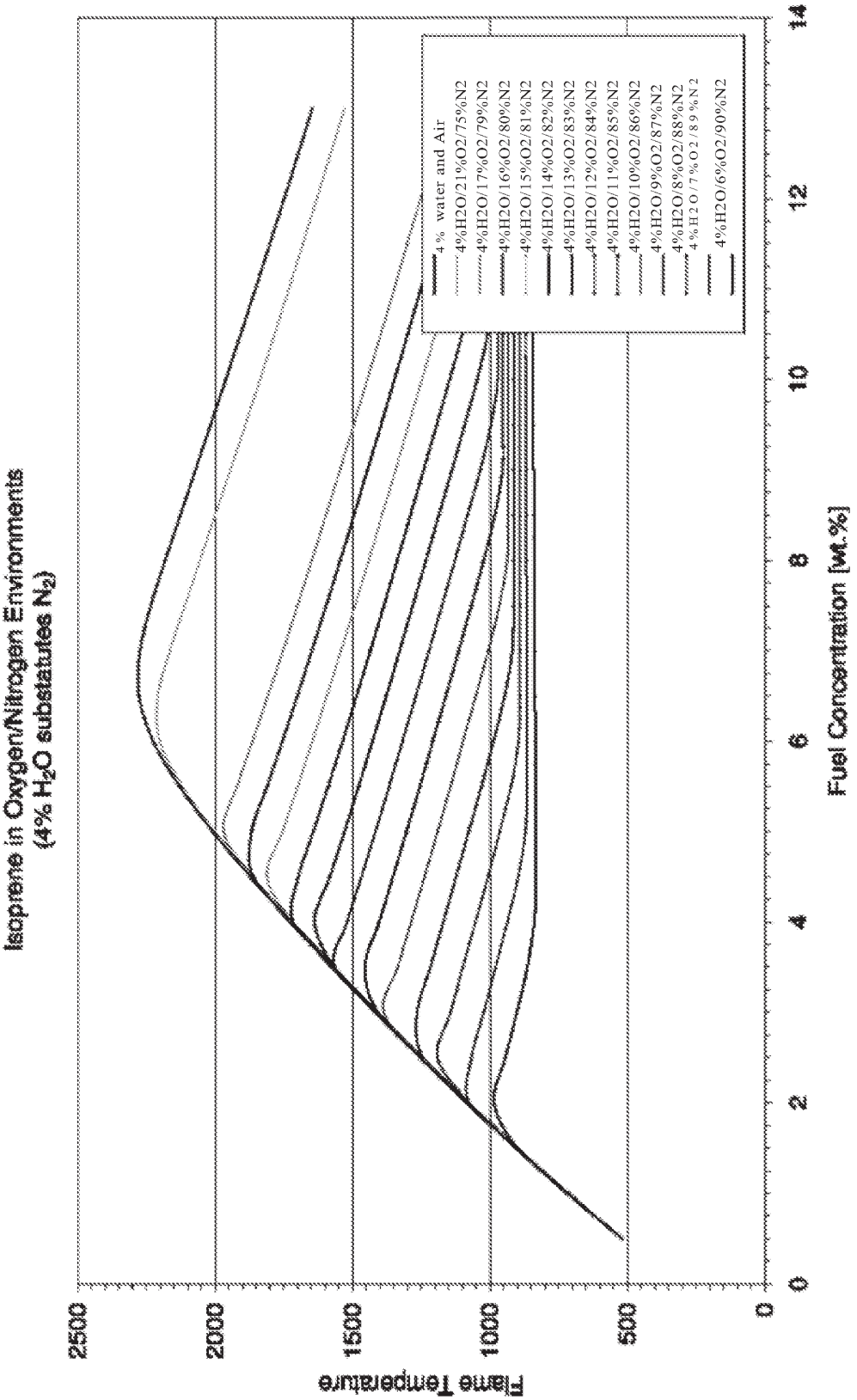
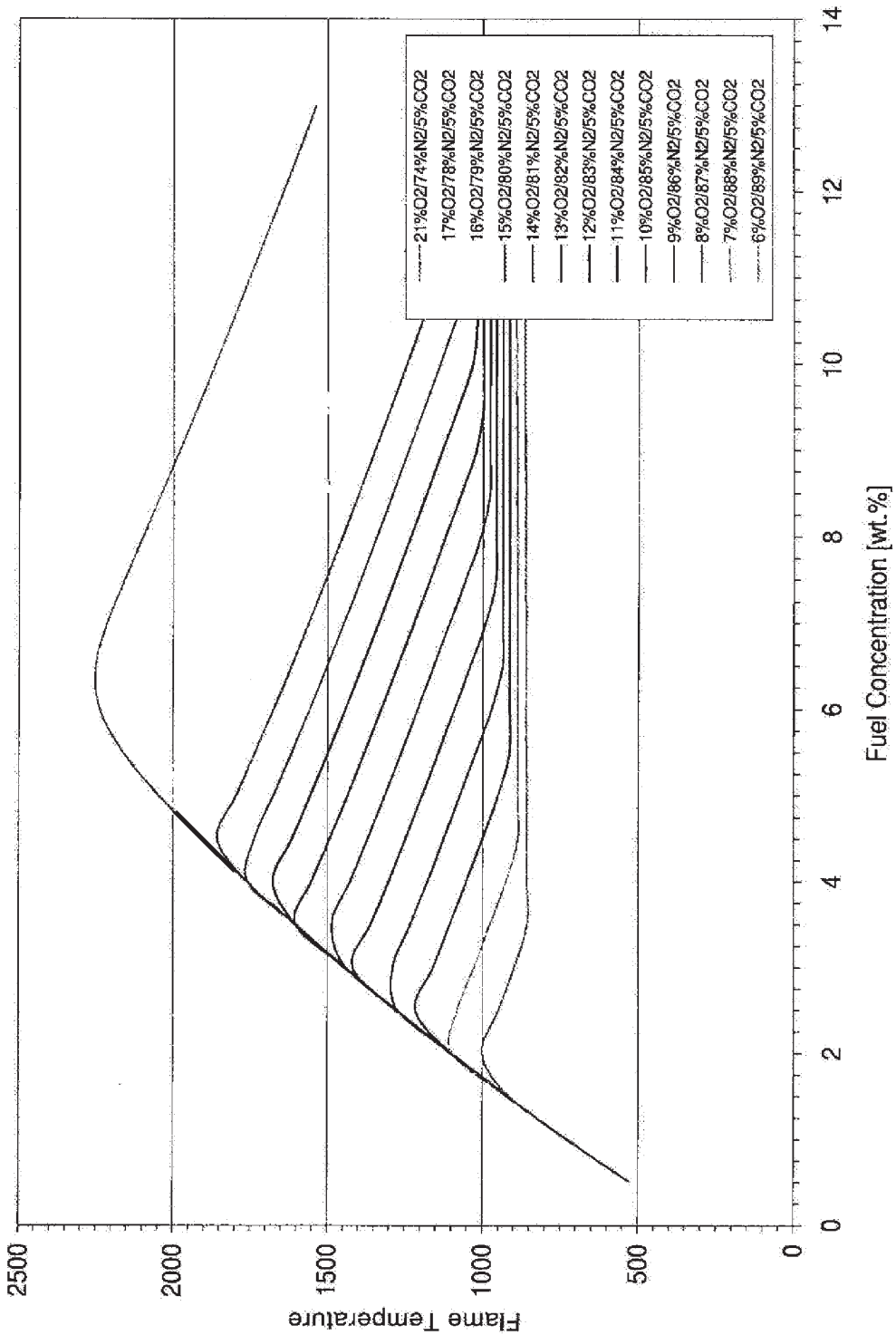

Isoprene in Oxygen/Nitrogen Environments
(4% H_2O substatutes N_2)
Flame Temperature
Fuel Concentration [wt.%]
2500
2000
1500
1000
500
0
0
2
4
6
8
10
12
14
4% water and Air
4%H2O/21%O2/75%N2
4%H2O/17%O2/79%N2
4%H2O/16%O2/80%N2
4%H2O/15%O2/81%N2
4%H2O/14%O2/82%N2
4%H2O/13%O2/83%N2
4%H2O/12%O2/84%N2
4%H2O/11%O2/85%N2
4%H2O/10%O2/86%N2
4%H2O/9%O2/87%N2
4%H2O/8%O2/88%N2
4%H2O/7%O2/89%N2
4%H2O/6%O2/90%N2

Figure 70


Isoprene in Oxygen/Nitrogen Environments
(5% CO_2 substatutes N_2)
Flame Temperature
Fuel Concentration [wt.%]
0
500
1000
1500
2000
2500
0
2
4
6
8
10
12
14
21%O2/74%N2/5%CO2
17%O2/78%N2/5%CO2
16%O2/79%N2/5%CO2
15%O2/80%N2/5%CO2
14%O2/81%N2/5%CO2
13%O2/82%N2/5%CO2
12%O2/83%N2/5%CO2
11%O2/84%N2/5%CO2
10%O2/85%N2/5%CO2
9%O2/86%N2/5%CO2
8%O2/87%N2/5%CO2
7%O2/88%N2/5%CO2
6%O2/89%N2/5%CO2

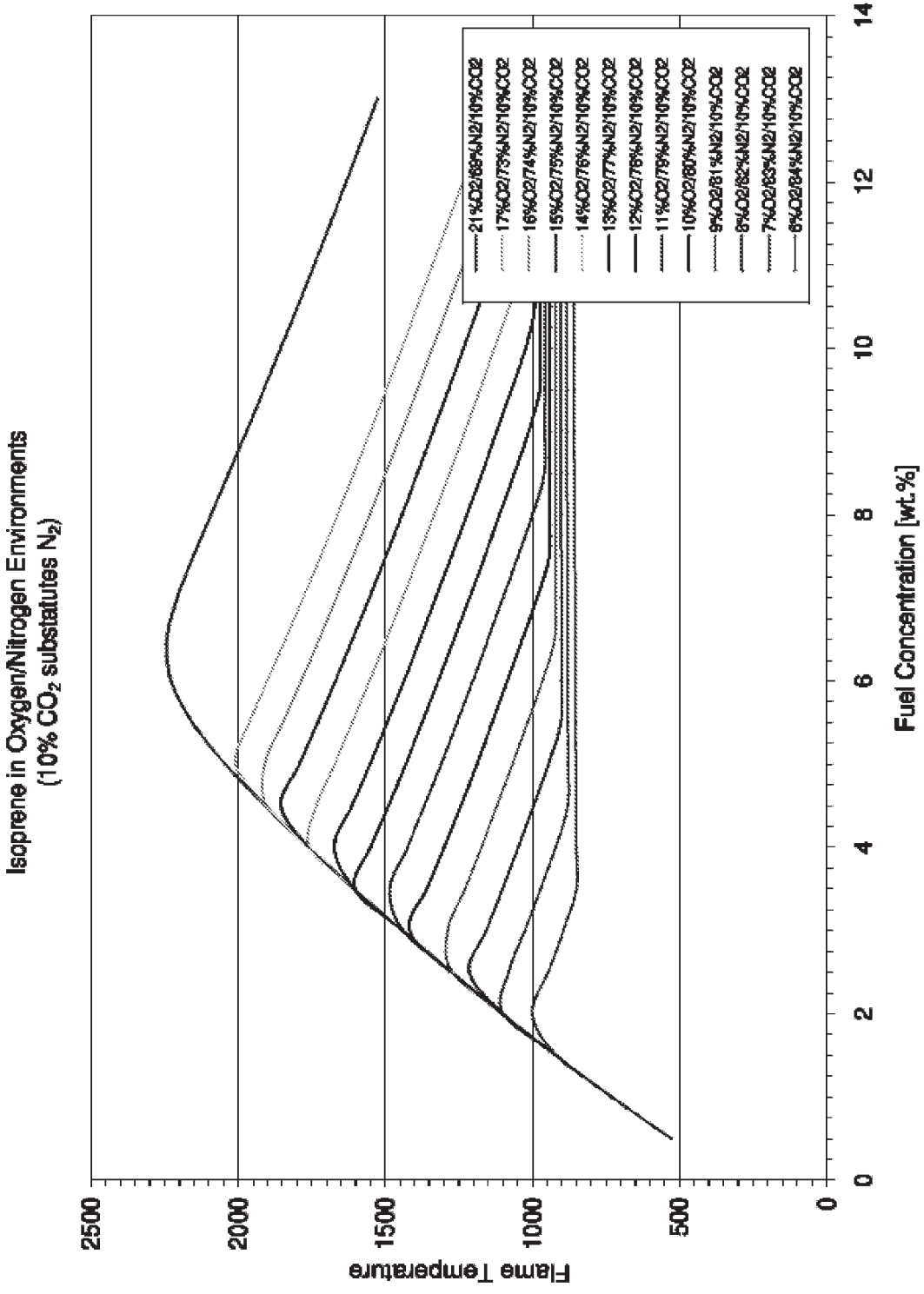

Isoprene in Oxygen/Nitrogen Environments
(10% CO_2 substatutes N_2)
Flame Temperature
Fuel Concentration [wt.%]
0
500
1000
1500
2000
2500
0
2
4
6
8
10
12
14
21%O2/69%N2/10%CO2
17%O2/73%N2/10%CO2
16%O2/74%N2/10%CO2
15%O2/75%N2/10%CO2
14%O2/76%N2/10%CO2
13%O2/77%N2/10%CO2
12%O2/78%N2/10%CO2
11%O2/79%N2/10%CO2
10%O2/80%N2/10%CO2
9%O2/81%N2/10%CO2
8%O2/82%N2/10%CO2
7%O2/83%N2/10%CO2
6%O2/84%N2/10%CO2

Figure 71

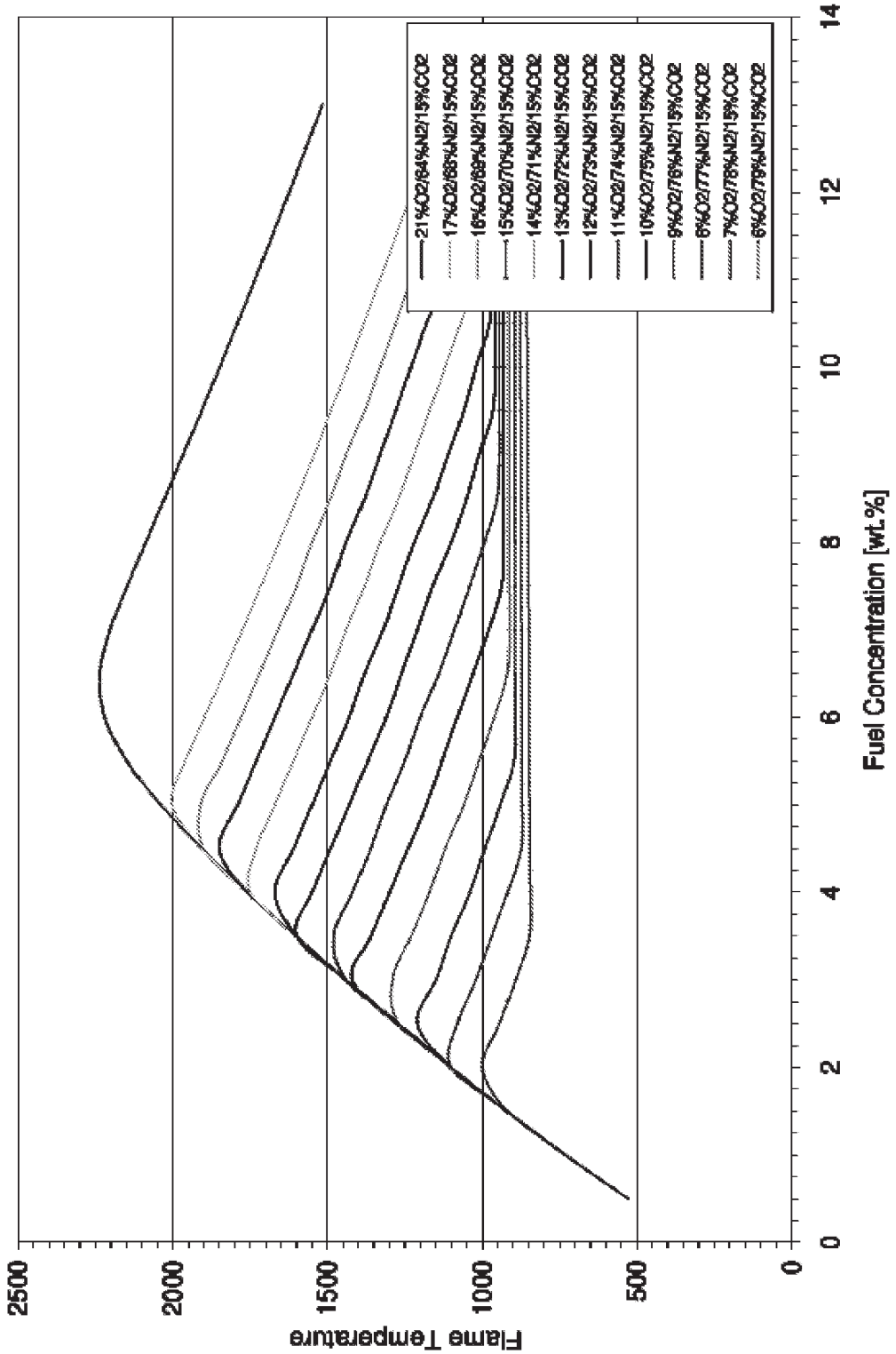

Isoprene in Oxygen/Nitrogen Environments
(15% CO_2 substitutes N_2)
Flame Temperature
Fuel Concentration [wt.%]
2500
2000
1500
1000
500
0
0
2
4
6
8
10
12
14
21%O2/64%N2/15%CO2
17%O2/68%N2/15%CO2
16%O2/69%N2/15%CO2
15%O2/70%N2/15%CO2
14%O2/71%N2/15%CO2
13%O2/72%N2/15%CO2
12%O2/73%N2/15%CO2
11%O2/74%N2/15%CO2
10%O2/75%N2/15%CO2
9%O2/76%N2/15%CO2
8%O2/77%N2/15%CO2
7%O2/78%N2/15%CO2
6%O2/79%N2/15%CO2

Figure 72

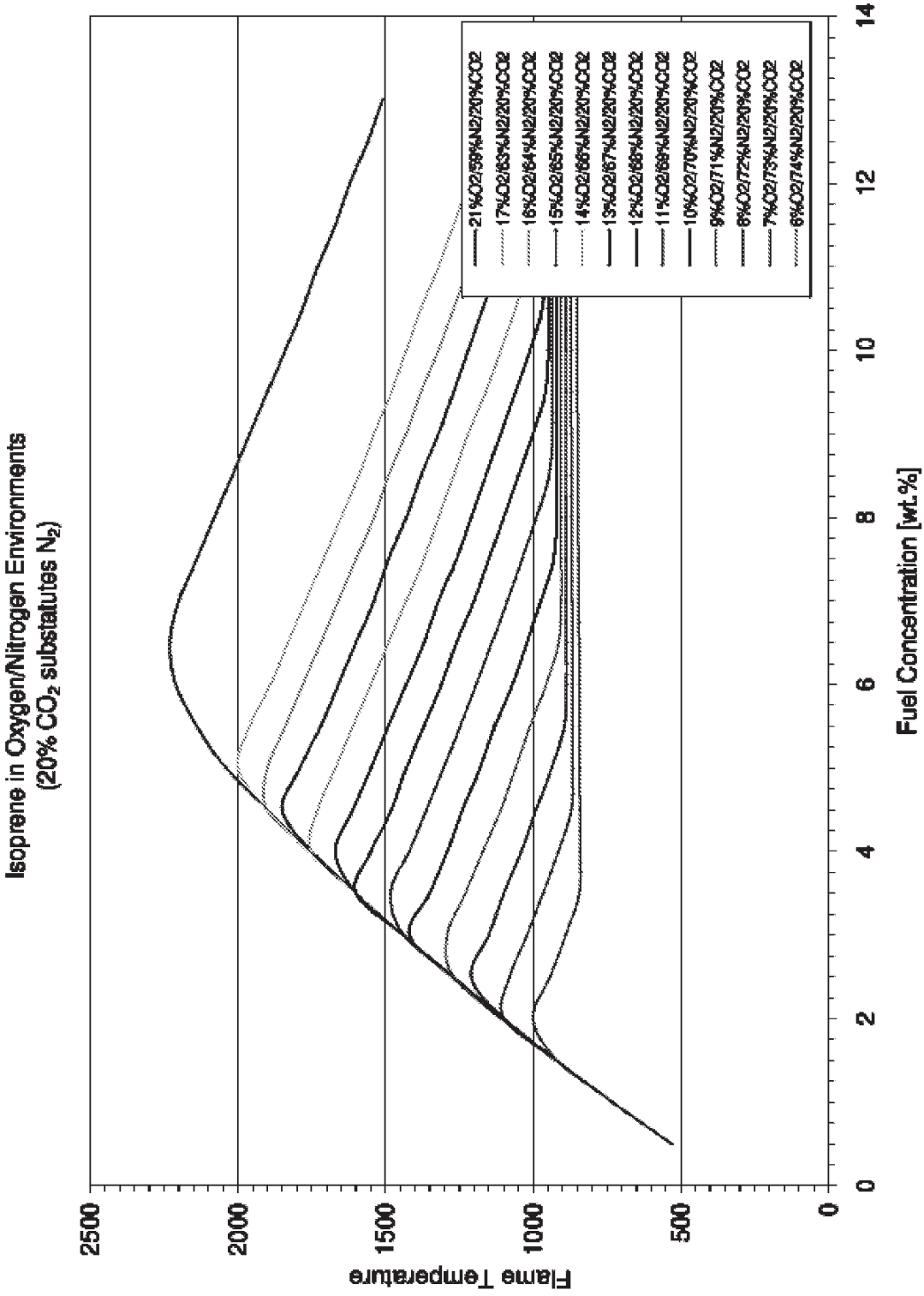

Isoprene in Oxygen/Nitrogen Environments
(20% CO_2 substatutes N_2)
Flame Temperature
Fuel Concentration [wt.%]
2500
2000
1500
1000
500
0
0
2
4
6
8
10
12
14
21%O2/59%N2/20%CO2
17%O2/63%N2/20%CO2
16%O2/64%N2/20%CO2
15%O2/65%N2/20%CO2
14%O2/66%N2/20%CO2
13%O2/67%N2/20%CO2
12%O2/68%N2/20%CO2
11%O2/69%N2/20%CO2
10%O2/70%N2/20%CO2
9%O2/71%N2/20%CO2
8%O2/72%N2/20%CO2
7%O2/73%N2/20%CO2
6%O2/74%N2/20%CO2

Figure 73

Figure 74

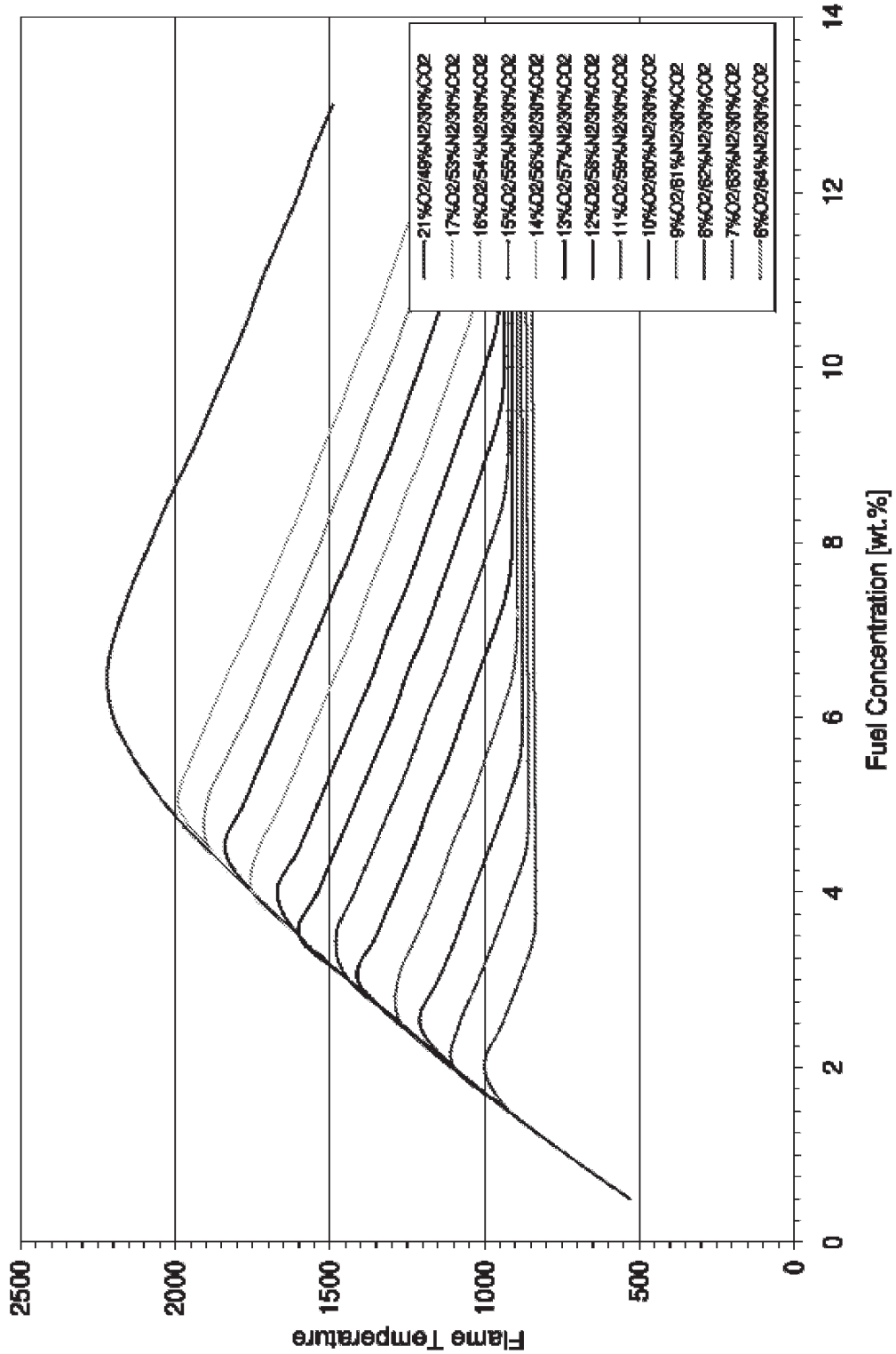

Isoprene in Oxygen/Nitrogen Environments
(30% CO_2 substatutes N_2)
Flame Temperature
Fuel Concentration [wt.%]
2500
2000
1500
1000
500
0
0
2
4
6
8
10
12
14
21%O2/49%N2/30%CO2
17%O2/53%N2/30%CO2
16%O2/54%N2/30%CO2
15%O2/55%N2/30%CO2
14%O2/56%N2/30%CO2
13%O2/57%N2/30%CO2
12%O2/58%N2/30%CO2
11%O2/59%N2/30%CO2
10%O2/60%N2/30%CO2
9%O2/61%N2/30%CO2
8%O2/62%N2/30%CO2
7%O2/63%N2/30%CO2
6%O2/64%N2/30%CO2

Figure 75A

Concentration at Deflagration															
		Fuel Makeup	Oxidizer Makeup			Molar Concentration based on 100g of sample					Volumetric Concentrations based on ideal gas law				
Fuel Conc.	Oxidizer Conc.	Isoprene	H_2O	O_2	N_2	Isoprene	H_2O	O_2	N_2	Total	Isoprene	O_2	N_2	H_2O
(wt.%)	(wt.%)	(wt. %)	(wt. %)	(wt. %)	(wt. %)	(mole)	(mole)	(mole)	(mole)	(mole)	(vol. %)	(vol. %)	(vol. %)	(vol. %)
3.10	96.90	100	0	12	88	4.56	0.00	36.34	304.54	345.44	1.32	10.52	88.16	0.00
3.10	96.90	100	0	13	87	4.56	0.00	39.37	301.08	345.01	1.32	11.41	87.27	0.00
3.10	96.90	100	0	14	86	4.56	0.00	42.39	297.62	344.57	1.32	12.30	86.37	0.00
3.10	96.90	100	0	15	85	4.56	0.00	45.42	294.16	344.14	1.32	13.20	85.48	0.00
3.10	96.90	100	0	16	84	4.56	0.00	48.45	290.70	343.71	1.33	14.10	84.58	0.00
3.10	96.90	100	0	17	83	4.56	0.00	51.48	287.24	343.28	1.33	15.00	83.68	0.00
3.10	96.90	100	0	21	79	4.56	0.00	63.59	273.40	341.55	1.33	18.62	80.05	0.00
3.50	96.50	100	0	11.1	88.9	5.15	0.00	33.47	306.39	345.01	1.49	9.70	88.81	0.00
4.40	95.60	100	0	12	88	6.47	0.00	35.85	300.46	342.78	1.89	10.46	87.65	0.00
5.50	94.50	100	0	13	87	8.09	0.00	38.39	293.63	340.10	2.38	11.29	86.33	0.00
6.60	93.40	100	0	14	86	9.71	0.00	40.86	286.87	337.44	2.88	12.11	85.01	0.00
7.60	92.40	100	0	15	85	11.18	0.00	43.31	280.50	334.99	3.34	12.93	83.73	0.00
8.50	91.50	100	0	16	84	12.50	0.00	45.75	274.50	332.75	3.76	13.75	82.49	0.00
9.60	90.40	100	0	17	83	14.12	0.00	48.03	267.97	330.11	4.28	14.55	81.18	0.00
13.50	86.50	100	0	21	79	19.85	0.00	56.77	244.05	320.67	6.19	17.70	76.11	0.00

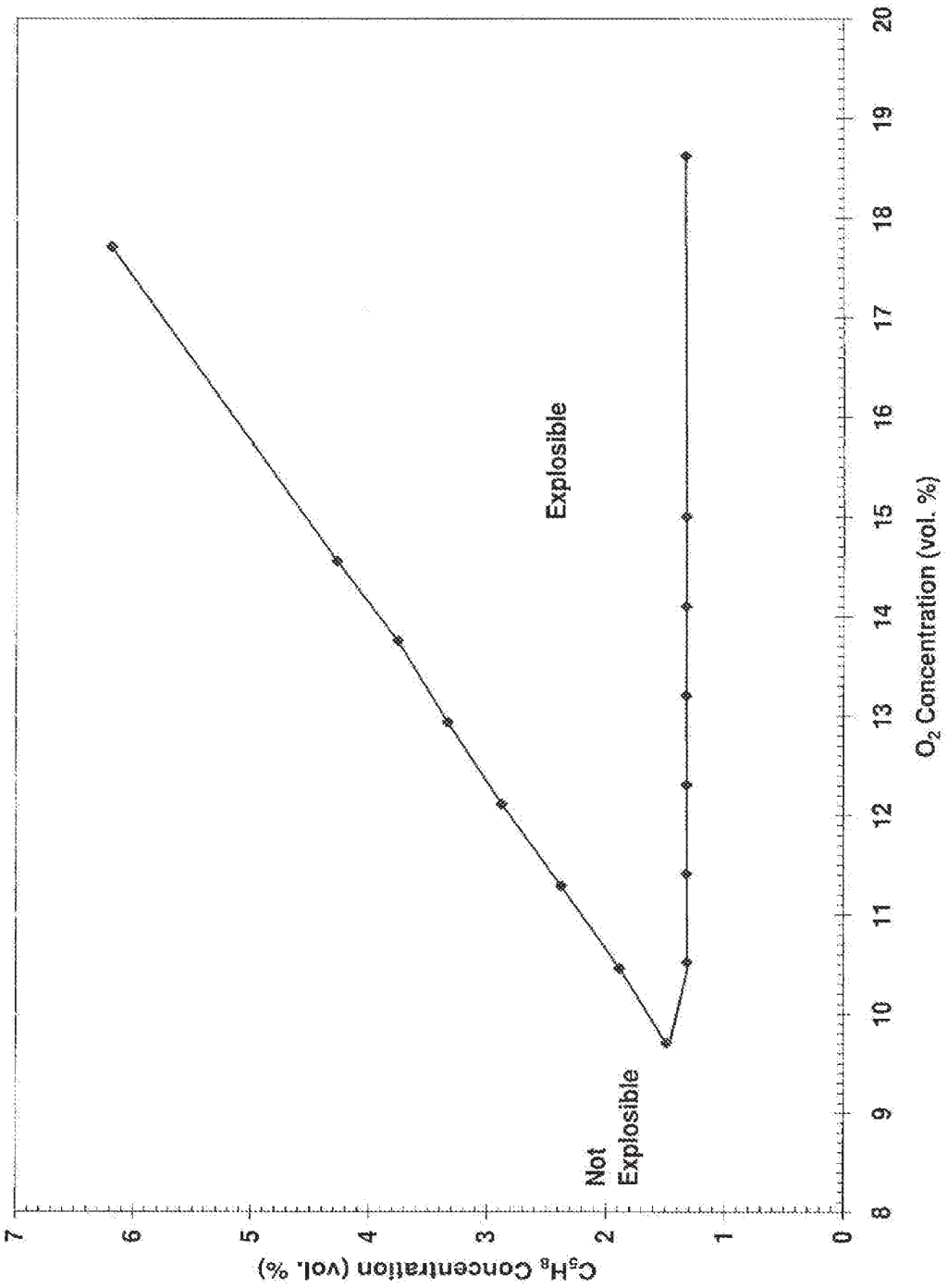

Explosible
Not Explosible
C_3H_8 Concentration (vol. %)
O_2 Concentration (vol. %)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

Figure 75B

Figure 76A

Concentration at Deflagration																
		Fuel Makeup	Oxidizer Makeup			Molar Concentration based on 100g of sample					Volumetric Concentrations based on ideal gas law					
Fuel Conc.	Oxidizer Conc.	Isoprene	H_2O (wt. %)	O_2 (wt. %)	N_2 (wt. %)	Isoprene	H_2O	O_2	N_2	Total	Isoprene	O_2	N_2	H_2O		
(wt.%)	(wt.%)	(wt. %)				(mole)	(mole)	(mole)	(mole)	(mole)	(vol. %)	(vol. %)	(vol. %)	(vol. %)		
3.252	96.748	100	4	12	84	4.78	21.50	36.28	290.24	352.81	1.36	10.28	82.27	6.09		
3.274	96.726	100	4	13	83	4.81	21.49	39.29	286.72	352.33	1.37	11.15	81.38	6.10		
3.290	96.710	100	4	14	82	4.84	21.49	42.31	283.22	351.86	1.38	12.02	80.49	6.11		
3.288	96.712	100	4	15	81	4.84	21.49	45.33	279.77	351.43	1.38	12.90	79.61	6.12		
3.286	96.714	100	4	16	80	4.83	21.49	48.36	276.33	351.01	1.38	13.78	78.72	6.12		
3.284	96.716	100	4	17	79	4.83	21.49	51.38	272.88	350.58	1.38	14.66	77.84	6.13		
3.276	96.724	100	4	21	75	4.82	21.49	63.48	259.08	348.87	1.38	18.19	74.26	6.16		
3.500	96.500	100	4	11.5	84.5	5.15	21.44	34.68	291.22	352.49	1.46	9.84	82.62	6.08		
4.200	95.800	100	4	12	84	6.18	21.29	35.93	287.40	350.79	1.76	10.24	81.93	6.07		
5.300	94.700	100	4	13	83	7.79	21.04	38.47	280.72	348.03	2.24	11.05	80.66	6.05		
6.400	93.600	100	4	14	82	9.41	20.80	40.95	274.11	345.28	2.73	11.86	79.39	6.02		
7.400	92.600	100	4	15	81	10.88	20.58	43.41	267.88	342.74	3.18	12.66	78.16	6.00		
8.500	91.500	100	4	16	80	12.50	20.33	45.75	261.43	340.01	3.68	13.46	76.89	5.98		
9.400	90.600	100	4	17	79	13.82	20.13	48.13	255.62	337.71	4.09	14.25	75.69	5.96		
13.300	86.700	100	4	21	75	19.56	19.27	56.90	232.23	327.95	5.96	17.35	70.81	5.87		

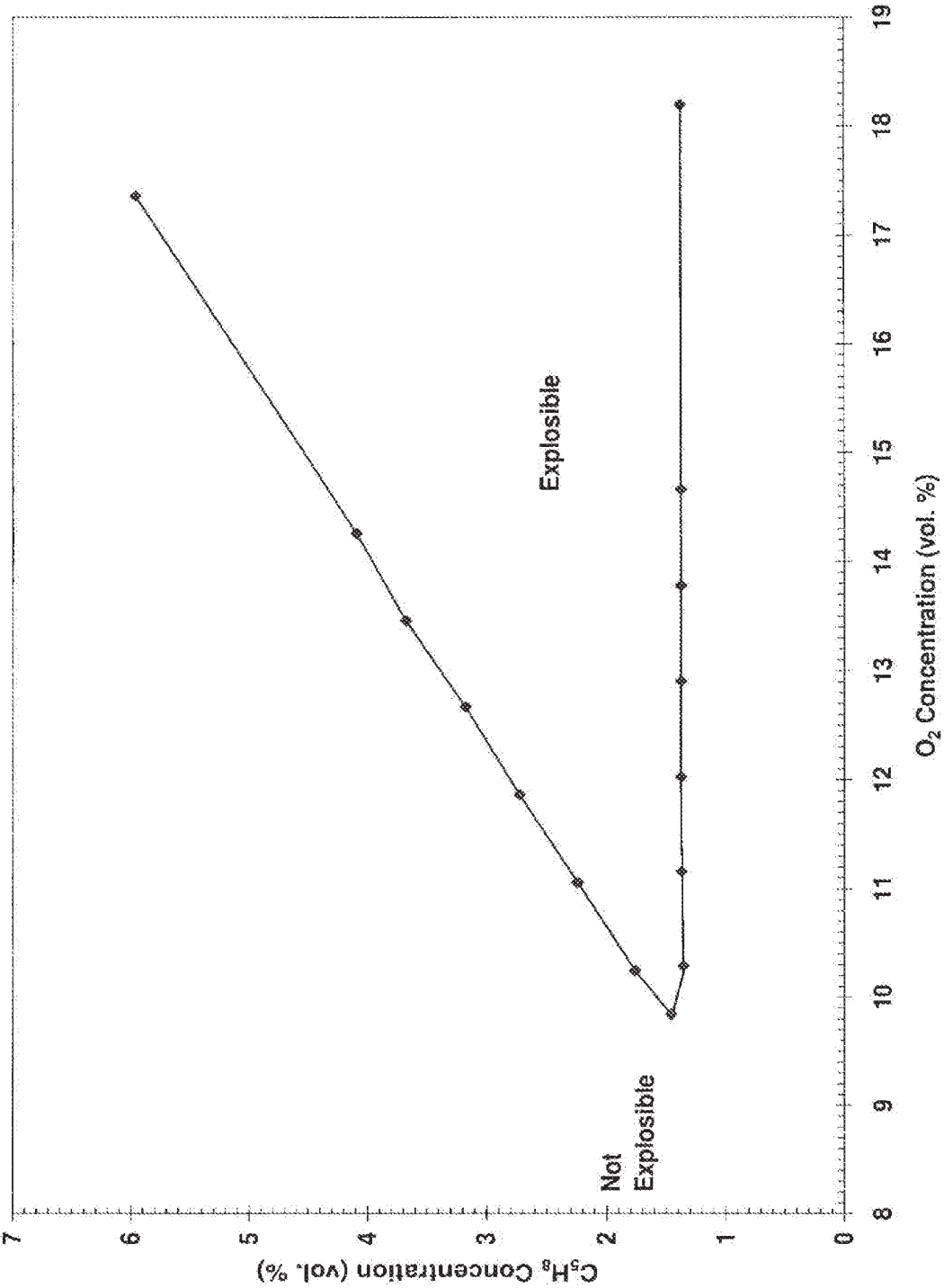
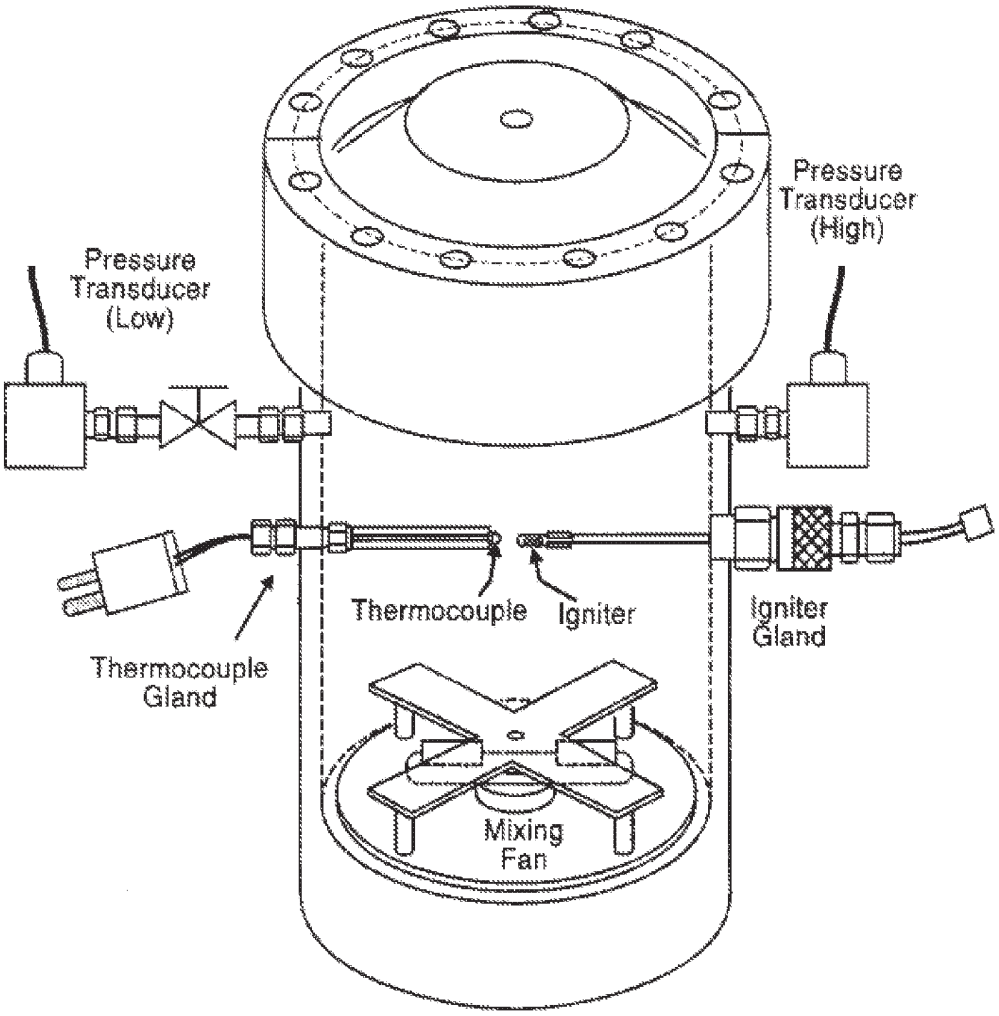

Explosible
Not Explosible
C_3H_8 Concentration (vol. %)
O_2 Concentration (vol. %)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19

Figure 76B

Figure 77


Pressure Transducer (High)
Pressure Transducer (Low)
Thermocouple
Igniter
Igniter Gland
Thermocouple Gland
Mixing Fan

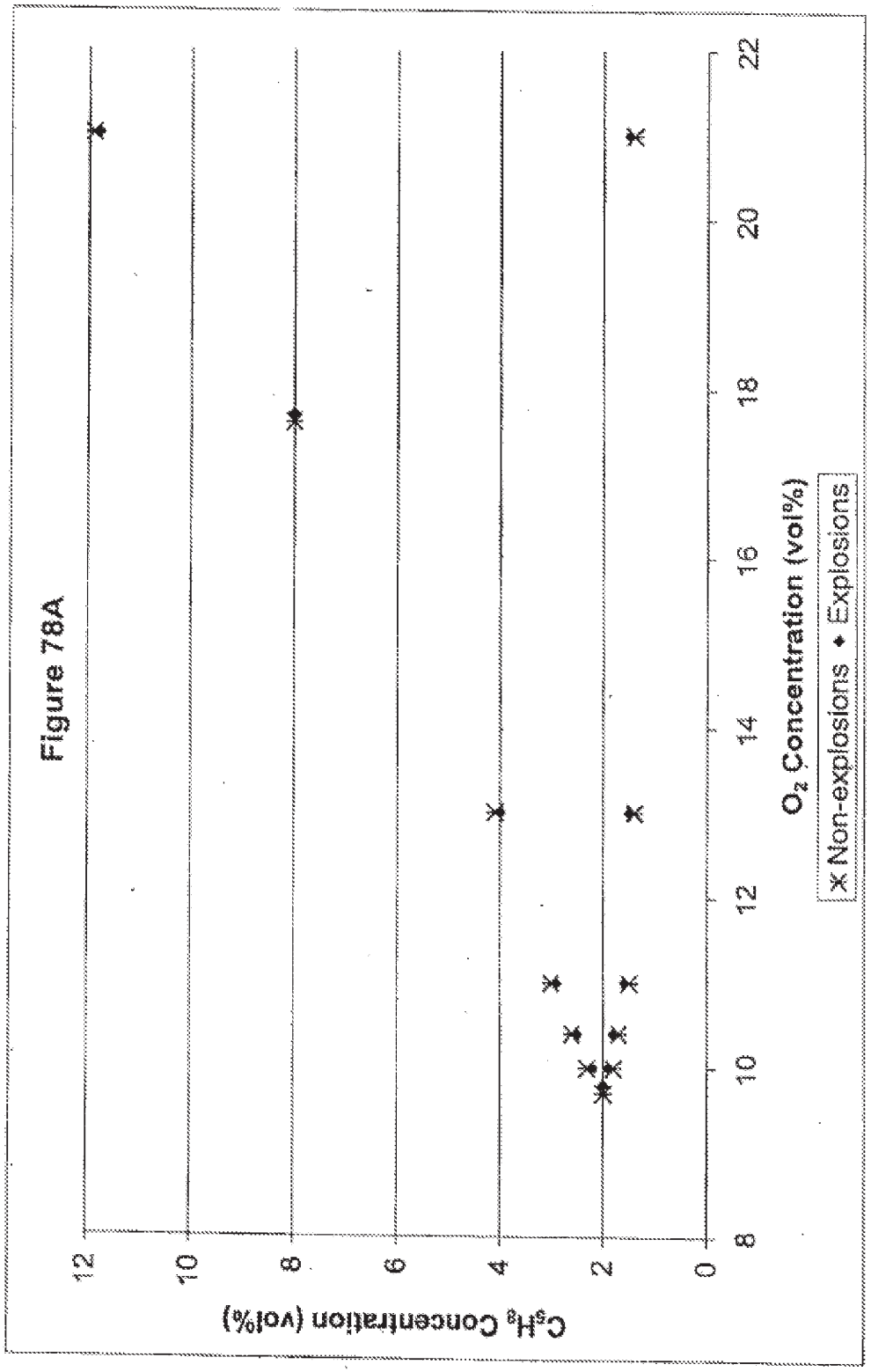
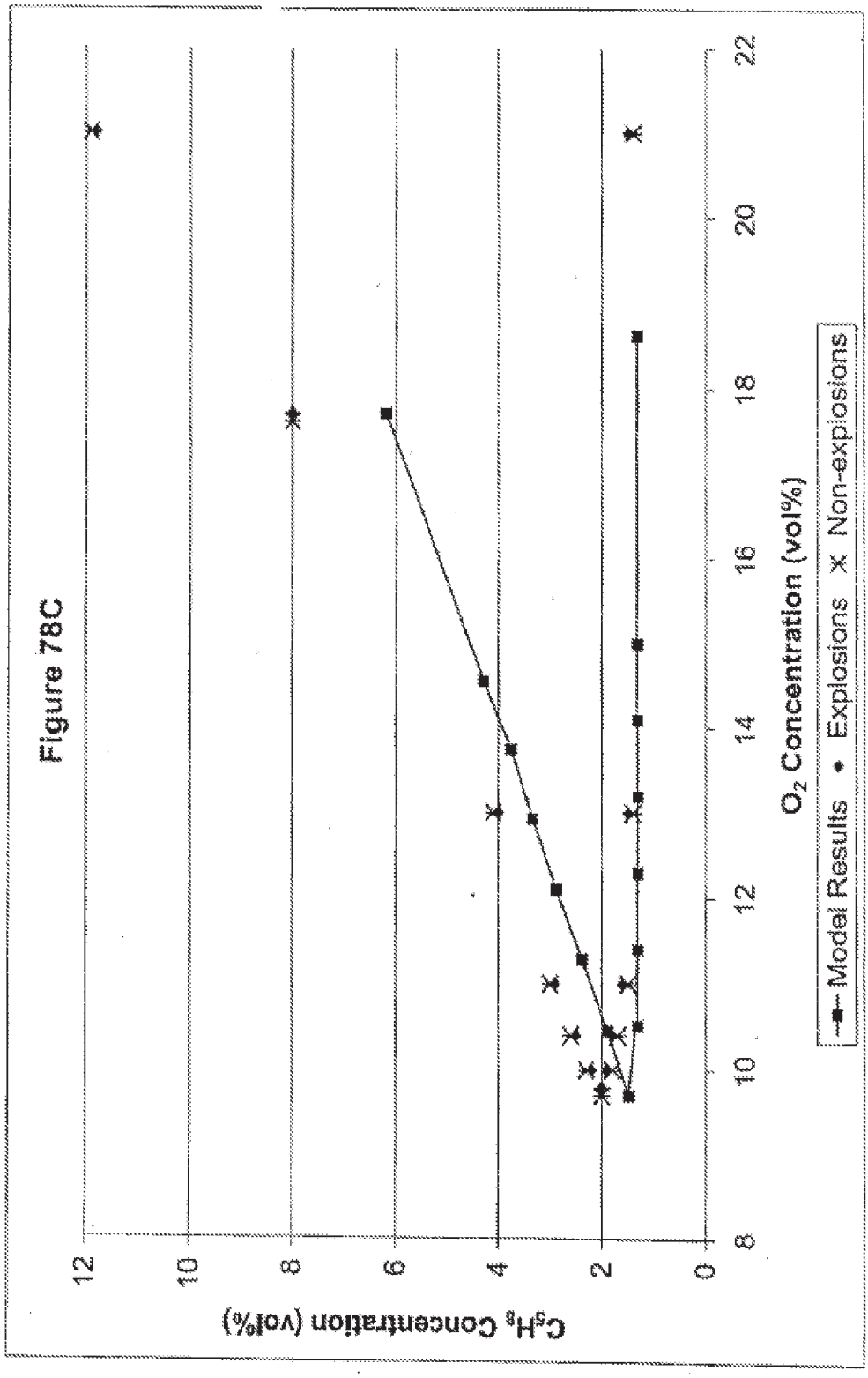

Figure 78A
C3H8 Concentration (vol%)
0
2
4
6
8
10
12
8
10
12
14
16
18
20
22
O2 Concentration (vol%)
x Non-explosions ♦ Explosions

Figure 78B

Explosions		Non-explosions	
O_2 Concentration (vol. %)	C_5H_8 Concentration (vol. %)	O_2 Concentration (vol. %)	C_5H_8 Concentration (vol. %)
21.0	1.5	21.0	1.4
13.0	1.5	13.0	1.4
11.0	1.6	11.0	1.5
10.4	1.8	10.4	1.7
10.0	1.9	10.0	1.8
9.8	2	9.7	2
10.0	2.2	10.0	2.3
10.4	2.5	10.4	2.6
11.0	2.9	11.0	3.0
13.0	4.0	13.0	4.1
17.7	8.0	17.6	8.0
21.0	11.8	21.0	11.9


Figure 78C
C_3H_8 Concentration (vol%)
0
2
4
6
8
10
12
8
10
12
14
16
18
20
22
O_2 Concentration (vol%)
Model Results
Explosions
Non-explosions

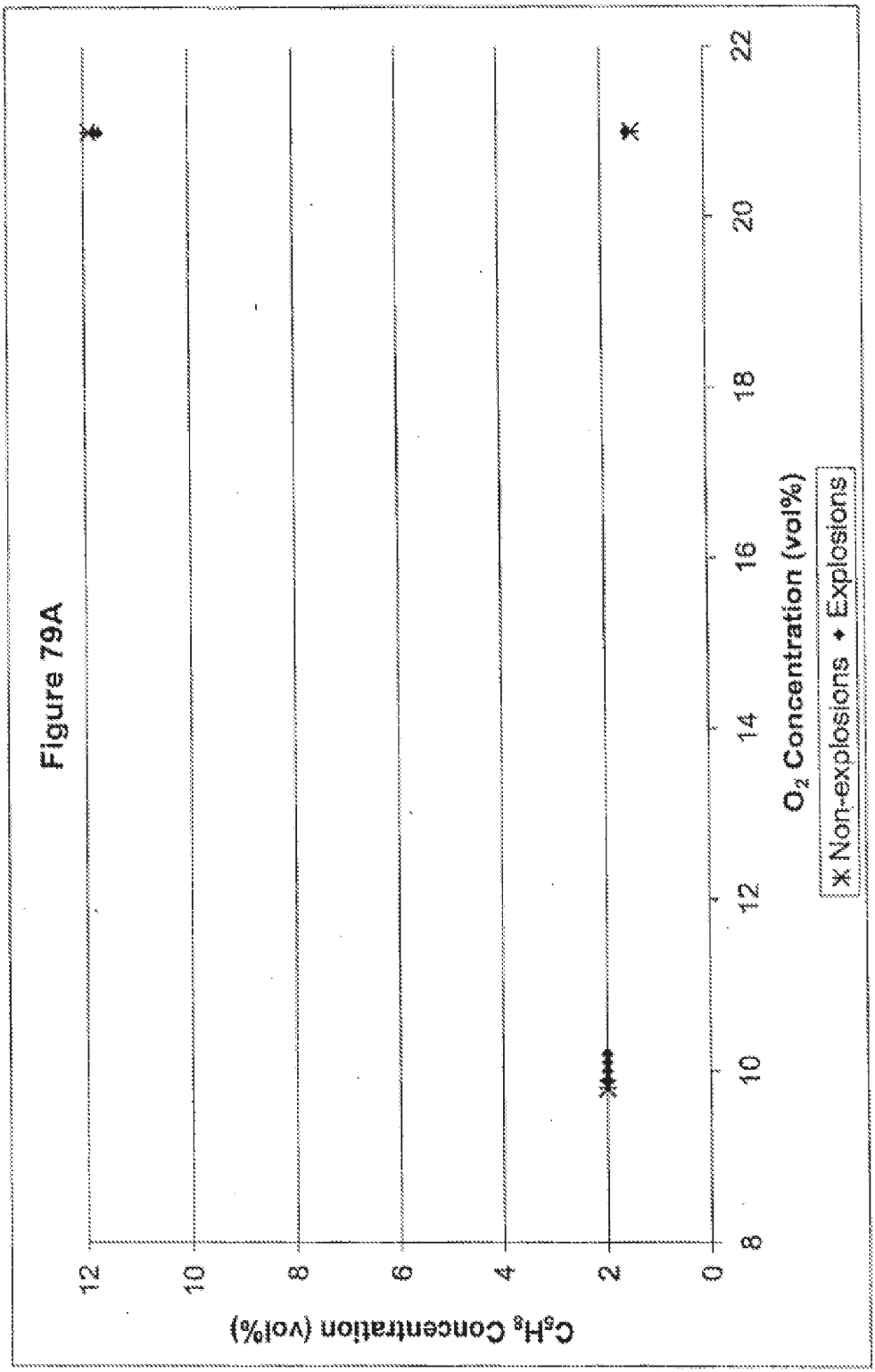

Figure 79A
C_3H_8 Concentration (vol%)
0
2
4
6
8
10
12
8
10
12
14
16
18
20
22
O_2 Concentration (vol%)
* Non-explosions ♦ Explosions

Figure 79B

Explosions		Non-explosions	
O_2 Concentration (vol. %)	C_5H_8 Concentration (vol. %)	O_2 Concentration (vol. %)	C_5H_8 Concentration (vol. %)
21.0	11.7	21.0	11.9
21.0	11.8	21.0	11.9
21.0	11.8	21.0	11.9
21.0	1.5	21.0	1.4
21.0	1.5	21.0	1.4
10.2	2.0	21.0	1.4
10.1	2.0	9.8	2.0
10.0	2.0	9.8	2.0
9.9	2.0	9.8	2.0

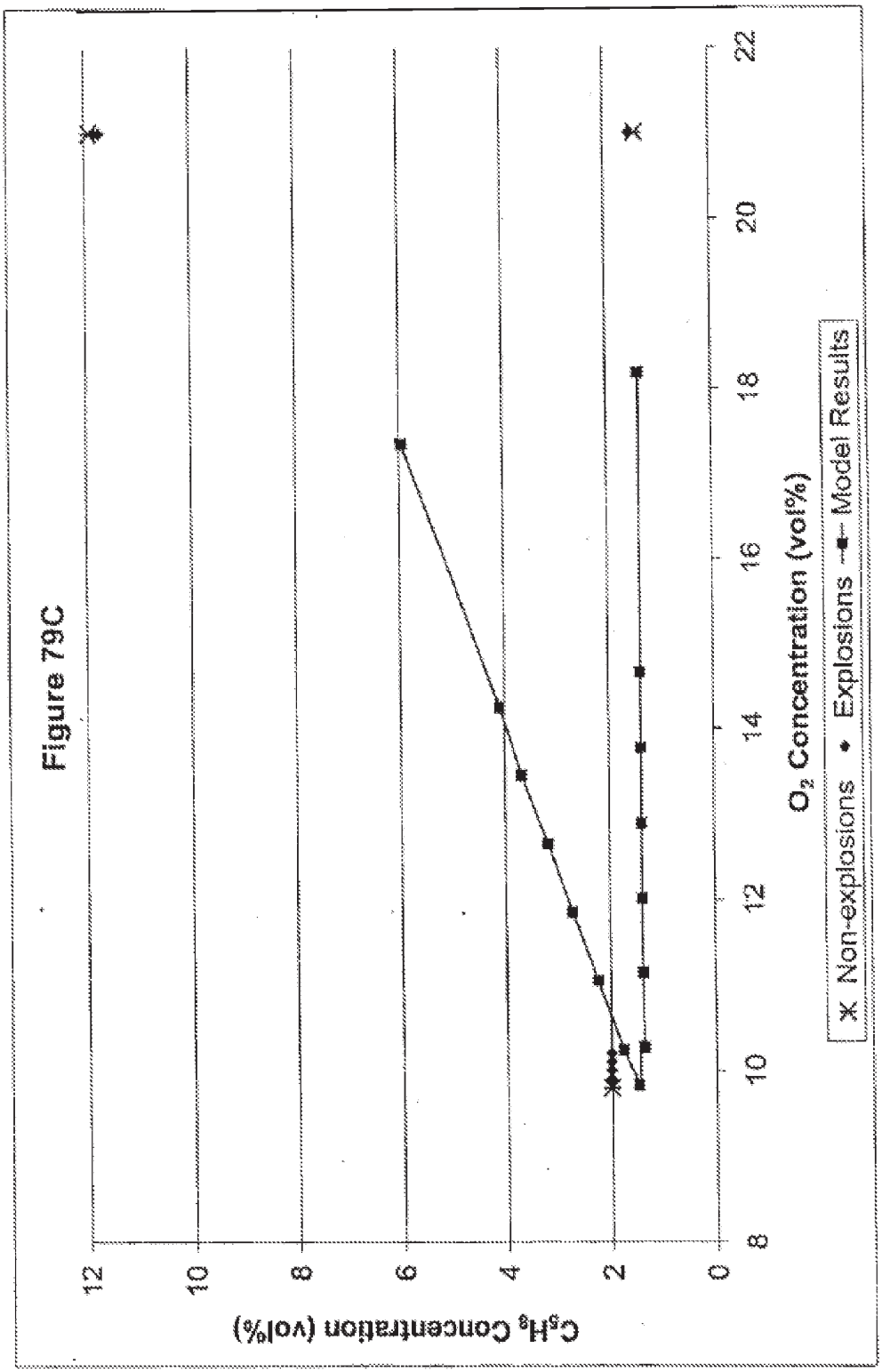

Figure 79C
C3H8 Concentration (vol%)
O2 Concentration (vol%)
Non-explosions
Explosions
Model Results
0
2
4
6
8
10
12
8
10
12
14
16
18
20
22

Figure 80A

TEST SERIES 1

Test	Data File Name	Temp	Initial Pressure	Partial Pressures			Concentrations			Result	Pex
				C_5H_8	N_2	O_2	C_5H_8	N_2	O_2		
		°C	bara	mbar	mbar	mbar	vol. %	vol. %	vol. %		bara
1	T11120700	40	1.012	12	787	213	1.2	77.8	21.0	Non-Explosion	1.05
2	T11120701	40	1.016	16	787	213	1.6	77.5	21.0	Explosion	5.5
3	T11120702	40	1.015	14	788	213	1.4	77.6	21.0	Non-Explosion	<1.02
4	T11120703	40	1.014	15	786	213	1.5	77.5	21.0	Non-Explosion	<1.02
5	T11120704	40	1.014	15	786	213	1.5	77.5	21.0	Explosion	4.31
6	T11120705	40	1.017	18	785	214	1.8	77.2	21.0	Explosion	5.47
7	T11120706	40	1.014	15	786	213	1.5	77.5	21.0	Explosion	4.51
8	T11120707	40	1.014	14	787	213	1.4	77.6	21.0	Non-Explosion	<1.02
9	T11120708	40	1.014	14	787	213	1.4	77.6	21.0	Non-Explosion	1.05
10	T11120709	40	1.015	102	700	213	10.0	69.0	21.0	Explosion	1.45
11	T11120710	40	1.014	102	699	213	10.1	68.9	21.0	Explosion	1.39
12	T11120711	40	1.014	106	695	213	10.5	68.5	21.0	Explosion	1.34
13	T11120712	40	1.014	113	688	213	11.1	67.9	21.0	Explosion	1.29
14	T11120713	40	1.014	122	679	213	12.0	67.0	21.0	Non-Explosion	<1.02
15	T11120714	40	1.014	117	684	213	11.5	67.5	21.0	Explosion	1.32
16	T11120715	40	1.014	120	681	213	11.8	67.2	21.0	Non-Explosion	1.08
17	T11130700	40	1.014	120	681	213	11.8	67.2	21.0	Explosion	1.09
18	T11130701	40	1.014	121	680	213	11.9	67.1	21.0	Non-Explosion	1.07
19	T11130702	40	1.015	121	681	213	11.9	67.1	21.0	Non-Explosion	1.06
20	T11130703	40	1.015	121	681	213	11.9	67.1	21.0	Non-Explosion	1.07
21	T11130704	40	1.015	30	853	132	3.0	84.0	13.0	Explosion	1.61
22	T11130705	40	1.014	36	846	132	3.6	83.4	13.0	Explosion	1.28
23	T11130706	40	1.014	39	843	132	3.8	83.1	13.0	Explosion	1.12
24	T11130707	40	1.015	41	842	132	4.0	83.0	13.0	Explosion	1.09
25	T11130708	40	1.014	42	840	132	4.1	82.8	13.0	Non-Explosion	1.06
26	T11130709	40	1.015	42	841	132	4.1	82.9	13.0	Non-Explosion	1.06
27	T11130710	40	1.014	42	840	132	4.1	82.8	13.0	Non-Explosion	1.05
28	T11130711	40	1.014	15	867	132	1.5	85.5	13.0	Non-Explosion	1.03
29	T11130712	40	1.014	16	866	132	1.6	85.4	13.0	Explosion	4.81
30	T11130713	40	1.014	15	867	132	1.5	85.5	13.0	Explosion	4
31	T11130714	40	1.014	14	868	132	1.4	85.6	13.0	Non-Explosion	1.03
32	T11130715	40	1.014	14	868	132	1.4	85.6	13.0	Non-Explosion	<1.02
33	T11130716	40	1.014	14	868	132	1.4	85.6	13.0	Non-Explosion	1.03
34	T11130717	40	1.015	20	883	112	2.0	87.0	11.0	Explosion	1.7
35	T11130718	40	1.014	28	874	112	2.8	86.2	11.0	Non-Explosion	1.08
36	T11130719	40	1.014	28	874	112	2.8	86.2	11.0	Non-Explosion	1.08
37	T11130720	40	1.014	28	874	112	2.8	86.2	11.0	Explosion	1.13
38	T11130721	40	1.015	29	874	112	2.9	86.1	11.0	Non-Explosion	1.08
39	T11130722	40	1.014	29	873	112	2.9	86.1	11.0	Explosion	1.1

Figure 80B

Test	Data File Name	Temp	Initial Pressure	Partial Pressures			Concentrations			Result	Pex
				C_5H_8	N_2	O_2	C_5H_8	N_2	O_2		
		℃	bara	mbar	mbar	mbar	vol. %	vol. %	vol. %		bara
40	T11130723	40	1.014	30	872	112	3.0	86.0	11.0	Non-Explosion	1.08
41	T11130724	40	1.014	30	872	112	3.0	86.0	11.0	Non-Explosion	1.05
42	T11130725	40	1.014	30	872	112	3.0	86.0	11.0	Non-Explosion	1.05
43	T11130726	40	1.014	15	887	112	1.5	87.5	11.0	Non-Explosion	<1.02
44	T11130727	40	1.014	15	887	112	1.5	87.5	11.0	Non-Explosion	<1.02
45	T11140700	40	1.014	16	886	112	1.6	87.4	11.0	Non-Explosion	<1.02
46	T11140701	40	1.014	17	885	112	1.7	87.3	11.0	Explosion	1.81
47	T11140702	40	1.014	16	886	112	1.6	87.4	11.0	Explosion	1.54
48	T11140703	40	1.014	15	887	112	1.5	87.5	11.0	Non-Explosion	<1.02
49	T11140704	40	1.015	20	899	96	2.0	88.6	9.5	Non-Explosion	1.05
50	T11140705	40	1.014	20	898	96	2.0	88.6	9.5	Non-Explosion	1.05
51	T11140706	40	1.014	23	890	101	2.3	87.8	10.0	Non-Explosion	1.05
52	T11140707	40	1.015	23	886	106	2.3	87.3	10.4	Explosion	1.19
53	T11140708	40	1.014	25	864	105	2.5	87.2	10.4	Explosion	1.09
54	T11140709	40	1.014	26	883	105	2.6	87.1	10.4	Non-Explosion	1.05
55	T11140710	40	1.014	26	883	105	2.6	87.1	10.4	Non-Explosion	1.06
56	T11140711	40	1.014	26	883	105	2.6	87.1	10.4	Non-Explosion	1.07
57	T11140712	40	1.014	20	889	105	2.0	87.7	10.4	Explosion	1.21
58	T11140713	40	1.014	17	892	105	1.7	88.0	10.4	Non-Explosion	1.04
59	T11140714	40	1.014	18	891	105	1.8	87.9	10.4	Explosion	1.21
60	T11140715	40	1.014	17	892	105	1.7	88.0	10.4	Non-Explosion	1.03
61	T11140716	40	1.014	17	892	105	1.7	88.0	10.4	Non-Explosion	1.03
62	T11140717	40	1.014	21	890	103	2.1	87.8	10.2	Explosion	1.1
63	T11140718	40	1.014	21	891	102	2.1	87.9	10.1	Explosion	1.09
64	T11140719	40	1.014	21	892	101	2.1	88.0	10.0	Explosion	1.09
65	T11140720	40	1.014	22	891	101	2.2	87.9	10.0	Explosion	1.1
66	T11140721	40	1.014	23	890	101	2.3	87.8	10.0	Non-Explosion	1.06
67	T11140722	40	1.014	23	890	101	2.3	87.8	10.0	Non-Explosion	1.08
68	T11140723	40	1.014	19	894	101	1.9	88.2	10.0	Explosion	1.12
69	T11140724	40	1.014	18	895	101	1.8	88.3	10.0	Non-Explosion	1.06
70	T11140725	40	1.014	18	895	101	1.8	88.3	10.0	Non-Explosion	1.03
71	T11140726	40	1.014	18	895	101	1.8	88.3	10.0	Non-Explosion	1.04
72	T11140727	40	1.014	20	895	99	2.0	88.3	9.8	Non-Explosion	1.08
73	T11140728	40	1.014	20	895	99	2.0	88.3	9.8	Explosion	1.1
74	T11140729	40	1.014	20	896	98	2.0	88.4	9.7	Non-Explosion	1.06
75	T11140730	40	1.014	20	896	98	2.0	88.4	9.7	Non-Explosion	1.08
76	T11140731	40	1.014	20	896	98	2.0	88.4	9.7	Non-Explosion	1.07
77	T11140732	40	1.014	81	761	172	8.0	75.0	17.0	Non-Explosion	1.04
78	T11140733	40	1.014	81	750	183	8.0	74.0	18.0	Explosion	1.3
79	T11140734	40	1.014	81	754	179	8.0	74.4	17.7	Explosion	1.24
80	T11140735	40	1.014	81	757	176	8.0	74.7	17.4	Non-Explosion	1.03
81	T11140736	40	1.014	81	755	178	8.0	74.5	17.6	Non-Explosion	1.05
82	T11140737	40	1.014	81	755	178	8.0	74.5	17.6	Non-Explosion	1.03
83	T11140738	40	1.014	81	755	178	8.0	74.5	17.6	Non-Explosion	1.03

Figure 81

TEST SERIES 2

Test	Data File Name	Temp	Initial Pressure	Partial Pressures				Concentrations				Result	Pex
				H_2O	C_3H_8	N_2	O_2	H_2O	C_3H_8	N_2	O_2		
		°C	bara	mbar	mbar	mbar	mbar	vol. %	vol. %	vol. %	vol. %		bara
1	T11150700	40	1.014	41	119	641	213	4.0	11.7	63.2	21.0	Explosion	1.33
2	T11150701	40	1.014	40	121	640	213	3.9	11.9	63.1	21.0	Non-explosion	1.07
3	T11150702	40	1.014	41	120	640	213	4.0	11.8	63.1	21.0	Explosion	1.09
4	T11150703	40	1.014	40	121	640	213	3.9	11.9	63.1	21.0	Non-explosion	1.06
5	T11150704	40	1.014	40	120	641	213	3.9	11.8	63.2	21.0	Explosion	1.09
6	T11150705	40	1.014	40	121	640	213	3.9	11.9	63.1	21.0	Non-explosion	1.08
7	T11150706	40	1.014	40	15	746	213	3.9	1.5	73.6	21.0	Explosion	4.68
8	T11150707	40	1.014	41	15	745	213	4.0	1.5	73.5	21.0	Explosion	5.27
9	T11150708	40	1.014	41	14	746	213	4.0	1.4	73.6	21.0	Non-explosion	1.03
10	T11150709	40	1.014	42	14	745	213	4.1	1.4	73.5	21.0	Non-explosion	1.03
11	T11160700	40	1.014	41	14	746	213	4.0	1.4	73.6	21.0	Non-explosion	1.03
12	T11160701	40	1.014	41	20	850	103	4.0	2.0	83.8	10.2	Explosion	1.11
13	T11160702	40	1.014	41	20	851	102	4.0	2.0	83.9	10.1	Explosion	1.11
14	T11160703	40	1.014	41	20	852	101	4.0	2.0	84.0	10.0	Explosion	1.09
15	T11160704	40	1.014	41	20	853	100	4.0	2.0	84.1	9.9	Explosion	1.09
16	T11160705	40	1.014	41	20	854	99	4.0	2.0	84.2	9.8	Non-explosion	1.07
17	T11160706	40	1.014	40	20	855	99	3.9	2.0	84.3	9.8	Non-explosion	1.06
18	T11160707	40	1.014	41	20	854	99	4.0	2.0	84.2	9.8	Non-explosion	1.08

Figure 82

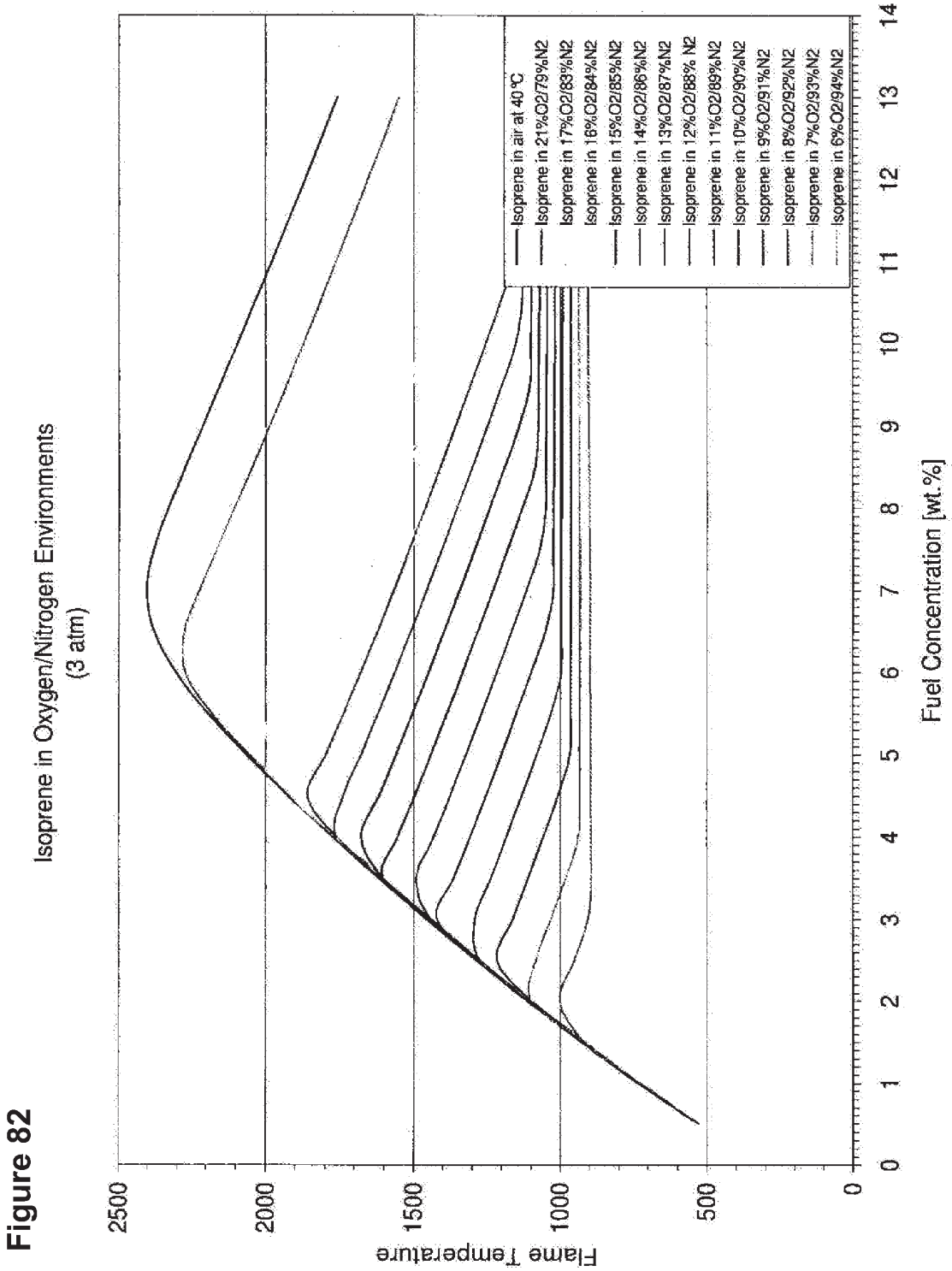

Isoprene in Oxygen/Nitrogen Environments
(3 atm)
Flame Temperature
Fuel Concentration [wt.%]
2500
2000
1500
1000
500
0
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Isoprene in air at 40°C
Isoprene in 21%O2/79%N2
Isoprene in 17%O2/83%N2
Isoprene in 16%O2/84%N2
Isoprene in 15%O2/85%N2
Isoprene in 14%O2/86%N2
Isoprene in 13%O2/87%N2
Isoprene in 12%O2/88% N2
Isoprene in 11%O2/89%N2
Isoprene in 10%O2/90%N2
Isoprene in 9%O2/91%N2
Isoprene in 8%O2/92%N2
Isoprene in 7%O2/93%N2
Isoprene in 6%O2/94%N2

Figure 83

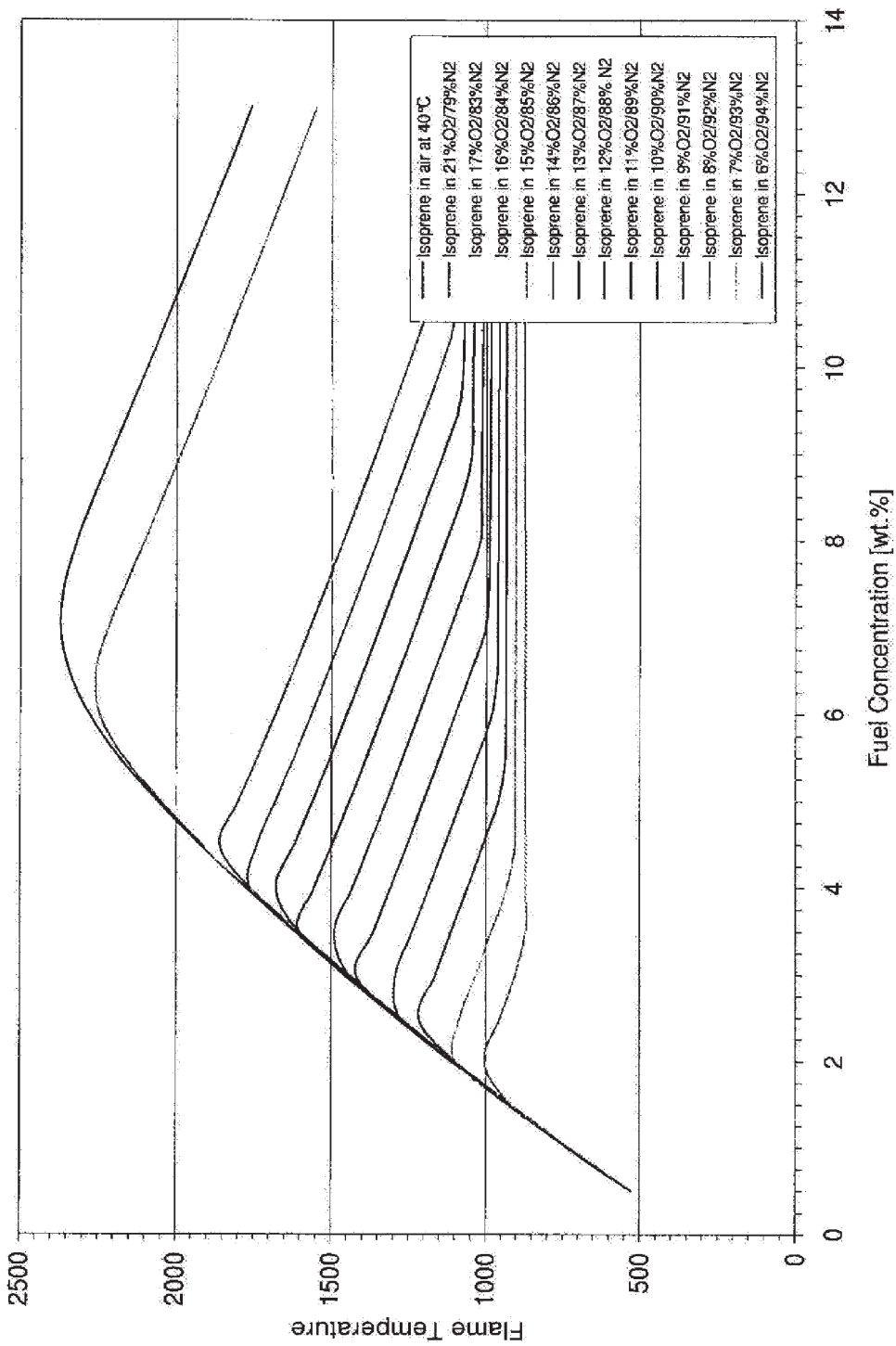

Isoprene in Oxygen/Nitrogen Environments
(1 atm)
Flame Temperature
2500
2000
1500
1000
500
0
0
2
4
6
8
10
12
14
Fuel Concentration [wt.%]
Isoprene in air at 40°C
Isoprene in 21%O2/79%N2
Isoprene in 17%O2/83%N2
Isoprene in 16%O2/84%N2
Isoprene in 15%O2/85%N2
Isoprene in 14%O2/86%N2
Isoprene in 13%O2/87%N2
Isoprene in 12%O2/88% N2
Isoprene in 11%O2/89%N2
Isoprene in 10%O2/90%N2
Isoprene in 9%O2/91%N2
Isoprene in 8%O2/92%N2
Isoprene in 7%O2/93%N2
Isoprene in 6%O2/94%N2

Figure 84

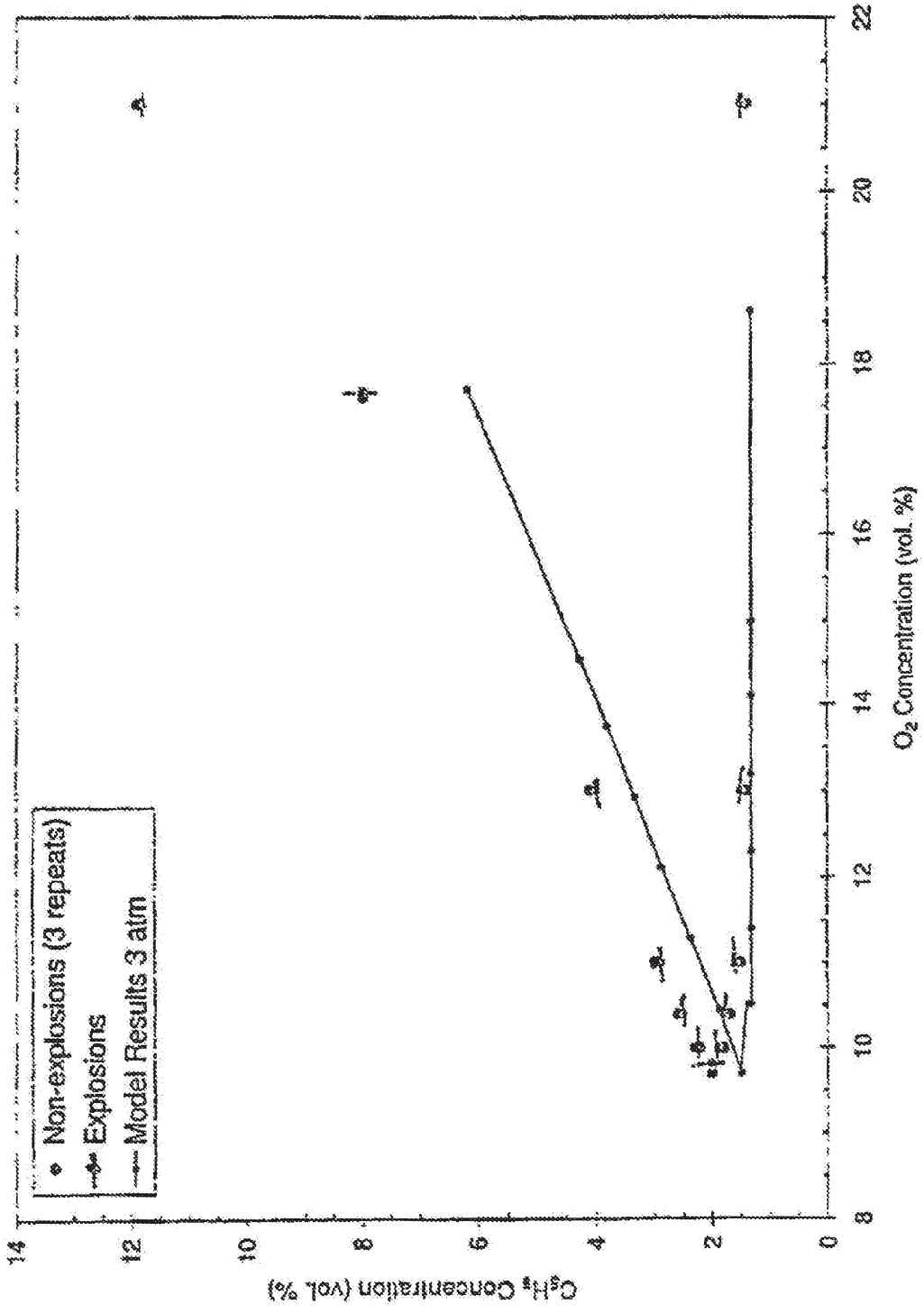

Non-explosions (3 repeats)
Explosions
Model Results 3 atm
C_3H_8 Concentration (vol %)
O_2 Concentration (vol. %)
0
2
4
6
8
10
12
14
8
10
12
14
16
18
20
22

Figure 85

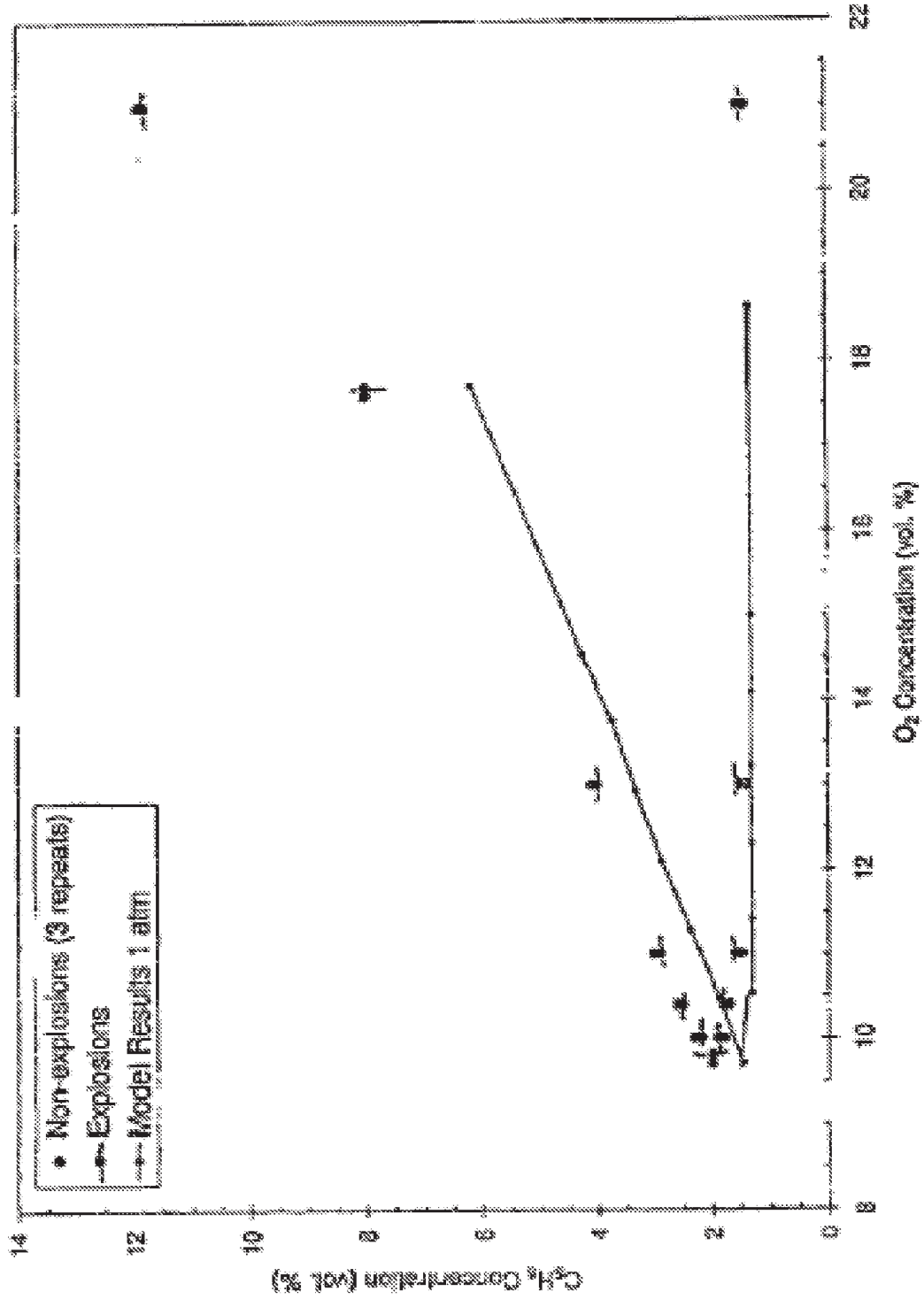

Non-explosions (3 repeats)
Explosions
Model Results 1 atm
C_2H_4 Concentration (vol. %)
O_2 Concentration (vol. %)
0
2
4
6
8
10
12
14
8
10
12
14
16
18
20
22

Figure 86A

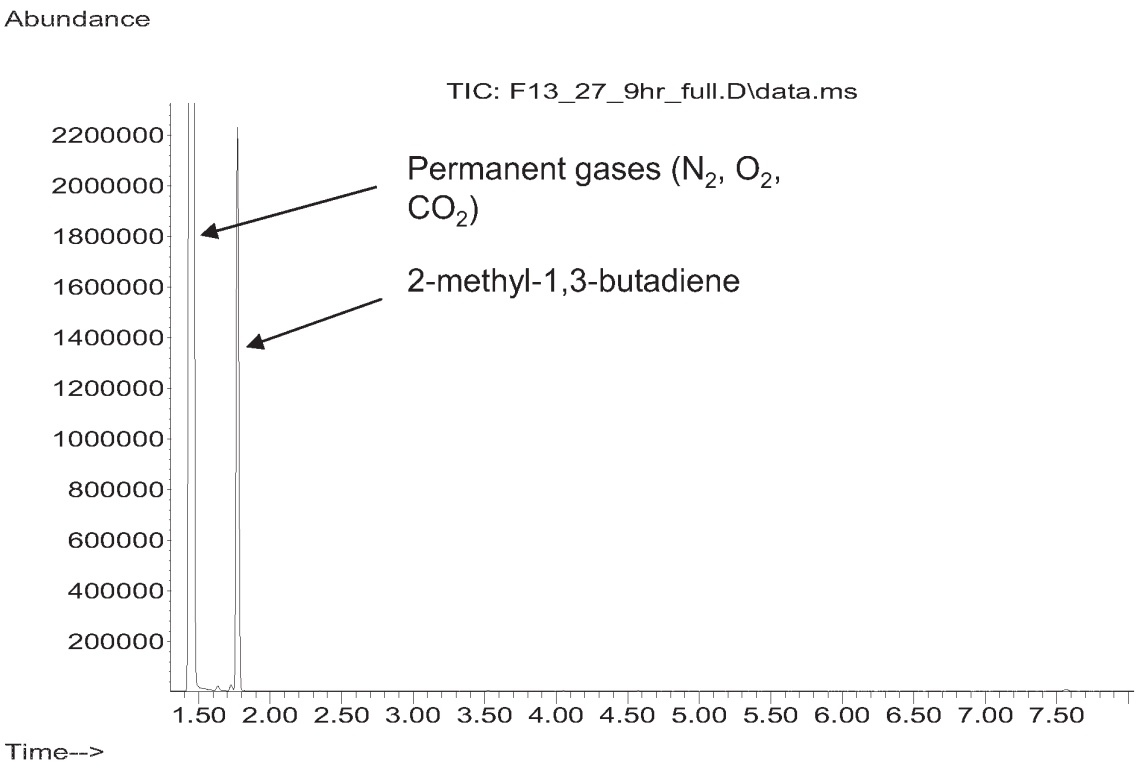

Abundance
TIC: F13_27_9hr_full.D\data.ms
2200000
2000000
1800000
1600000
1400000
1200000
1000000
800000
600000
400000
200000
Permanent gases (N_2, O_2, CO_2)
2-methyl-1,3-butadiene
1.50 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 6.00 6.50 7.00 7.50
Time-->

Figure 86B

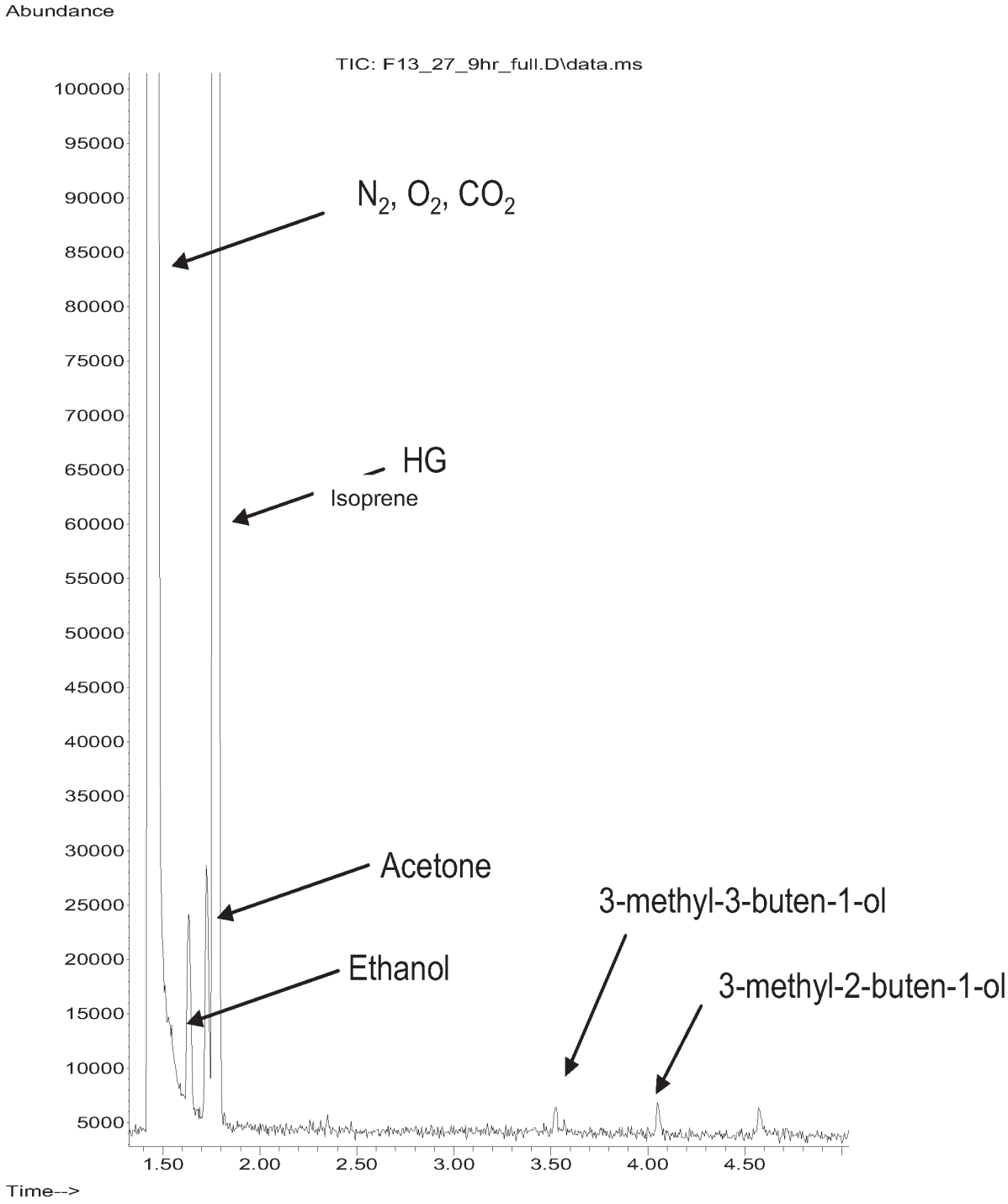

Abundance
TIC: F13_27_9hr_full.D\data.ms
100000
95000
90000
85000
80000
75000
70000
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
N2, O2, CO2
HG
Isoprene
Acetone
Ethanol
3-methyl-3-buten-1-ol
3-methyl-2-buten-1-ol
1.50
2.00
2.50
3.00
3.50
4.00
4.50
Time-->

Figure 87A

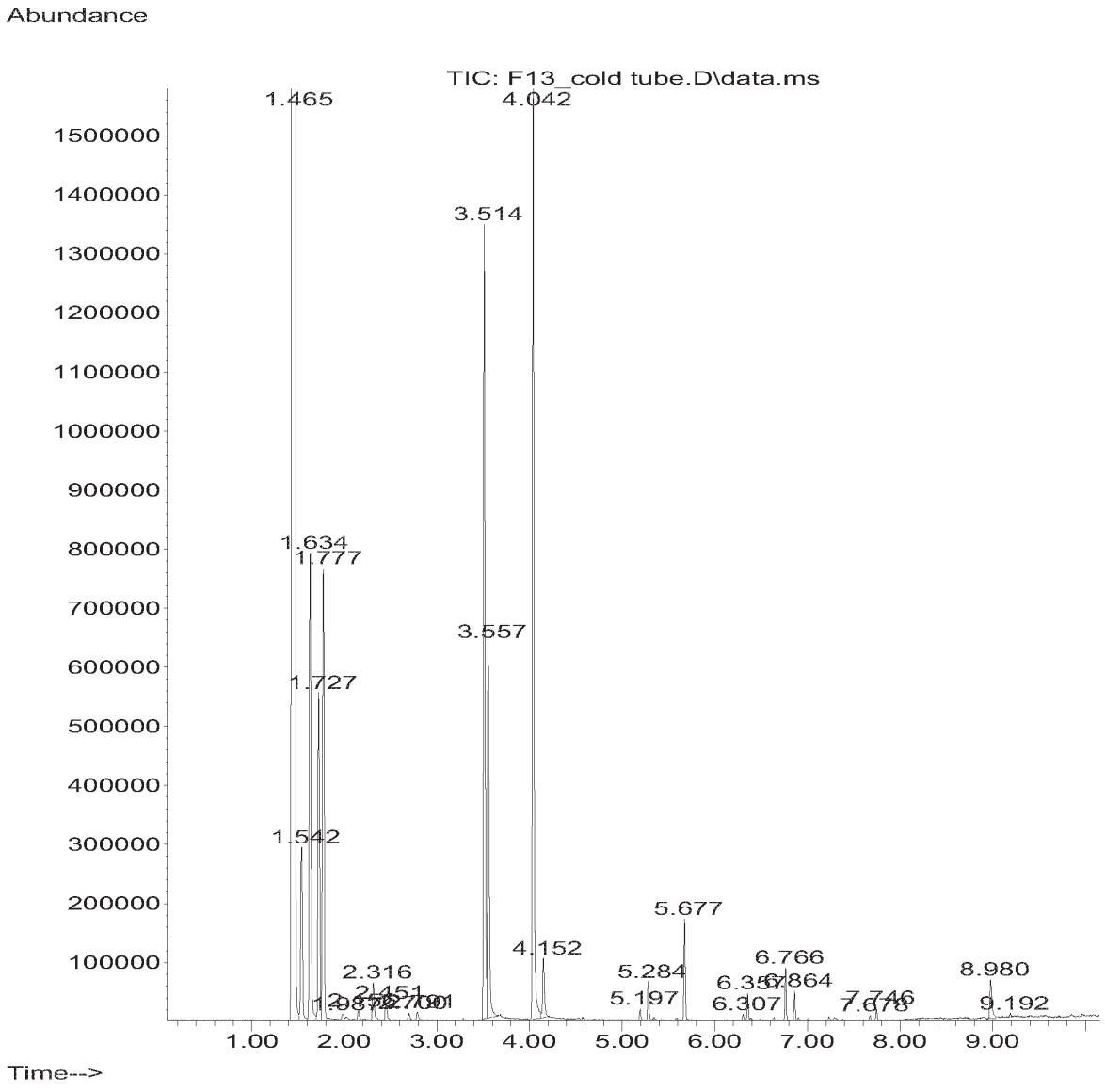

Abundance
TIC: F13_cold tube.D\data.ms
1.465
4.042
3.514
1.634
1.777
3.557
1.727
1.542
5.677
4.152
2.316
5.284
6.766
8.980
5.197
6.307
9.192
1500000
1400000
1300000
1200000
1100000
1000000
900000
800000
700000
600000
500000
400000
300000
200000
100000
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Time-->

Figure 87B

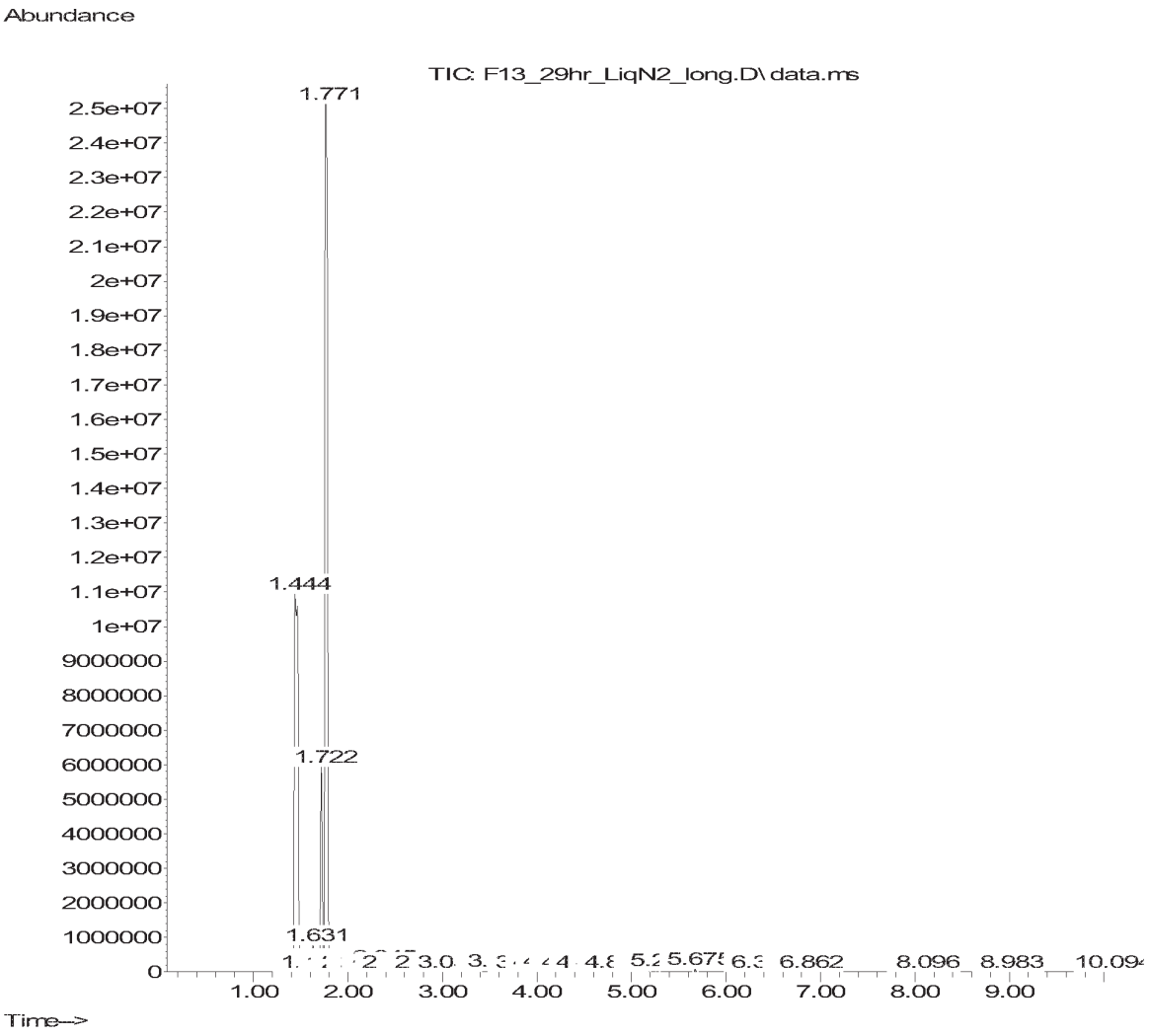

Abundance
TIC: F13_29hr_LiqN2_long.D\data.ms
1.771
1.444
1.722
1.631
2.5e+07
2.4e+07
2.3e+07
2.2e+07
2.1e+07
2e+07
1.9e+07
1.8e+07
1.7e+07
1.6e+07
1.5e+07
1.4e+07
1.3e+07
1.2e+07
1.1e+07
1e+07
9000000
8000000
7000000
6000000
5000000
4000000
3000000
2000000
1000000
0
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
6.862
8.096
8.983
Time-->

Figure 87C

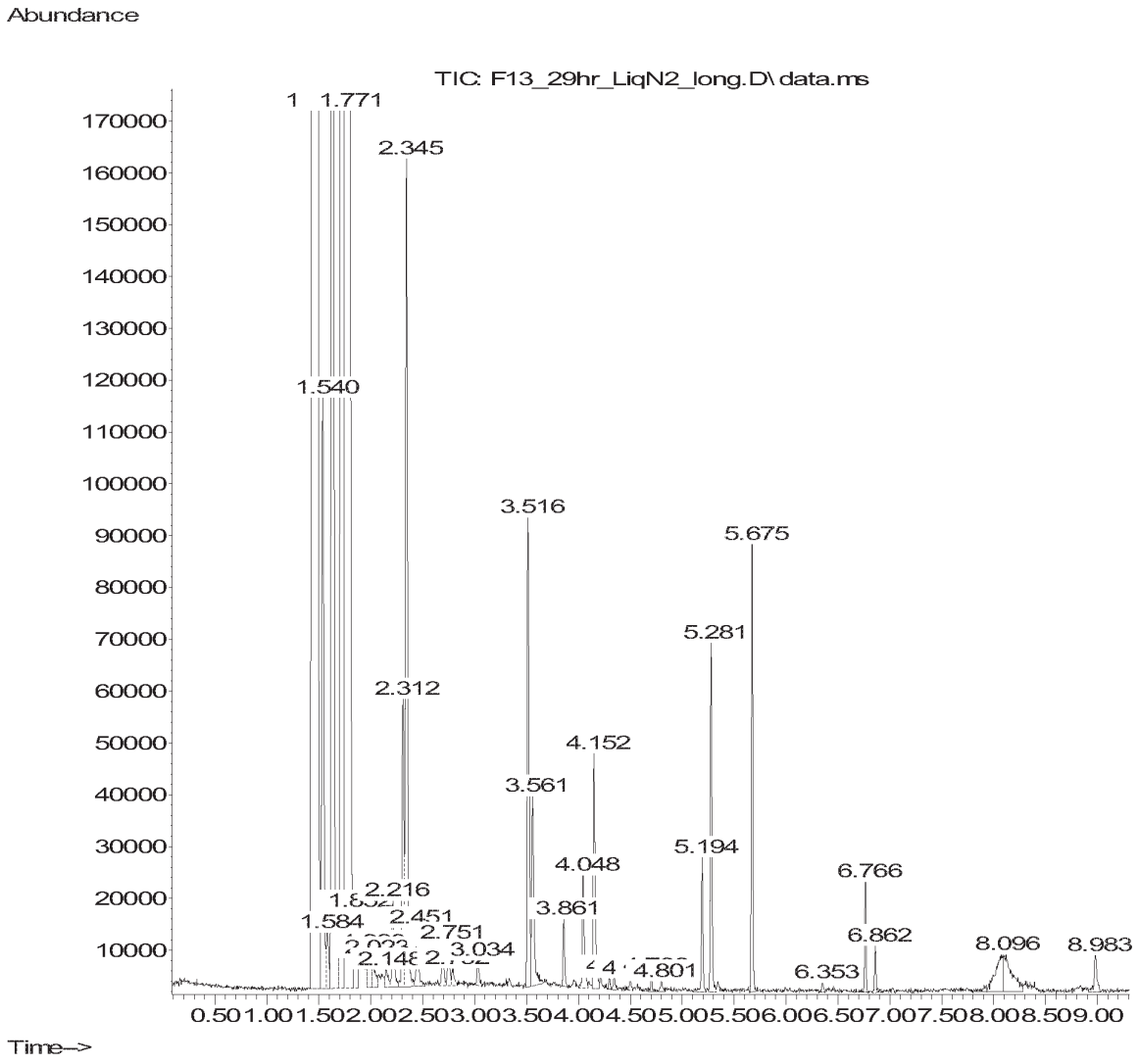

Abundance
TIC: F13_29hr_LiqN2_long.D\data.ms
1.771
2.345
1.540
3.516
5.675
5.281
2.312
4.152
3.561
5.194
4.048
6.766
2.216
3.861
1.584
2.451
2.751
6.862
3.034
8.096
8.983
4.801
6.353
0.501.001.502.002.503.003.504.004.505.005.506.006.507.007.508.008.509.00
Time-->

Figure 87D

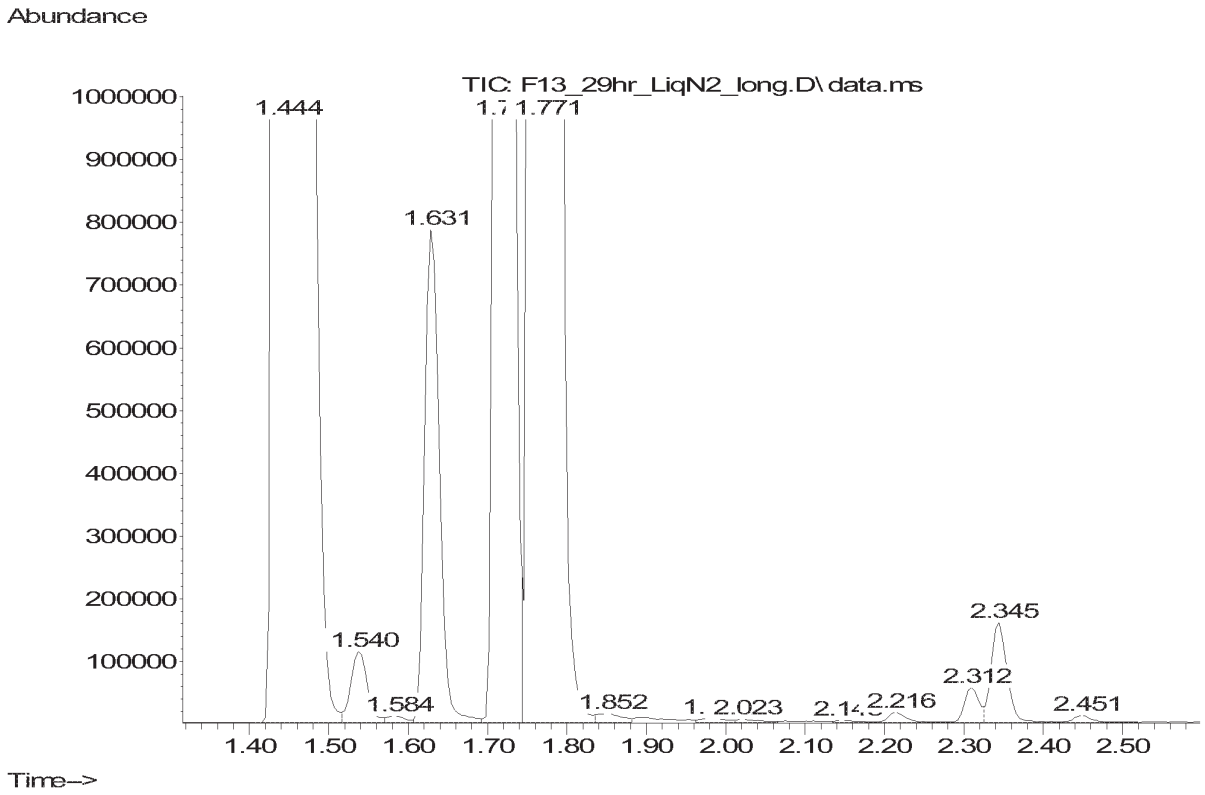
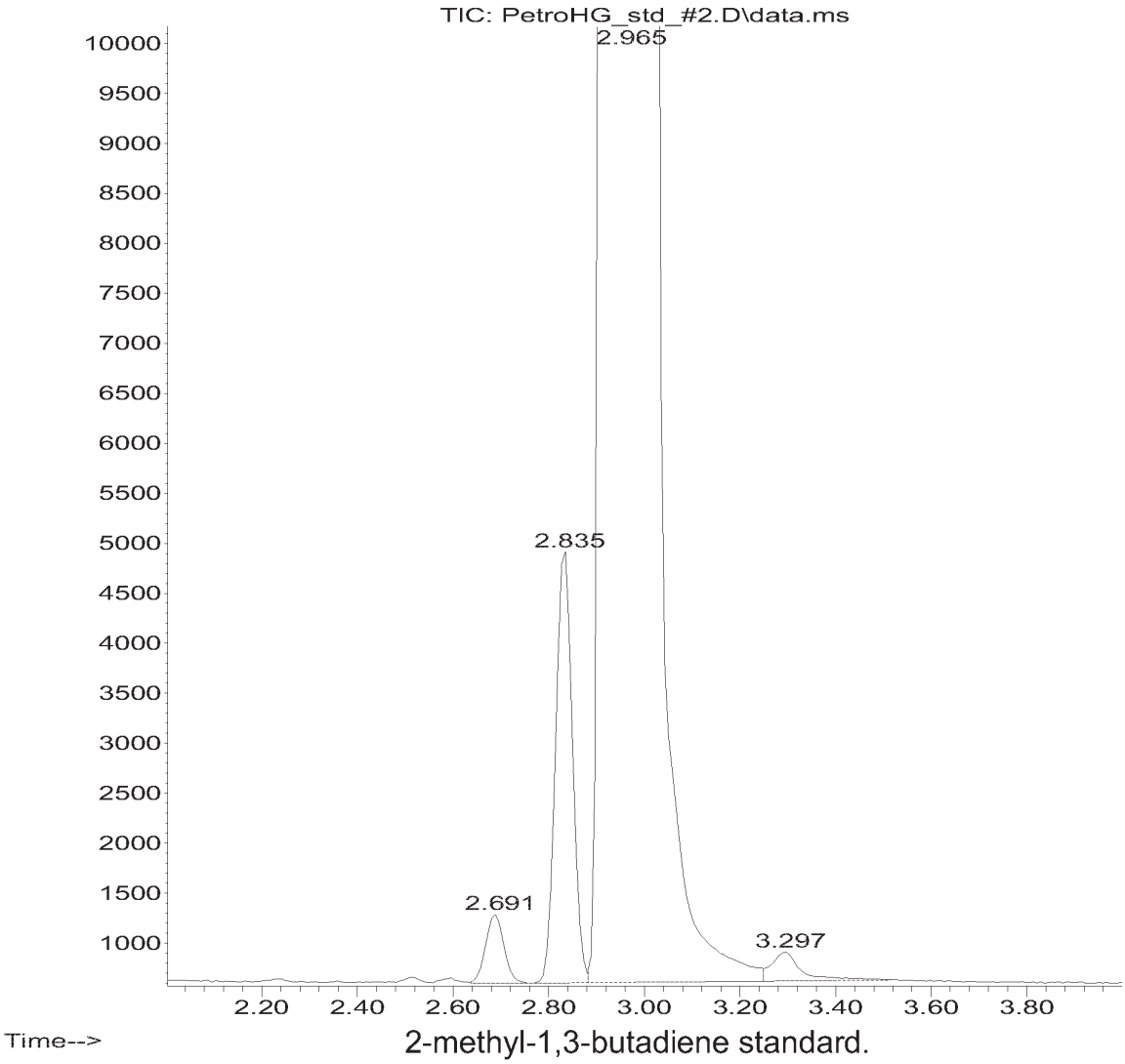
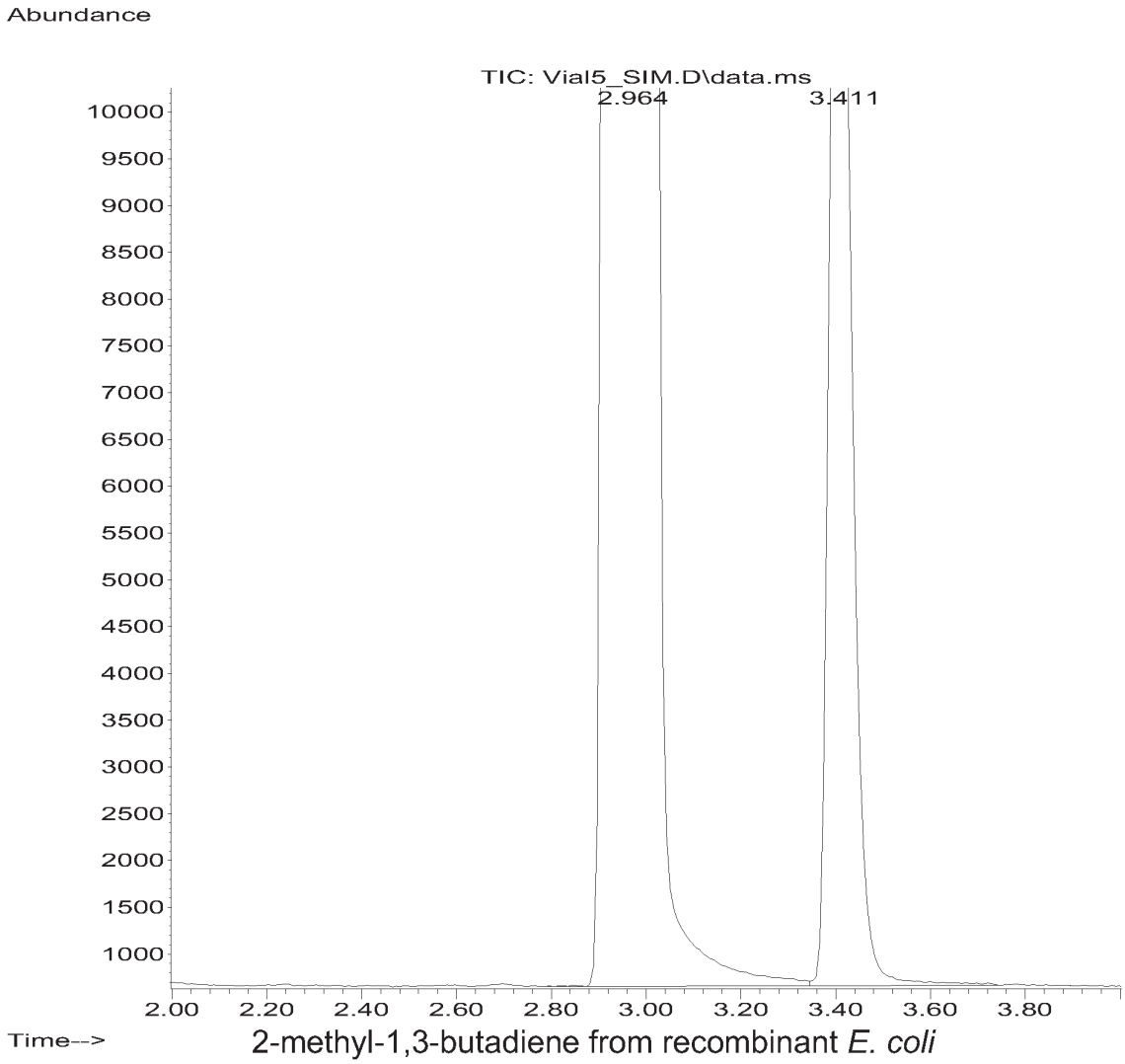

Abundance
TIC: F13_29hr_LiqN2_long.D\data.ms
1000000
900000
800000
700000
600000
500000
400000
300000
200000
100000
1.444
1.631
1.771
1.540
1.584
1.852
2.345
2.312
2.216
2.451
1.40
1.50
1.60
1.70
1.80
1.90
2.00
2.10
2.20
2.30
2.40
2.50
Time-->

Figure 88A



2-methyl-1,3-butadiene standard.

Figure 88B



2-methyl-1,3-butadiene from recombinant *E. coli*

Figure 89

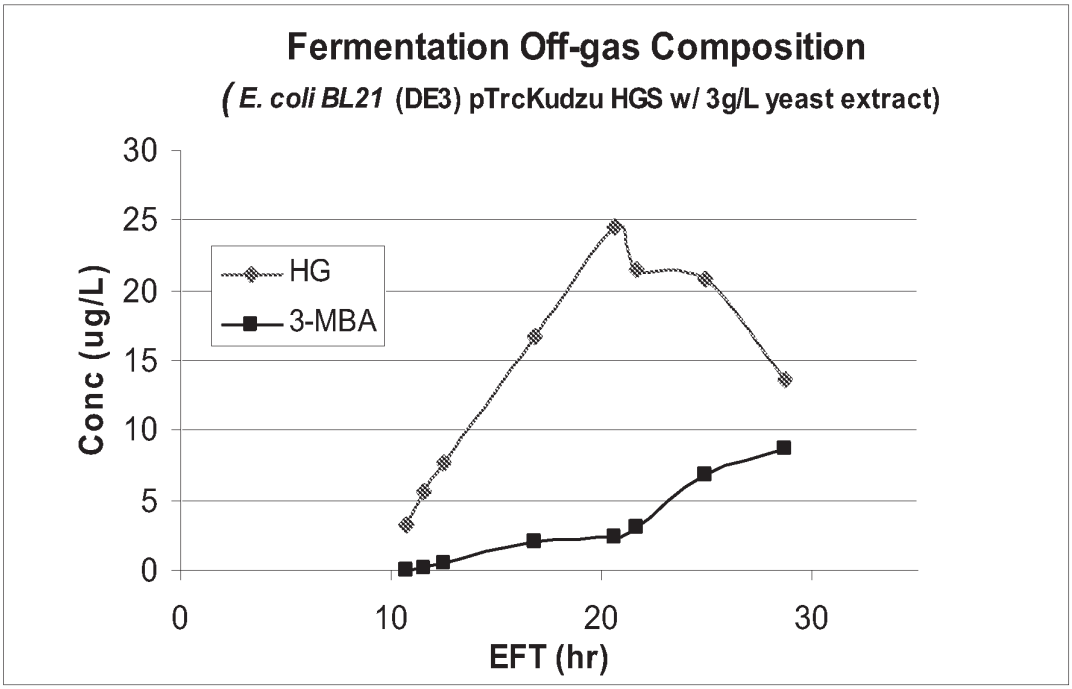
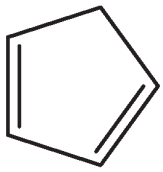
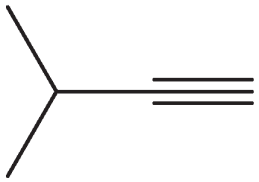

Fermentation Off-gas Composition
(E. coli BL21 (DE3) pTrcKudzu HGS w/ 3g/L yeast extract)
Conc (ug/L)
EFT (hr)
HG
3-MBA
0
5
10
15
20
25
30
0
10
20
30

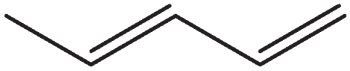
Figure 90



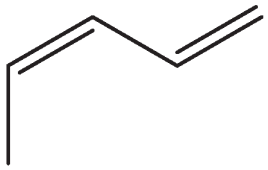
cyclopentadiene



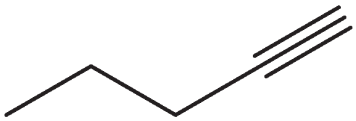
"isopryne" = 3-Me-1-butyne



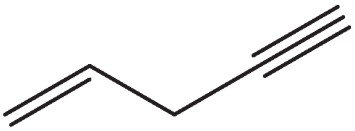
trans-piperylene



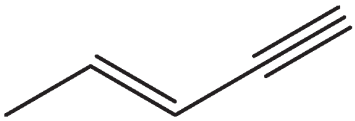
cis-piperylene



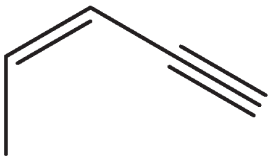
1-pentyne



pent-4-ene-1-yne



trans-pent-3-ene-1-yne



cis-pent-3-ene-1-yne

Figure 91

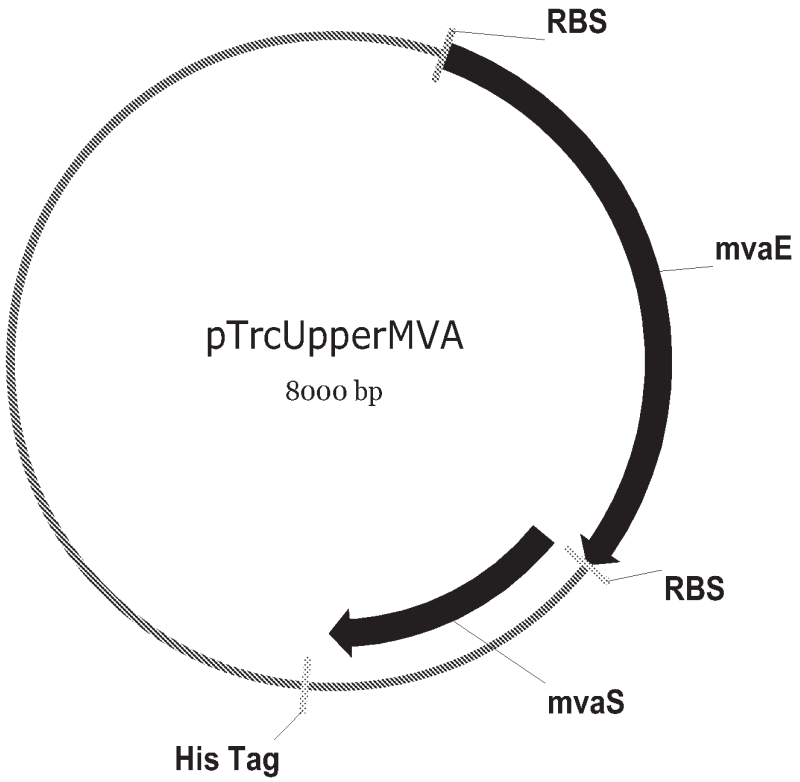


Figure 92A

1-

gtttgacagcttatcatcgactgcacggtgcaccaatgcttctggcgtcaggcagccatcggaagctgtggtatggctgtgc
aggtcgtaaatcactgcataattcgtgtcgctcaaggcgcactcccgttctggataatgtttttgcgccgacatcataacggtt
ctggcaaatattctgaaatgagctgttgacaattaatcatccggctcgtataatgtgtggaattgtgagcggataacaatttca
cacaggaaacagcgccgctgagaaaaagcgaagcggcactgctctttaacaatttatcagacaatctgtgtgggcactc
gaccggaattatcgattaactttattattaaaaattaaagaggtatatattaatgtatcgattaaataaggaggaataaaccat
ggatccgagctcaggaggtaaaaaaacatgaaaacagtagttattattgatgcattacgaacaccaattggaaaatataa
aggcagcttaagtcaagtaagtgccgtagacttaggaacacatgttacaacacaacttttaaaaagacattccactatttctg
aagaaattgatcaagtaatctttggaaatgttttacaagctggaaatggccaaaatcccgcacgacaaatagcaataaac
agcggtttgtctcatgaaattcccgcaatgacggttaatgaggtctgcggatcaggaatgaaggccgttattttggcgaaac
aattgattcaattaggagaagcggaagttttaattgctggcgggattgagaatatgtcccaagcacctaaattacaacgtttta
attacgaaacagaaagctacgatgcgccttttttctagtatgatgtatgatggattaacggatgcctttagtggtcaggcaatgg
gcttaactgctgaaaatgtggccgaaaagtatcatgtaactagagaagagcaagatcaattttctgtacattcacaattaaa
agcagctcaagcacaagcagaagggatattcgctgacgaaatagccccattagaagtatcaggaacgcttgtggagaa
agatgaagggattcgccctaattcgagcgttgagaagctaggaacgcttaaaacagtttttaaagaagacggtactgtaac
agcagggaatgcatcaaccattaatgatggggcttctgctttgattattgcttcacaagaatatgccgaagcacacggtcttc
cttatttagctattattcgagacagtgtggaagtcggtattgatccagcctatatgggaatttcgccgattaaagccattcaaaa
actgttagcgcgcaatcaacttactacggaagaaattgatctgtatgaaatcaacgaagcatttgcagcaacttcaatcgtg
gtccaaagagaactggctttaccagaggaaaaggtcaacatttatggtggcggtatttcattaggtcatgcgattggtgcca
caggtgctcgtttattaacgagtttaagttatcaattaaatcaaaaagaaaagaaatatggagtggcttctttatgtatcggcg
gtggcttaggactcgctatgctactagagagacctcagcaaaaaaaaaacagccgattttatcaaatgagtcctgaggaa
cgcctggcttctcttcttaatgaaggccagatttctgctgatacaaaaaaagaatttgaaaatacggctttatcttcgcagattg
ccaatcatatgattgaaaatcaaatcagtgaaacagaagtgccgatgggcgttggcttacatttaacagtggacgaaactg
attatttggtaccaatggcgacagaagagccctcagttattgcggctttgagtaatggtgcaaaaatagcacaaggatttaa
aacagtgaatcaacaacgcttaatgcgtggacaaatcgtttttacgatgttgcagatcccgagtcattgattgataaactaca
agtaagagaagcggaagtttttcaacaagcagagttaagttatccatctatcgttaaacggggcggcggcttaagagatttg
caatatcgtacttttgatgaatcatttgtatctgtcgacttttagtagatgttaaggatgcaatgggggcaaatatcgttaacgct
atgttggaaggtgtggccgagttgttccgtgaatggtttgcggagcaaaagattttattcagtattttaagtaattatgccacgg
agtcggttgttacgatgaaaacggctattccagtttcacgtttaagtaaggggagcaatggccgggaaattgctgaaaaaat
tgttttagcttcacgctatgcttcattagatccttatcgggcagtcacgcataacaaaggaatcatgaatggcattgaagctgta
gttttagctacaggaaatgatacacgcgctgttagcgcttcttgtcatgcttttgcggtgaaggaaggtcgctaccaaggcttg
actagttggacgctggatggcgaacaactaattggtgaaatttcagttccgcttgctttagccacggttggcggtgccacaaa
agtcttacctaaatctcaagcagctgctgatttgttagcagtgacggatgcaaaagaactaagtcgagtagtagcggctgtt
ggtttggcacaaaatttagcggcgttacgggccttagtctctgaaggaattcaaaaaggacacatggctctacaagcacgtt
ctttagcgatgacggtcggagctactggtaaagaagttgaggcagtcgctcaacaattaaaacgtcaaaaaacgatgaa
ccaagaccgagccatggctattttaaatgatttaagaaaacaataaaggaggtaaaaaaacatgacaattgggattgata
aaattagttttttttgtgccccccttattatattgatatgacggcactggctgaagccagaaatgtagaccctggaaaatttcatatt
ggtattgggcaagaccaaatggcggtgaacccaatcagccaagatattgtgacatttgcagccaatgccgcagaagcga
tcttgaccaaagaagataaagaggccattgatatggtgattgtcgggactgagtccagtatcgatgagtcaaaagcggcc
gcagttgtcttacatcgtttaatggggattcaacctttcgctcgctctttcgaaatcaaggaagcttgttacggagcaacagca
ggcttacagttagctaagaatcacgtagccttacatccagataaaaaagtcttggtcgtagcggcagatattgcaaaatatg
gcttaaattctggcggtgagcctacacaaggagctggggcggttgcaatgttagttgctagtgaaccgcgcattttggctttaa
aagaggataatgtgatgctgacgcaagatatctatgacttttggcgtccaacaggccacccgtatcctatggtcgatggtcct
ttgtcaaacgaaacctacatccaatcttttgcccaagtctgggatgaacataaaaaacgaaccggtcttgattttgcagattat
gatgctttagcgttccatattccttacacaaaaatgggcaaaaaagccttattagcaaaaatctccgaccaaactgaagca
gaacaggaacgaattttagcccgttatgaagaaagtatcgtctatagtcgtcgcgtaggaaacttgtatacgggttcactttat
ctgggactcatttccctttagaaaatgcaacgactttaaccgcaggcaatcaaattggtttattcagttatggttctggtgctgtc
gctgaatttttcactggtgaattag

Figure 92B

tagctggttatcaaaatcatttacaaaaagaaactcatttagcactgctggataatcggacagaactttctatcgctgaatat
gaagccatgtttgcagaaactttagacacagacattgatcaaacgttagaagatgaattaaaatatagtatttctgctattaa
taataccgttcgttcttatcgaaactaagagatctgcagctggtaccatatgggaattcgaagcttgggcccgaacaaaaa
ctcatctcagaagaggatctgaatagcgccgtcgaccatcatcatcatcattgagtttaaacggtctccagcttggctgt
tttggcggatgagagaagattttcagcctgatacagattaaatcagaacgcagaagcggtctgataaaacagaatttgcc
tggcggcagtagcgcggtggtcccacctgaccccatgccgaactcagaagtgaaacgccgtagcgccgatggtagtgt
ggggtctccccatgcgagagtagggaactgccaggcatcaaataaaacgaaaggctcagtcgaaagactgggccttt
cgttttatctgttgtttgtcggtgaacgctctcctgagtaggacaaatccgccgggagcggatttgaacgttgcgaagcaac
ggcccggagggtggcgggcaggacgcccgccataaactgccaggcatcaaattaagcagaaggccatcctgacgg
atggccttttgcgtttctacaaactctttttgtttatttttctaaatacattcaaatatgtatccgctcatgagacaataaccctgat
aaatgcttcaataatattgaaaaaggaagagtatgagtattcaacatttccgtgtcgcccttattccctttttgcggcattttgc
cttcctgtttttgctcacccagaaacgctggtgaaagtaaaagatgctgaagatcagttgggtgcacgagtgggttacatcg
aactggatctcaacagcggtaagatccttgagagttttcgccccgaagaacgttttccaatgatgagcacttttaaagttctg
ctatgtggcgcggtattatcccgtgttgacgccgggcaagagcaactcggtcgccgcatacactattctcagaatgacttg
gttgagtactcaccagtcacagaaaagcatcttacggatggcatgacagtaagagaattatgcagtgctgccataaccat
gagtgataacactgcggccaacttacttctgacaacgatcggaggaccgaaggagctaaccgcttttttgcacaacatg
ggggatcatgtaactcgccttgatcgttgggaaccggagctgaatgaagccataccaaacgacgagcgtgacaccac
gatgcctgtagcaatggcaacaacgttgcgcaaactattaactggcgaactacttactctagcttcccggcaacaattaat
agactggatggaggcggataaagttgcaggaccacttctgcgctcggcccttccggctggctggtttattgctgataaatct
ggagccggtgagcgtgggtctcgcggtatcattgcagcactggggccagatggtaagccctcccgtatcgtagttatcta
cacgacggggagtcaggcaactatggatgaacgaaatagacagatcgctgagataggtgcctcactgattaagcattg
gtaactgtcagaccaagtttactcatatatactttagattgatttaaaacttcatttttaatttaaaaggatctaggtgaagatcct
ttttgataatctcatgaccaaaatcccttaacgtgagttttcgttccactgagcgtcagaccccgtagaaaagatcaaagga
tcttcttgagatccttttttttctgcgcgtaatctgctgcttgcaaacaaaaaaaccaccgctaccagcggtggtttgtttgccgg
atcaagagctaccaactctttttccgaaggtaactggcttcagcagagcgcagataccaaatactgtccttctagtgtagcc
gtagttaggccaccacttcaagaactctgtagcaccgcctacatacctcgctctgctaatcctgttaccagtggctgctgcc
agtggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccggataaggcgcagcggtcgggctgaacg
gggggttcgtgcacacagcccagcttggagcgaacgacctacaccgaactgagatacctacagcgtgagctatgaga
aagcgccacgcttcccgaagggagaaaggcggacaggtatccggtaagcggcagggtcggaacaggagagcgca
cgagggagcttccagggggaaacgcctggtatctttatagtcctgtcgggtttcgccacctctgacttgagcgtcgatttttgt
gatgctcgtcaggggggcggagcctatggaaaaacgccagcaacgcggccttttacggttcctggccttttgctggccttt
tgctcacatgttctttcctgcgttatcccctgattctgtggataaccgtattaccgcctttgagtgagctgataccgctcgccgca
gccgaacgaccgagcgcagcgagtcagtgagcgaggaagcggaagagcgcctgatgcggtattttctccttacgcat
ctgtgcggtatttcacaccgcatatggtgcactctcagtacaatctgctctgatgccgcatagttaagccagtatacactccg
ctatcgctacgtgactgggtcatggctgcgccccgacacccgccaacacccgctgacgcgccctgacgggcttgtctgct
cccggcatccgcttacagacaagctgtgaccgtctccgggagctgcatgtgtcagaggttttcaccgtcatcaccgaaac
gcgcgaggcagcagatcaattcgcgcgcgaaggcgaagcggcatgcatttacgttgacaccatcgaatggtgcaaaa
cctttcgcggtatggcatgatagcgcccggaagagagtcaattcagggtggtgaatgtgaaaccagtaacgttatacgat
gtcgcagagtatgccggtgtctcttatcagaccgtttcccgcgtggtgaaccaggccagccacgtttctgcgaaaacgcg
ggaaaaagtggaagcggcgatggcggagctgaattacattcccaaccgcgtggcacaacaactggcgggcaaaca
gtcgttgctgattggcgttgccacctccagtctggccctgcacgcgccgtcgcaaattgtcgcggcgattaaatctcgcgcc
gatcaactgggtgccagcgtggtggtgtcgatggtagaacgaagcggcgtcgaagcctgtaaagcggcggtgcacaa
tcttctcgcgcaacgcgtcagtgggctgatcattaactatccgctggatgaccaggatgccattgctgtggaagctgcctgc
actaatgttccggcgttatttcttgatgtctctgaccagacacccatcaacagtattattttctcccatgaagacggtacgcga
ctgggcgtggagcatctggtcgcattgggtcaccagcaaatcgcgctgttagcgggcccattaagttctgtctcggcgcgt
ctgcgtctggctggctggcataaatatctcactcgcaatcaaattcagccgatagcggaacgggaaggcgactggagtg
ccatgtccggttttcaacaaaccatgcaaatgctgaatgagggcatcg

Figure 92C

ttcccactgcgatgctggttgccaacgatcagatggcgctgggcgcaatgcgcgccattaccgagtccgggct
gcgcgttggtgcggatatctcggtagtgggatacgacgataccgaagacagctcatgttatatcccgccgtca
accaccatcaaacaggattttcgcctgctggggcaaaccagcgtggaccgcttgctgcaactctctcagggc
caggcggtgaagggcaatcagctgttgcccgtctcactggtgaaaagaaaaaccaccctggcgcccaatac
gcaaaccgcctctccccgcgcgttggccgattcattaatgcagctggcacgacaggtttcccgactggaaag
cgggcagtgagcgcaacgcaattaatgtgagttagcgcgaattgatctg

(SEQ ID NO:23)

Figure 93

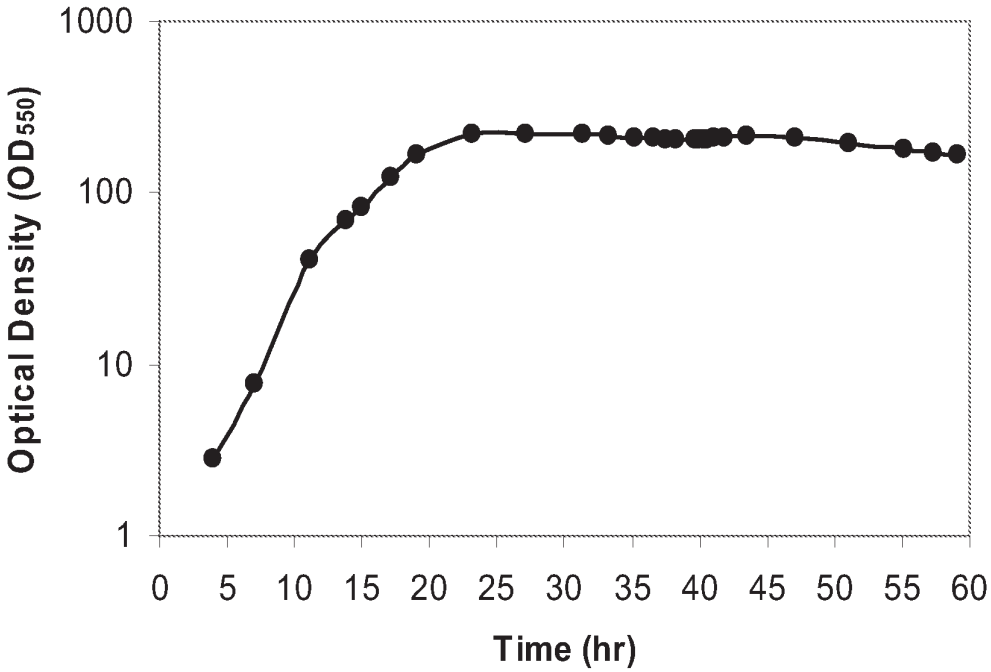

1000
100
10
1
Optical Density (OD550)
0
5
10
15
20
25
30
35
40
45
50
55
60
Time (hr)

Figure 94

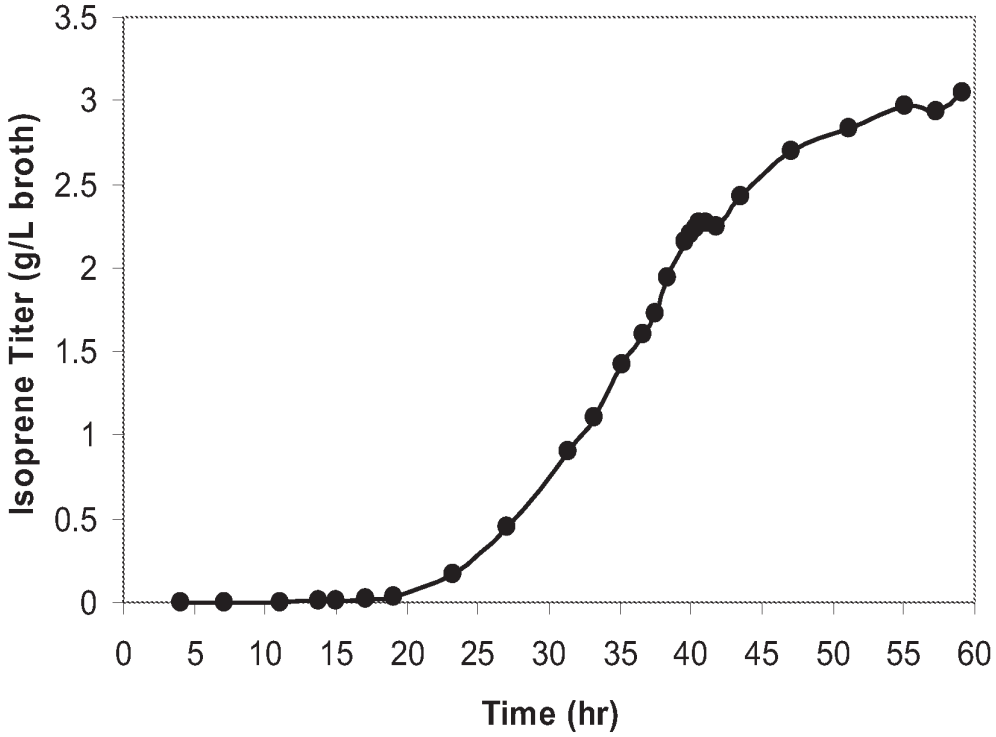

Isoprene Titer (g/L broth)
3.5
3
2.5
2
1.5
1
0.5
0
0 5 10 15 20 25 30 35 40 45 50 55 60
Time (hr)

Figure 95

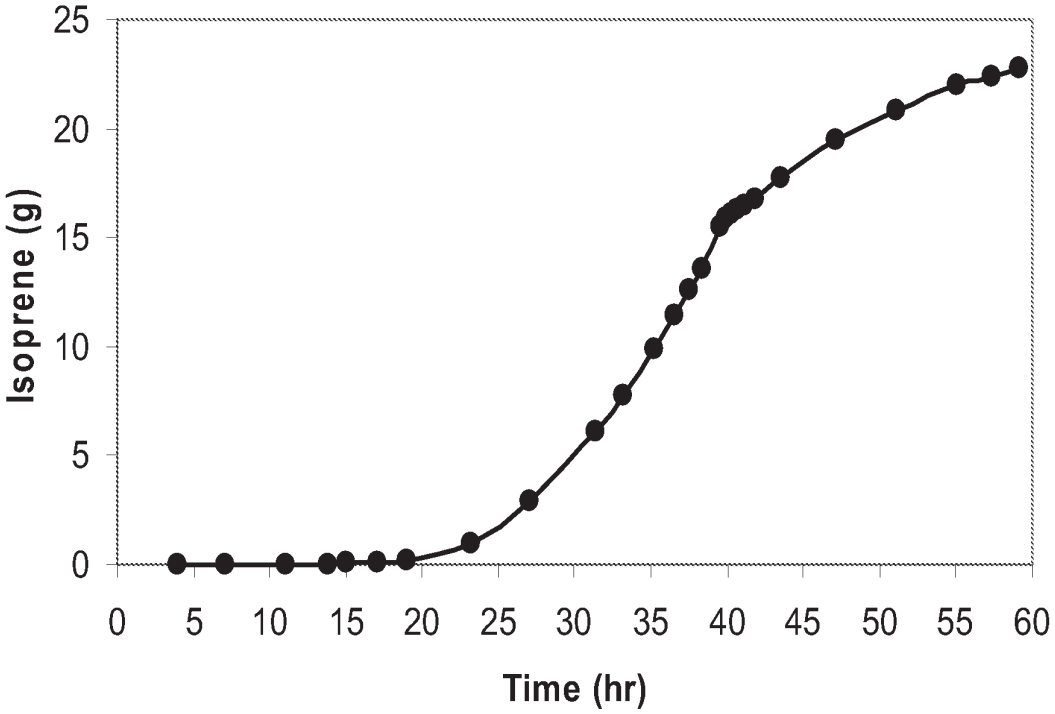


Figure 96

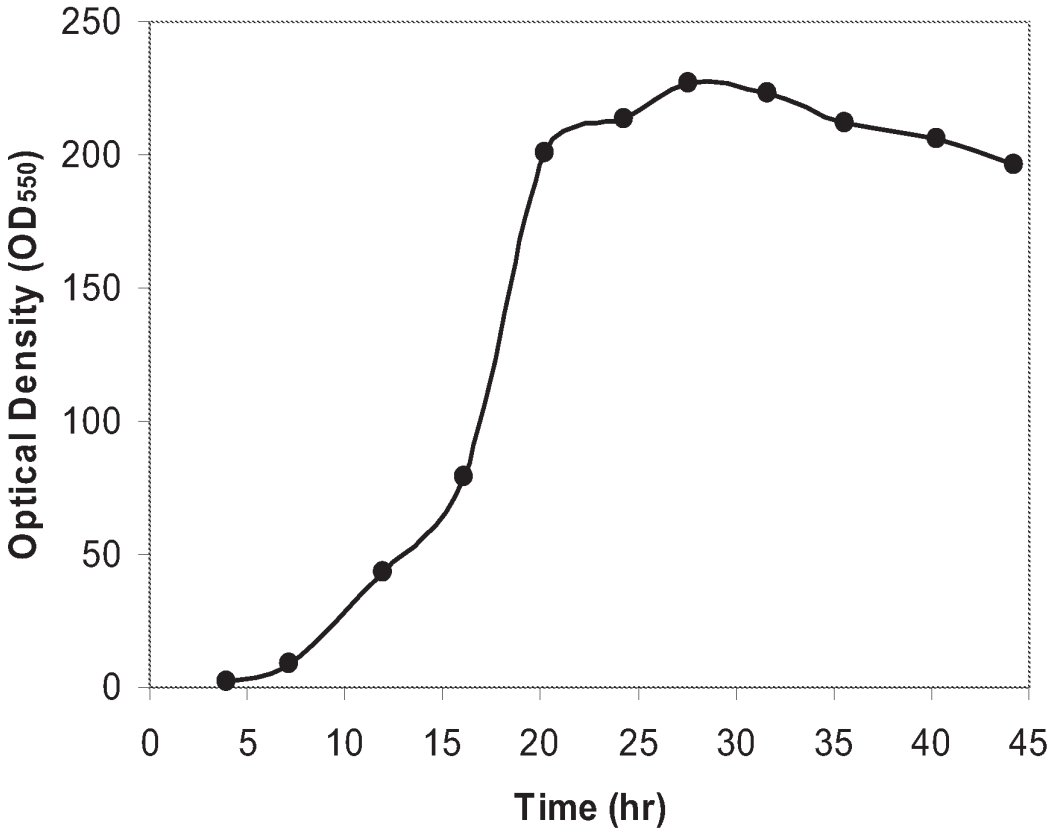

Optical Density (OD550)
250
200
150
100
50
0
0
5
10
15
20
25
30
35
40
45
Time (hr)

Figure 97

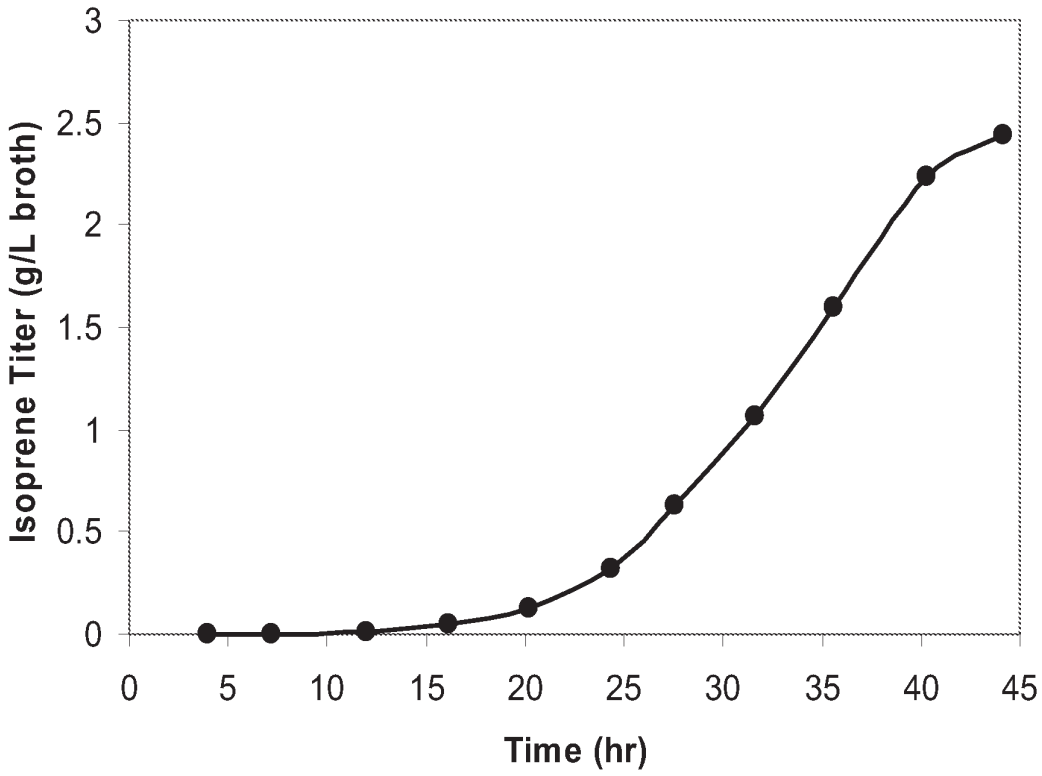

Isoprene Titer (g/L broth)
3
2.5
2
1.5
1
0.5
0
0
5
10
15
20
25
30
35
40
45
Time (hr)

Figure 98

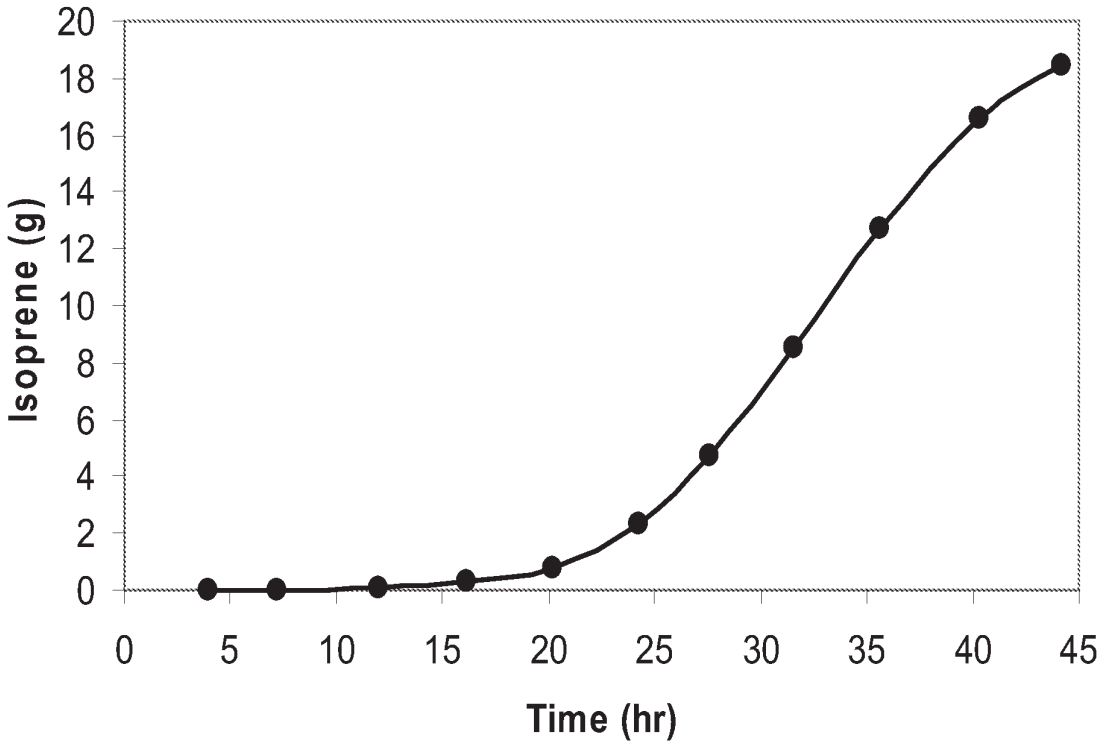

Isoprene (g)
0
2
4
6
8
10
12
14
16
18
20
0
5
10
15
20
25
30
35
40
45
Time (hr)

Figure 99

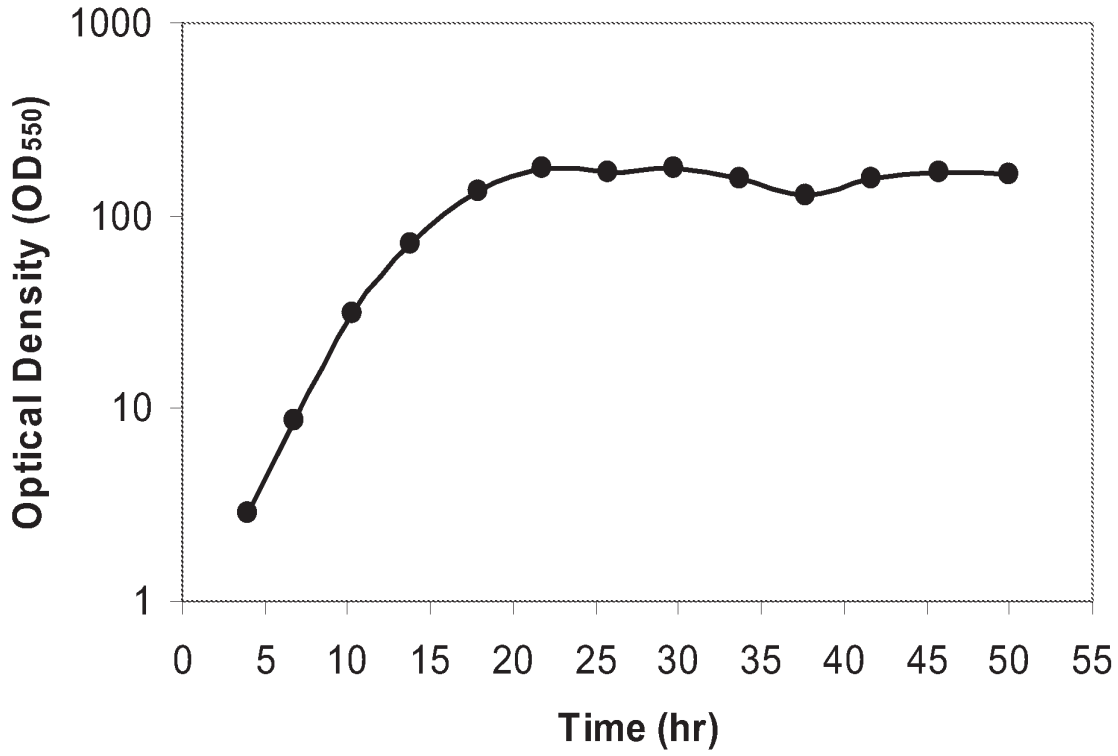

1000
100
10
1
Optical Density (OD550)
0
5
10
15
20
25
30
35
40
45
50
55
Time (hr)

Figure 100

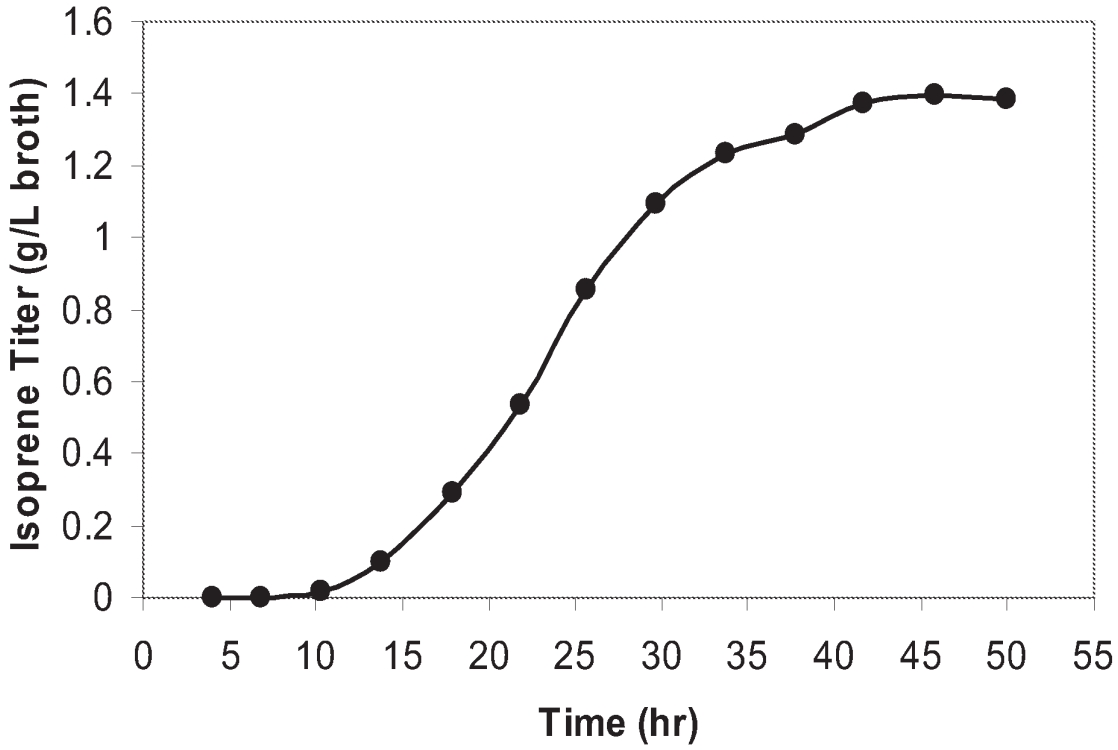

Isoprene Titer (g/L broth)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0 5 10 15 20 25 30 35 40 45 50 55
Time (hr)

Figure 101

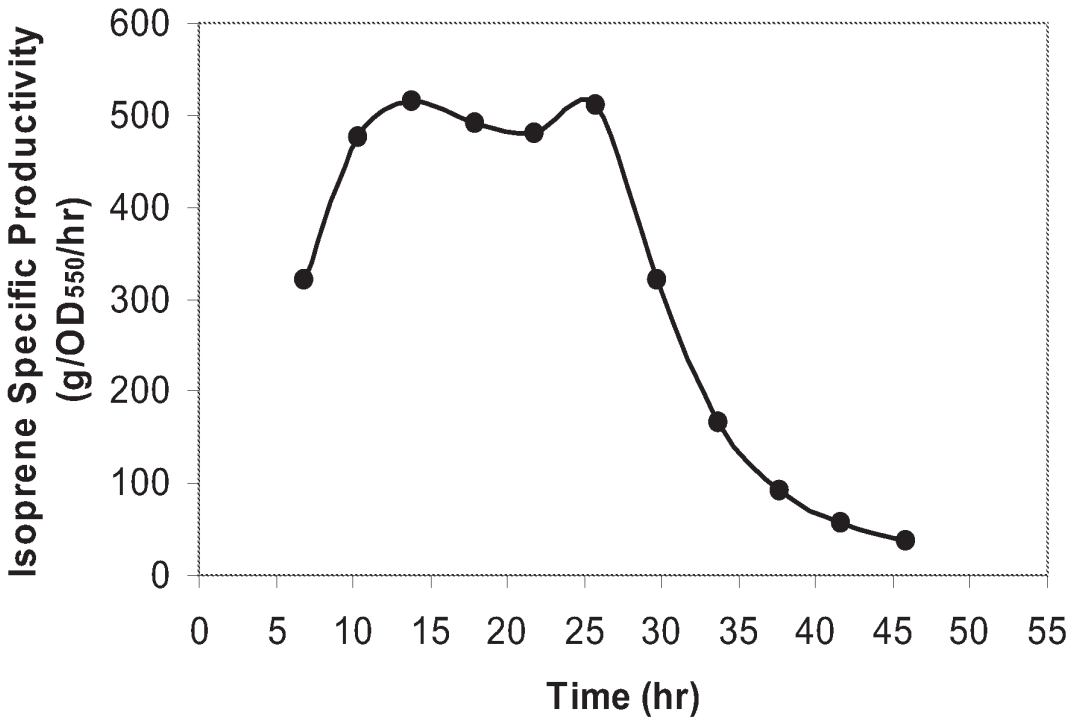

Isoprene Specific Productivity (g/OD550/hr)
600
500
400
300
200
100
0
0
5
10
15
20
25
30
35
40
45
50
55
Time (hr)

Figure 102

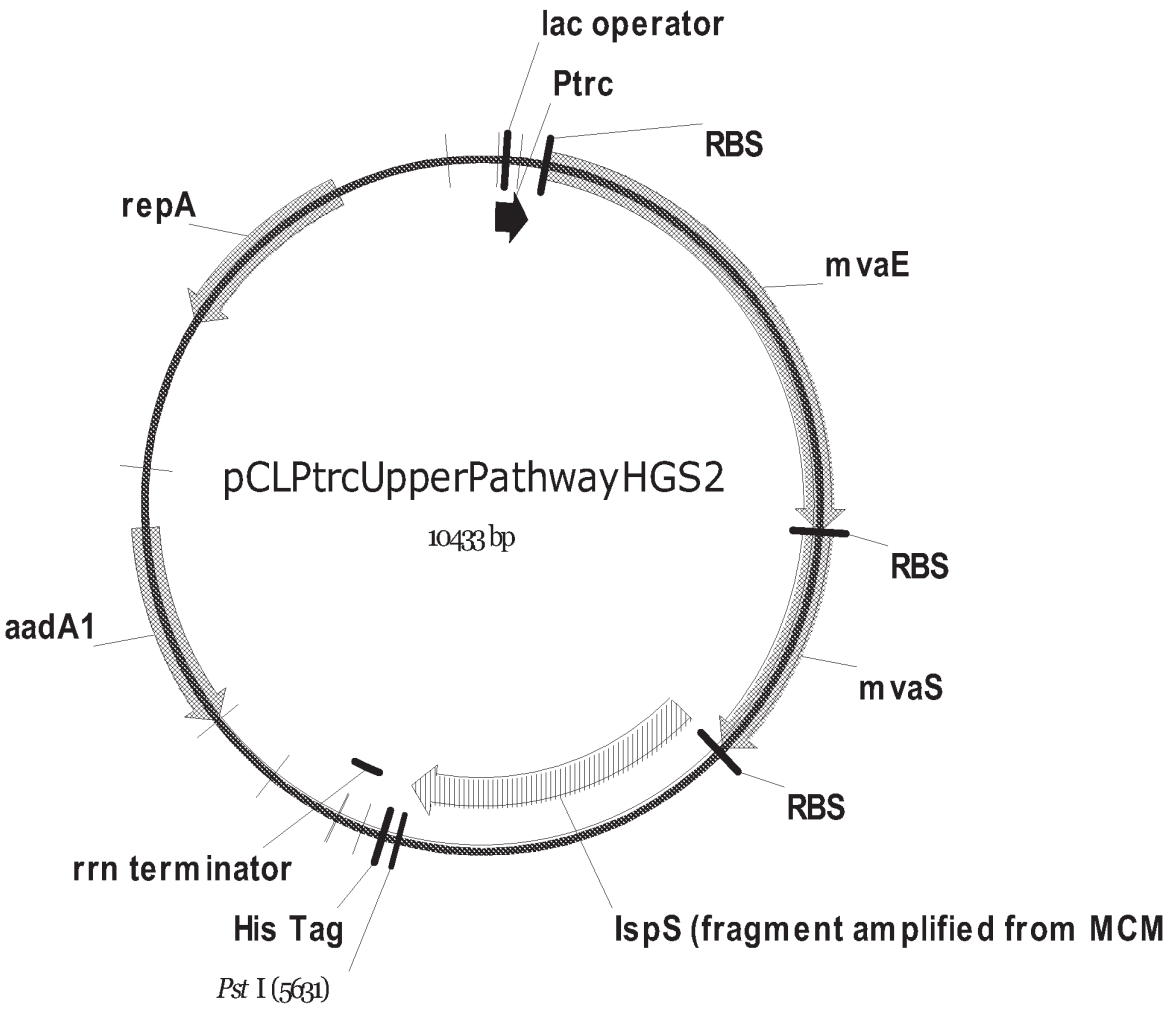

lac operator
Ptrc
RBS
repA
mvaE
pCLPtrcUpperPathwayHGS2
10433 bp
RBS
aadA1
mvaS
RBS
rrn terminator
His Tag
IspS (fragment amplified from MCM
Pst I (5631)

Figure 103A

cccgtcttactgtcgggaattcgcgttggccgattcattaatgcagattctgaaatgagctgttgacaattaatcatccggctc
gtataatgtgtggaattgtgagcggataacaatttcacacaggaaacagcgccgctgagaaaaagcgaagcggcact
gctctttaacaatttatcagacaatctgtgtgggcactcgaccggaattatcgattaactttattattaaaaattaaagaggtat
atattaatgtatcgattaaataaggaggaataaaccatggatccgagctcaggaggtaaaaaaacatgaaaacagtag
ttattattgatgcattacgaacaccaattggaaaatataaaggcagcttaagtcaagtaagtgccgtagacttaggaacac
atgttacaacacaacttttaaaaagacattccactatttctgaagaaattgatcaagtaatctttggaaatgttttacaagctg
gaaatggccaaaatcccgcacgacaaatagcaataaacagcggtttgtctcatgaaattcccgcaatgacggttaatga
ggtctgcggatcaggaatgaaggccgttattttggcgaaacaattgattcaattaggagaagcggaagttttaattgctggc
gggattgagaatatgtcccaagcacctaaattacaacgttttaattacgaaacagaaagctacgatgcgccttttttctagtat
gatgtatgatggattaacggatgcctttagtggtcaggcaatgggcttaactgctgaaaatgtggccgaaaagtatcatgta
actagagaagagcaagatcaattttctgtacattcacaattaaaagcagctcaagcacaagcagaagggatattcgctg
acgaaatagccccattagaagtatcaggaacgcttgtggagaaagatgaagggattcgccctaattcgagcgttgaga
agctaggaacgcttaaaacagtttttaaagaagacggtactgtaacagcagggaatgcatcaaccattaatgatggggc
ttctgctttgattattgcttcacaagaatatgccgaagcacacggtcttccttatttagctattattcgagacagtgtggaagtcg
gtattgatccagcctatatgggaatttcgccgattaaagccattcaaaaactgttagcgcgcaatcaacttactacggaag
aaattgatctgtatgaaatcaacgaagcatttgcagcaacttcaatcgtggtccaaagagaactggctttaccagaggaa
aaggtcaacatttatggtggcggtatttcattaggtcatgcgattggtgccacaggtgctcgtttattaacgagtttaagttatc
aattaaatcaaaaagaaaagaaatatggagtggcttctttatgtatcggcggtggcttaggactcgctatgctactagaga
gacctcagcaaaaaaaaaacagccgattttatcaaatgagtcctgaggaacgcctggcttctcttcttaatgaaggccag
atttctgctgatacaaaaaaagaatttgaaaatacggctttatcttcgcagattgccaatcatatgattgaaaatcaaatcag
tgaaacagaagtgccgatgggcgttggcttacatttaacagtggacgaaactgattatttggtaccaatggcgacagaag
agccctcagttattgcggctttgagtaatggtgcaaaaatagcacaaggatttaaaacagtgaatcaacaacgcttaatg
cgtggacaaatcgtttttacgatgttgcagatcccgagtcattgattgataaactacaagtaagagaagcggaagtttttca
acaagcagagttaagttatccatctatcgttaaacggggcggcggcttaagagatttgcaatatcgtacttttgatgaatcat
ttgtatctgtcgacttttagtagatgttaaggatgcaatgggggcaaatatcgttaacgctatgttggaaggtgtggccgagt
tgttccgtgaatggtttgcggagcaaaagattttattcagtattttaagtaattatgccacggagtcggttgttacgatgaaaac
ggctattccagtttcacgtttaagtaaggggagcaatggccgggaaattgctgaaaaaattgttttagcttcacgctatgctt
cattagatccttatcgggcagtcacgcataacaaaggaatcatgaatggcattgaagctgtagttttagctacaggaaatg
atacacgcgctgttagcgcttcttgtcatgcttttgcggtgaaggaaggtcgctaccaaggcttgactagttggacgctggat
ggcgaacaactaattggtgaaatttcagttccgcttgctttagccacggttggcggtgccacaaaagtcttacctaaatctc
aagcagctgctgatttgttagcagtgacggatgcaaaagaactaagtcgagtagtagcggctgttggtttggcacaaaatt
tagcggcgttacgggccttagtctctgaaggaattcaaaaaggacacatggctctacaagcacgttctttagcgatgacg
gtcggagctactggtaaagaagttgaggcagtcgctcaacaattaaaacgtcaaaaaacgatgaaccaagaccgag
ccatggctattttaaatgatttaagaaaacaataaaggaggtaaaaaaacatgacaattgggattgataaaattagttttttt
gtgccccctattatatattgatatgacggcactggctgaagccagaaatgtagaccctggaaaatttcatattggtattgggca
agaccaaatggcggtgaacccaatcagccaagatattgtgacatttgcagccaatgccgcagaagcgatcttgaccaa
agaagataaagaggccattgatatggtgattgtcgggactgagtccagtatcgatgagtcaaaagcggccgcagttgtct
tacatcgtttaatggggattcaacctttcgctcgctctttcgaaatcaaggaagcttgttacggagcaacagcaggcttaca
gttagctaagaatcacgtagccttacatccagataaaaaagtcttggtcgtagcggcagatattgcaaaatatggcttaaa
ttctggcggtgagcctacacaaggagctggggcggttgcaatgttagttgctagtgaaccgcgcattttggctttaaaaga
ggataatgtgatgctgacgcaagatatctatgacttttggcgtccaacaggccacccgtatcctatggtcgatggtcctttgt
caaacgaaacctacatccaatcttttgcccaagtctgggatgaacataaaaaacgaaccggtcttgattttgcagattatg
atgctttagcgttccatattccttacacaaaaatgggcaaaaaagccttattagcaaaaatctccgaccaaactgaagca
gaacaggaacgaattttagcccgttatgaagaaagtatcgtctatagtcgtcgcgtaggaaacttgtatacgggttcacttt
atctgggactcatttccctttagaaaatgcaacgactttaaccgcaggcaatcaaattggtttattcagttatggttctggtgct
gtcgctgaatttttcactggtgaattagtagctggttatcaaaatcatttacaaaaagaaactcatttagcactgctggataat
cggacagaactttctatcgctgaatatgaagccatgtttgcagaaactttagacacagacattgatcaaacgtta

Figure 103B

gaagatgaattaaaatatagtatttctgctattaataataccgttcgttcttatcgaaactaaagatctgcatcctgcattcgc
ccttaggaggtaaaaaaacatgtgtgcgacctcttctcaatttactcagattaccgagcataattcccgtcgttccgcaaa
ctatcagccaaacctgtggaatttcgaattcctgcaatccctggagaacgacctgaaagtggaaaagctggaggaga
aagcgaccaaactggaggaagaagttcgctgcatgatcaaccgtgtagacacccagccgctgtccctgctggagctg
atcgacgatgtgcagcgcctgggtctgacctacaaatttgaaaaagacatcattaaagccctggaaaacatcgtactg
ctggacgaaaacaaaaagaacaaatctgacctgcacgcaaccgctctgtctttccgtctgctgcgtcagcacggtttcg
aggtttctcaggatgtttttgagcgtttcaaggataaagaaggtggtttcagcggtgaactgaaaggtgacgtccaaggc
ctgctgagcctgtatgaagcgtcttacctgggtttcgagggtgagaacctgctggaggaggcgcgtacctttttccatcacc
cacctgaagaacaacctgaaagaaggcattaataccaaggttgcagaacaagtgagccacgccctggaactgcca
tatcaccagcgtctgcaccgtctggaggcacgttggttcctggataaatacgaaccgaaagaaccgcatcaccagctg
ctgctggagctggcgaagctggattttaacatggtacagaccctgcaccagaaagagctgcaagatctgtcccgctgg
tggaccgagatgggcctggctagcaaactggattttgtacgcgaccgcctgatggaagtttatttctgggcactgggtatg
gcgccagacccgcagtttggtgaatgtcgcaaagctgttactaaaatgtttggtctggtgacgatcatcgatgacgtgtat
gacgtttatggcactctggacgaactgcaactgttcaccgatgctgtagagcgctgggacgttaacgctattaacaccct
gccggactatatgaaactgtgtttcctggcactgtacaacaccgttaacgacacgtcctattctattctgaaagagaaag
gtcataacaacctgtcctatctgacgaaaagctggcgtgaactgtgcaaagcctttctgcaagaggcgaaatggtcca
acaacaaaattatcccggctttctccaagtacctggaaaacgccagcgtttcctcctccggtgtagcgctgctggcgccg
tcttacttttccgtatgccagcagcaggaagacatctccgaccacgcgctgcgttccctgaccgacttccatggtctggtg
cgttctagctgcgttatcttccgcctgtgcaacgatctggccacctctgcggcggagctggaacgtggcgagactacca
attctatcattagctacatgcacgaaaacgatggtaccagcgaggaacaggcccgcgaagaactgcgtaaactgatc
gacgccgaatggaaaaagatgaatcgtgaacgcgttagcgactccaccctgctgcctaaagcgttcatggaaatcgc
agttaacatggcacgtgtttcccactgcacctaccagtatggcgatggtctgggtcgcccagactacgcgactgaaaac
cgcatcaaactgctgctgattgacccttcccgattaaccagctgatgtatgtctaactgcagctggtaccatatgggaatt
cgaagcttgggcccgaacaaaaactcatctcagaagaggatctgaatagcgccgtcgaccatcatcatcatcatcatt
gagtttaaacggtctccagcttggctgttttggcggatgagagaagattttcagcctgatacagattaaatcagaacgca
gaagcggtctgataaaacagaatttgcctggcggcagtagcgcggtggtcccacctgaccccatgccgaactcagaa
gtgaaacgccgtagcgccgatggtagtgtggggtctccccatgcgagagtagggaactgccaggcatcaaataaaa
cgaaaggctcagtcgaaagactgggcctttcgttttatctgttgtttgtcggtgaacgctctcctgagtaggacaaatccgc
cgggagcggatttgaacgttgcgaagcaacggcccggagggtggcgggcaggacgcccgccataaactgccagg
catcaaattaagcagaaggccatcctgacggatggccttttgcgtttctacaaactcttttgtttatttttctaaatacattca
aatatgtatccgctcatgagacaataaccctgataaatgcttcaataatctggcgtaatagcgaagaggcccgcaccg
atcgcccttcccaacagttgcgcagcctgaatggcgaatggcgcctgatgcggtattttctccttacgcatctgtgcggtat
ttcacaccgcatatggtgcactctcagtacaatctgctctgatgccgcatagttaagccagccccgacacccgccaaca
cccgctgacgagcttagtaaagccctcgctagattttaatgcggatgttgcgattacttcgccaactattgcgataacaag
aaaaagccagcctttcatgatatatctcccaatttgtgtagggcttattatgcacgcttaaaaataataaaagcagacttg
acctgatagtttggctgtgagcaattatgtgcttagtgcatctaacgcttgagttaagccgcgccgcgaagcggcgtcgg
cttgaacgaattgttagacattatttgccgactaccttggtgatctcgcctttcacgtagtggacaaattcttccaactgatctg
cgcgcgaggccaagcgatcttcttcttgtccaagataagcctgtctagcttcaagtatgacgggctgatactgggccggc
aggcgctccattgcccagtcggcagcgacatccttcggcgcgattttgccggttactgcgctgtaccaaatgcgggaca
acgtaagcactacatttcgctcatcgccagcccagtcgggcggcgagttccatagcgttaaggtttcatttagcgcctca
aatagatcctgttcaggaaccggatcaaagagttcctccgccgctggacctaccaaggcaacgctatgttctcttgctttt
gtcagcaagatagccagatcaatgtcgatcgtggctggctcgaagatacctgcaagaatgtcattgcgctgccattctcc
aaattgcagttcgcgcttagctggataacgccacggaatgatgtcgtcgtgcacaacaatggtgacttctacagcgcgg
agaatctcgctctctccaggggaagccgaagtttccaaaaggtcgttgatcaaagctcgccgcgttgtttcatcaagcctt
acggtcaccgtaaccagcaaatcaatatcactgtgtggcttcaggccgccatccactgcggagccgtacaaatgtacg
gccagcaacgtcggttcgagatggcgctcgatgacgccaactacctctgatagttgagtcgatacttcggcgatcaccg
cttccctcatgatgtttaactttgttttagggcgactgccctgctgcgtaacatcgttgctgctccataacatcaaacatcgac
ccacggcgtaacgcgcttgctgcttggat

Figure 103C

gcccgaggcatagactgtaccccaaaaaaacagtcataacaagccatgaaaaccgccactgcgccgttacc
accgctgcgttcggtcaaggttctggaccagttgcgtgagcgcatacgctacttgcattacagcttacgaaccga
acaggcttatgtccactgggttcgtgccttcatccgtttccacggtgtgcgtcacccggcaaccttgggcagcagc
gaagtcgaggcatttctgtcctggctggcgaacgagcgcaaggtttcggtctccacgcatcgtcaggcattggc
ggccttgctgttcttctacggcaaggtgctgtgcacggatctgccctggcttcaggagatcggaagacctcggcc
gtcgcggcgcttgccggtggtgctgaccccggatgaagtggttcgcatcctcggttttctggaaggcgagcatcg
tttgttcgcccagcttctgtatggaacgggcatgcggatcagtgagggtttgcaactgcgggtcaaggatctggatt
tcgatcacggcacgatcatcgtgcgggagggcaagggctccaaggatcgggccttgatgttacccgagagctt
ggcacccagcctgcgcgagcaggggaattaattcccacgggttttgctgcccgcaaacgggctgttctggtgttg
ctagtttgttatcagaatcgcagatccggcttcagccggtttgccggctgaaagcgctatttcttccagaattgccat
gatttttccccacgggaggcgtcactggctcccgtgttgtcggcagctttgattcgataagcagcatcgcctgtttc
aggctgtctatgtgtgactgttgagctgtaacaagttgtctcaggtgttcaatttcatgttctagttgctttgttttactggtt
tcacctgttctattaggtgttacatgctgttcatctgttacattgtcgatctgttcatggtgaacagctttgaatgcacca
aaaactcgtaaaagctctgatgtatctatctttttacaccgttttcatctgtgcatatggacagttttccctttgatatgta
acggtgaacagttgttctacttttgtttgttagtcttgatgcttcactgatagatacaagagccataagaacctcagat
ccttccgtatttagccagtatgttctctagtgtggttcgttgtttttgcgtgagccatgagaacgaaccattgagatcat
acttactttgcatgtcactcaaaaattttgcctcaaaactggtgagctgaatttttgcagttaaagcatcgtgtagtgtt
tttcttagtccgttatgtaggtaggaatctgatgtaatggttgttggtattttgtcaccattcatttttatctggttgttctcaa
gttcggttacgagatccatttgtctatctagttcaacttggaaaatcaacgtatcagtcgggcggcctcgcttatcaa
ccaccaatttcatattgctgtaagtgtttaaatctttacttattggtttcaaaacccattggttaagccttttaaactcatg
gtagttatttttcaagcattaacatgaacttaaattcatcaaggctaatctctatatttgccttgtgagttttcttttgtgttag
ttcttttaataaccactcataaatcctcatagagtatttgttttcaaaagacttaacatgttccagattatattttatgaatt
tttttaactggaaaagataaggcaatatctcttcactaaaaactaattctaatttttcgcttgagaacttggcatagttt
gtccactggaaaatctcaaagcctttaaccaaaggattcctgatttccacagttctcgtcatcagctctctggttgctt
tagctaatacaccataagcattttccctactgatgttcatcatctgagcgtattggttataagtgaacgataccgtcc
gttctttccttgtagggttttcaatcgtggggttgagtagtgccacacagcataaaattagcttggtttcatgctccgtta
agtcatagcgactaatcgctagttcatttgctttgaaaacaactaattcagacatacatctcaattggtctaggtgatt
ttaatcactataccaattgagatgggctagtcaatgataattactagtccttttccttgagttgtgggtatctgtaaatt
ctgctagacctttgctggaaaacttgtaaattctgctagaccctctgtaaattccgctagacctttgtgtgttttttttgttt
atattcaagtggttataatttatagaataaagaaagaataaaaaaagataaaaagaatagatcccagccctgtg
tataactcactactttagtcagttccgcagtattacaaaaggatgtcgcaaacgctgtttgctcctctacaaaacag
accttaaaaccctaaaggcttaagtagcaccctcgcaagctcgggcaaatcgctgaatattccttttgtctccgac
catcaggcacctgagtcgctgtctttttcgtgacattcagttcgctgcgctcacggctctggcagtgaatgggggta
aatggcactacaggcgccttttatggattcatgcaaggaaactacccataatacaagaaaagcccgtcacggg
cttctcagggcgttttatggcgggtctgctatgtggtgctatctgactttttgctgttcagcagttcctgccctctgattttc
cagtctgaccacttcggattatcccgtgacaggtcattcagactggctaatgcacccagtaaggcagcggtatca
tcaacaggctta

(SEQ ID NO:24)

Figure 104

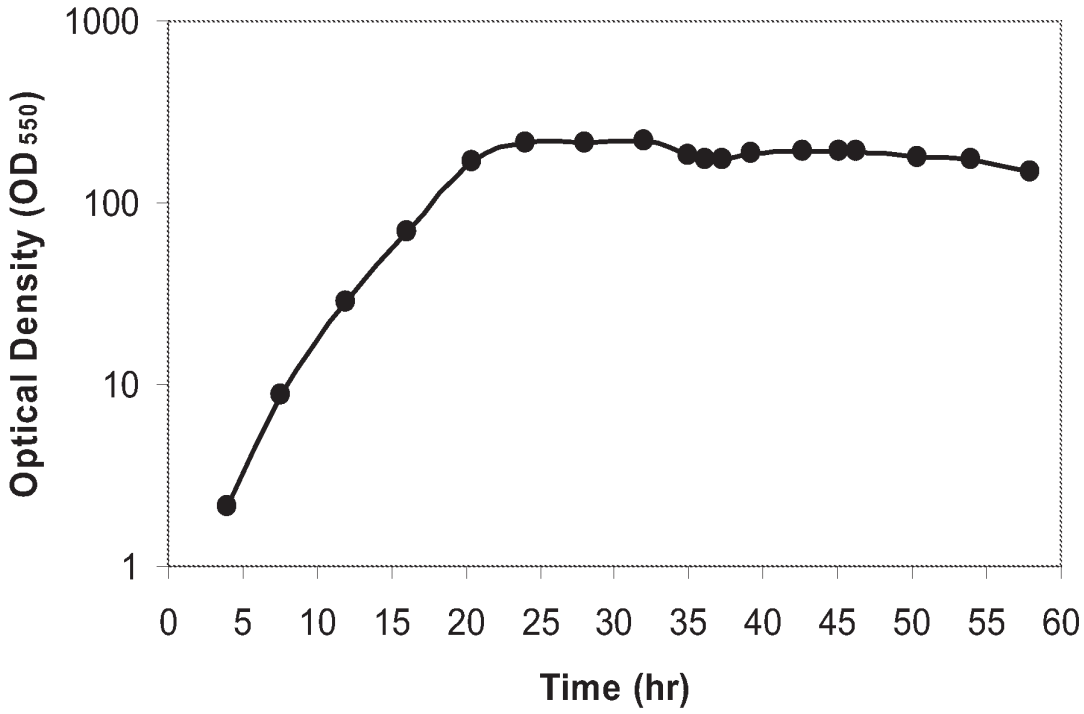

1000
100
10
1
Optical Density (OD 550)
0
5
10
15
20
25
30
35
40
45
50
55
60
Time (hr)

Figure 105

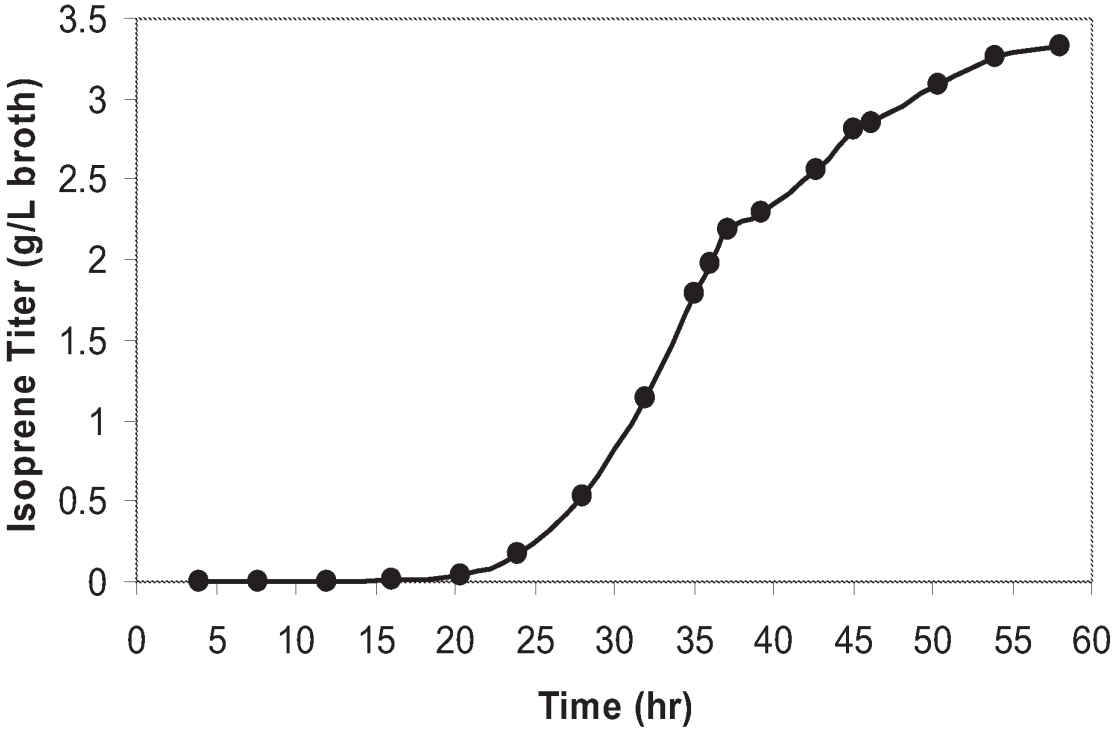

Isoprene Titer (g/L broth)
3.5
3
2.5
2
1.5
1
0.5
0
0 5 10 15 20 25 30 35 40 45 50 55 60
Time (hr)

Figure 106

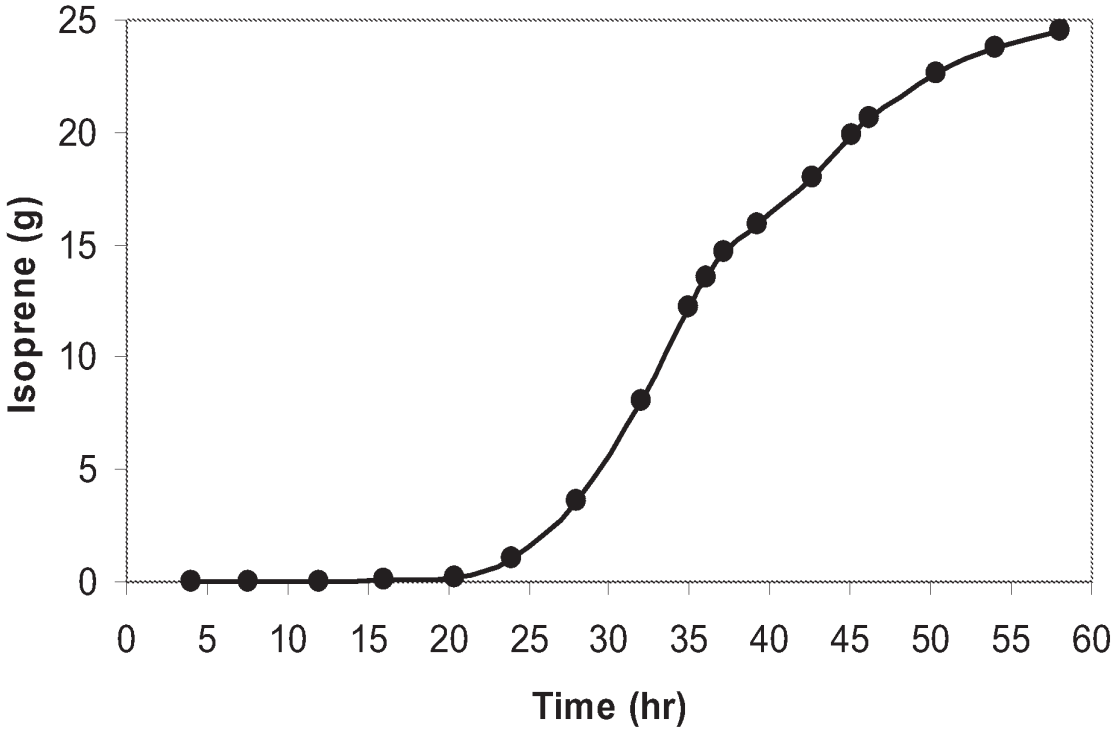
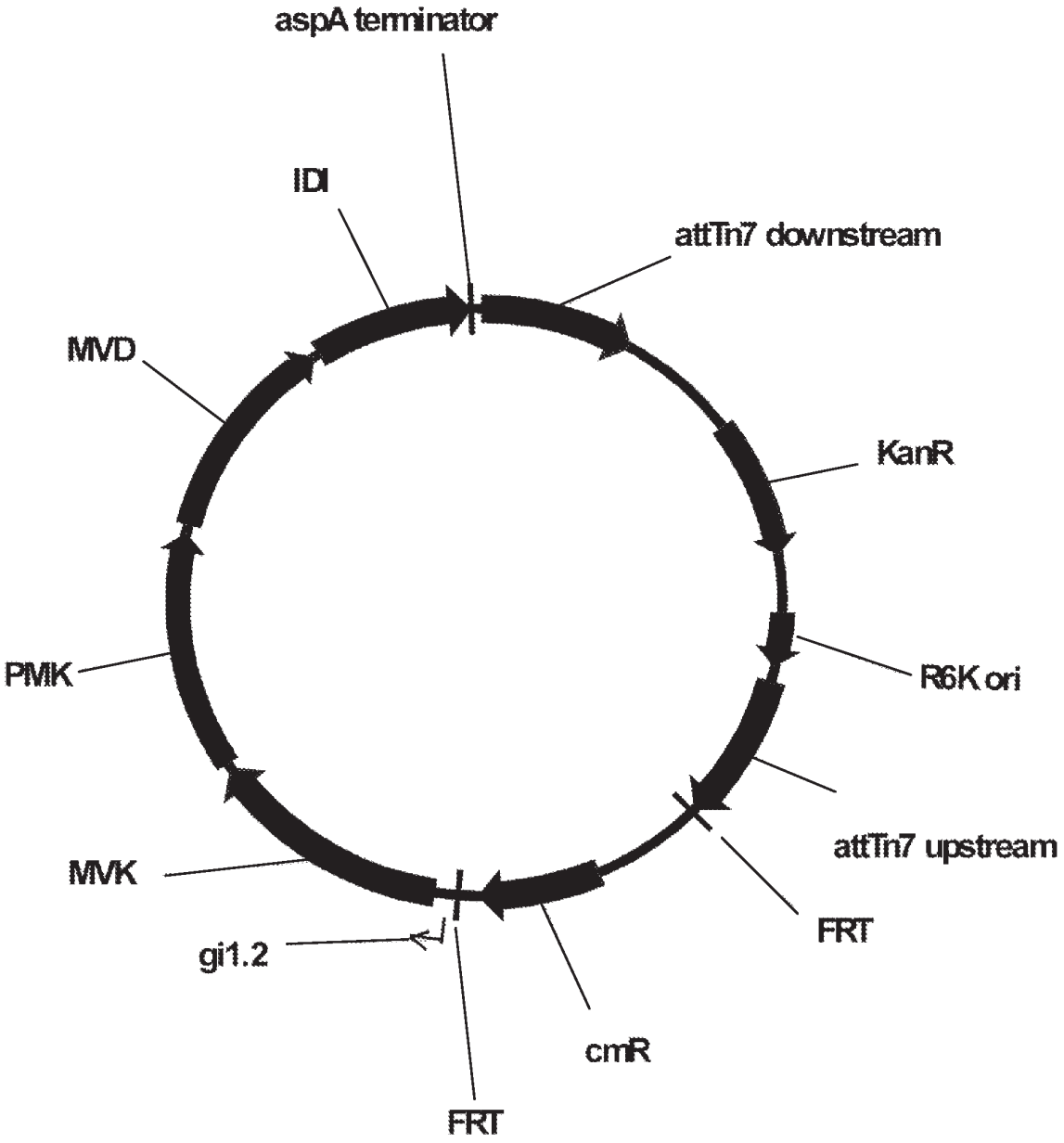


Figure 107



MCM330 - FRT-cm-FRT-gi1.2-KKDyI at attTn7

10356 bp

Figure 108A

1-

caagaaaaatgccccgcttacgcagggcatccatttattactcaaccgtaaccgattttgccaggttacgcggctggtcaa
cgtcggtgcctttgatcagcgcgacatggtaagccagcagctgcagcggaacggtgtagaagatcggtgcaatcacct
cttccacatgcggcatctcgatgatgtgcatgttatcgctacttacaaaacccgcatcctgatcggcgaagacatacaact
gaccgccacgcgcgcgaacttcttcaatgttggatttcagtttttccagcaattcgttgttcggtgcaacaacaataaccggc
atatcggcatcaattagcgccagcggaccgtgtttcagttcgccagcagcgtaggcttcagcgtgaatgtaagagatctct
ttcaacttcaatgcgccttccagcgcgattgggtactgatcgccacggcccaggaacagcgcgtgatgtttgtcagagaa
atcttctgccagcgcttcaatgcgtttgtcctgagacagcatctgctcaatacggctcggcagcgcctgcagaccatgcac
gatgtcatgttcaatggaggcatccagacctttcaggcgagacagcttcgccaccagcatcaacagcacagttaactga
gtggtgaatgctttagtggatgccacgccgatttctgtacccgcgttggtcattagcgccagatcggattcgcgcaccagag
aagaacccggaacgttacagattgccagtgaaccaaggtaacccagctctttcgacagacgcaggccagccagggta
tccgcggtttcgccagactgtgacacgatcgcccttcccaacagttgcgcagcctatacgtacggcagtttaaggtttacac
ctataaaagagagagccgttatcgtctgtttgtggatgtacagagtgatattattgacacgccggggcgacggatggtgat
ccccctggccagtgcacgtctgctgtcagataaagtctcccgtgaactttacccggtggtgcatatcggggatgaaagctg
gcgcatgatgaccaccgatatggccagtgtgccggtctccgttatcggggaagaagtggctgatctcagccaccgcgaa
aatgacatcaaaaacgccattaacctgatgttctggggaatataaatgtcaggcatgagattatcaaaaaggatcttcac
ctagatccttttcacgtagaaagccagtccgcagaaacggtgctgaccccggatgaatgtcagctactgggctatctgga
caagggaaaacgcaagcgcaaagagaaagcaggtagcttgcagtgggcttacatggcgatagctagactgggcggt
tttatggacagcaagcgaaccggaattgccagctggggcgccctctggtaaggttgggaagccctgcaaagtaaactg
gatggctttctcgccgccaaggatctgatggcgcaggggatcaagctctgatcaagagacaggatgaggatcgtttcgc
atgattgaacaagatggattgcacgcaggttctccggccgcttgggtggagaggctattcggctatgactgggcacaaca
gacaatcggctgctctgatgccgccgtgttccggctgtcagcgcaggggcgcccggttctttttgtcaagaccgacctgtcc
ggtgccctgaatgaactgcaagacgaggcagcgcggctatcgtggctggccacgacgggcgttccttgcgcagctgtg
ctcgacgttgtcactgaagcgggaagggactggctgctattgggcgaagtgccggggcaggatctcctgtcatctcacct
tgctcctgccgagaaagtatccatcatggctgatgcaatgcggcggctgcatacgcttgatccggctacctgcccattcga
ccaccaagcgaaacatcgcatcgagcgagcacgtactcggatggaagccggtcttgtcgatcaggatgatctggacg
aagagcatcaggggctcgcgccagccgaactgttcgccaggctcaaggcgagcatgcccgacggcgaggatctcgt
cgtgacccatggcgatgcctgcttgccgaatatcatggtggaaaatggccgcttttctggattcatcgactgtggccggctg
ggtgtggcggaccgctatcaggacatagcgttggctacccgtgatattgctgaagagcttggcggcgaatgggctgacc
gcttcctcgtgctttacggtatcgccgctcccgattcgcagcgcatcgccttctatcgccttcttgacgagttcttctgaattatta
acgcttacaatttcctgatgcggtattttctccttacgcatctgtgcggtatttcacaccgcatacaggtggcacttttcgggga
aatgtgcgcggaacccctatttgtttatttttctaaatacattcaaatatgtatccgctcatgagacaataaccctgataaatgc
ttcaataatagcacgtgaggagggccaccatggccaagttgaccagtgccgttccggtgctcaccgcgcgcgacgtcg
ccggagcggtcgagttctggaccgaccggctcgggttctcccctagtaacggccgccagtgtgctggaattcaggcagtt
caacctgttgatagtacgtactaagctctcatgtttcacgtactaagctctcatgtttaacgtactaagctctcatgtttaacga
actaaaccctcatggctaacgtactaagctctcatggctaacgtactaagctctcatgtttcacgtactaagctctcatgtttg
aacaataaaattaatataaatcagcaacttaaatagcctctaaggttttaagttttataagaaaaaaaagaatatataagg
cttttaaagcttttaaggtttaacggttgtggacaacaagccagggatgtaacgcactgagaagcccttagagcctctcaa
agcaattttcagtgacacaggaacacttaacggctgacagcctgaattctgcagatatctgtttttccactcttcgttcactttc
gccaggtagctggtgaagacgaaggaagtcccggagccatctgcgcggcgtactacagcaatgttttgtgaaggcagtt
tcagacccggattcagtttggcgatggcttcatcatcccacttcttgattttgcccaggtagatgtcgccgagggttttaccatc
cagcaccagttcgccagacttcagccctggaatgttaaccgccagcaccacgccgccaatcacggtcgggaactgga
acagaccttcctgagccagtttttcgtcagacagcggcgcgtcagaggcaccaaaatcaacggtattagcgataatctgt
tttacgccaccggaagaaccgataccctggtagttaactttattaccggtttctttctggtaagtgtcagcccatttggcataca
ccggcgcagggaaggttgcacctgcacctgtcaggcttgcttctgcaaacacagagaaagcactcatcgataaggtcg
cggcgacaacagttgcgacggtggtacgcataactttcataatgtctcctgggaggattcataaagcattgtttgttggctac
gagaagcaaaataggacaaacaggtgacagttatatgtaaggaatatgacagttttatgacagagagataaagtcttca
gtctgatttaaataagcgttgatattcagtcaattacaaacattaataacg

Figure 108B

aagagatgacagaaaaattttcattctgtgacagagaaaaagtagccgaagatgacggtttgtcacatggagttggcag
gatgtttgattaaaagcaattaaccctcactaaagggcggccgcgaagttcctattctctagaaagtataggaacttcattct
accgggtaggggaggcgcttttcccaaggcagtctggagcatgcgctttagcagccccgctgggcacttggcgctacac
aagtggcctctggcctcgcacacattccacatccaccggtaggcgccaaccggctccgttctttggtggccccttcgcgcc
accttccactcctcccctagtcaggaagttcccccccgccccgcagctcgcgtcgtgcaggacgtgacaaatggaagta
gcacgtctcactagtctcgtgcagatggacagcaccgctgagcaatggaagcgggtaggcctttggggcagcggcca
atagcagctttgctccttcgctttctgggctcagaggctgggaaggggtgggtccgggggcgggctcaggggcgggctc
aggggcggggcgggcgcccgaaggtcctccggaggcccggcattctgcacgcttcaaaagcgcacgtctgccgcgct
gttctcctcttcctcatctccgggcctttcgacctgcagcagcacgtgttgacaattaatcatcggcatagtatatcggcatag
tataatacgacaaggtgaggaactaaaccatggagaaaaaaatcactggatataccaccgttgatatatcccaatggc
atcgtaaagaacattttgaggcatttcagtcagttgctcaatgtacctataaccagaccgttcagctggatattacggccttttt
aaagaccgtaaagaaaaataagcacaagttttatccggcctttattcacattcttgcccgcctgatgaatgctcatccgga
attccgtatggcaatgaaagacggtgagctggtgatatgggatagtgttcacccttgttacaccgttttccatgagcaaactg
aaacgttttcatcgctctggagtgaataccacgacgatttccggcagtttctacacatatattcgcaagatgtggcgtgttac
ggtgaaaacctggcctatttccctaaagggtttattgagaatatgtttttcgtctcagccaatccctgggtgagtttcaccagttt
tgatttaaacgtggccaatatggacaacttcttcgcccccgttttcaccatgggcaaatattatacgcaaggcgacaaggt
gctgatgccgctggcgattcaggttcatcatgccgtttgtgatggcttccatgtcggcagaatgcttaatgaattacaacagt
actgcgatgagtggcagggcggggcgtaagcgggactctggggttcgaataaagaccgaccaagcgacgtctgaga
gctccctggcgaattcggtaccaataaaagagctttatttttcatgatctgtgtgttggtttttgtgtgcggcgcggaagttcctatt
ctctagaaagtataggaacttcctcgagccctatagtgagtcgtattagcccttgacgatgccacatcctgagcaaataatt
caaccactaattgtgagcggataacacaaggaggaaacagctatgtcattaccgttcttaacttctgcaccgggaaaggt
tattatttttggtgaacactctgctgtgtacaacaagcctgccgtcgctgctagtgtgtctgcgttgagaacctacctgctaata
agcgagtcatctgcaccagatactattgaattggacttcccggacattagctttaatcataagtggtccatcaatgatttcaat
gccatcaccgaggatcaagtaaactcccaaaaattggccaaggctcaacaagccaccgatggcttgtctcaggaactc
gttagtcttttggatccgttgttagctcaactatccgaatccttccactaccatgcagcgttttgtttcctgtatatgtttgtttgcctat
gcccccatgccaagaatattaagttttctttaaagtctactttacccatcggtgctgggttgggctcaagcgcctctatttctgta
tcactggccttagctatggcctacttgggggggttaataggatctaatgacttggaaaagctgtcagaaaacgataagcat
atagtgaatcaatgggccttcataggtgaaaagtgtattcacggtacccccttcaggaatagataacgctgtggccacttatg
gtaatgccctgctatttgaaaaagactcacataatggaacaataaacacaaacaattttaagttcttagatgatttcccagc
cattccaatgatcctaacctatactagaattccaaggtctacaaaagatcttgttgctcgcgttcgtgtgttggtcaccgaga
aatttcctgaagttatgaagccaattctagatgccatgggtgaatgtgccctacaaggcttagagatcatgactaagttaag
taaatgtaaaggcaccgatgacgaggctgtagaaactaataatgaactgtatgaacaactattggaattgataagaata
aatcatggactgcttgtctcaatcggtgtttctcatcctggattagaacttattaaaaatctgagcgatgatttgagaattggct
ccacaaaacttaccggtgctggtggcggcggttgctctttgactttgttacgaagagacattactcaagagcaaattgaca
gcttcaaaaagaaattgcaagatgattttagttacgagacatttgaaacagacttgggtgggactggctgctgtttgttaagc
gcaaaaaatttgaataaagatcttaaaatcaaatccctagtattccaattatttgaaaataaaactaccacaaagcaaca
aattgacgatctattattgccaggaaacacgaatttaccatggacttcataagctaatttgcgataggcctgcacccttaag
gaggaaaaaaacatgtcagagttgagagccttcagtgccccagggaaagcgttactagctggtggatatttagttttagat
acaaaatatgaagcatttgtagtcggattatcggcaagaatgcatgctgtagcccatccttacggttcattgcaagggtctg
ataagtttgaagtgcgtgtgaaaagtaaacaatttaaagatggggagtggctgtaccatataagtcctaaaagtggcttca
ttcctgtttcgataggcggatctaagaacccttttcattgaaaaagttatcgctaacgtatttagctactttaaacctaacatgga
cgactactgcaatagaaacttgttcgttattgatattttctctgatgatgcctaccattctcaggaggatagcgttaccgaacat
cgtggcaacagaagattgagttttcattcgcacagaattgaagaagttcccaaaacagggctgggctcctcggcaggttt
agtcacagttttaactacagctttggcctccttttttgtatcggacctggaaaataatgtagacaaatatagagaagttattcat
aatttagcacaagttgctcattgtcaagctcagggtaaaattggaagcgggtttgatgtagcggcggcagcatatggatct
atcagatatagaagattcccacccgcattaatctctaatttgccagatattggaagtgctacttacggcagtaaactggcgc
atttggttgatgaagaagactggaatattacgattaaaagtaaccatttaccttc

Figure 108C

gggattaactttatggatgggcgatattaagaatggttcagaaacagtaaaactggtccagaaggtaaaaaatt
ggtatgattcgcatatgccagaaagcttgaaaatatatacagaactcgatcatgcaaattctagatttatggatgg
actatctaaactagatcgcttacacgagactcatgacgattacagcgatcagatatttgagtctcttgagaggaat
gactgtacctgtcaaaagtatcctgaaatcacagaagttagagatgcagttgccacaattagacgttcctttaga
aaaataactaaagaatctggtgccgatatcgaacctcccgtacaaactagcttattggatgattgccagacctta
aaaggagttcttacttgcttaatacctggtgctggtggttatgacgccattgcagtgattactaagcaagatgttgat
cttagggctcaaaccgctaatgacaaaagattttctaaggttcaatggctggatgtaactcaggctgactggggt
gttaggaaagaaaaagatccggaaacttatcttgataaataacttaaggtagctgcatgcagaattcgcccttaa
ggaggaaaaaaaaatgaccgtttacacagcatccgttaccgcacccgtcaacatcgcaacccttaagtattgg
gggaaaagggacacgaagttgaatctgcccaccaattcgtccatatcagtgactttatcgcaagatgacctcag
aacgttgacctctgcggctactgcacctgagtttgaacgcgacactttgtggttaaatggagaaccacacagcat
cgacaatgaaagaactcaaaattgtctgcgcgacctacgccaattaagaaaggaaatggaatcgaaggacg
cctcattgcccacattatctcaatggaaactccacattgtctccgaaaataactttcctacagcagctggtttagctt
cctccgctgctggctttgctgcattggtctctgcaattgctaagttataccaattaccacagtcaacttcagaaatatc
tagaatagcaagaaaggggtctggttcagcttgtagatcgttgtttggcggatacgtggcctgggaaatgggaa
aagctgaagatggtcatgattccatggcagtacaaatcgcagacagctctgactggcctcagatgaaagcttgt
gtcctagttgtcagcgatattaaaaaggatgtgagttccactcagggtatgcaattgaccgtggcaacctccgaa
ctatttaaagaaagaattgaacatgtcgtaccaaagagatttgaagtcatgcgtaaagccattgttgaaaaagat
ttcgccacctttgcaaaggaaacaatgatggattccaactctttccatgccacatgtttggactctttccctccaatat
tctacatgaatgacacttccaagcgtatcatcagttggtgccacaccattaatcagttttacggagaaacaatcgtt
gcatacacgtttgatgcaggtccaaatgctgtgttgtactacttagctgaaaatgagtcgaaactctttgcatttatct
ataaattgtttggctctgttcctggatgggacaagaaatttactactgagcagcttgaggctttcaaccatcaatttg
aatcatctaactttactgcacgtgaattggatcttgagttgcaaaaggatgttgccagagtgattttaactcaagtcg
gttcaggcccacaagaaacaaacgaatctttgattgacgcaaagactggtctaccaaaggaataagatcaatt
cgctgcatcgcccttaggaggtaaaaaaaaatgactgccgacaacaatagtatgccccatggtgcagtatcta
gttacgccaaattagtgcaaaaccaaacacctgaagacattttggaagagtttcctgaaattattccattacaaca
aagacctaatacccgatctagtgagacgtcaaatgacgaaagcggagaaacatgtttttctggtcatgatgagg
agcaaattaagttaatgaatgaaaattgtattgttttggattgggacgataatgctattggtgccggtaccaagaaa
gtttgtcatttaatggaaaatattgaaaagggtttactacatcgtgcattctccgtctttattttcaatgaacaaggtga
attacttttacaacaaagagccactgaaaaaataactttccctgatctttggactaacacatgctgctctcatccact
atgtattgatgacgaattaggtttgaagggtaagctagacgataagattaagggcgctattactgcggcggtgag
aaaactagatcatgaattaggtattccagaagatgaaactaagacaaggggtaagtttcacttttaaacagaat
ccattacatggcaccaagcaatgaaccatggggtgaacatgaaattgattacatcctattttataagatcaacgct
aaagaaaacttgactgtcaacccaaacgtcaatgaagttagagacttcaaatgggtttcaccaaatgatttgaa
aactatgtttgctgacccaagttacaagtttacgccttggtttaagattatttgcgagaattacttattcaactggtggg
agcaattagatgacctttctgaagtggaaaatgacaggcaaattcatagaatgctataacaacgcgtctacaaa
taaaaaaggcacgtcagatgacgtgccttttttcttggggcc

(SEQ ID NO:25)

Figure 109

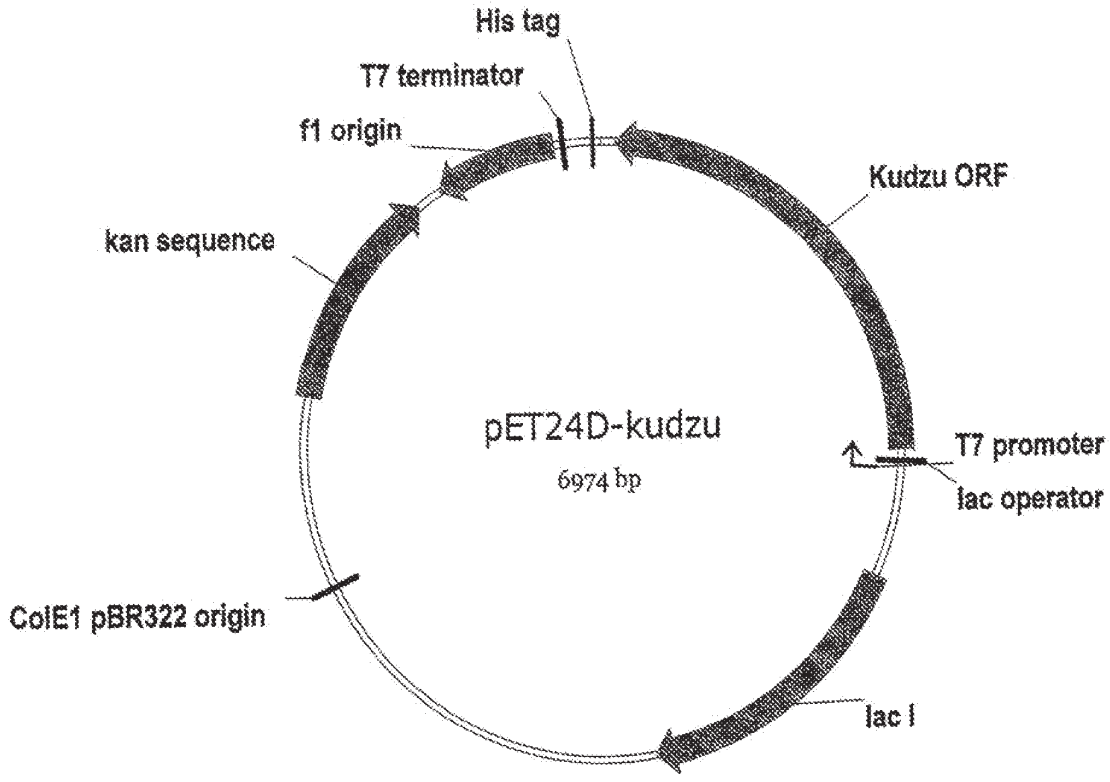

His tag
T7 terminator
f1 origin
Kudzu ORF
kan sequence
pET24D-kudzu
6974 bp
T7 promoter
lac operator
ColE1 pBR322 origin
lac I

Figure 110A

1-

gtgcggccgcaagcttgtcgacggagctcgaattcggatccctgcagttagacatacatcagctggttaatcgggaaagg
gtcaatcagcagcagtttgatgcggttttcagtcgcgtagtctgggcgacccagaccatcgccatactggtaggtgcagtg
ggaaacacgtgccatgttaactgcgatttccatgaacgctttaggcagcagggtggagtcgctaacgcgttcacgattcat
ctttttccattcggcgtcgatcagtttacgcagttcttcgcgggcctgttcctcgctggtaccatcgttttcgtgcatgtagctaatg
atagaattggtagtctcgccacgttccagctccgccgcagaggtggccagatcgttgcacaggcggaagataacgcagc
tagaacgcaccagaccatggaagtcggtcagggaacgcagcgcgtggtcggagatgtcttcctgctgctggcatacgg
aaaagtaagacggcgccagcagcgctacaccggaggaggaaacgctggcgttttccaggtacttggagaaagccgg
gataattttgttgttggaccatttcgcctcttgcagaaaggctttgcacagttcacgccagcttttcgtcagataggacaggttgt
tatgacctttctctttcagaatagaataggacgtgtcgttaacggtgttgtacagtgccaggaaacacagtttcatatagtccg
gcagggtgttaatagcgttaacgtcccagcgctctacagcatcggtgaacagttgcagttcgtccagagtgccataaacgt
catacacgtcatcgatgatcgtcaccagaccaaacattttagtaacagctttgcgacattcaccaaactgcgggtctggcg
ccatacccagtgcccagaaataaacttccatcaggcggtcgcgtacaaaatccagtttgctagccaggcccatctcggtc
caccagcgggacagatcttgcagctctttctggtgcagggtctgtaccatgttaaaatccagcttcgccagctccagcagc
agctggtgatgcggttctttcggttcgtatttatccaggaaccaacgtgcctccagacggtgcagacgctggtgatatggca
gttccagggcgtggctcacttgttctgcaaccttggtattaatgccttctttcaggttgttcttcaggtgggtgatggaaaaggta
cgcgcctcctccagcaggttctcaccctcgaaacccaggtaagacgcttcatacaggctcagcaggccttggacgtcac
ctttcagttcaccgctgaaaccaccttctttatccttgaaacgctcaaaaacatcctgagaaacctcgaaaccgtgctgacg
cagcagacggaaagacagagcggttgcgtgcaggtcagatttgttctttttgttttcgtccagcagtacgatgttttccagggc
tttaatgatgtctttttcaaatttgtaggtcagacccaggcgctgcacatcgtcgatcagctccagcagggacagcggctgg
gtgtctacacggttgatcatgcagcgaacttcttcctccagtttggtcgctttctcctccagcttttccactttcaggtcgttctcca
gggattgcaggaattcgaaattccacaggtttggctgatagtttgcggaacgacgggaattatgctcggtaatctgagtaaa
ttgagaagaggtcgcacacatggtatatctccttcttaaagttaaacaaaattatttctagaggggaattgttatccgctcaca
attcccctatagtgagtcgtattaatttcgcgggatcgagatctcgatcctctacgccggacgcatcgtggccggcatcacc
ggcgccacaggtgcggttgctggcgcctatatcgccgacatcaccgatggggaagatcgggctcgccacttcgggctca
tgagcgcttgtttcggcgtgggtatggtggcaggccccgtggccgggggactgttgggcgccatctccttgcatgcaccatt
ccttgcggcggcggtgctcaacggcctcaacctactactgggctgcttcctaatgcaggagtcgcataagggagagcgtc
gagatcccggacaccatcgaatggcgcaaaaccctttcgcggtatggcatgatagcgcccggaagagagtcaattcagg
gtggtgaatgtgaaaccagtaacgttatacgatgtcgcagagtatgccggtgtctcttatcagaccgtttcccgcgtggtgaa
ccaggccagccacgtttctgcgaaaacgcgggaaaaagtggaagcggcgatggcggagctgaattacattcccaacc
gcgtggcacaacaactggcgggcaaacagtcgttgctgattggcgttgccacctccagtctggccctgcacgcgccgtcg
caaattgtcgcggcgattaaatctcgcgccgatcaactgggtgccagcgtggtggtgtcgatggtagaacgaagcggcgt
cgaagcctgtaaagcggcggtgcacaatcttctcgcgcaacgcgtcagtgggctgatcattaactatccgctggatgacc
aggatgccattgctgtggaagctgcctgcactaatgttccggcgttatttcttgatgtctctgaccagacacccatcaacagta
ttattttctcccatgaagacggtacgcgactgggcgtggagcatctggtcgcattgggtcaccagcaaatcgcgctgttagc
gggcccattaagttctgtctcggcgcgtctgcgtctggctggctggcataaatatctcactcgcaatcaaattcagccgatag
cggaacgggaaggcgactggagtgccatgtccggttttcaacaaaccatgcaaatgctgaatgagggcatcgttcccac
tgcgatgctggttgccaacgatcagatggcgctgggcgcaatgcgcgccattaccgagtccgggctgcgcgttggtgcgg
atatctcggtagtgggatacgacgataccgaagacagctcatgttatatcccgccgttaaccaccatcaaacaggattttc
gcctgctggggcaaaccagcgtggaccgcttgctgcaactctctcagggccaggcggtgaagggcaatcagctgttgcc
cgtctcactggtgaaaagaaaaaccaccctggcgcccaatacgcaaaccgcctctccccgcgcgttggccgattcatta
atgcagctggcacgacaggtttcccgactggaaagcgggcagtgagcgcaacgcaattaatgtaagttagctcactcatt
aggcaccgggatctcgaccgatgcccttgagagccttcaacccagtcagctccttccggtgggcgcggggcatgactatc
gtcgccgcacttatgactgtcttctttatcatgcaactcgtaggacaggtgccggcagcgctctgggtcattttcggcgagga
ccgctttcgctggagcgcgacgatgatcggcctgtcgcttgcggtattcggaatcttgcacgccctcgctcaagccttcgtca
ctggtcccgccaccaaacgtttcggcgagaagcaggccattatcgccggcatggcggccccacgggtgcgcatgatcgt
gctcctg

Figure 110B

tcgttgaggacccggctaggctggcggggttgccttactggttagcagaatgaatcaccgatacgcgagcgaacgtg
aagcgactgctgctgcaaaacgtctgcgacctgagcaacaacatgaatggtcttcggtttccgtgtttcgtaaagtctg
gaaacgcggaagtcagcgccctgcaccattatgttccggatctgcatcgcaggatgctgctggctaccctgtggaac
acctacatctgtattaacgaagcgctggcattgaccctgagtgatttttctctggtcccgccgcatccataccgccagttg
tttaccctcacaacgttccagtaaccgggcatgttcatcatcagtaacccgtatcgtgagcatcctctctcgtttcatcggt
atcattacccccatgaacagaaatcccccttacacggaggcatcagtgaccaaacaggaaaaaaccgcccttaac
atggcccgctttatcagaagccagacattaacgcttctggagaaactcaacgagctggacgcggatgaacaggca
gacatctgtgaatcgcttcacgaccacgctgatgagctttaccgcagctgcctcgcgcgtttcggtgatgacggtgaaa
acctctgacacatgcagctcccggagacggtcacagcttgtctgtaagcggatgccgggagcagacaagcccgtc
agggcgcgtcagcgggtgttggcgggtgtcggggcgcagccatgacccagtcacgtagcgatagcggagtgtata
ctggcttaactatgcggcatcagagcagattgtactgagagtgcaccatatatgcggtgtgaaataccgcacagatgc
gtaaggagaaaataccgcatcaggcgctcttccgcttcctcgctcactgactcgctgcgctcggtcgttcggctgcggc
gagcggtatcagctcactcaaaggcggtaatacggttatccacagaatcaggggataacgcaggaaagaacatgt
gagcaaaaggccagcaaaaggccaggaaccgtaaaaaggccgcgttgctggcgtttttccataggctccgccccc
ctgacgagcatcacaaaaatcgacgctcaagtcagaggtggcgaaacccgacaggactataaagataccaggc
gtttcccccctggaagctccctcgtgcgctctcctgttccgaccctgccgcttaccggatacctgtccgcctttctcccttcgg
gaagcgtggcgctttctatagctcacgctgtaggtatctcagttcggtgtaggtcgttcgctccaagctgggctgtgtgc
acgaaccccccgttcagcccgaccgctgcgccttatccggtaactatcgtcttgagtccaacccggtaagacacgac
ttatcgccactggcagcagccactggtaacaggattagcagagcgaggtatgtaggcggtgctacagagttcttgaa
gtggtggcctaactacggctacactagaaggacagtatttggtatctgcgctctgctgaagccagttaccttcggaaaa
agagttggtagctcttgatccggcaaacaaaccaccgctggtagcggtggtttttttgtttgcaagcagcagattacgcg
cagaaaaaaaggatctcaagaagatcctttgatcttttctacggggtctgacgctcagtggaacgaaaactcacgtta
agggattttggtcatgaacaataaaactgtctgcttacataaacagtaatacaaggggtgttatgagccatattcaacg
ggaaacgtcttgctctaggccgcgattaaattccaacatggatgctgatttatatgggtataaatgggctcgcgataatg
tcgggcaatcaggtgcgacaatctatcgattgtatgggaagcccgatgcgccagagttgtttctgaaacatggcaaag
gtagcgttgccaatgatgttacagatgagatggtcagactaaactggctgacggaatttatgcctcttccgaccatcaa
gcattttatccgtactcctgatgatgcatggttactcaccactgcgatccccgggaaaacagcattccaggtattagaag
aatatcctgattcaggtgaaaatattgttgatgcgctggcagtgttcctgcgccggttgcattcgattcctgtttgtaattgtc
cttttaacagcgatcgcgtatttcgtctcgctcaggcgcaatcacgaatgaataacggtttggttgatgcgagtgattttga
tgacgagcgtaatggctggcctgttgaacaagtctggaaagaaatgcataaacttttgccattctcaccggattcagtc
gtcactcatggtgatttctcacttgataaccttatttttgacgaggggaaattaataggttgtattgatgttggacgagtcgg
aatcgcagaccgataccaggatcttgccatcctatggaactgcctcggtgagttttctccttcattacagaaacggcttttt
caaaaatatggtattgataatcctgatatgaataaattgcagtttcatttgatgctcgatgagtttttctaagaattaattcat
gagcggatacatatttgaatgtatttagaaaaataaacaaatagggttccgcgcacatttccccgaaaagtgccacc
tgaaattgtaaacgttaatattttgttaaaattcgcgttaaatttttgttaaatcagctcatttttaaccaataggccgaaatc
ggcaaaatcccttataaatcaaaagaatagaccgagatagggttgagtgttgttccagtttggaacaagagtccacta
ttaaagaacgtggactccaacgtcaaagggcgaaaaaccgtctatcagggcgatggcccactacgtgaaccatca
ccctaatcaagtttttttggggtcgaggtgccgtaaagcactaaatcggaaccctaaagggagcccccgatttagagct
tgacggggaaagccggcgaacgtggcgagaaaggaagggaagaaagcgaaaggagcgggcgctagggcg
ctggcaagtgtagcggtcacgctgcgcgtaaccaccacacccgccgcgcttaatgcgccgctacagggcgcgtcc
cattcgccaatccggatatagttcctcctttcagcaaaaaaccccctcaagacccgtttagaggccccaaggggttatg
ctagttattgctcagcggtggcagcagccaactcagcttcctttcgggctttgttagcagccggatctcagtggtggtggt
ggtggtgctcga

(SEQ ID NO:26)

Figure 111A

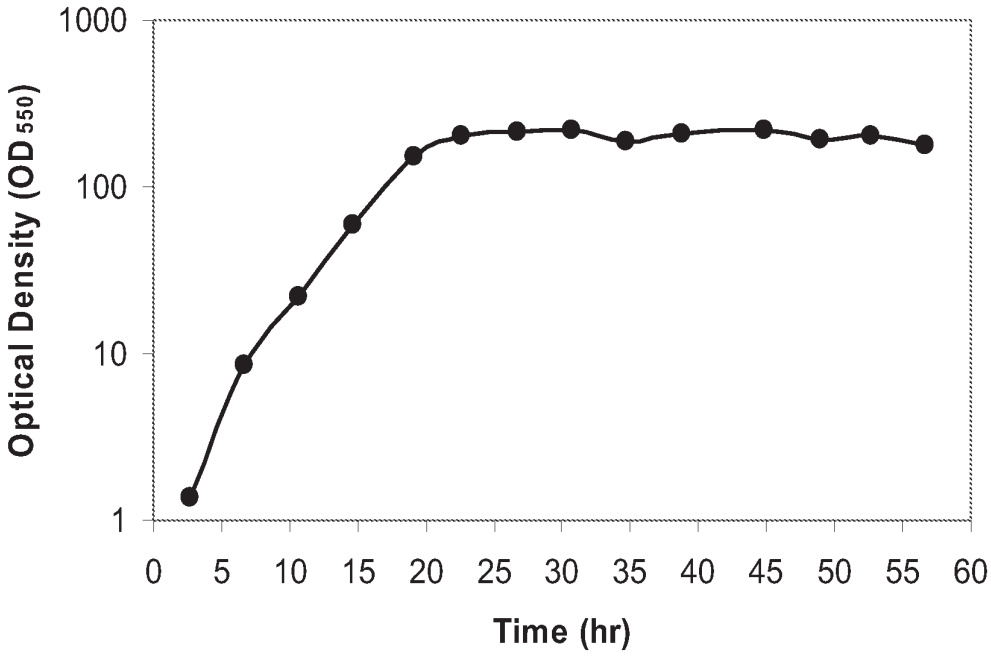

1000
100
10
1
Optical Density (OD 550)
0
5
10
15
20
25
30
35
40
45
50
55
60
Time (hr)

Figure 111B

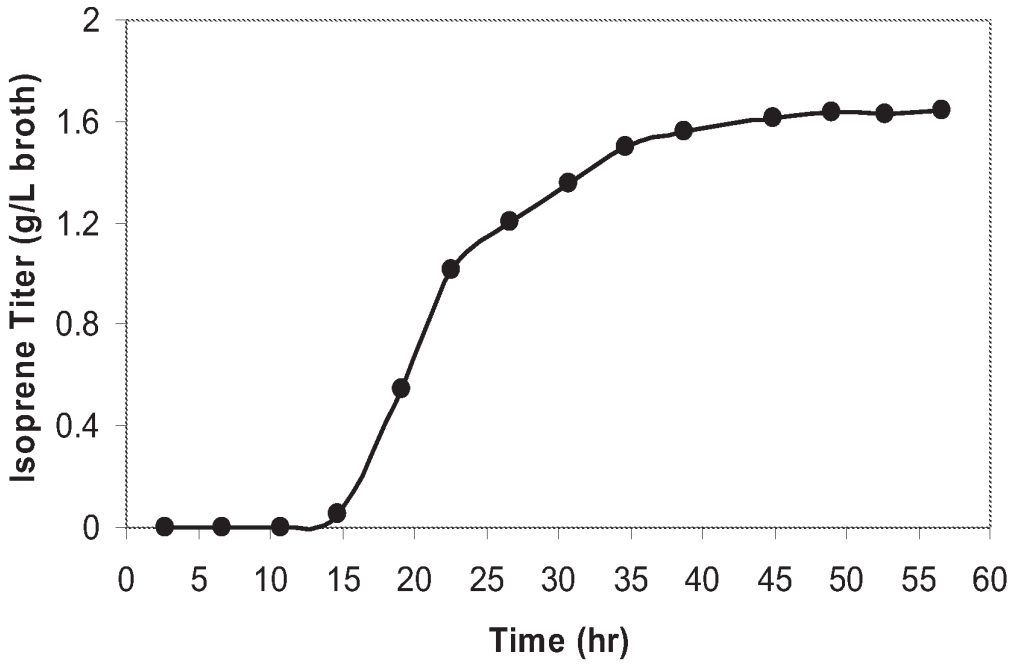
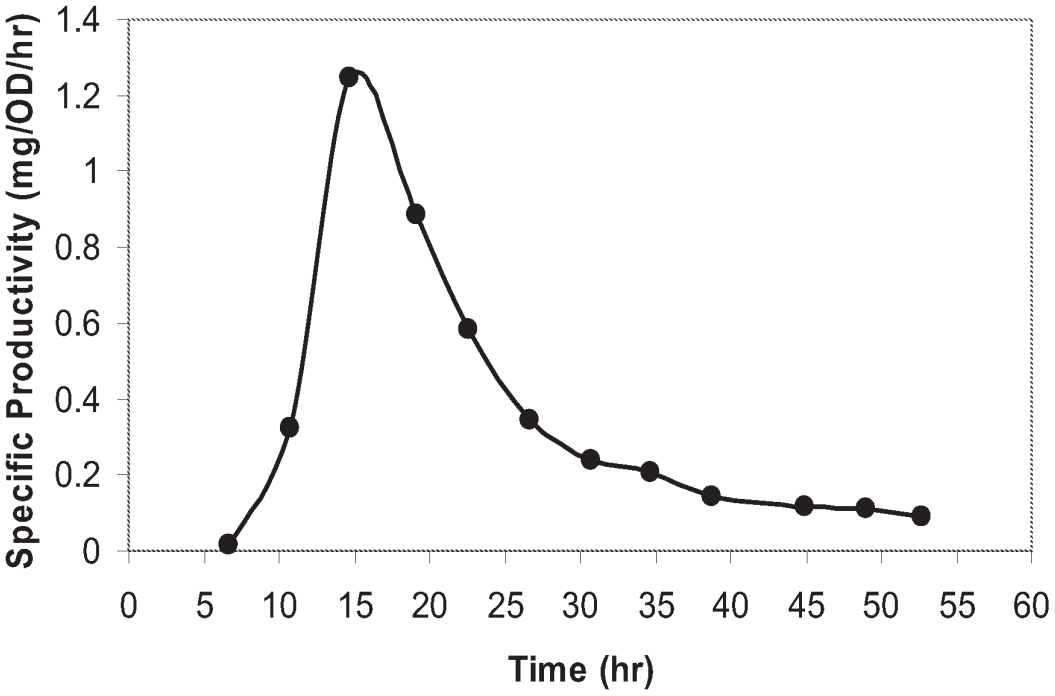

Isoprene Titer (g/L broth)
2
1.6
1.2
0.8
0.4
0
0 5 10 15 20 25 30 35 40 45 50 55 60
Time (hr)

Figure 111C


Specific Productivity (mg/OD/hr)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0 5 10 15 20 25 30 35 40 45 50 55 60
Time (hr)

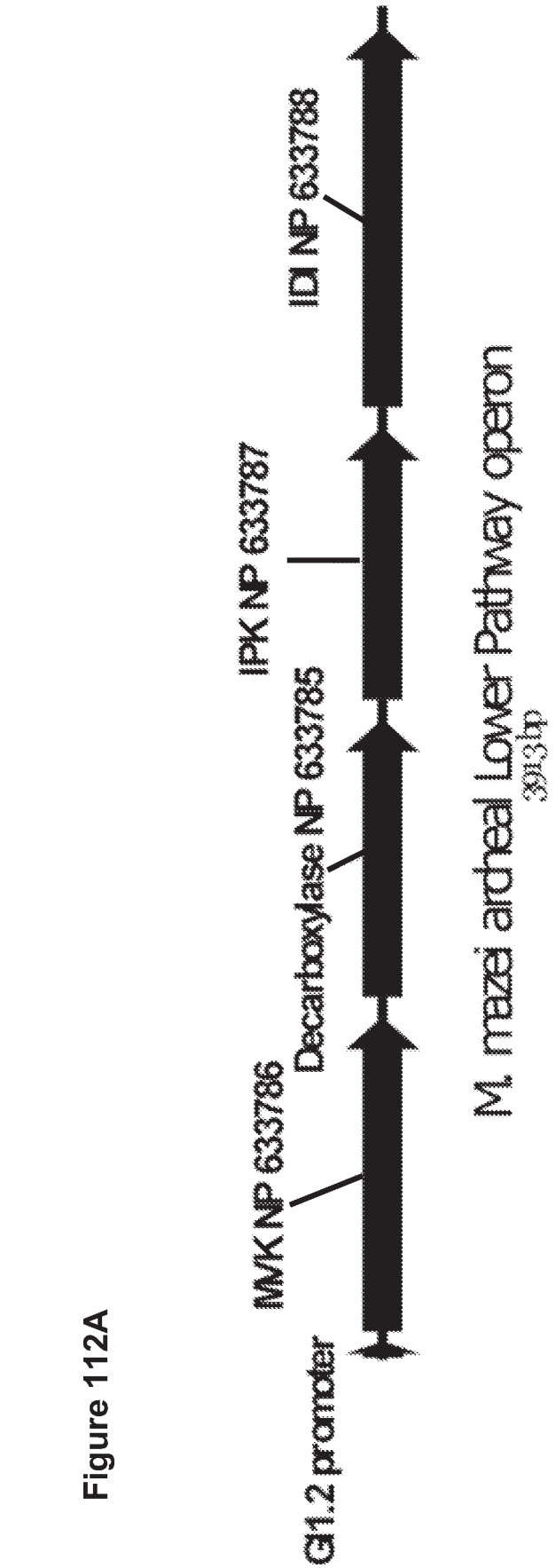

G1.2 promoter
MVK NP 633786
Decarboxylase NP 633785
IPK NP 633787
IDI NP 633788
M. mazei archeal Lower Pathway operon
3913bp

Figure 112A

Figure 112B

gcggccgcgcccttgacgatgccacatcctgagcaaataattcaaccactaattgtgagcggataacacaaggagga
aacagccatggtatcctgttctgcgccgggtaagatttacctgttcggtgaacacgccgtagtttatggcgaaactgcaatt
gcgtgtgcggtggaactgcgtacccgtgttcgcgcggaactcaatgactctatcactattcagagccagatcggccgca
ccggtctggatttcgaaaagcacccttatgtgtctgcggtaattgagaaaatgcgcaaatctattcctattaacggtgttttctt
gaccgtcgattccgacatcccggtgggctccggtctgggtagcagcgcagccgttactatcgcgtctattggtgcgctga
acgagctgttcggctttggcctcagcctgcaagaaatcgctaaactgggccacgaaatcgaaattaaagtacagggtg
ccgcgtccccaaccgatacgtatgtttctaccttcggcggcgtggttaccatcccggaacgtcgcaaactgaaaactccg
gactgcggcattgtgattggcgataccggcgttttctcctccaccaaagagttagtagctaacgtacgtcagctgcgcgaa
agctacccggatttgatcgaaccgctgatgacctctattggcaaaatctctcgtatcggcgaacaactggttctgtctggcg
actacgcatccatcggccgcctgatgaacgtcaaccagggtctcctggacgccctgggcgttaacatcttagaactgag
ccagctgatctattccgctcgtgcggcaggtgcgtttggcgctaaaatcacgggcgctggcggcggtggctgtatggttgc
gctgaccgctccggaaaaatgcaaccaagtggcagaagcggtagcaggcgctggcggtaaagtgactatcactaaa
ccgaccgagcaaggtctgaaagtagattaagccttgacttaatagctgcttatttcgcccttatggtacctagtaggagga
aaaaaacatggaaatgcgtcaaccggctgtcgcaggtcaattctacccactgcgttgcgagaacctggaaaacgaac
tgaaacgctgcttcgaaggcctggagatccgcgaacaagaagtgctgggcgcagtctgtccgcacgccggttatatgt
actctggcaaagttgcggcgcacgtctatgccactctgccggaagctgatacctacgtaatcttcggcccgaaccacac
cggctacggtagccctgtctctgtgagccgtgaaacttggaagaccccgttgggcaatatcgatgttgacctggaactgg
cggacggcttcctgggttccatcgtagatgcggatgaactcggtcacaaatacgaacactctatcgaagttcagctgccg
tttctgcaataccgttttgaacgcgatttcaaaattctgccaatctgcatgggtatgcaagacgaagaaaccgcggtcgaa
gtaggtaacctgctggcggatctgatcagcgagtccggtaaacgtgctgtgatcatcgcaagctctgatttcacccactat
gagacggctgaacgtgccaaagaaatcgattccgaagttattgattctatcctgaactttgacatctctggcatgtacgatc
gcctgtatcgccgtaacgcctctgtttgcggttacggcccgatcaccgctatgctgacggcaagcaaaaagctgggcgg
ctctcgtgcgactttgctgaaatacgcaaacagcggtgacgtgtccggtgataaagacgctgtggtgggctacgccgcc
atcatcgttgagtaagctgattaaaggttgaacagataggatttcgtcatggatcctacaaggaggaaaaaaacatgaa
tgcttctaatgaaccggtgattctgaaactgggtggctctgctattaccgacaaaggtgcctacgaaggcgtagttaagga
agctgatttgctgcgcatcgcacaggaagttagcggtttccgtggcaagatgatcgtggttcatggtgctggtagcttcggc
catacgtacgcgaagaaatacggcctggaccgtaccttcgacccagagggcgcaattgttactcatgaatctgttaaaa
agctcgcctccaaagttgtaggtgctctgaatagcttcggcgtgcgtgctatcgcggtgcatcctatggactgcgcagtatg
ccgtaacggtcgtatcgaaacgatgtatctggactccatcaagttaatgctggaaaaaggtctggtgccggttctgcacg
gcgacgtcgcaatggatattgaactgggcacttgtatcctgtccggtgatcaaatcgttccttacctggccaaagaactgg
gtatctcccgcctcggcctgggcagcgcagaggatggtgtgctggatatggagggcaaacctgtaccggaaatcaccc
cagaaactttcgaagagttccgccactgcatcggtggttctggttctactgatgtaaccggtggcatgctgggcaaagtgc
tggaacttctggaattgagcaaaaattcttccattactagctacattttcaacgctggtaaagcagacaacatctaccgcttt
ctgaatggtgagtccatcggcactcgcatcagcccggacaagcgtgtttaagctagttattaacctaaatgctctaaacca
gttatgagctctacaaggaggaaaaaaacatgattaacactaccagccgccgcaaaattgaacacctgaaactctgc
gcagaatccccggttgaagcgcgtcaggtatctgccggctttgaagacgttactctgatccaccgcgctttaccggagct
gaacatggatgaactggacctcagcgttgatttcctgggtaaacgcatcaaagcgccgttcctgattgcgtctatcacgg
gtggtcacccagataccatcccggttaacgctgcgctggcagctgctgctgaggagctgggtgttggcatcggcgttggc
tctcagcgcgcggccattgatgatccgagccaggaagacagcttccgtgtagtgcgtgatgaagccccagatgcgtttg
tttatggcaacgtcggcgcagcacagatccgtcagtatggtgttgaaggtgttgaaaaactgatcgaaatgattgacgca
gatgccttggcaatccacctgaactttctgcaagaagcggtccaaccggaaggtgaccgcgacgcgaccggttgcctg
gacatgattaccgaaatttgctctcagattaaaactccggtaatcgtgaaagaaaccggtgcaggcattagccgtgaag
atgcgattctgttccagaaagctggcgtgagcgcaatcgacgttggcggcgcgggcggcacctcctgggctggcgtcg
aggtctaccgtgctaaagaaagccgtgactctgttagcgagcgtttaggtgagctgttttgggatttcggcattccgacggt
agcttctctgattgaatcccgcgtttccttgccgctgatcgcaaccggcggtatccgtaacggtctggacattgctaaaagc
attgctctcggcgcaagcgctgccagcgccgctctgccgttcgttggtccgtccctggagggcaaagaatccgttgtacgt
gtgctgagctgcatgctggaagaatttaaagcagcaatgtttttgtgcggttgcggcaacatcaaaga

Figure 112C

cctgcacaactctccagtagtggtaactggttggacccgcgaatacctggagcagcgcggttttaacgttaa
ggacctctccctgccgggcaacgctctgtaagcttcaacgcgtctacaaataaaaaaggcacgtcagatga
cgtgccttttttcttgtctaga

(SEQ ID NO:27)

Figure 113A

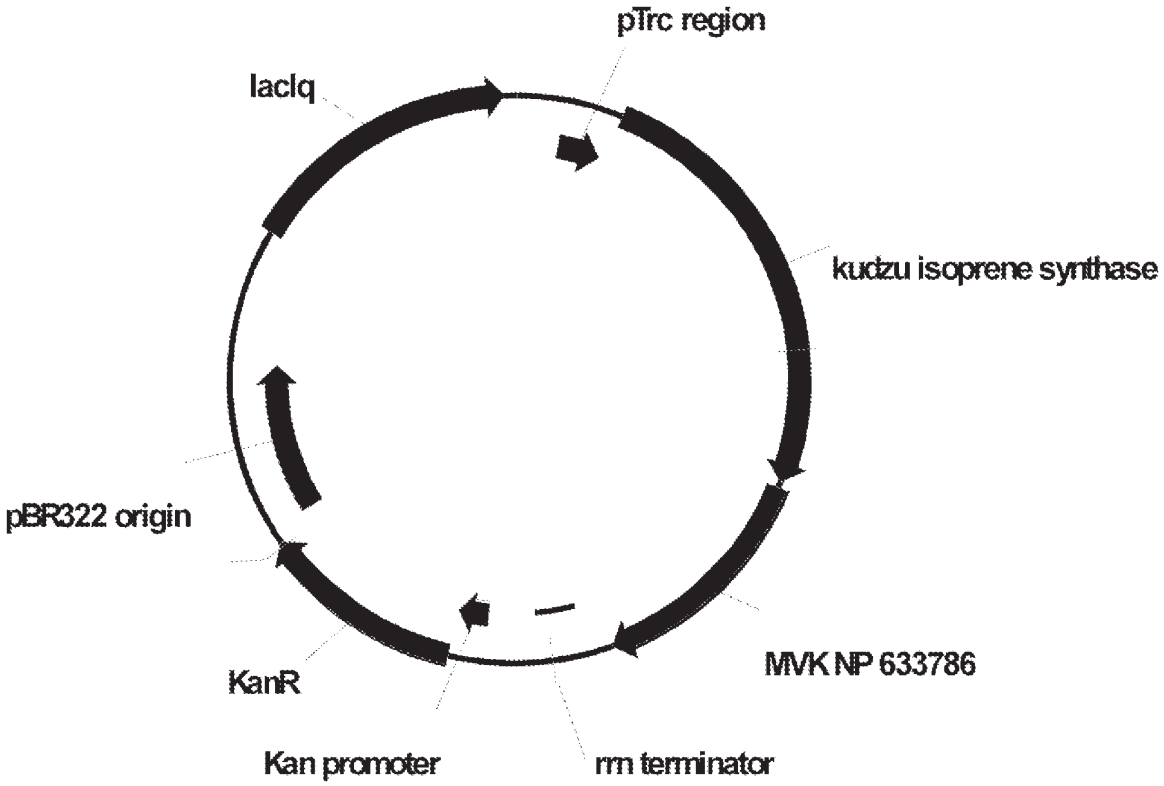

pTrc region
lacIq
kudzu isoprene synthase
pBR322 origin
MVK NP 633786
KanR
Kan promoter
rrn terminator
MCM382 - pTrcKudzuMVK(mazei)
6848 bp

Figure 113B

gtttgacagcttatcatcgactgcacggtgcaccaatgcttctggcgtcaggcagccatcggaagctgtggtatggctgtgc
aggtcgtaaatcactgcataattcgtgtcgctcaaggcgcactcccgttctggataatgttttttgcgccgacatcataacggt
tctggcaaatattctgaaatgagctgttgacaattaatcatccggctcgtataatgtgtggaattgtgagcggataacaatttc
acacaggaaacagcgccgctgagaaaaagcgaagcggcactgctctttaacaatttatcagacaatctgtgtgggcac
tcgaccggaattatcgattaactttattattaaaaattaaagaggtatatattaatgtatcgattaaataaggaggaataaac
catgtgtgcgacctcttctcaatttactcagattaccgagcataattcccgtcgttccgcaaactatcagccaaacctgtgga
atttcgaattcctgcaatccctggagaacgacctgaaagtggaaaagctggaggagaaagcgaccaaactggagga
agaagttcgctgcatgatcaaccgtgtagacacccagccgctgtccctgctggagctgatcgacgatgtgcagcgcctg
ggtctgacctacaaatttgaaaaagacatcattaaagccctggaaaacatcgtactgctggacgaaaacaaaaagaa
caaatctgacctgcacgcaaccgctctgtctttccgtctgctgcgtcagcacggtttcgaggtttctcaggatgtttttgagcgt
ttcaaggataaagaaggtggtttcagcggtgaactgaaaggtgacgtccaaggcctgctgagcctgtatgaagcgtctta
cctgggtttcgagggtgagaacctgctggaggaggcgcgtacctttccatcacccacctgaagaacaacctgaaaga
aggcattaataccaaggttgcagaacaagtgagccacgccctggaactgccatatcaccagcgtctgcaccgtctgga
ggcacgttggttcctggataaatacgaaccgaaagaaccgcatcaccagctgctgctggagctggcgaagctggatttt
aacatggtacagaccctgcaccagaaagagctgcaagatctgtcccgctggtggaccgagatgggcctggctagcaa
actggattttgtacgcgaccgcctgatggaagtttatttctgggcactgggtatggcgccagacccgcagtttggtgaatgtc
gcaaagctgttactaaaatgtttggtctggtgacgatcatcgatgacgtgtatgacgtttatggcactctggacgaactgca
actgttcaccgatgctgtagagcgctgggacgttaacgctattaacaccctgccggactatatgaaactgtgtttcctggca
ctgtacaacaccgttaacgacacgtcctattctattctgaaagagaaaggtcataacaacctgtcctatctgacgaaaag
ctggcgtgaactgtgcaaagcctttctgcaagaggcgaaatggtccaacaacaaaattatcccggctttctccaagtacct
ggaaaacgccagcgtttcctcctccggtgtagcgctgctggcgccgtcttacttttccgtatgccagcagcaggaagacat
ctccgaccacgcgctgcgttccctgaccgacttccatggtctggtgcgttctagctgcgttatcttccgcctgtgcaacgatct
ggccacctctgcggcggagctggaacgtggcgagactaccaattctatcattagctacatgcacgaaaacgatggtacc
agcgaggaacaggcccgcgaagaactgcgtaaactgatcgacgccgaatggaaaaagatgaatcgtgaacgcgtt
agcgactccaccctgctgcctaaagcgttcatggaaatcgcagttaacatggcacgtgtttcccactgcacctaccagtat
ggcgatggtctgggtcgcccagactacgcgactgaaaaccgcatcaaactgctgctgattgacccttccgattaacca
gctgatgtatgtctaactgcataaaggaggtaaaaaaacatggtatcctgttctgcgccgggtaagatttacctgttcggtg
aacacgccgtagtttatggcgaaactgcaattgcgtgtgcggtggaactgcgtacccgtgttcgcgcggaactcaatgac
tctatcactattcagagccagatcggccgcaccggtctggatttcgaaaagcaccttatgtgtctgcggtaattgagaaa
atgcgcaaatctattcctattaacggtgttttcttgaccgtcgattccgacatcccggtgggctccggtctgggtagcagcgc
agccgttactatcgcgtctattggtgcgctgaacgagctgttcggctttggcctcagcctgcaagaaatcgctaaactgggc
cacgaaatcgaaattaaagtacagggtgccgcgtccccaaccgatacgtatgtttctaccttcggcggcgtggttaccatc
ccggaacgtcgcaaactgaaaactccggactgcggcattgtgattggcgataccggcgttttctcctccaccaaagagtt
agtagctaacgtacgtcagctgcgcgaaagctacccggatttgatcgaaccgctgatgacctctattggcaaaatctctcg
tatcggcgaacaactggttctgtctggcgactacgcatccatcggccgcctgatgaacgtcaaccagggtctcctggacg
ccctgggcgttaacatcttagaactgagccagctgatctattccgctcgtgcggcaggtgcgtttggcgctaaaatcacgg
gcgctggcggcggtggctgtatggttgcgctgaccgctccggaaaaatgcaaccaagtggcagaagcggtagcaggc
gctggcggtaaagtgactatcactaaaccgaccgagcaaggtctgaaagtagattaaagtctagttaaagtttaaacggt
ctccagcttggctgttttggcggatgagagaagattttcagcctgatacagattaaatcagaacgcagaagcggtctgata
aaacagaatttgcctggcggcagtagcgcggtggtcccacctgaccccatgccgaactcagaagtgaaacgccgtag
cgccgatggtagtgtggggtctccccatgcgagagtagggaactgccaggcatcaaataaaacgaaaggctcagtcg
aaagactgggcctttcgttttatctgttgtttgtcggtgaacgctctcctgagtaggacaaatccgccgggagcggatttgaa
cgttgcgaagcaacggcccggagggtggcgggcaggacgcccgccataaactgccaggcatcaaattaagcagaa
ggccatcctgacggatggccttttgcgtttctacaaactcttttgtttatttttctaaatacattcaaatatgtatccgcttaaccg
gaattgccagctggggcgccctctggtaaggttgggaagccctgcaaagtaaactggatggctttctcgccgccaagga
tctgatggcgcaggggatcaagctctgatcaagagacaggatgaggatcgtttcgcatgattgaacaagatggattgca
cgcaggttctccggccgcttgggtggagaggctattcggctatgactgggcacaa

Figure 113C

cagacaatcggctgctctgatgccgccgtgttccggctgtcagcgcaggggcgcccggttctttttgtcaagaccga
cctgtccggtgccctgaatgaactgcaagacgaggcagcgcggctatcgtggctggccacgacgggcgttccttg
cgcagctgtgctcgacgttgtcactgaagcgggaagggactggctgctattgggcgaagtgccggggcaggatct
cctgtcatctcaccttgctcctgccgagaaagtatccatcatggctgatgcaatgcggcggctgcatacgcttgatcc
ggctacctgcccattcgaccaccaagcgaaacatcgcatcgagcgagcacgtactcggatggaagccggtcttgt
cgatcaggatgatctggacgaagagcatcaggggctcgcgccagccgaactgttcgccaggctcaaggcgagc
atgcccgacggcgaggatctcgtcgtgacccatggcgatgcctgcttgccgaatatcatggtggaaaatggccgctt
ttctggattcatcgactgtggccggctgggtgtggcggaccgctatcaggacatagcgttggctacccgtgatattgct
gaagagcttggcggcgaatgggctgaccgcttcctcgtgctttacggtatcgccgctcccgattcgcagcgcatcgc
cttctatcgccttcttgacgagttcttctgacgcatgaccaaaatcccttaacgtgagttttcgttccactgagcgtcaga
ccccgtagaaaagatcaaaggatcttcttgagatccttttttttctgcgcgtaatctgctgcttgcaaacaaaaaaacca
ccgctaccagcggtggtttgtttgccggatcaagagctaccaactctttttccgaaggtaactggcttcagcagagcg
cagataccaaatactgtccttctagtgtagccgtagttaggccaccacttcaagaactctgtagcaccgcctacatac
ctcgctctgctaatcctgttaccagtggctgctgccagtggcgataagtcgtgtcttaccgggttggactcaagacgat
agttaccggataaggcgcagcggtcgggctgaacgggggttcgtgcacacagcccagcttggagcgaacgac
ctacaccgaactgagatacctacagcgtgagctatgagaaagcgccacgcttcccgaagggagaaaggcgga
caggtatccggtaagcggcagggtcggaacaggagagcgcacgagggagcttccagggggaaacgcctggt
atctttatagtcctgtcgggtttcgccacctctgacttgagcgtcgatttttgtgatgctcgtcaggggggcggagcctat
ggaaaaacgccagcaacgcggccttttacggttcctggccttttgctggccttttgctcacatgttctttcctgcgttatcc
cctgattctgtggataaccgtattaccgcctttgagtgagctgataccgctcgccgcagccgaacgaccgagcgca
gcgagtcagtgagcgaggaagcggaagagcgcctgatgcggtattttctccttacgcatctgtgcggtatttcacac
cgcatatggtgcactctcagtacaatctgctctgatgccgcatagttaagccagtatacactccgctatcgctacgtga
ctgggtcatggctgcgccccgacacccgccaacacccgctgacgcgccctgacgggcttgtctgctcccggcatc
cgcttacagacaagctgtgaccgtctccgggagctgcatgtgtcagaggttttcaccgtcatcaccgaaacgcgcg
aggcagcagatcaattcgcgcgcgaaggcgaagcggcatgcatttacgttgacaccatcgaatggtgcaaaacc
tttcgcggtatggcatgatagcgcccggaagagagtcaattcagggtggtgaatgtgaaaccagtaacgttatacg
atgtcgcagagtatgccggtgtctcttatcagaccgtttcccgcgtggtgaaccaggccagccacgtttctgcgaaaa
cgcgggaaaaagtggaagcggcgatggcggagctgaattacattcccaaccgcgtggcacaacaactggcgg
gcaaacagtcgttgctgattggcgttgccacctccagtctggccctgcacgcgccgtcgcaaattgtcgcggcgatt
aaatctcgcgccgatcaactgggtgccagcgtggtggtgtcgatggtagaacgaagcggcgtcgaagcctgtaaa
gcggcggtgcacaatcttctcgcgcaacgcgtcagtgggctgatcattaactatccgctggatgaccaggatgccat
tgctgtggaagctgcctgcactaatgttccggcgttatttcttgatgtctctgaccagacacccatcaacagtattattttct
cccatgaagacggtacgcgactgggcgtggagcatctggtcgcattgggtcaccagcaaatcgcgctgttagcgg
gcccattaagttctgtctcggcgcgtctgcgtctggctggctggcataaatatctcactcgcaatcaaattcagccgat
agcggaacgggaaggcgactggagtgccatgtccggttttcaacaaaccatgcaaatgctgaatgagggcatcg
ttcccactgcgatgctggttgccaacgatcagatggcgctgggcgcaatgcgcgccattaccgagtccgggctgcg
cgttggtgcggatatctcggtagtgggatacgacgataccgaagacagctcatgttatatcccgccgtcaaccacca
tcaaacaggattttcgcctgctggggcaaaccagcgtggaccgcttgctgcaactctctcagggccaggcggtgaa
gggcaatcagctgttgcccgtctcactggtgaaaagaaaaaccaccctggcgcccaatacgcaaaccgcctctcc
ccgcgcgttggccgattcattaatgcagctggcacgacaggtttcccgactggaaagcgggcagtgagcgcaac
gcaattaatgtgagttagcgcgaattgatctg

(SEQ ID NO:28)

Figure 114A

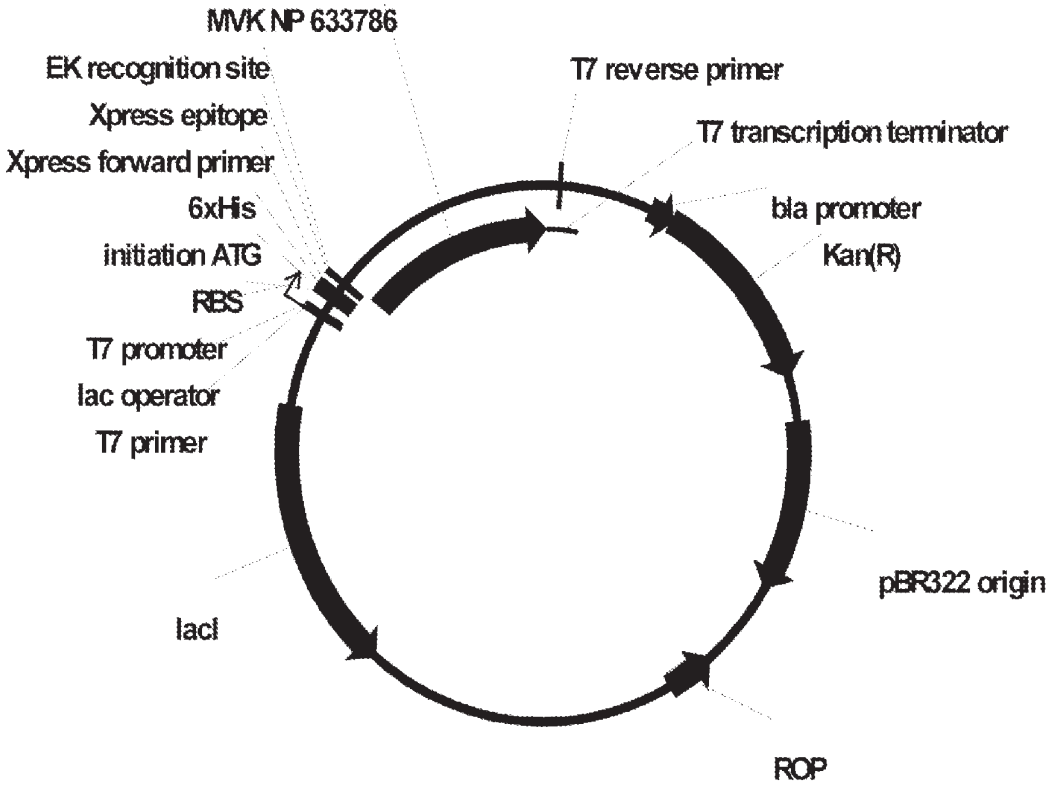

MVK NP 633786
EK recognition site
Xpress epitope
Xpress forward primer
6xHis
initiation ATG
RBS
T7 promoter
lac operator
T7 primer
lacI
T7 reverse primer
T7 transcription terminator
bla promoter
Kan(R)
pBR322 origin
ROP
MCM376 - MVK from M. mazei archeal Lowerin pET200D
6647 bp

Figure 114B

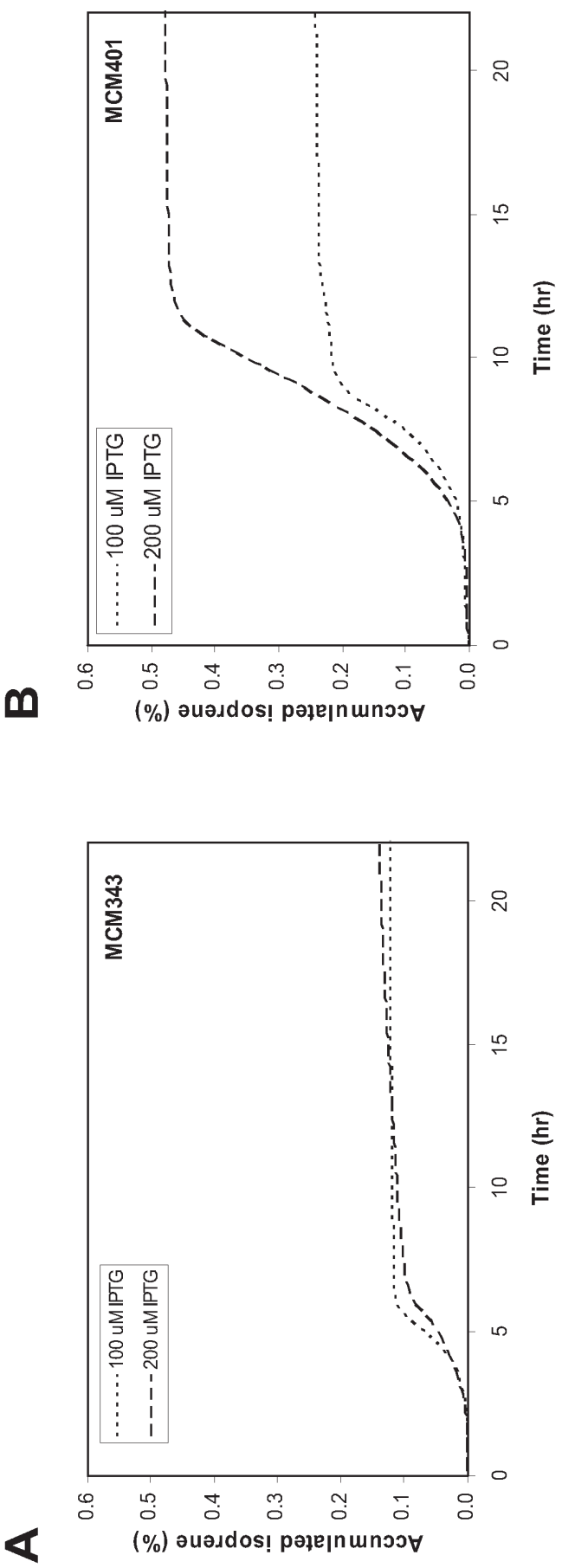
aagggcgagctcaacgatccggctgctaacaaagcccgaaaggaagctgagttggctgctgccaccgctgagca
ataactagcataaccccttggggcctctaaacgggtcttgaggagttttttgctgaaaggaggaactatatccggatatc
ccgcaagaggcccggcagtaccggcataaccaagcctatgcctacagcatccagggtgacggtgccgaggatga
cgatgagcgcattgttagatttcatacacggtgcctgactgcgttagcaatttaactgtgataaactaccgcattaaagct
tatcgatgataagctgtcaaacatgagaattaattcttgaagacgaaagggcctcgtgatacgcctatttttataggttaa
tgtcatgataataatggtttcttagacgtcaggtggcacttttcggggaaatgtgcgcggaacccctatttgtttatttttcta
aatacattcaaatatgtatccgctcatgagacaataaccctgataaatgcttcaataatattgaaaaaggaagagtatg
attgaacaagatggattgcacgcaggttctccggccgcttgggtggagaggctattcggctatgactgggcacaactg
acaatcggctgctctgatgccgccgtgttccggctgtcagcgcaggggcgcccggttctttttgtcaagaccgacctgtc
cggtgccctgaatgaactgcaggacgaggcagcgcggctatcgtggctggccacgacgggcgttccttgcgcagct
gtgctcgacgttgtcactgaagcgggaagggactggctgctattgggcgaagtgccggggcaggatctcctgtcatct
caccttgctcctgccgagaaagtatccatcatggctgatgcaatgcggcggctgcatacgcttgatccggctacctgcc
cattcgaccaccaagcgaaacatcgcatcgagcgggcacgtactcggatggaagccggtcttgtcgatcaggatg
atctggacgaagagcatcaggggctcgcgccagccgaactgttcgccaggctcaaggcgcgcatgcccgacggc
gaggatctcgtcgtgacacatggcgatgcctgcttgccgaatatcatggtggaaaatggccgcttttctggattcatcga
ctgtggccggctgggtgtggcggaccgctatcaggacatagcgttggctacccgtgatattgctgaagagcttggcgg
cgaatgggctgaccgcttcctcgtgctttacggtatcgccgctcccgattcgcagcgcatcgccttctatcgccttcttga
cgagttcttctgagcgggactctggggttcgaaatgaccgaccaagcgacgcctaactgtcagaccaagtttactcat
atatactttagattgatttaaaacttcatttttaatttaaaaggatctaggtgaagatccttttttgataatctcatgaccaaaat
cccttaacgtgagttttcgttccactgagcgtcagaccccgtagaaaagatcaaaggatcttcttgagatcctttttttctgc
gcgtaatctgctgcttgcaaacaaaaaaaccaccgctaccagcggtggtttgtttgccggatcaagagctaccaactc
tttttccgaaggtaactggcttcagcagagcgcagataccaaatactgtccttctagtgtagccgtagttaggccaccac
ttcaagaactctgtagcaccgcctacatacctcgctctgctaatcctgttaccagtggctgctgccagtggcgataagtc
gtgtcttaccgggttggactcaagacgatagttaccggataaggcgcagcggtcgggctgaacgggggttcgtgc
acacagcccagcttggagcgaacgacctacaccgaactgagatacctacagcgtgagctatgagaaagcgccac
gcttcccgaagggagaaaggcggacaggtatccggtaagcggcagggtcggaacaggagagcgcacgaggg
agcttccagggggaaacgcctggtatctttatagtcctgtcgggtttcgccacctctgacttgagcgtcgatttttgtgatgc
tcgtcaggggggcggagcctatggaaaaacgccagcaacgcggccttttacggttcctggccttttgctggccttttgc
tcacatgttctttcctgcgttatcccctgattctgtggataaccgtattaccgcctttgagtgagctgataccgctcgccgca
gccgaacgaccgagcgcagcgagtcagtgagcgaggaagcggaagagcgcctgatgcggtattttctccttacgc
atctgtgcggtatttcacaccgcaatggtgcactctcagtacaatctgctctgatgccgcatagttaagccagtatacact
ccgctatcgctacgtgactgggtcatggctgcgccccgacacccgccaacacccgctgacgcgccctgacgggctt
gtctgctcccggcatccgcttacagacaagctgtgaccgtctccgggagctgcatgtgtcagaggttttcaccgtcatc
accgaaacgcgcgaggcagctgcggtaaagctcatcagcgtggtcgtgaagcgattcacagatgtctgcctgttcat
ccgcgtccagctcgttgagtttctccagaagcgttaatgtctggcttctgataaagcgggccatgttaagggcggttttttc
ctgtttggtcactgatgcctccgtgtaagggggatttctgttcatgggggtaatgataccgatgaaacgagagaggatg
ctcacgatacgggttactgatgatgaacatgcccggttactggaacgttgtgagggtaaacaactggcggtatggatg
cggcgggaccagagaaaaatcactcagggtcaatgccagcgcttcgttaatacagatgtaggtgttccacagggta
gccagcagcatcctgcgatgcagatccggaacataatggtgcagggcgctgacttccgcgtttccagactttacgaa
acacggaaaccgaagaccattcatgttgttgctcaggtcgcagacgttttgcagcagcagtcgcttcacgttcgctcgc
gtatcggtgattcattctgctaaccagtaaggcaaccccgccagcctagccgggtcctcaacgacaggagcacgat
catgcgcacccgtggccaggacccaacgctgcccgagatgcgccgcgtgcggctgctggagatggcggacgcg
atggatatgttctgccaagggttggtttgcgcattcacagttctccgcaagaattgattggctccaattcttggagtggtga
atccgttagcgaggtgccgccggcttccattcaggtcgaggtggcccggctccatgcaccgcgacgcaacgcggg
gaggcagacaaggtatagggcggcgcctacaatccatgccaacccgttccatgtgctcgccgaggcggcataaat
cgccgtgacgatcagcggtccaatgatcgaagttaggctggtaagagccgcgagcgatccttgaagctgtccctgat
ggtcgtcatctacctgcctggacagcatggcctgcaacgcgggcatcccgatgccgccggaagcgagaagaatca
taatggggaaggccatccagcctcgcgtcgcgaacgccagcaagacgtagcccagcgcgt

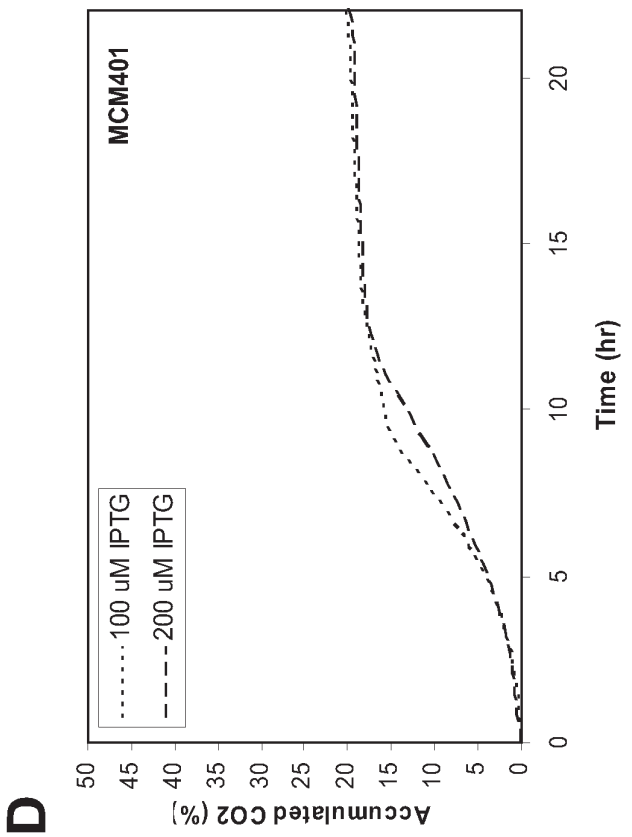
Figure 114C

cggccgccatgccggcgataatggcctgcttctcgccgaaacgtttggtggcgggaccagtgacgaaggcttg
agcgagggcgtgcaagattccgaataccgcaagcgacaggccgatcatcgtcgcgctccagcgaaagcgg
tcctcgccgaaaatgacccagagcgctgccggcacctgtcctacgagttgcatgataaagaagacagtcataa
gtgcggcgacgatagtcatgccccgcgcccaccggaaggagctgactgggttgaaggctctcaagggcatcg
gtcgagatcccggtgcctaatgagtgagctaacttacattaattgcgttgcgctcactgcccgctttccagtcggga
aacctgtcgtgccagctgcattaatgaatcggccaacgcgcggggagaggcggtttgcgtattgggcgccagg
gtggtttttctttcaccagtgagacgggcaacagctgattgcccttcaccgcctggccctgagagagttgcagca
agcggtccacgctggtttgccccagcaggcgaaaatcctgtttgatggtggttaacggcgggatataacatgag
ctgtcttcggtatcgtcgtatcccactaccgagatatccgcaccaacgcgcagcccggactcggtaatggcgcg
cattgcgcccagcgccatctgatcgttggcaaccagcatcgcagtgggaacgatgccctcattcagcatttgcat
ggtttgttgaaaaccggacatggcactccagtcgccttcccgttccgctatcggctgaatttgattgcgagtgagat
atttatgccagccagccagacgcagacgcgccgagacagaacttaatgggcccgctaacagcgcgatttgct
ggtgacccaatgcgaccagatgctccacgcccagtcgcgtaccgtcttcatgggagaaaataatactgttgatg
ggtgtctggtcagagacatcaagaaataacgccggaacattagtgcaggcagcttccacagcaatggcatcct
ggtcatccagcggatagttaatgatcagcccactgacgcgttgcgcgagaagattgtgcaccgccgctttacag
gcttcgacgccgcttcgttctaccatcgacaccaccacgctggcacccagttgatcggcgcgagatttaatcgcc
gcgacaatttgcgacggcgcgtgcagggccagactggaggtggcaacgccaatcagcaacgactgtttgccc
gccagttgttgtgccacgcggttgggaatgtaattcagctccgccatcgccgcttccacttttcccgcgttttcgcag
aaacgtggctggcctggttcaccacgcgggaaacggtctgataagagacaccggcatactctgcgacatcgt
ataacgttactggtttcacattcaccaccctgaattgactctcttccgggcgctatcatgccataccgcgaaaggttt
tgcgccattcgatggtgtccgggatctcgacgctctcccttatgcgactcctgcattaggaagcagcccagtagta
ggttgaggccgttgagcaccgccgccgcaaggaatggtgcatgcaaggagatggcgcccaacagtcccccg
gccacggggcctgccaccatacccacgccgaaacaagcgctcatgagcccgaagtggcgagcccgatcttc
cccatcggtgatgtcggcgatataggcgccagcaaccgcacctgtggcgccggtgatgccggccacgatgcg
tccggcgtagaggatcgagatctcgatcccgcgaaattaatacgactcactatagggaattgtgagcggata
acaattcccctctagaaataattttgtttaactttaagaaggagatatacatatgcggggttctcatcatcatcatcat
catggtatggctagcatgactggtggacagcaaatgggtcgggatctgtacgacgatgacgataaggatcatc
ccttcaccatggtatcctgttctgcgccgggtaagatttacctgttcggtgaacacgccgtagtttatggcgaaactg
caattgcgtgtgcggtggaactgcgtacccgtgttcgcgcggaactcaatgactctatcactattcagagccaga
tcggccgcaccggtctggatttcgaaaagcacccttatgtgtctgcggtaattgagaaaatgcgcaaatctattcc
tattaacggtgttttcttgaccgtcgattccgacatcccggtgggctccggtctgggtagcagcgcagccgttactat
cgcgtctattggtgcgctgaacgagctgttcggctttggcctcagcctgcaagaaatcgctaaactgggccacga
aatcgaaattaaagtacagggtgccgcgtccccaaccgatacgtatgtttctaccttcggcggcgtggttaccatc
ccggaacgtcgcaaactgaaaactccggactgcggcattgtgattggcgataccggcgttttctcctccaccaa
agagttagtagctaacgtacgtcagctgcgcgaaagctacccggatttgatcgaaccgctgatgacctctattgg
caaaatctctcgtatcggcgaacaactggttctgtctggcgactacgcatccatcggccgcctgatgaacgtcaa
ccagggtctcctggacgccctgggcgttaacatcttagaactgagccagctgatctattccgctcgtgcggcagg
tgcgtttggcgctaaaatcacgggcgctggcggcggtggctgtatggttgcgctgaccgctccggaaaaatgca
accaagtggcagaagcggtagcaggcgctggcggtaaagtgactatcactaaaccgaccgagcaaggtctg
aaagtagattaa

(SEQ ID NO:29)

Figure 115


A
MCM343
Accumulated isoprene (%)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0
5
10
15
20
Time (hr)
100 uM IPTG
200 uM IPTG
B
MCM401
Accumulated isoprene (%)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0
5
10
15
20
Time (hr)
100 uM IPTG
200 uM IPTG


D
MCM401
100 uM IPTG
200 uM IPTG
Accumulated CO2 (%)
Time (hr)
0
5
10
15
20
25
30
35
40
45
50

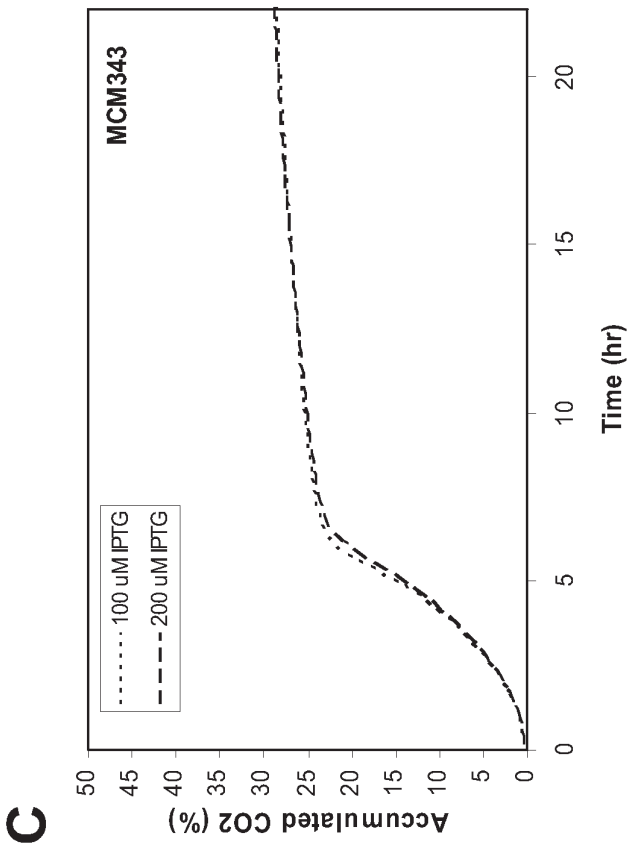

C
MCM343
100 uM IPTG
200 uM IPTG
Accumulated CO2 (%)
Time (hr)
0
5
10
15
20
25
30
35
40
45
50

Figure 115

Figure 116

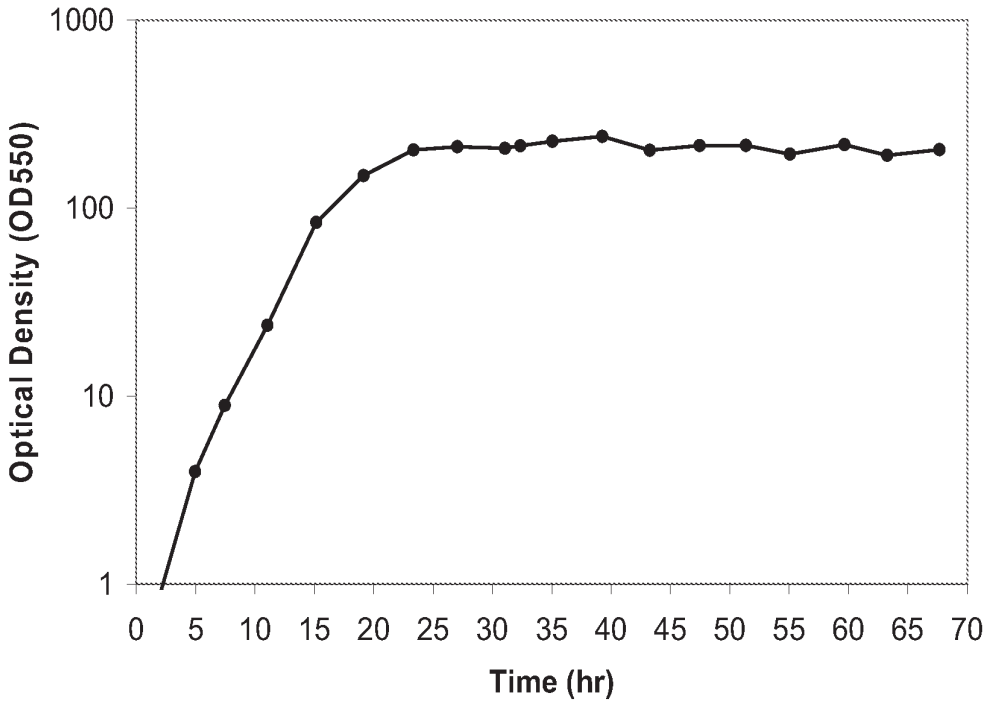

1000
100
10
1
Optical Density (OD550)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70
Time (hr)

Figure 117

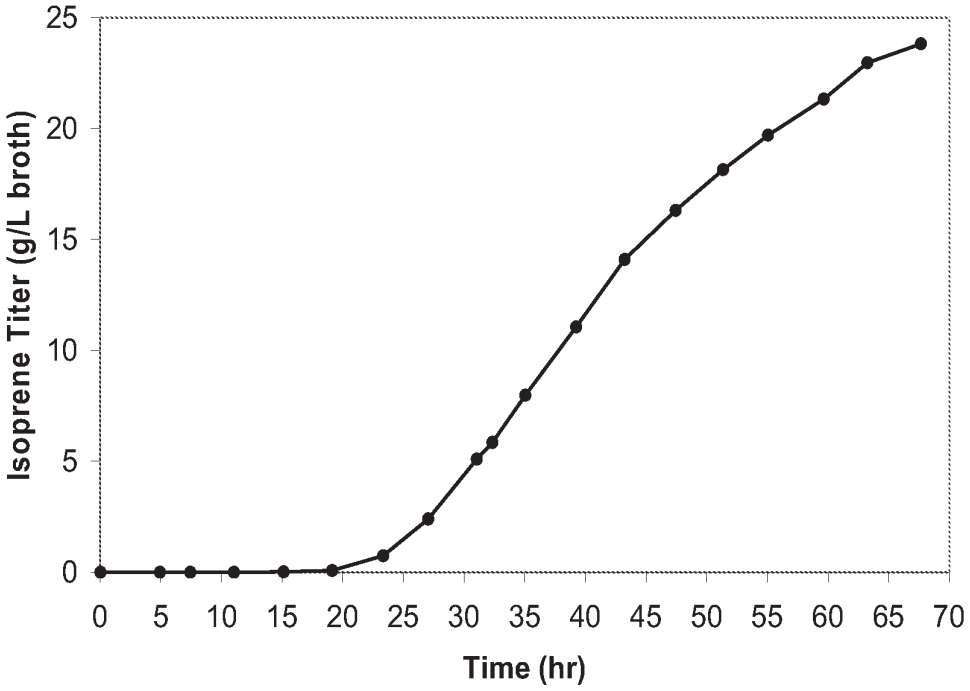

Isoprene Titer (g/L broth)
25
20
15
10
5
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70
Time (hr)

Figure 118

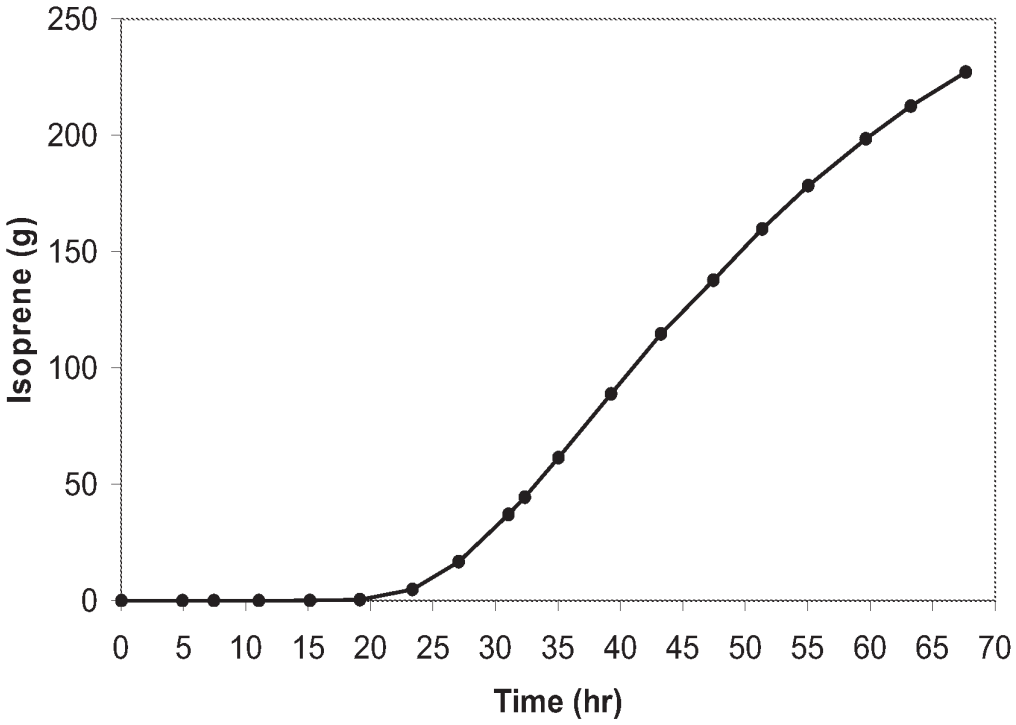

250
200
150
100
50
0
Isoprene (g)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70
Time (hr)

Figure 119

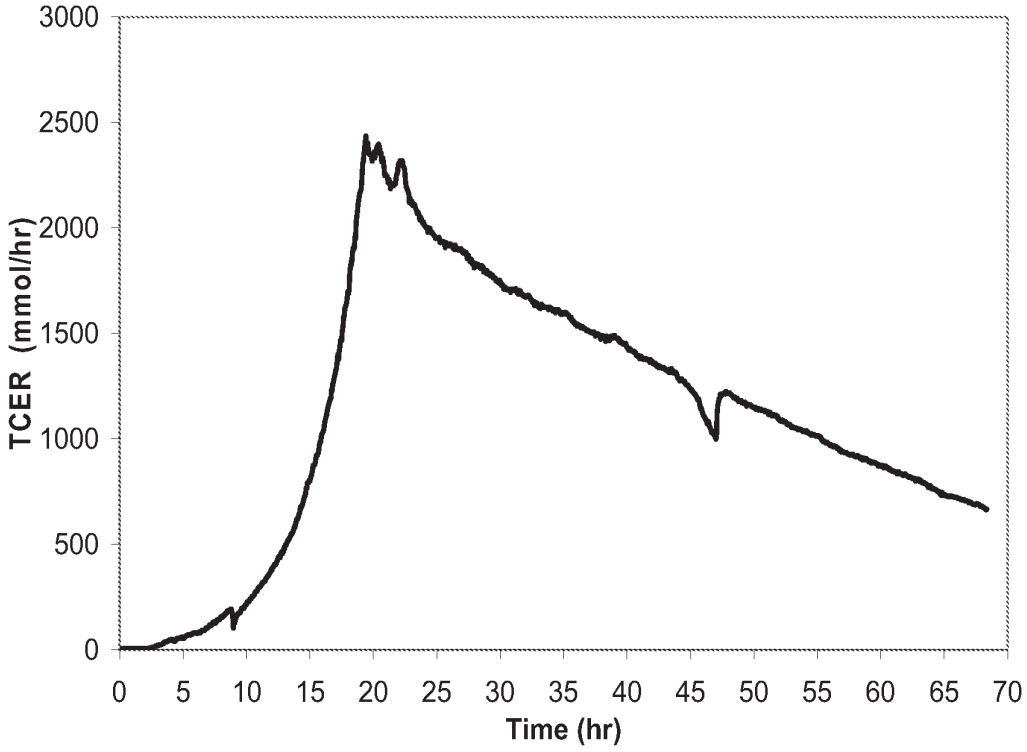

3000
2500
2000
1500
1000
500
0
TCER (mmol/hr)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70
Time (hr)

Figure 120

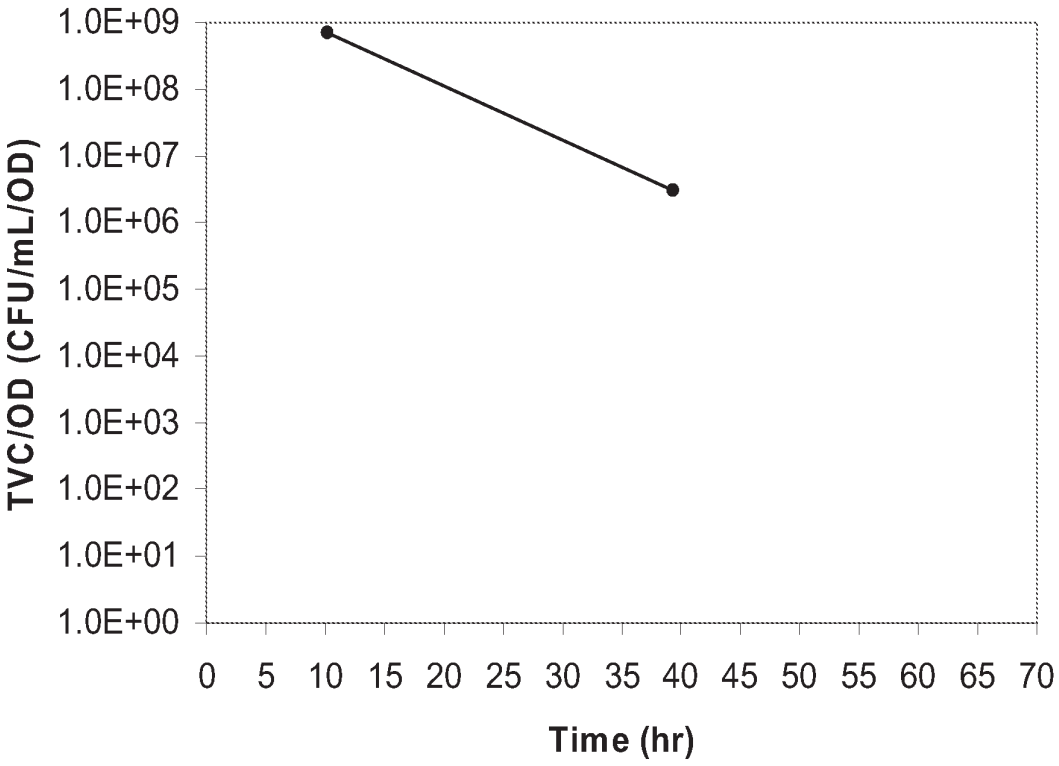

1.0E+09
1.0E+08
1.0E+07
1.0E+06
1.0E+05
1.0E+04
1.0E+03
1.0E+02
1.0E+01
1.0E+00
TVC/OD (CFU/mL/OD)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70
Time (hr)

Figure 121

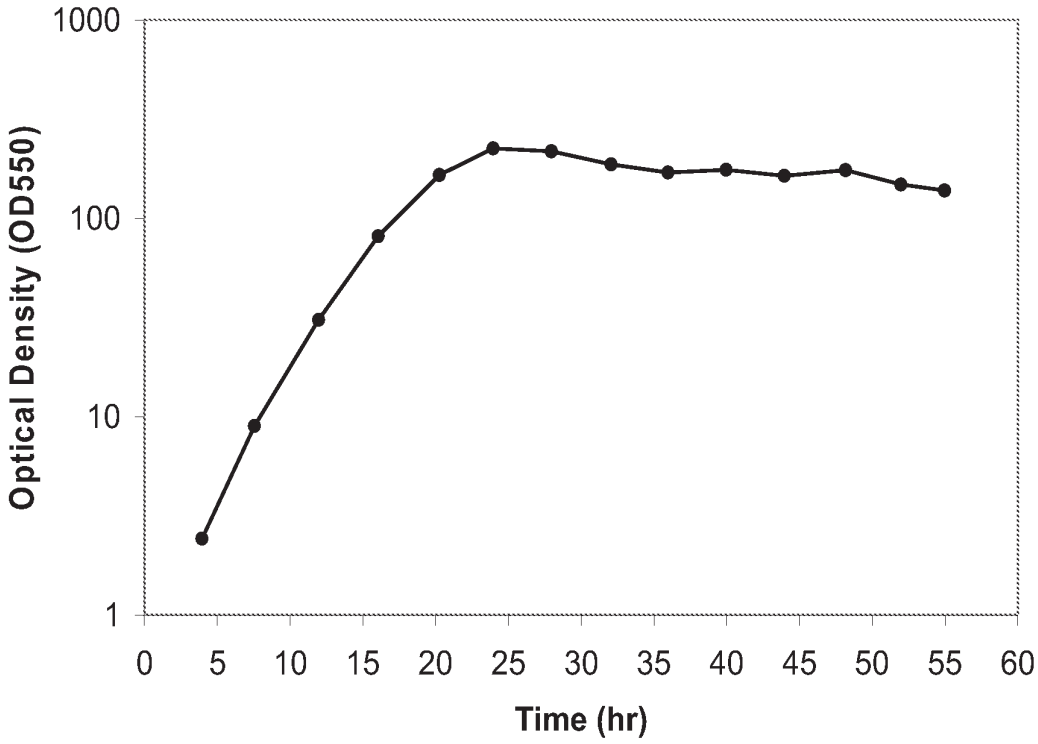

1000
100
10
1
Optical Density (OD550)
0
5
10
15
20
25
30
35
40
45
50
55
60
Time (hr)

Figure 122

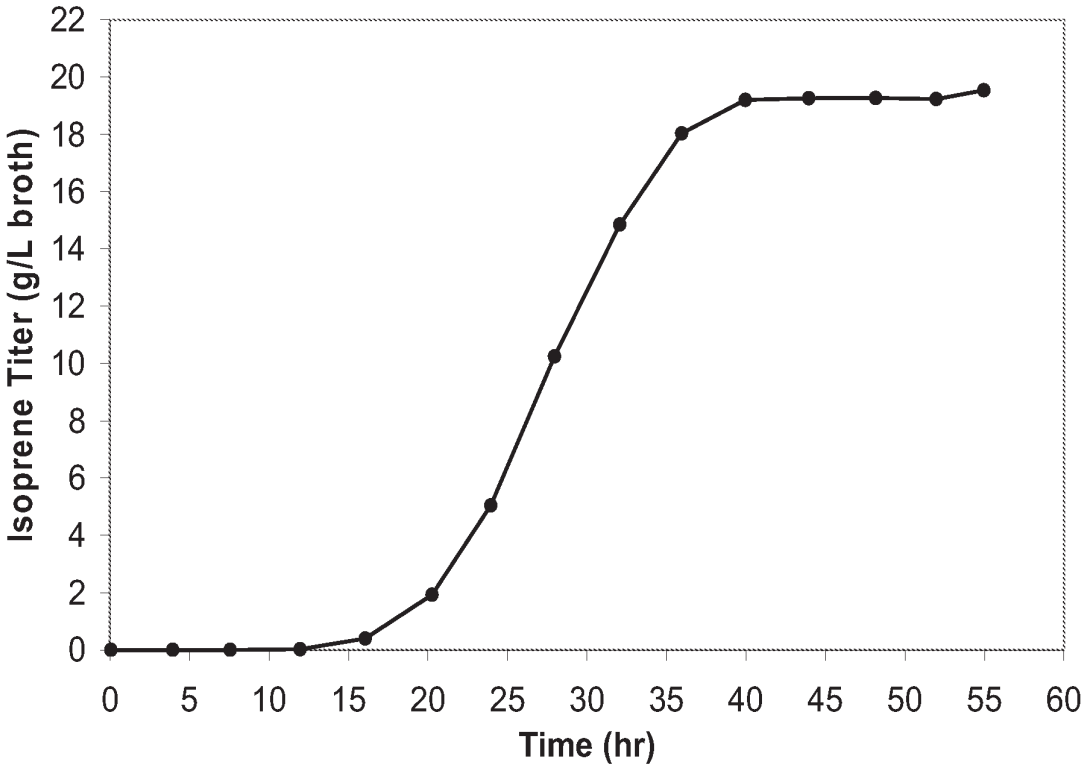

Isoprene Titer (g/L broth)
22
20
18
16
14
12
10
8
6
4
2
0
0
5
10
15
20
25
30
35
40
45
50
55
60
Time (hr)

Figure 123

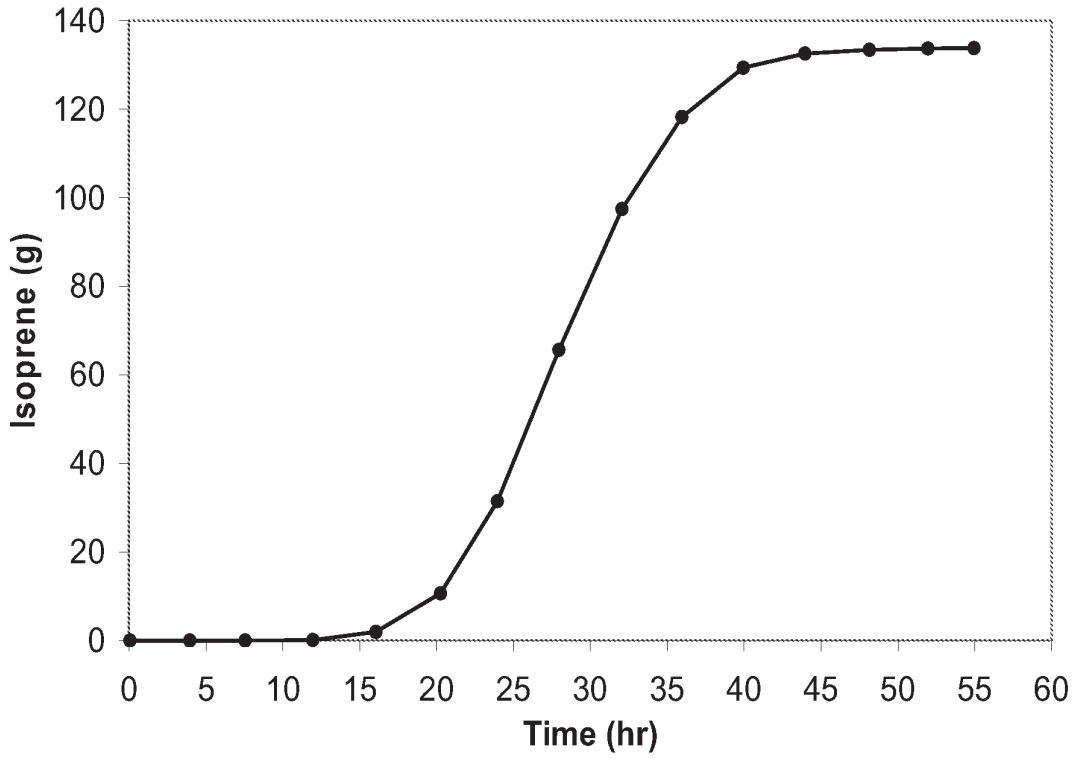

Isoprene (g)
140
120
100
80
60
40
20
0
0 5 10 15 20 25 30 35 40 45 50 55 60
Time (hr)

Figure 124

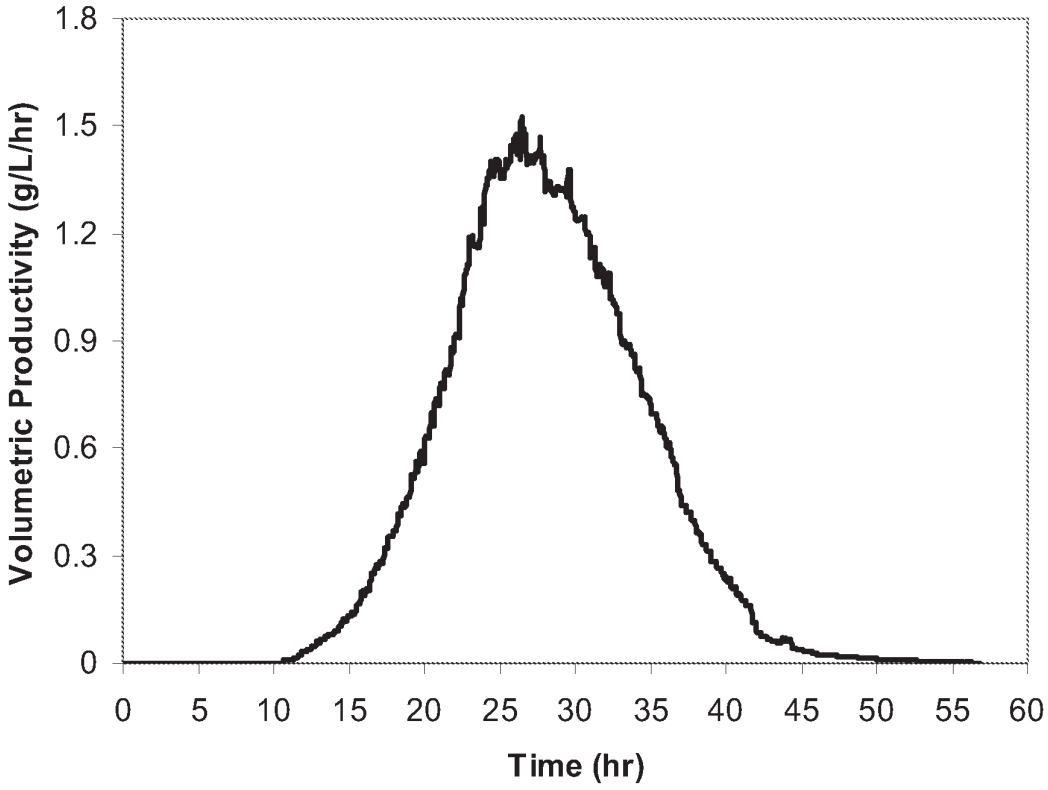

Volumetric Productivity (g/L/hr)
1.8
1.5
1.2
0.9
0.6
0.3
0
0 5 10 15 20 25 30 35 40 45 50 55 60
Time (hr)

Figure 125

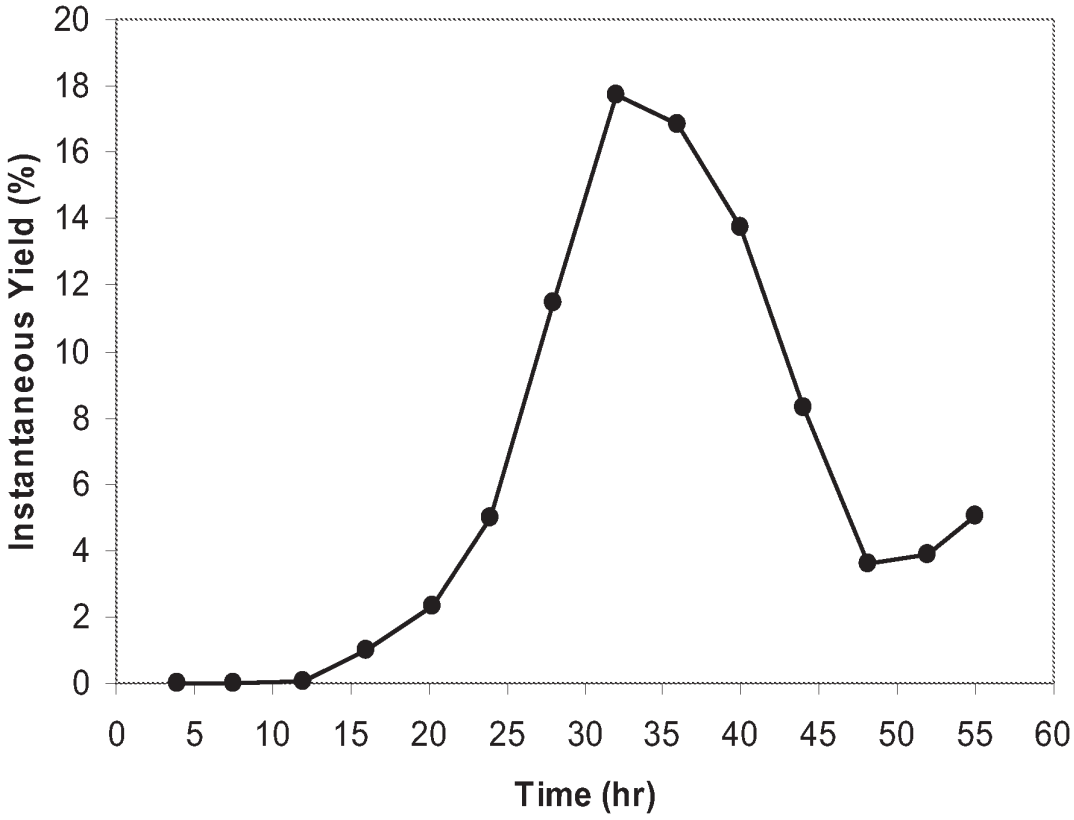

Instantaneous Yield (%)
20
18
16
14
12
10
8
6
4
2
0
0
5
10
15
20
25
30
35
40
45
50
55
60
Time (hr)

Figure 126

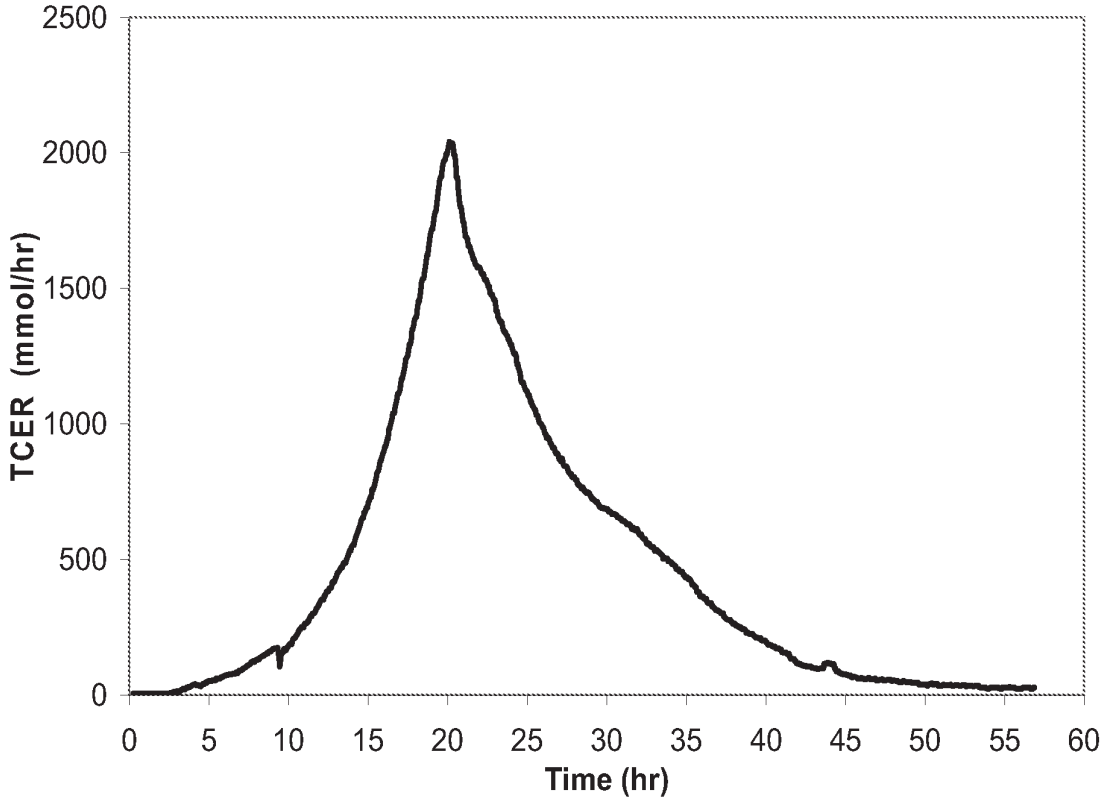

2500
2000
1500
1000
500
0
TCER (mmol/hr)
0
5
10
15
20
25
30
35
40
45
50
55
60
Time (hr)

Figure 127

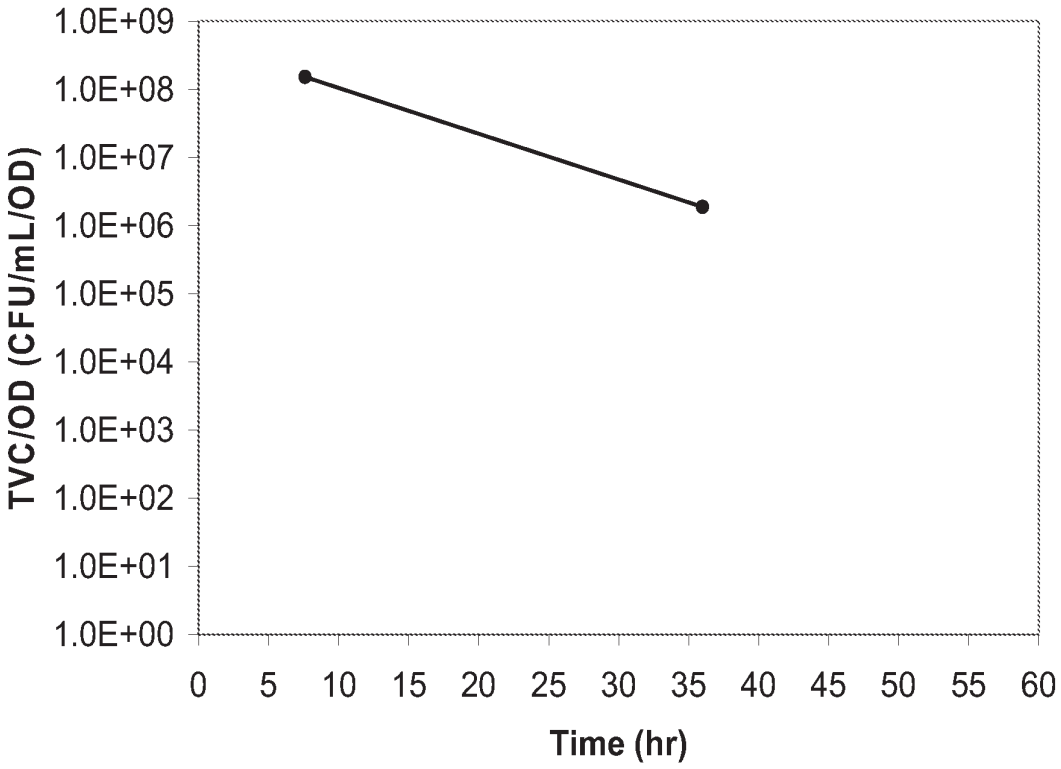

1.0E+09
1.0E+08
1.0E+07
1.0E+06
1.0E+05
1.0E+04
1.0E+03
1.0E+02
1.0E+01
1.0E+00
TVC/OD (CFU/mL/OD)
0
5
10
15
20
25
30
35
40
45
50
55
60
Time (hr)

Figure 128

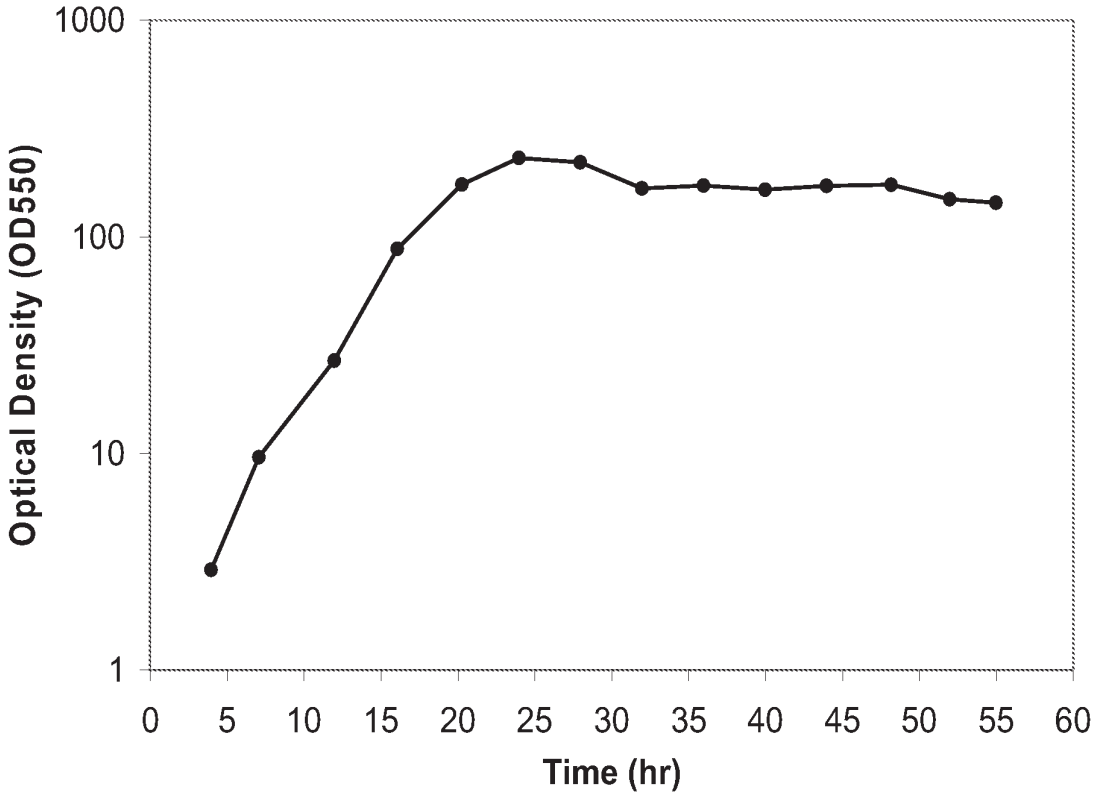

1000
100
10
1
Optical Density (OD550)
0
5
10
15
20
25
30
35
40
45
50
55
60
Time (hr)

Figure 129

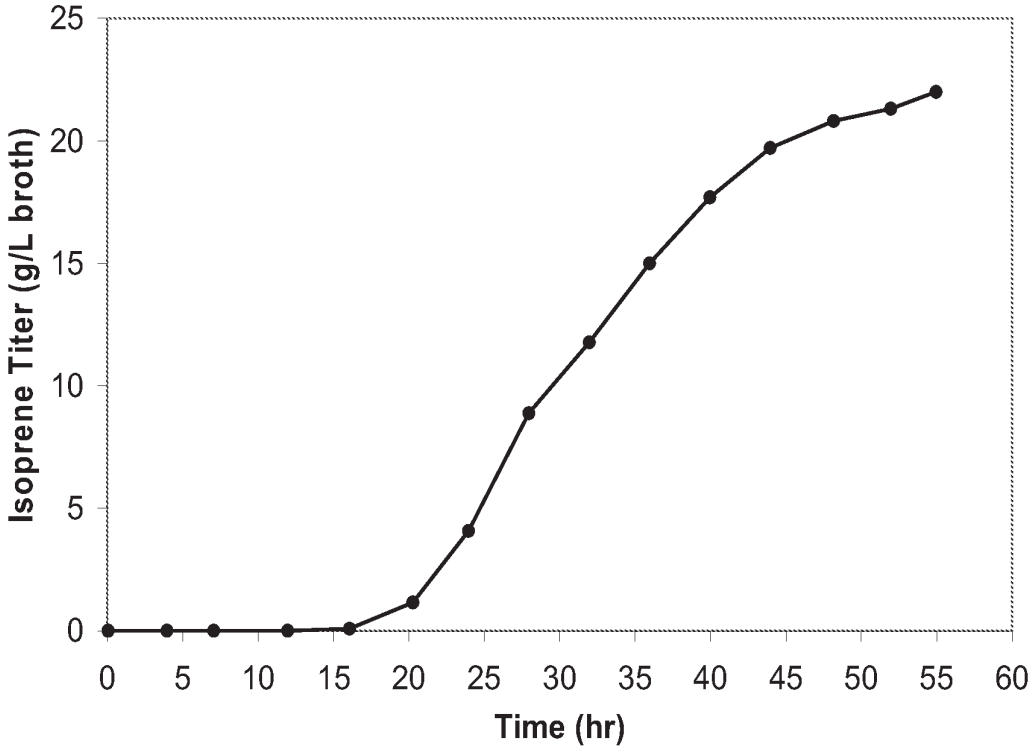

Isoprene Titer (g/L broth)
25
20
15
10
5
0
0 5 10 15 20 25 30 35 40 45 50 55 60
Time (hr)

Figure 130

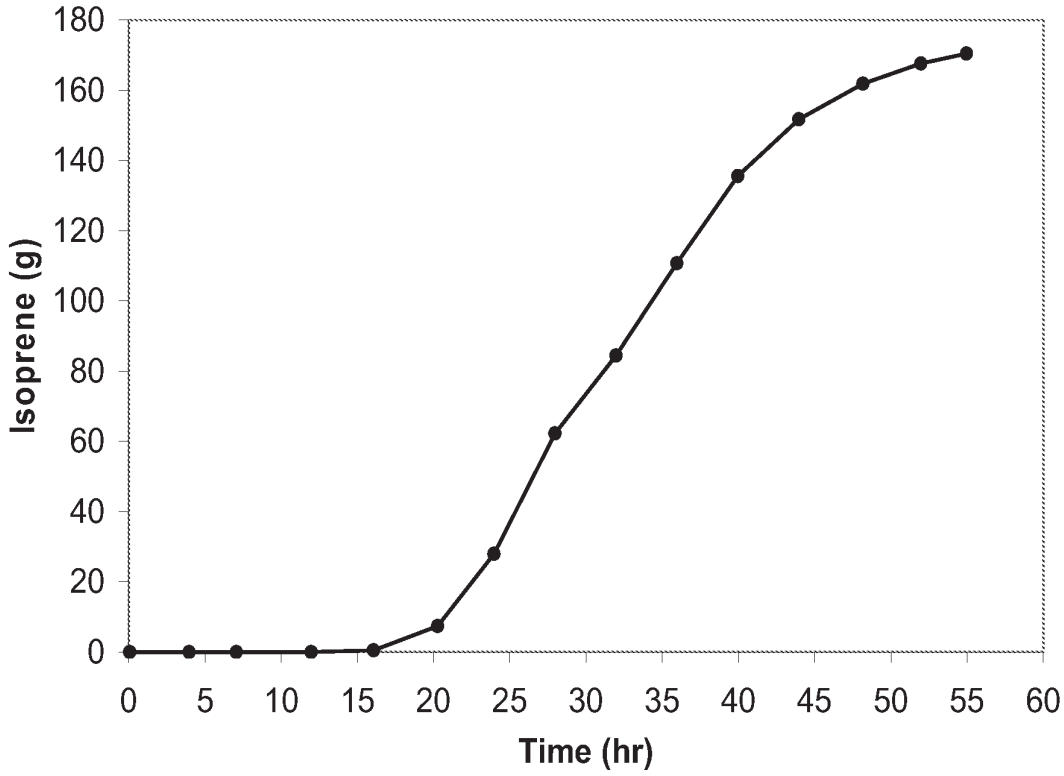

Isoprene (g)
180
160
140
120
100
80
60
40
20
0
0
5
10
15
20
25
30
35
40
45
50
55
60
Time (hr)

Figure 131

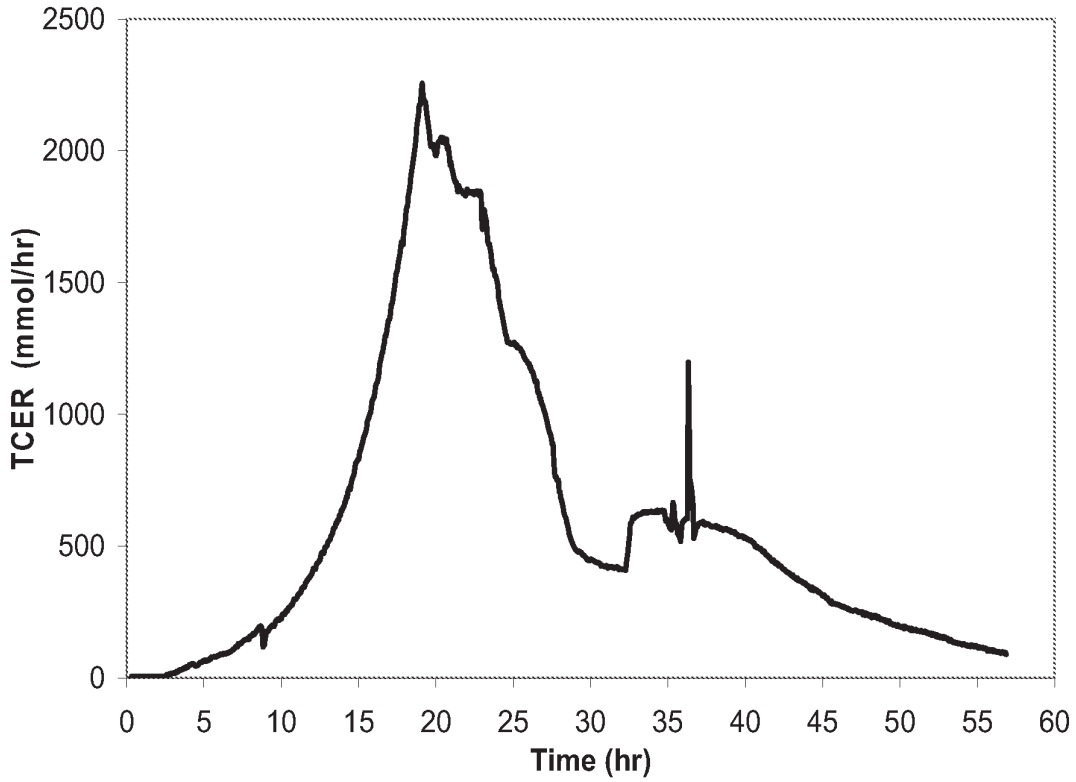

2500
2000
1500
1000
500
0
TCER (mmol/hr)
0
5
10
15
20
25
30
35
40
45
50
55
60
Time (hr)

Figure 132

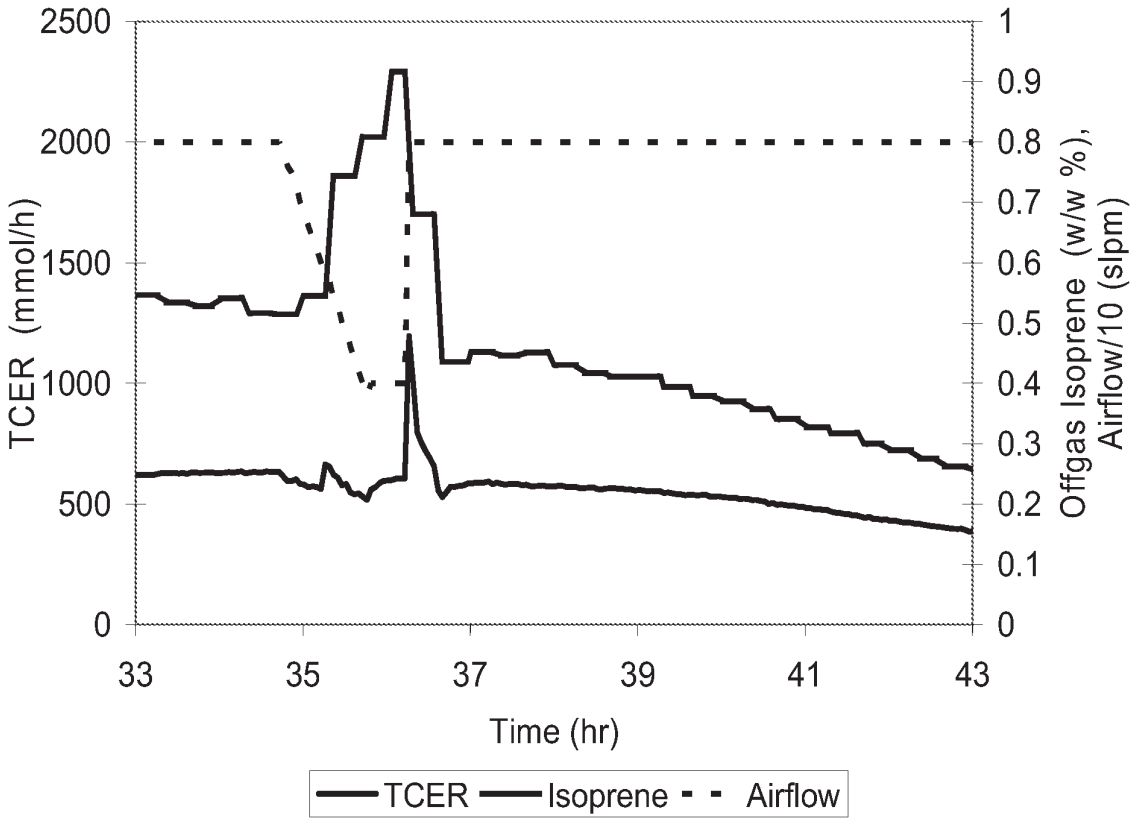

2500
2000
1500
1000
500
0
TCER (mmol/h)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Offgas Isoprene (w/w %), Airflow/10 (slpm)
33
35
37
39
41
43
Time (hr)
TCER
Isoprene
Airflow

Figure 133

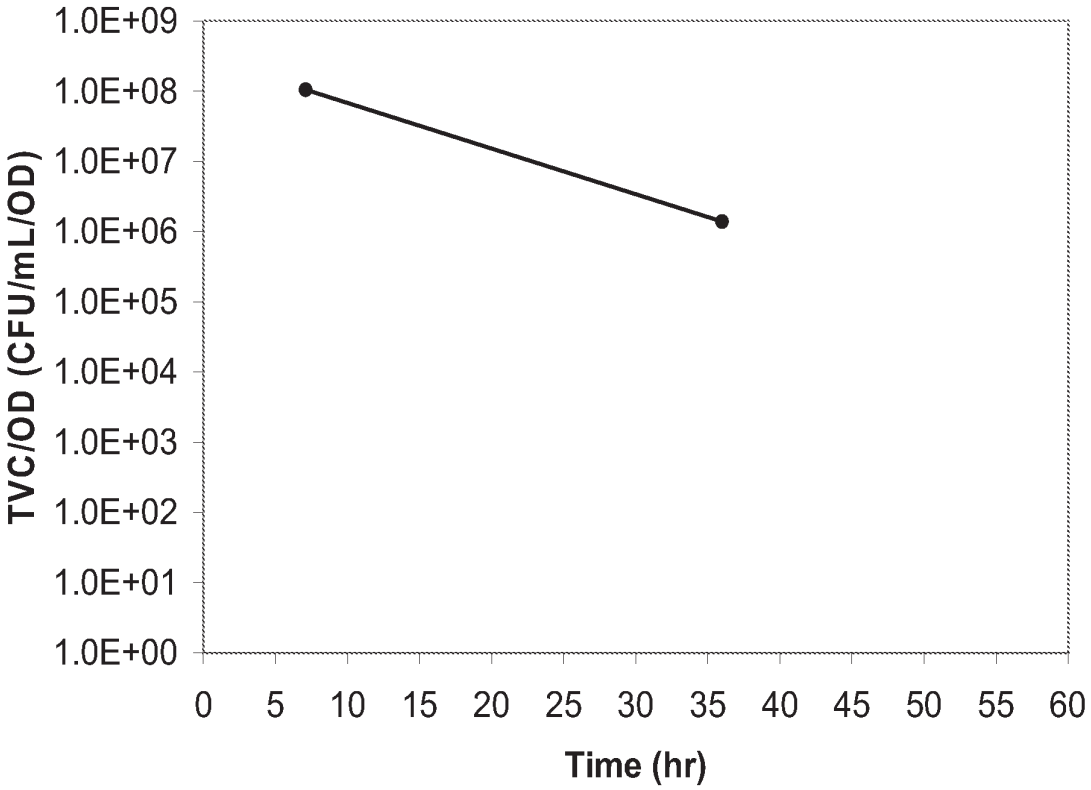

1.0E+09
1.0E+08
1.0E+07
1.0E+06
1.0E+05
1.0E+04
1.0E+03
1.0E+02
1.0E+01
1.0E+00
TVC/OD (CFU/mL/OD)
0
5
10
15
20
25
30
35
40
45
50
55
60
Time (hr)

Figure 134

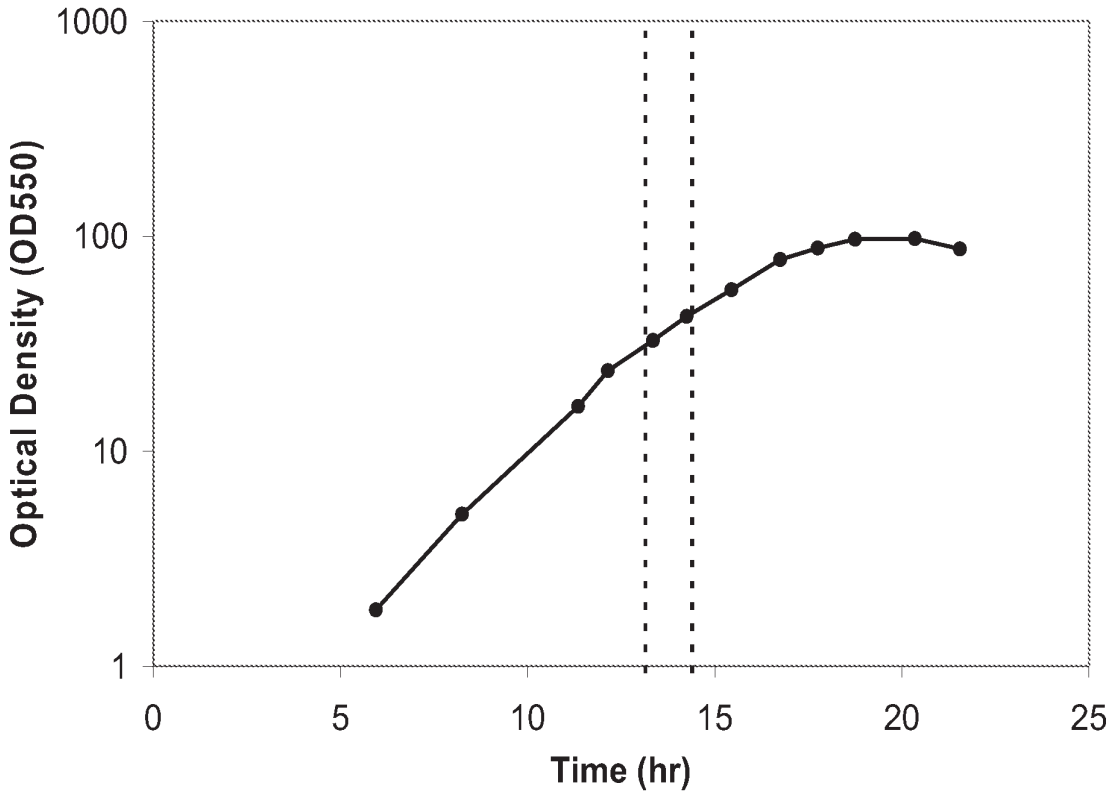


Figure 135

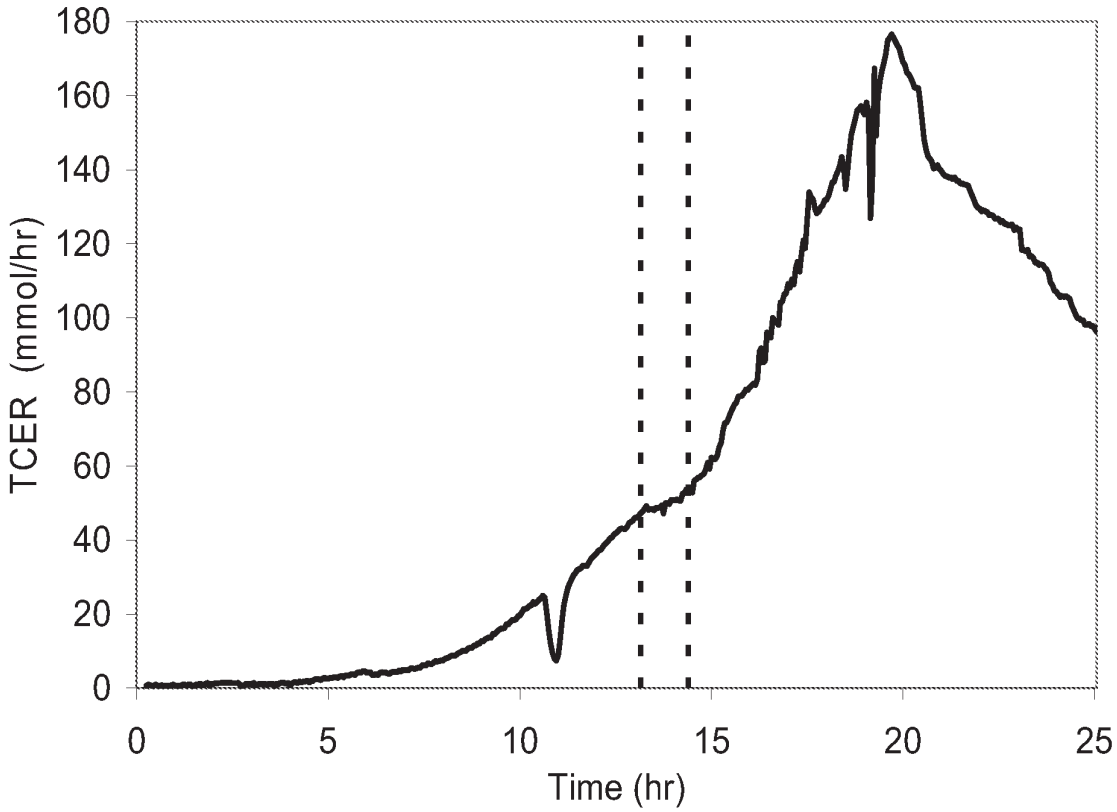

180
160
140
120
100
80
60
40
20
0
TCER (mmol/hr)
0
5
10
15
20
25
Time (hr)

Figure 136

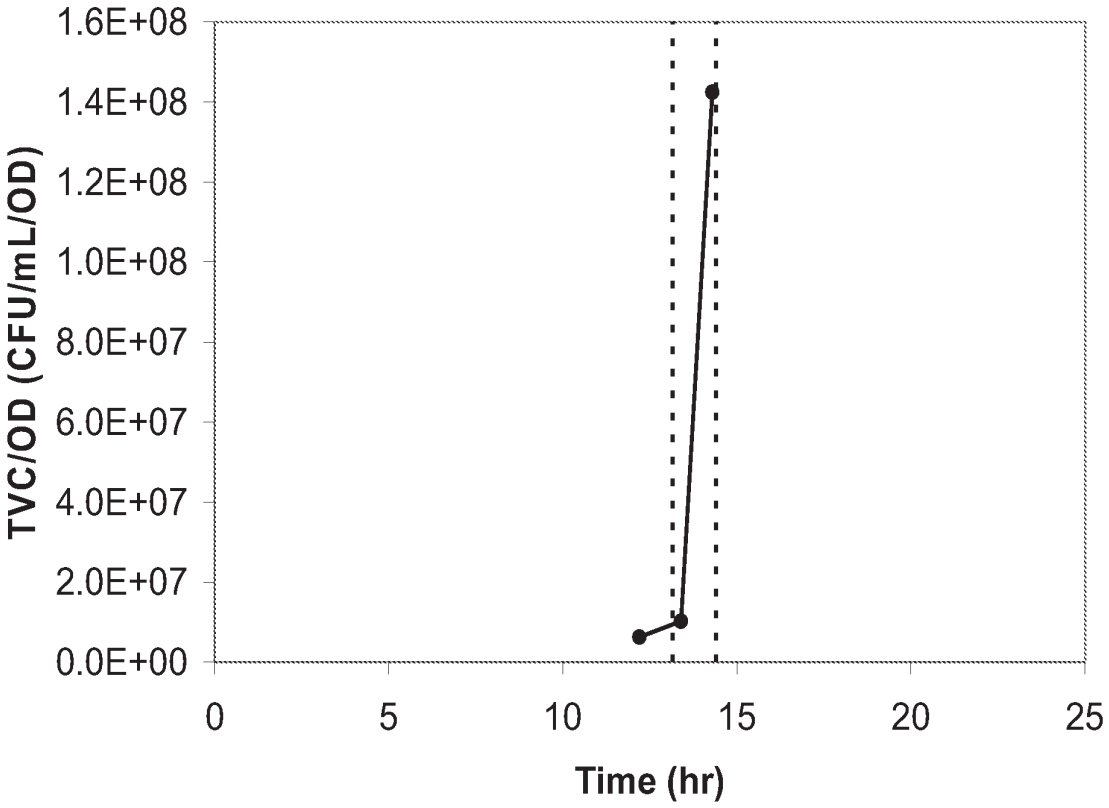

1.6E+08
1.4E+08
1.2E+08
1.0E+08
8.0E+07
6.0E+07
4.0E+07
2.0E+07
0.0E+00
TVC/OD (CFU/mL/OD)
0
5
10
15
20
25
Time (hr)

Figure 137A

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagcgtgaccgctacact
tgccagcgccctagcgcccgctcctttcgctttcttcccttcctttctcgccacgttcgccggctttccccgtcaagctctaaatc
gggggctccctttagggttccgatttagtgctttacggcacctcgaccccaaaaaacttgattagggtgatggttcacgtagt
gggccatcgccctgatagacggtttttcgcccttgacgttggagtccacgttctttaatagtggactcttgttccaaactggaa
caacactcaaccctatctcggtctattcttttgatttataagggattttgccgatttcggcctattggttaaaaaatgagctgattt
aacaaaaatttaacgcgaattttaacaaaatattaacgtttacaatttcaggtggcacttttcggggaaatgtgcgcggaac
ccctatttgtttatttttctaaatacattcaaatatgtatccgctcatgaattaattcttagaaaaactcatcgagcatcaaatgaa
actgcaatttattcatatcaggattatcaataccatatttttgaaaaagccgtttctgtaatgaaggagaaaactcaccgagg
cagttccataggatggcaagatcctggtatcggtctgcgattccgactcgtccaacatcaatacaacctattaatttcccctc
gtcaaaaataaggttatcaagtgagaaatcaccatgagtgacgactgaatccggtgagaatggcaaaagtttatgcattt
ctttccagacttgttcaacaggccagccattacgctcgtcatcaaaatcactcgcatcaaccaaaccgttattcattcgtgatt
gcgcctgagcgagacgaaatacgcgatcgctgttaaaaggacaattacaaacaggaatcgaatgcaaccggcgcag
gaacactgccagcgcatcaacaatattttcacctgaatcaggatattcttctaatacctggaatgctgttttcccggggatcg
cagtggtgagtaaccatgcatcatcaggagtacggataaaatgcttgatggtcggaagaggcataaattccgtcagcca
gtttagtctgaccatctcatctgtaacatcattggcaacgctacctttgccatgtttcagaaacaactctggcgcatcgggctt
cccatacaatcgatagattgtcgcacctgattgcccgacattatcgcgagcccatttatacccatataaatcagcatccatg
ttggaatttaatcgcggcctagagcaagacgtttcccgttgaatatggctcataacacccccttgtattactgtttatgtaagca
gacagttttattgttcatgaccaaaatcccttaacgtgagttttcgttccactgagcgtcagaccccgtagaaaagatcaaa
ggatcttcttgagatccttttttttctgcgcgtaatctgctgcttgcaaacaaaaaaaccaccgctaccagcggtggtttgtttgc
cggatcaagagctaccaactctttttccgaaggtaactggcttcagcagagcgcagataccaaatactgtccttctagtgta
gccgtagttaggccaccacttcaagaactctgtagcaccgcctacatacctcgctctgctaatcctgttaccagtggctgct
gccagtggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccggataaggcgcagcggtcgggctgaa
cgggggttcgtgcacacagcccagcttggagcgaacgacctacaccgaactgagatacctacagcgtgagctatga
gaaagcgccacgcttcccgaagggagaaaggcggacaggtatccggtaagcggcagggtcggaacaggagagc
gcacgagggagcttccagggggaaacgcctggtatctttatagtcctgtcgggtttcgccacctctgacttgagcgtcgattt
ttgtgatgctcgtcaggggggcggagcctatggaaaaacgccagcaacgcggccttttacggttcctggccttttgctggc
cttttgctcacatgttctttcctgcgttatcccctgattctgtggataaccgtattaccgcctttgagtgagctgataccgctcgcc
gcagccgaacgaccgagcgcagcgagtcagtgagcgaggaagcggaagagcgcctgatgcggtattttctccttacg
catctgtgcggtatttcacaccgcatatatggtgcactctcagtacaatctgctctgatgccgcatagttaagccagtataca
ctccgctatcgctacgtgactgggtcatggctgcgccccgacacccgccaacacccgctgacgcgccctgacgggcttg
tctgctcccggcatccgcttacagacaagctgtgaccgtctccgggagctgcatgtgtcagaggttttcaccgtcatcaccg
aaacgcgcgaggcagctgcggtaaagctcatcagcgtggtcgtgaagcgattcacagatgtctgcctgttcatccgcgtc
cagctcgttgagtttctccagaagcgttaatgtctggcttctgataaagcgggccatgttaagggcggttttttcctgtttggtca
ctgatgcctccgtgtaagggggatttctgttcatgggggtaatgataccgatgaaacgagagaggatgctcacgatacgg
gttactgatgatgaacatgcccggttactggaacgttgtgagggtaaacaactggcggtatggatgcggcgggaccaga
gaaaaatcactcagggtcaatgccagcgcttcgttaatacagatgtaggtgttccacagggtagccagcagcatcctgc
gatgcagatccggaacataatggtgcagggcgctgacttccgcgtttccagactttacgaaacacggaaaccgaagac
cattcatgttgttgctcaggtcgcagacgttttgcagcagcagtcgcttcacgttcgctcgcgtatcggtgattcattctgctaa
ccagtaaggcaaccccgccagcctagccgggtcctcaacgacaggagcacgatcatgcgcacccgtggggccgcc
atgccggcgataatggcctgcttctcgccgaaacgtttggtggcgggaccagtgacgaaggcttgagcgagggcgtgc
aagattccgaataccgcaagcgacaggccgatcatcgtcgcgctccagcgaaagcggtcctcgccgaaaatgaccc
agagcgctgccggcacctgtcctacgagttgcatgataaagaagacagtcataagtgcggcgacgatagtcatgcccc
gcgcccaccggaaggagctgactgggttgaaggctctcaagggcatcggtcgagatcccggtgcctaatgagtgagct
aacttacattaattgcgttgcgctcactgcccgctttccagtcgggaaacctgtcgtgccagctgcattaatgaatcggcca
acgcgcggggagaggcggtttgcgtattgggcgccagggtggtttttcttttcaccagtgagacgggcaacagctgattgc
ccttcaccgcctggccctgagagagttgcagcaagcggtccacgctggtttgccccagcaggcgaaaatcctgtttgatg
gtggttaacggcgggatataacatgagctgtcttcggtatc

Figure 137B

gtcgtatcccactaccgagatatccgcaccaacgcgcagcccggactcggtaatggcgcgcattgcgcccagcg
ccatctgatcgttggcaaccagcatcgcagtgggaacgatgccctcattcagcatttgcatggtttgttgaaaaccgg
acatggcactccagtcgccttcccgttccgctatcggctgaatttgattgcgagtgagatatttatgccagccagccag
acgcagacgcgccgagacagaacttaatgggcccgctaacagcgcgatttgctggtgacccaatgcgaccagat
gctccacgcccagtcgcgtaccgtcttcatgggagaaaataatactgttgatgggtgtctggtcagagacatcaaga
aataacgccggaacattagtgcaggcagcttccacagcaatggcatcctggtcatccagcggatagttaatgatca
gcccactgacgcgttgcgcgagaagattgtgcaccgccgctttacaggcttcgacgccgcttcgttctaccatcgac
accaccacgctggcacccagttgatcggcgcgagatttaatcgccgcgacaatttgcgacggcgcgtgcagggc
cagactggaggtggcaacgccaatcagcaacgactgtttgcccgccagttgttgtgccacgcggttgggaatgtaa
ttcagctccgccatcgccgcttccacttttcccgcgttttcgcagaaacgtggctggcctggttcaccacgcgggaaa
cggtctgataagagacaccggcatactctgcgacatcgtataacgttactggtttcacattcaccaccctgaattgact
ctcttccgggcgctatcatgccataccgcgaaaggttttgcgccattcgatggtgtccgggatctcgacgctctcccctta
tgcgactcctgcattaggaagcagcccagtagtaggttgaggccgttgagcaccgccgccgcaaggaatggtgc
atgcaaggagatggcgcccaacagtcccccggccacggggcctgccaccatacccacgccgaaacaagcgct
catgagcccgaagtggcgagcccgatcttccccatcggtgatgtcggcgatataggcgccagcaaccgcacctgt
ggcgccggtgatgccggccacgatgcgtccggcgtagaggatcgagatctcgatcccgcgaaattaatacgactc
actataggggaattgtgagcggataacaattcccctctagaaataattttgtttaactttaagaaggagatatacatat
gcgttgtagcgtgtccaccgaaaatgtgtctttcaccgaaactgaaaccgaagctcgtcgttctgcgaactacgaac
ctaacagctgggactatgattacctgctgtcctccgacacggacgagtccatcgaagtatacaaagacaaagcga
aaaagctggaagccgaagttcgtcgcgagattaataacgaaaaagcagaatttctgaccctgctggaactgattg
acaacgtccagcgcctgggcctgggttaccgtttcgagtctgatatccgtggtgcgctggatcgcttcgtttcctccgg
cggcttcgatgcggtaaccaagacttccctgcacggtacggcactgtctttccgtctgctgcgtcaacacggttttgag
gtttctcaggaagcgttcagcggcttcaaagaccaaaacggcaacttcctggagaacctgaaggaagatatcaaa
gctatcctgagcctgtacgaggccagcttcctggctctggaaggcgaaaacatcctggacgaggcgaaggttttcg
caatctctcatctgaaagaactgtctgaagaaaagatcggtaaagagctggcagaacaggtgaaccatgcactg
gaactgccactgcatcgccgtactcagcgtctggaagcagtatggtctatcgaggcctaccgtaaaaaggaggac
gcgaatcaggttctgctggagctggcaattctggattacaacatgatccagtctgtataccagcgtgatctgcgtgaa
acgtcccgttggtggcgtcgtgtgggtctggcgaccaaactgcactttgctcgtgaccgcctgattgagagcttctact
gggccgtgggtgtagcattcgaaccgcaatactccgactgccgtaactccgtcgcaaaaatgttttctttcgtaaccat
tatcgacgatatctacgatgtatacggcaccctggacgaactggagctgtttactgatgcagttgagcgttgggacgt
aaacgccatcaacgacctgccggattacatgaaactgtgctttctggctctgtataacactattaacgaaatcgccta
cgacaacctgaaagataaaggtgagaacatcctgccgtatctgaccaaagcctgggctgacctgtgcaacgctttc
ctgcaagaagccaagtggctgtacaacaaatctactccgacctttgacgactacttcggcaacgcatggaaatcct
cttctggcccgctgcaactggtgttcgcttacttcgctgtcgtgcagaacattaaaaaggaagagatcgaaaacctg
caaaaataccatgacaccatctctcgtccttcccatatcttccgtctgtgcaatgacctggctagcgcgtctgcggaaa
ttgcgcgtggtgaaaccgcaaatagcgtttcttgttacatgcgcactaaaggtatctccgaagaactggctaccgaa
agcgtgatgaatctgatcgatgaaacctggaaaaagatgaacaaggaaaaactgggtggtagcctgttcgcgaa
accgttcgtggaaaccgcgatcaacctggcacgtcaatctcactgcacttatcataacggcgacgcgcatacctctc
cggatgagctgacccgcaaacgcgttctgtctgtaatcactgaaccgattctgccgtttgaacgctaaggatccgaat
tcgagctccgtcgacaagcttgcggccgcactcgagcaccaccaccaccaccactgagatccggctgctaacaa
agcccgaaaggaagctgagttggctgctgccaccgctgagcaataactagcataaccccttggggcctctaaacg
ggtcttgaggggtttttgctgaaaggaggaactatatccggat

(SEQ ID NO:30)

Figure 137C

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagcgtgaccgctaca
cttgccagcgccctagcgcccgctcctttcgctttcttcccttcctttctcgccacgttcgccggctttccccgtcaagctctaa
atcgggggctccctttagggttccgatttagtgctttacggcacctcgaccccaaaaaacttgattagggtgatggttcac
gtagtgggccatcgccctgatagacggtttttcgccctttgacgttggagtccacgttctttaatagtggactcttgttccaaa
ctggaacaacactcaaccctatctcggtctattcttttgatttataagggattttgccgatttcggcctattggttaaaaaatga
gctgatttaacaaaaatttaacgcgaatttaacaaaatattaacgtttacaatttcaggtggcacttttcggggaaatgtgc
gcggaacccctatttgtttatttttctaaatacattcaaatatgtatccgctcatgaattaattcttagaaaaactcatcgagca
tcaaatgaaactgcaatttattcatatcaggattatcaataccatatttttgaaaaagccgtttctgtaatgaaggagaaaa
ctcaccgaggcagttccataggatggcaagatcctggtatcggtctgcgattccgactcgtccaacatcaatacaacct
attaatttcccctcgtcaaaaataaggttatcaagtgagaaatcaccatgagtgacgactgaatccggtgagaatggca
aaagtttatgcatttctttccagacttgttcaacaggccagccattacgctcgtcatcaaaatcactcgcatcaaccaaac
cgttattcattcgtgattgcgcctgagcgagacgaaatacgcgatcgctgttaaaaggacaattacaaacaggaatcg
aatgcaaccggcgcaggaacactgccagcgcatcaacaatattttcacctgaatcaggatattcttctaatacctggaat
gctgttttcccggggatcgcagtggtgagtaaccatgcatcatcaggagtacggataaaatgcttgatggtcggaagag
gcataaattccgtcagccagtttagtctgaccatctcatctgtaacatcattggcaacgctacctttgccatgtttcagaaac
aactctggcgcatcgggcttcccatacaatcgatagattgtcgcacctgattgcccgacattatcgcgagcccatttatac
ccatataaatcagcatccatgttggaatttaatcgcggcctagagcaagacgtttcccgttgaatatggctcataacaccc
cttgtattactgtttatgtaagcagacagttttattgttcatgaccaaaatcccttaacgtgagttttcgttccactgagcgtcag
accccgtagaaaagatcaaaggatcttcttgagatccttttttttctgcgcgtaatctgctgcttgcaaacaaaaaaaccac
cgctaccagcggtggtttgtttgccggatcaagagctaccaactctttttccgaaggtaactggcttcagcagagcgcag
ataccaaatactgtccttctagtgtagccgtagttaggccaccacttcaagaactctgtagcaccgcctacatacctcgct
ctgctaatcctgttaccagtggctgctgccagtggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccg
gataaggcgcagcggtcgggctgaacgggggggttcgtgcacacagcccagcttggagcgaacgacctacaccga
actgagatacctacagcgtgagctatgagaaagcgccacgcttcccgaagggagaaaggcggacaggtatccggt
aagcggcagggtcggaacaggagagcgcacgagggagcttccagggggaaacgcctggtatctttatagtcctgtc
gggtttcgccacctctgacttgagcgtcgatttttgtgatgctcgtcaggggggcggagcctatggaaaaacgccagca
acgcggccttttacggttcctggccttttgctggccttttgctcacatgttctttcctgcgttatcccctgattctgtggataaccg
tattaccgcctttgagtgagctgataccgctcgccgcagccgaacgaccgagcgcagcgagtcagtgagcgaggaa
gcggaagagcgcctgatgcggtattttctccttacgcatctgtgcggtatttcacaccgcatatatggtgcactctcagtac
aatctgctctgatgccgcatagttaagccagtatacactccgctatcgctacgtgactgggtcatggctgcgccccgaca
cccgccaacacccgctgacgcgccctgacgggcttgtctgctcccggcatccgcttacagacaagctgtgaccgtctc
cgggagctgcatgtgtcagaggttttcaccgtcatcaccgaaacgcgcgaggcagctgcggtaaagctcatcagcgt
ggtcgtgaagcgattcacagatgtctgcctgttcatccgcgtccagctcgttgagtttctccagaagcgttaatgtctggctt
ctgataaagcgggccatgttaagggcggttttttcctgtttggtcactgatgcctccgtgtaagggggatttctgttcatggg
ggtaatgataccgatgaaacgagagaggatgctcacgatacgggttactgatgatgaacatgcccggttactggaac
gttgtgagggtaaacaactggcggtatggatgcggcgggaccagagaaaaatcactcagggtcaatgccagcgctt
cgttaatacagatgtaggtgttccacagggtagccagcagcatcctgcgatgcagatccggaacataatggtgcaggg
cgctgacttccgcgtttccagactttacgaaacacggaaaccgaagaccattcatgttgttgctcaggtcgcagacgtttt
gcagcagcagtcgcttcacgttcgctcgcgtatcggtgattcattctgctaaccagtaaggcaaccccgccagcctagc
cgggtcctcaacgacaggagcacgatcatgcgcacccgtggggccgccatgccggcgataatggcctgcttctcgcc
gaaacgtttggtggcgggaccagtgacgaaggcttgagcgagggcgtgcaagattccgaataccgcaagcgacag
gccgatcatcgtcgcgctccagcgaaagcggtcctcgccgaaaatgacccagagcgctgccggcacctgtcctacg
agttgcatgataaagaagacagtcataagtgcggcgacgatagtcatgccccgcgcccaccggaaggagctgactg
ggttgaaggctctcaagggcatcggtcgagatcccggtgcctaatgagtgagctaacttacattaattgcgttgcgctca
ctgcccgctttccagtcgggaaacctgtcgtgccagctgcattaatgaatcggccaacgcgcggggagaggcggtttg
cgtattgggcgccagggtggtttttcttttcaccagtgagacgggcaacagctgattgcccttcaccgcctggccctgaga
gagttgcagcaagcggtccacgctggtttgccccagcaggcgaaaatcctgtttgatggtggttaacggcgggatataa
catgagctgtcttcggtatc

Figure 137D

gtcgtatcccactaccgagatatccgcaccaacgcgcagcccggactcggtaatggcgcgcattgcgcccagcgc
catctgatcgttggcaaccagcatcgcagtgggaacgatgccctcattcagcatttgcatggtttgttgaaaaccggac
atggcactccagtcgccttcccgttccgctatcggctgaatttgattgcgagtgagatatttatgccagccagccagacg
cagacgcgccgagacagaacttaatgggcccgctaacagcgcgatttgctggtgacccaatgcgaccagatgctc
cacgcccagtcgcgtaccgtcttcatgggagaaaataatactgttgatgggtgtctggtcagagacatcaagaaataa
cgccggaacattagtgcaggcagcttccacagcaatggcatcctggtcatccagcggatagttaatgatcagcccac
tgacgcgttgcgcgagaagattgtgcaccgccgctttacaggcttcgacgccgcttcgttctaccatcgacaccacca
cgctggcacccagttgatcggcgcgagatttaatcgccgcgacaatttgcgacggcgcgtgcagggccagactgga
ggtggcaacgccaatcagcaacgactgtttgcccgccagttgttgtgccacgcggttgggaatgtaattcagctccgc
catcgccgcttccactttttcccgcgttttcgcagaaacgtggctggcctggttcaccacgcgggaaacggtctgataa
gagacaccggcatactctgcgacatcgtataacgttactggtttcacattcaccaccctgaattgactctcttccgggcg
ctatcatgccataccgcgaaaggttttgcgccattcgatggtgtccgggatctcgacgctctcccttatgcgactcctgca
ttaggaagcagcccagtagtaggttgaggccgttgagcaccgccgccgcaaggaatggtgcatgcaaggagatg
gcgcccaacagtcccccggccacggggcctgccaccatacccacgccgaaacaagcgctcatgagcccgaagt
ggcgagcccgatcttccccatcggtgatgtcggcgatataggcgccagcaaccgcacctgtggcgccggtgatgcc
ggccacgatgcgtccggcgtagaggatcgagatctcgatcccgcgaaattaatacgactcactataggggaattgtg
agcggataacaattcccctctagaaataattttgtttaactttaagaaggagatatacatatgcgttgtagcgtgtccacc
gaaaatgtgtctttcaccgaaactgaaaccgaaacgcgtcgttctgcgaactacgaacctaacagctgggactatga
ttacctgctgtcctccgacacggacgagtccatcgaagtatacaaagacaaagcgaaaaagctggaagccgaagt
tcgtcgcgagattaataacgaaaaagcagaatttctgaccctgccggaactgattgacaacgtccagcgcctgggc
ctgggttaccgtttcgagtctgatatccgtcgtgcgctggatcgcttcgtttcctccggcggcttcgatgcggtaaccaag
acttccctgcacgcgacggcactgtctttccgtctgctgcgtcaacacggttttgaggtttctcaggaagcgttcagcgg
cttcaaagaccaaaacggcaacttcctgaaaaacctgaaggaagatatcaaagctatcctgagcctgtacgaggc
cagcttcctggctctggaaggcgaaaacatcctggacgaggcgaaggttttcgcaatctctcatctgaaagaactgtc
tgaagaaaagatcggtaaagatctggcagaacaggtgaaccatgcactggaactgccactgcatcgccgtactca
gcgtctggaagcagtatggtctatcgaggcctaccgtaaaaaggaggacgcggatcaggttctgctggagctggca
attctggattacaacatgatccagtctgtataccagcgtgatctgcgtgaaacgtcccgttggtggcgtcgtgtgggtctg
gcgaccaaactgcactttgctcgtgaccgcctgattgagagcttctactgggccgtgggtgtagcattcgaaccgcaat
actccgactgccgtaactccgtcgcaaaaatgttttctttcgtaaccattatcgacgatatctacgatgtatacggcaccc
tggacgaactggagctgtttactgacgcagttgagcgttgggacgtaaacgccatcgacgatctgccggattacatga
aactgtgctttctggctctgtataacactattaacgaaatcgcctacgacaacctgaaagataaaggtgagaacatcct
gccgtatctgaccaaagcctgggctgacctgtgcaacgctttcctgcaagaagccaagtggctgtacaacaaatcta
ctccgacctttgacgaatacttcggcaacgcatggaaatcctcttctggcccgctgcaactggtgttcgcttacttcgctgt
cgtgcagaacattaaaaaggaagagatcgataacctgcaaaaataccatgacatcatctctcgtccttcccatatcttc
cgtctgtgcaatgacctggctagcgcgtctgcggaaattgcgcgtggtgaaaccgcaaatagcgtttcttgttacatgc
gcactaaaggtatctccgaagaactggctaccgaaagcgtgatgaatctgatcgatgaaacctggaaaaagatga
acaaggaaaaactgggtggtagcctgttcgcgaaaccgttcgtggaaaccgcgatcaacctggcacgtcaatctca
ctgcacttatcataacggcgacgcgcatacctctccggatgagctgacccgcaaacgcgttctgtctgtaatcactga
accgattctgccgtttgaacgctaaggatccgaattcgagctccgtcgacaagcttgcggccgcactcgagcaccac
caccaccaccactgagatccggctgctaacaaagcccgaaaggaagctgagttggctgctgccaccgctgagca
ataactagcataaccccttggggcctctaaacgggtcttgaggggttttttgctgaaaggaggaactatatccggat

(SEQ ID NO:31)

Figure 137E

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagcgtgaccgctacact
tgccagcgccctagcgcccgctcctttcgctttcttcccttcctttctcgccacgttcgccggctttccccgtcaagctctaaatc
gggggctccctttagggttccgatttagtgctttacggcacctcgaccccaaaaaacttgattagggtgatggttcacgtagt
gggccatcgccctgatagacggtttttcgccctttgacgttggagtccacgttctttaatagtggactcttgttccaaactggaa
caacactcaaccctatctcggtctattcttttgatttataagggattttgccgatttcggcctattggttaaaaaatgagctgattt
aacaaaaatttaacgcgaattttaacaaaatattaacgtttacaatttcaggtggcacttttcggggaaatgtgcgcggaac
ccctatttgtttatttttctaaatacattcaaatatgtatccgctcatgaattaattcttagaaaaactcatcgagcatcaaatgaa
actgcaatttattcatatcaggattatcaataccatatttttgaaaaagccgtttctgtaatgaaggagaaaactcaccgagg
cagttccataggatggcaagatcctggtatcggtctgcgattccgactcgtccaacatcaatacaacctattaatttcccctc
gtcaaaaataaggttatcaagtgagaaatcaccatgagtgacgactgaatccggtgagaatggcaaaagtttatgcattt
ctttccagacttgttcaacaggccagccattacgctcgtcatcaaaatcactcgcatcaaccaaaccgttattcattcgtgatt
gcgcctgagcgagacgaaatacgcgatcgctgttaaaaggacaattacaaacaggaatcgaatgcaaccggcgcagg
gaacactgccagcgcatcaacaatattttcacctgaatcaggatattcttctaatacctggaatgctgttttcccggggatcg
cagtggtgagtaaccatgcatcatcaggagtacggataaaatgcttgatggtcggaagaggcataaattccgtcagcca
gtttagtctgaccatctcatctgtaacatcattggcaacgctacctttgccatgtttcagaaacaactctggcgcatcgggctt
cccatacaatcgatagattgtcgcacctgattgcccgacattatcgcgagcccatttatacccatataaatcagcatccatg
ttggaatttaatcgcggcctagagcaagacgtttcccgttgaatatggctcataacacccttgtattactgtttatgtaagca
gacagttttattgttcatgaccaaaatcccttaacgtgagttttcgttccactgagcgtcagaccccgtagaaaagatcaaa
ggatcttcttgagatcctttttttctgcgcgtaatctgctgcttgcaaacaaaaaaaccaccgctaccagcggtggtttgtttgc
cggatcaagagctaccaactctttttccgaaggtaactggcttcagcagagcgcagataccaaatactgtccttctagtgta
gccgtagttaggccaccacttcaagaactctgtagcaccgcctacatacctcgctctgctaatcctgttaccagtggctgct
gccagtggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccggataaggcgcagcggtcgggctgaa
cgggggttcgtgcacacagcccagcttggagcgaacgacctacaccgaactgagatacctacagcgtgagctatga
gaaagcgccacgcttcccgaagggagaaaggcggacaggtatccggtaagcggcagggtcggaacaggagagc
gcacgagggagcttccagggggaaacgcctggtatctttatagtcctgtcgggtttcgccacctctgacttgagcgtcgattt
ttgtgatgctcgtcaggggggcggagcctatggaaaaacgccagcaacgcggccttttacggttcctggccttttgctggc
cttttgctcacatgttctttcctgcgttatcccctgattctgtggataaccgtattaccgcctttgagtgagctgataccgctcgcc
gcagccgaacgaccgagcgcagcgagtcagtgagcgaggaagcggaagagcgcctgatgcggtattttctccttacg
catctgtgcggtatttcacaccgcatatatggtgcactctcagtacaatctgctctgatgccgcatagttaagccagtataca
ctccgctatcgctacgtgactgggtcatggctgcgccccgacacccgccaacacccgctgacgcgccctgacgggcttg
tctgctcccggcatccgcttacagacaagctgtgaccgtctccgggagctgcatgtgtcagaggttttcaccgtcatcaccg
aaacgcgcgaggcagctgcggtaaagctcatcagcgtggtcgtgaagcgattcacagatgtctgcctgttcatccgcgtc
cagctcgttgagtttctccagaagcgttaatgtctggcttctgataaagcgggccatgttaagggcggttttttcctgtttggtca
ctgatgcctccgtgtaagggggatttctgttcatgggggtaatgataccgatgaaacgagagaggatgctcacgatacgg
gttactgatgatgaacatgcccggttactggaacgttgtgagggtaaacaactggcggtatggatgcggcgggaccaga
gaaaaatcactcagggtcaatgccagcgcttcgttaatacagatgtaggtgttccacagggtagccagcagcatcctgc
gatgcagatccggaacataatggtgcagggcgctgacttccgcgtttccagactttacgaaacacggaaaccgaagac
cattcatgttgttgctcaggtcgcagacgttttgcagcagcagtcgcttcacgttcgctcgcgtatcggtgattcattctgctaa
ccagtaaggcaaccccgccagcctagccgggtcctcaacgacaggagcacgatcatgcgcacccgtggggccgcc
atgccggcgataatggcctgcttctcgccgaaacgtttggtggcgggaccagtgacgaaggcttgagcgagggcgtgc
aagattccgaataccgcaagcgacaggccgatcatcgtcgcgctccagcgaaagcggtcctcgccgaaaatgaccc
agagcgctgccggcacctgtcctacgagttgcatgataaagaagacagtcataagtgcggcgacgatagtcatgcccc
gcgcccaccggaaggagctgactgggttgaaggctctcaagggcatcggtcgagatcccggtgcctaatgagtgagct
aacttacattaattgcgttgcgctcactgcccgctttccagtcgggaaacctgtcgtgccagctgcattaatgaatcggcca
acgcgcggggagaggcggtttgcgtattgggcgccagggtggtttttcttttcaccagtgagacgggcaacagctgattgc
ccttcaccgcctggccctgagagagttgcagcaagcggtccacgctggtttgccccagcaggcgaaaatcctgtttgatg
gtggttaacggcgggatataacatgagctgtcttcggtatc

Figure 137F

gtcgtatcccactaccgagatatccgcaccaacgcgcagcccggactcggtaatggcgcgcattgcgcccagcg
ccatctgatcgttggcaaccagcatcgcagtgggaacgatgccctcattcagcatttgcatggtttgttgaaaaccgg
acatggcactccagtcgccttcccgttccgctatcggctgaatttgattgcgagtgagatatttatgccagccagccag
acgcagacgcgccgagacagaacttaatgggcccgctaacagcgcgatttgctggtgacccaatgcgaccagat
gctccacgcccagtcgcgtaccgtcttcatgggagaaaataatactgttgatgggtgtctggtcagagacatcaaga
aataacgccggaacattagtgcaggcagcttccacagcaatggcatcctggtcatccagcggatagttaatgatca
gcccactgacgcgttgcgcgagaagattgtgcaccgccgctttacaggcttcgacgccgcttcgttctaccatcgac
accaccacgctggcacccagttgatcggcgcgagatttaatcgccgcgacaatttgcgacggcgcgtgcagggc
cagactggaggtggcaacgccaatcagcaacgactgtttgcccgccagttgttgtgccacgcggttgggaatgtaa
ttcagctccgccatcgccgcttccacttttcccgcgttttcgcagaaacgtggctggcctggttcaccacgcgggaaa
cggtctgataagagacaccggcatactctgcgacatcgtataacgttactggtttcacattcaccaccctgaattgact
ctcttccgggcgctatcatgccataccgcgaaaggttttgcgccattcgatggtgtccgggatctcgacgctctccctta
tgcgactcctgcattaggaagcagcccagtagtaggttgaggccgttgagcaccgccgccgcaaggaatggtgc
atgcaaggagatggcgcccaacagtcccccggccacggggcctgccaccatacccacgccgaaacaagcgct
catgagcccgaagtggcgagcccgatcttccccatcggtgatgtcggcgatataggcgccagcaaccgcacctgt
ggcgccggtgatgccggccacgatgcgtccggcgtagaggatcgagatctcgatcccgcgaaattaatacgactc
actataggggaattgtgagcggataacaattcccctctagaaataattttgtttaactttaagaaggagatatacatat
gcgttgtagcgtgtccaccgaaaatgtgtctttctctgaaactgaaaccgaaacgcgtcgttctgcgaactacgaacc
taacagctgggactatgattacctgctgtcctccgacacggacgagtccatcgaagtacacaaagacaaagcga
aaaagctggaagccgaagttcgtcgcgagattaataacgaaaaagcagaatttctgaccctgctggaactgattg
acaacgtccagcgcctgggcctgggttaccgtttcgagtctgatatccgtcgtgcgctggatcgcttcgtttcctccggc
ggcttcgatggcgtaaccaagacttccctgcacggtacggcactgtctttccgtctgctgcgtcaacacggttttgagg
tttctcaggaagcgttcagcggcttcaaagaccaaaacggcaacttcctggagaacctgaaggaagatatcaaag
ctatcctgagcctgtacgaggccagcttcctggctctggaaggcgaaaacatcctggacgaggcgaaggttttcgc
aatctctcatctgaaagaactgtctgaagaaaagatcggtaaagagctggcagaacaggtgtcccatgcactgga
actgccactgcatcgccgtactcagcgtctggaagcagtatggtctatcgaggcctaccgtaaaaaggaggacgc
gaaccaggttctgctggagctggcaattctggattacaacatgatccagtctgtataccagcgtgatctgcgtgaaac
gtcccgttggtggcgtcgtgtgggtctggcgaccaaactgcactttgctcgtgaccgcctgattgagagcttctactgg
gccgtgggtgtagcattcgaaccgcaatactccgactgccgtaactccgtcgcaaaaatgttttctttcgtaaccattat
cgacgatatctacgatgtatacggcaccctggacgaactggagctgtttactgatgcagttgagcgttgggacgtaa
acgccatcaacgacctgccggattacatgaaactgtgctttctggctctgtataacactattaacgaaatcgcctacg
acaacctgaaagataaaggtgagaacatcctgccgtatctgaccaaagcctgggctgacctgtgcaacgctttcct
gcaagaagccaagtggctgtacaacaaatctactccgacctttgacgactacttcggcaacgcatggaaatcctctt
ctggcccgctgcaactgatcttcgcttacttcgctgtcgtgcagaacattaaaaaggaagagatcgaaaacctgca
aaaataccatgacatcatctctcgtccttcccatatcttccgtctgtgcaatgacctggctagcgcgtctgcggaaattg
cgcgtggtgaaaccgcaaatagcgtttcttgttacatgcgcactaaaggtatctccgaagaactggctaccgaaag
cgtgatgaatctgatcgatgaaacctggaaaaagatgaacaaggaaaaactgggtggtagcctgttcgcgaaac
cgttcgtggaaaccgcgatcaacctggcacgtcaatctcactgcacttatcataacggcgacgcgcatacctctccg
gatgagctgacccgcaaacgcgttctgtctgtaatcactgaaccgattctgccgtttgaacgctaaggatccgaattc
gagctccgtcgacaagcttgcggccgcactcgagcaccaccaccaccaccactgagatccggctgctaacaaa
gcccgaaaggaagctgagttggctgctgccaccgctgagcaataactagcataaccccttggggcctctaaacgg
gtcttgaggggtttttgctgaaaggaggaactatatccggat

(SEQ ID NO:32)

Figure 137G

MRCSVSTENVSFSETETETRRSANYEPNSWDYDYLLSSDTDESIEVHKDKAK
KLEAEVRREINNEKAEFLTLLELIDNVQRLGLGYRFESDIRRALDRFVSSGGFD
GVTKTSLHGTALSFRLLRQHGFEVSQEAFSGFKDQNGNFLENLKEDIKAILSL
YEASFLALEGENILDEAKVFAISHLKELSEEKIGKELAEQVSHALELPLHRRTQ
RLEAVWSIEAYRKKEDANQVLLELAILDYNMIQSVYQRDLRETSRWWRRVGL
ATKLHFARDRLIESFYWAVGVAFEPQYSDCRNSVAKMFSFVTIIDDIYDVYGTL
DELELFTDAVERWDVNAINDLPDYMKLCFLALYNTINEIAYDNLKDKGENILPY
LTKAWADLCNAFLQEAKWLYNKSTPTFDDYFGNAWKSSSGPLQLIFAYFAVV
QNIKKEEIENLQKYHDIISRPSHIFRLCNDLASASAEIARGETANSVSCYMRTK
GISEELATESVMNLIDETWKKMNKEKLGGSLFAKPFVETAINLARQSHCTYHN
GDAHTSPDELTRKRVLSVITEPILPFER

(SEQ ID NO: 33)

Figure 137H

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagcgtgaccgctaca
cttgccagcgccctagcgcccgctcctttcgctttcttcccttcctttctcgccacgttcgccggctttccccgtcaagctctaa
atcgggggctccctttagggttccgatttagtgctttacggcacctcgaccccaaaaaacttgattagggtgatggttcac
gtagtgggccatcgccctgatagacggtttttcgccctttgacgttggagtccacgttctttaatagtggactcttgttccaaa
ctggaacaacactcaaccctatctcggtctattcttttgatttataagggattttgccgatttcggcctattggttaaaaaatga
gctgatttaacaaaaatttaacgcgaatttaacaaaatattaacgtttacaatttcaggtggcacttttcggggaaatgtgc
gcggaacccctatttgtttatttttctaaatacattcaaatatgtatccgctcatgaattaattcttagaaaaactcatcgagca
tcaaatgaaactgcaatttattcatatcaggattatcaataccatatttttgaaaaagccgtttctgtaatgaaggagaaaa
ctcaccgaggcagttccataggatggcaagatcctggtatcggtctgcgattccgactcgtccaacatcaatacaacct
attaatttcccctcgtcaaaaataaggttatcaagtgagaaatcaccatgagtgacgactgaatccggtgagaatggca
aaagtttatgcatttctttccagacttgttcaacaggccagccattacgctcgtcatcaaaatcactcgcatcaaccaaac
cgttattcattcgtgattgcgcctgagcgagacgaaatacgcgatcgctgttaaaaggacaattacaaacaggaatcg
aatgcaaccggcgcaggaacactgccagcgcatcaacaatattttcacctgaatcaggatattcttctaatacctggaat
gctgttttcccggggatcgcagtggtgagtaaccatgcatcatcaggagtacggataaaatgcttgatggtcggaagag
gcataaattccgtcagccagtttagtctgaccatctcatctgtaacatcattggcaacgctacctttgccatgtttcagaaac
aactctggcgcatcgggcttcccatacaatcgatagattgtcgcacctgattgcccgacattatcgcgagcccatttatac
ccatataaatcagcatccatgttggaatttaatcgcggcctagagcaagacgtttcccgttgaatatggctcataacaccc
cttgtattactgtttatgtaagcagacagttttattgttcatgaccaaaatcccttaacgtgagttttcgttccactgagcgtcag
accccgtagaaaagatcaaaggatcttcttgagatccttttttttctgcgcgtaatctgctgcttgcaaacaaaaaaaccac
cgctaccagcggtggtttgtttgccggatcaagagctaccaactctttttccgaaggtaactggcttcagcagagcgcag
ataccaaatactgtccttctagtgtagccgtagttaggccaccacttcaagaactctgtagcaccgcctacatacctcgct
ctgctaatcctgttaccagtggctgctgccagtggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccg
gataaggcgcagcggtcgggctgaacgggggttcgtgcacacagcccagcttggagcgaacgacctacaccga
actgagatacctacagcgtgagctatgagaaagcgccacgcttcccgaagggagaaaggcggacaggtatccggt
aagcggcagggtcggaacaggagagcgcacgagggagcttccagggggaaacgcctggtatctttatagtcctgtc
gggtttcgccacctctgacttgagcgtcgatttttgtgatgctcgtcaggggggcggagcctatggaaaaacgccagca
acgcggccttttacggttcctggccttttgctggccttttgctcacatgttctttcctgcgttatcccctgattctgtggataaccg
tattaccgcctttgagtgagctgataccgctcgccgcagccgaacgaccgagcgcagcgagtcagtgagcgaggaa
gcggaagagcgcctgatgcggtattttctccttacgcatctgtgcggtatttcacaccgcatatatggtgcactctcagtac
aatctgctctgatgccgcatagttaagccagtatacactccgctatcgctacgtgactgggtcatggctgcgccccgaca
cccgccaacacccgctgacgcgccctgacgggcttgtctgctcccggcatccgcttacagacaagctgtgaccgtctc
cgggagctgcatgtgtcagaggttttcaccgtcatcaccgaaacgcgcgaggcagctgcggtaaagctcatcagcgt
ggtcgtgaagcgattcacagatgtctgcctgttcatccgcgtccagctcgttgagtttctccagaagcgttaatgtctggctt
ctgataaagcgggccatgttaagggcggttttttcctgtttggtcactgatgcctccgtgtaagggggatttctgttcatggg
ggtaatgataccgatgaaacgagagaggatgctcacgatacgggttactgatgatgaacatgcccggttactggaac
gttgtgagggtaaacaactggcggtatggatgcggcgggaccagagaaaaatcactcagggtcaatgccagcgctt
cgttaatacagatgtaggtgttccacagggtagccagcagcatcctgcgatgcagatccggaacataatggtgcaggg
cgctgacttccgcgtttccagactttacgaaacacggaaaccgaagaccattcatgttgttgctcaggtcgcagacgtttt
gcagcagcagtcgcttcacgttcgctcgcgtatcggtgattcattctgctaaccagtaaggcaaccccgccagcctagc
cgggtcctcaacgacaggagcacgatcatgcgcacccgtggggccgccatgccggcgataatggcctgcttctcgcc
gaaacgtttggtggcgggaccagtgacgaaggcttgagcgagggcgtgcaagattccgaataccgcaagcgacag
gccgatcatcgtcgcgctccagcgaaagcggtcctcgccgaaaatgacccagagcgctgccggcacctgtcctacg
agttgcatgataaagaagacagtcataagtgcggcgacgatagtcatgccccgcgcccaccggaaggagctgactg
ggttgaaggctctcaagggcatcggtcgagatcccggtgcctaatgagtgagctaacttacattaattgcgttgcgctca
ctgcccgctttccagtcgggaaacctgtcgtgccagctgcattaatgaatcggccaacgcgcggggagaggcggtttg
cgtattgggcgccagggtggtttttcttttcaccagtgagacgggcaacagctgattgcccttcaccgcctggccctgaga
gagttgcagcaagcggtccacgctggtttgccccagcaggcgaaaatcctgtttgatggtggttaacggcgggatataa
catgagctgtcttcggtatc

Figure 137I

gtcgtatcccactaccgagatatccgcaccaacgcgcagcccggactcggtaatggcgcgcattgcgcccagcgc
catctgatcgttggcaaccagcatcgcagtgggaacgatgccctcattcagcatttgcatggtttgttgaaaaccggac
atggcactccagtcgccttcccgttccgctatcggctgaatttgattgcgagtgagatatttatgccagccagccagacg
cagacgcgccgagacagaacttaatgggcccgctaacagcgcgatttgctggtgacccaatgcgaccagatgctc
cacgcccagtcgcgtaccgtcttcatgggagaaaataatactgttgatgggtgtctggtcagagacatcaagaaata
acgccggaacattagtgcaggcagcttccacagcaatggcatcctggtcatccagcggatagttaatgatcagccc
actgacgcgttgcgcgagaagattgtgcaccgccgctttacaggcttcgacgccgcttcgttctaccatcgacaccac
cacgctggcacccagttgatcggcgcgagatttaatcgccgcgacaatttgcgacggcgcgtgcagggccagact
ggaggtggcaacgccaatcagcaacgactgtttgcccgccagttgttgtgccacgcggttgggaatgtaattcagctc
cgccatcgccgcttccacttttcccgcgttttcgcagaaacgtggctggcctggttcaccacgcgggaaacggtctga
taagagacaccggcatactctgcgacatcgtataacgttactggtttcacattcaccaccctgaattgactctcttccgg
gcgctatcatgccataccgcgaaaggttttgcgccattcgatggtgtccgggatctcgacgctctcccttatgcgactcc
tgcattaggaagcagcccagtagtaggttgaggccgttgagcaccgccgccgcaaggaatggtgcatgcaagga
gatggcgcccaacagtcccccggccacggggcctgccaccatacccacgccgaaacaagcgctcatgagcccg
aagtggcgagcccgatcttccccatcggtgatgtcggcgatataggcgccagcaaccgcacctgtggcgccggtga
tgccggccacgatgcgtccggcgtagaggatcgagatctcgatcccgcgaaattaatacgactcactataggggaa
ttgtgagcggataacaattcccctctagaaataattttgtttaactttaagaaggagatatacatatgcatatgcgttgtag
cgtgtccaccgaaaatgtgtctttcaccgaaactgaaaccgaaacgcgtcgttctgcgaactacgaacctaacagct
gggactatgattacctgctgtcctccgacacggacgagtccatcgaagtatacaaagacaaagcgaaaaagctgg
aagccgaagttcgtcgcgagattaataacgaaaaagcagaatttctgaccctgctggaactgattgacaacgtcca
gcgcctgggcctgggttaccgtttcgagtctgatatccgtcgtgcgctggatcgcttcgtttcctccggcggcttcgatgc
ggtaaccaagacttccctgcacgcgacggcactgtctttccgtctgctgcgtcaacacggttttgaggtttctcaggaag
cgttcagcggcttcaaagaccaaaacggcaacttcctggagaacctgaaggaagatatcaaagctatcctgagcct
gtacgaggccagcttcctggctctggaaggcgaaaacatcctggacgaggcgaaggttttcgcaatctctcatctga
aagaactgtctgaagaaaagatcggtaaagatctggcagaacaggtgaaccatgcactggaactgccactgcatc
gccgtactcagcgtctggaagcagtactgtctatcgaggcctaccgtaaaaaggaggacgcggatcaggttctgctg
gagctggcaattctggattacaacatgatccagtctgtataccagcgtgatctgcgtgaaacgtcccgttggtggcgtc
gtgtgggtctggcgaccaaactgcactttgctcgtgaccgcctgattgagagcttctactgggccgtgggtgtagcattc
gaaccgcaatactccgactgccgtaactccgtcgcaaaaatgttttctttcgtaaccattatcgacgatatctacgatgt
atacggcaccctggacgaactggagctgtttactaacgcagttgagcgttgggacgtaaacgccatcgacgatctgc
cggattacatgaaactgtgctttctggctctgtataacactattaacgaaatcgcctacgacaacctgaaagaaaaag
gtgagaacatcctgccgtatctgaccaaagcctgggctgacctgtgcaacgctttcctgcaagaagccaagtggctg
tacaacaaatctactccgacctttgacgaatacttcggcaacgcatggaaatcctcttctggcccgctgcaactggtgtt
cgcttacttcgctgtcgtgcagaacattaaaaaggaagagatcgaaaacctgcaaaaataccatgacatcatctctc
gtccttcccatatcttccgtctgtgcaatgacctggctagcgcgtctgcggaaattgcgcgtggtgaaaccgcaaatag
cgtttcttgttacatgcgcactaaaggtatctccgaagaactggctaccgaaagcgtgatgaatctgatcgatgaaac
ctggaaaaagatgaacaaggaaaaactgggtggtagcctgttcgcgaaaccgttcgtggaaaccgcgatcaacct
ggcacgtcaatctcactgcacttatcataacggcgacgcgcatacctctccggatgagctgacccgcaaacgcgttc
tgtctgtaatcactgaaccgattctgccgtttgaacgctaaggatccgaattcgagctccgtcgacaagcttgcggccg
cactcgagcaccaccaccaccaccactgagatccggctgctaacaaagcccgaaaggaagctgagttggctgct
gccaccgctgagcaataactagcataaccccttggggcctctaaacgggtcttgaggggttttttgctgaaaggagg
aactatatccggat

(SEQ ID NO:34)

Figure 137J

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagcgtgaccgctaca
cttgccagcgccctagcgcccgctcctttcgctttcttcccttcctttctcgccacgttcgccggctttccccgtcaagctctaa
atcgggggctccctttagggttccgatttagtgctttacggcacctcgaccccaaaaaacttgattagggtgatggttcac
gtagtgggccatcgccctgatagacggtttttcgccctttgacgttggagtccacgttctttaatagtggactcttgttccaaa
ctggaacaacactcaaccctatctcggtctattcttttgatttataagggattttgccgatttcggcctattggttaaaaaatga
gctgatttaacaaaaatttaacgcgaatttaacaaaatattaacgtttacaatttcaggtggcacttttcggggaaatgtgc
gcggaacccctatttgtttatttttctaaatacattcaaatatgtatccgctcatgaattaattcttagaaaaactcatcgagca
tcaaatgaaactgcaatttattcatatcaggattatcaataccatatttttgaaaaagccgtttctgtaatgaaggagaaaa
ctcaccgaggcagttccataggatggcaagatcctggtatcggtctgcgattccgactcgtccaacatcaatacaacct
attaatttcccctcgtcaaaaataaggttatcaagtgagaaatcaccatgagtgacgactgaatccggtgagaatggca
aaagtttatgcatttctttccagacttgttcaacaggccagccattacgctcgtcatcaaaatcactcgcatcaaccaaac
cgttattcattcgtgattgcgcctgagcgagacgaaatacgcgatcgctgttaaaaggacaattacaaacaggaatcg
aatgcaaccggcgcaggaacactgccagcgcatcaacaatattttcacctgaatcaggatattcttctaatacctggaat
gctgttttcccggggatcgcagtggtgagtaaccatgcatcatcaggagtacggataaaatgcttgatggtcggaagag
gcataaattccgtcagccagtttagtctgaccatctcatctgtaacatcattggcaacgctacctttgccatgtttcagaaac
aactctggcgcatcgggcttcccatacaatcgatagattgtcgcacctgattgcccgacattatcgcgagcccatttatac
ccatataaatcagcatccatgttggaatttaatcgcggcctagagcaagacgtttcccgttgaatatggctcataacaccc
cttgtattactgtttatgtaagcagacagttttattgttcatgaccaaaatcccttaacgtgagttttcgttccactgagcgtcag
accccgtagaaaagatcaaaggatcttcttgagatccttttttttctgcgcgtaatctgctgcttgcaaacaaaaaaaccac
cgctaccagcggtggtttgtttgccggatcaagagctaccaactctttttccgaaggtaactggcttcagcagagcgcag
ataccaaatactgtccttctagtgtagccgtagttaggccaccacttcaagaactctgtagcaccgcctacatacctcgct
ctgctaatcctgttaccagtggctgctgccagtggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccg
gataaggcgcagcggtcgggctgaacgggggttcgtgcacacagcccagcttggagcgaacgacctacaccga
actgagatacctacagcgtgagctatgagaaagcgccacgcttcccgaagggagaaaggcggacaggtatccggt
aagcggcagggtcggaacaggagagcgcacgagggagcttccagggggaaacgcctggtatctttatagtcctgtc
gggtttcgccacctctgacttgagcgtcgatttttgtgatgctcgtcaggggggcggagcctatggaaaaacgccagca
acgcggccttttacggttcctggccttttgctggccttttgctcacatgttctttcctgcgttatcccctgattctgtggataaccg
tattaccgcctttgagtgagctgataccgctcgccgcagccgaacgaccgagcgcagcgagtcagtgagcgaggaa
gcggaagagcgcctgatgcggtattttctccttacgcatctgtgcggtatttcacaccgcatatatggtgcactctcagtac
aatctgctctgatgccgcatagttaagccagtatacactccgctatcgctacgtgactgggtcatggctgcgccccgaca
cccgccaacacccgctgacgcgccctgacgggcttgtctgctcccggcatccgcttacagacaagctgtgaccgtctc
cgggagctgcatgtgtcagaggttttcaccgtcatcaccgaaacgcgcgaggcagctgcggtaaagctcatcagcgt
ggtcgtgaagcgattcacagatgtctgcctgttcatccgcgtccagctcgttgagtttctccagaagcgttaatgtctggctt
ctgataaagcgggccatgttaagggcggttttttcctgtttggtcactgatgcctccgtgtaagggggatttctgttcatggg
ggtaatgataccgatgaaacgagagaggatgctcacgatacgggttactgatgatgaacatgcccggttactggaac
gttgtgagggtaaacaactggcggtatggatgcggcgggaccagagaaaaatcactcagggtcaatgccagcgctt
cgttaatacagatgtaggtgttccacagggtagccagcagcatcctgcgatgcagatccggaacataatggtgcaggg
cgctgacttccgcgtttccagactttacgaaacacggaaaccgaagaccattcatgttgttgctcaggtcgcagacgtttt
gcagcagcagtcgcttcacgttcgctcgcgtatcggtgattcattctgctaaccagtaaggcaaccccgccagcctagc
cgggtcctcaacgacaggagcacgatcatgcgcacccgtggggccgccatgccggcgataatggcctgcttctcgcc
gaaacgtttggtggcgggaccagtgacgaaggcttgagcgagggcgtgcaagattccgaataccgcaagcgacag
gccgatcatcgtcgcgctccagcgaaagcggtcctcgccgaaaatgacccagagcgctgccggcacctgtcctacg
agttgcatgataaagaagacagtcataagtgcggcgacgatagtcatgccccgcgcccaccggaaggagctgactg
ggttgaaggctctcaagggcatcggtcgagatcccggtgcctaatgagtgagctaacttacattaattgcgttgcgctca
ctgcccgctttccagtcgggaaacctgtcgtgccagctgcattaatgaatcggccaacgcgcggggagaggcggtttg
cgtattgggcgccagggtggtttttcttttcaccagtgagacgggcaacagctgattgcccttcaccgcctggccctgaga
gagttgcagcaagcggtccacgctggtttgccccagcaggcgaaaatcctgtttgatggtggttaacggcgggatataa
catgagctgtcttcggtatc

Figure 137K

gtcgtatcccactaccgagatatccgcaccaacgcgcagcccggactcggtaatggcgcgcattgcgcccagcgc
catctgatcgttggcaaccagcatcgcagtgggaacgatgccctcattcagcatttgcatggtttgttgaaaaccggac
atggcactccagtcgccttcccgttccgctatcggctgaatttgattgcgagtgagatatttatgccagccagccagacg
cagacgcgccgagacagaacttaatgggcccgctaacagcgcgatttgctggtgacccaatgcgaccagatgctc
cacgcccagtcgcgtaccgtcttcatgggagaaaataatactgttgatgggtgtctggtcagagacatcaagaaataa
cgccggaacattagtgcaggcagcttccacagcaatggcatcctggtcatccagcggatagttaatgatcagcccac
tgacgcgttgcgcgagaagattgtgcaccgccgctttacaggcttcgacgccgcttcgttctaccatcgacaccacca
cgctggcacccagttgatcggcgcgagatttaatcgccgcgacaatttgcgacggcgcgtgcagggccagactgga
ggtggcaacgccaatcagcaacgactgtttgcccgccagttgttgtgccacgcggttgggaatgtaattcagctccgc
catcgccgcttccacttttcccgcgttttcgcagaaacgtggctggcctggttcaccacgcgggaaacggtctgataa
gagacaccggcatactctgcgacatcgtataacgttactggtttcacattcaccaccctgaattgactctcttccgggcg
ctatcatgccataccgcgaaaggttttgcgccattcgatggtgtccgggatctcgacgctctcccttatgcgactcctgca
ttaggaagcagcccagtagtaggttgaggccgttgagcaccgccgccgcaaggaatggtgcatgcaaggagatg
gcgcccaacagtcccccggccacggggcctgccaccatacccacgccgaaacaagcgctcatgagcccgaagt
ggcgagcccgatcttccccatcggtgatgtcggcgatataggcgccagcaaccgcacctgtggcgccggtgatgcc
ggccacgatgcgtccggcgtagaggatcgagatctcgatcccgcgaaattaatacgactcactataggggaattgtg
agcggataacaattcccctctagaaataattttgtttaactttaagaaggagatatacatatgtgctctgtttctaccgaga
acgtttccttcactgagacggaaaccgaggcacgtcgtagcgcgaactacgagccgaatagctgggactacgattt
cctgctgtcttccgatactgacgaatctattgaggtgtacaaagacaaagcaaagaaactggaggctgaagtgcgcc
gcgaaattaacaacgagaaagctgaattcctgactctgctggagctgatcgataacgtacagcgcctgggtctgggtt
accgcttcgaatctgatatccgtcgcgcactggatcgtttcgtaagcagcggcggtttcgatggcgtgaccaaaacga
gcctgcacgctaccgcgctgtccttccgtctgctgcgtcagcacggcttcgaagtttctcaggaagcattctccggtttca
aagatcaaaacggtaacttcctggaaaacctgaaagaagacactaaggcgatcctgagcctgtatgaggcaagct
ttctggccctggagggtgagaacatcctggatgaggcgcgcgtattctccatctcccatctgaaagagctgtctgaag
agaaaatcggtaaggaactggcagagcaggttaatcacgcactggaactgccgctgcatcgtcgtacccagcgtct
ggaggcggtttggtccatcgaagcgtaccgcaaaaaggaggatgctaaccaggttctgctggaactggccatcctg
gactacaacatgatccagtccgtttaccagcgtgatctgcgtgaaacctcccgttggtggcgccgtgtgggcctggcg
accaaactgcacttcgctaaggaccgcctgattgagtctttttactgggcagtcggcgttgcgttcgaacctcagtattct
gactgccgtaacagcgttgcgaaaatgttcagcttcgttactattatcgacgacatctacgacgtttacggtactctgga
cgagctggaactgtttaccgacgctgtcgaacgttgggatgttaacgccatcaacgatctgcctgactacatgaaact
gtgcttcctggcactgtataacacgatcaacgaaattgcatacgacaacctgaaagacaaaggtgaaaacatcctg
ccgtacctgactaaagcgtgggcggatctgtgtaacgcttttctgcaagaagcgaaatggctgtataacaaatccact
ccgacctttgacgattatttcggcaatgcctggaaatccagctctggcccgctgcaactgatcttcgcttattttgcggttgt
ccaaaacatcaaaaaggaggaaattgaaaacctgcaaaaataccacgatatcattagccgtccttctcatatctttcg
cctgtgcaacgacctggcaagcgcgtccgcagagatcgcacgtggcgaaaccgctaactctgtttcctgctacatgc
gcaccaagggcatttccgaagagctggcaaccgagagcgtaatgaatctgatcgacgaaacctgtaagaaaatg
aacaaagaaaaactgggtggctccctgttcgctaaaccgttcgtagagactgctattaacctggcacgtcagagcca
ctgcacctaccacaatggtgacgcacatactagcccggatgaactgactcgtaaacgtgtactgtctgttatcaccga
accgattctgccgttcgaacgttaactgcagctggtaggatccgaattcgagctccgtcgacaagcttgcggccgcac
tcgagcaccaccaccaccaccactgagatccggctgctaacaaagcccgaaaggaagctgagttggctgctgcc
accgctgagcaataactagcataaccccttggggcctctaaacgggtcttgaggggttttttgctgaaaggaggaact
atatccggat

(SEQ ID NO:35)

Figure 137L

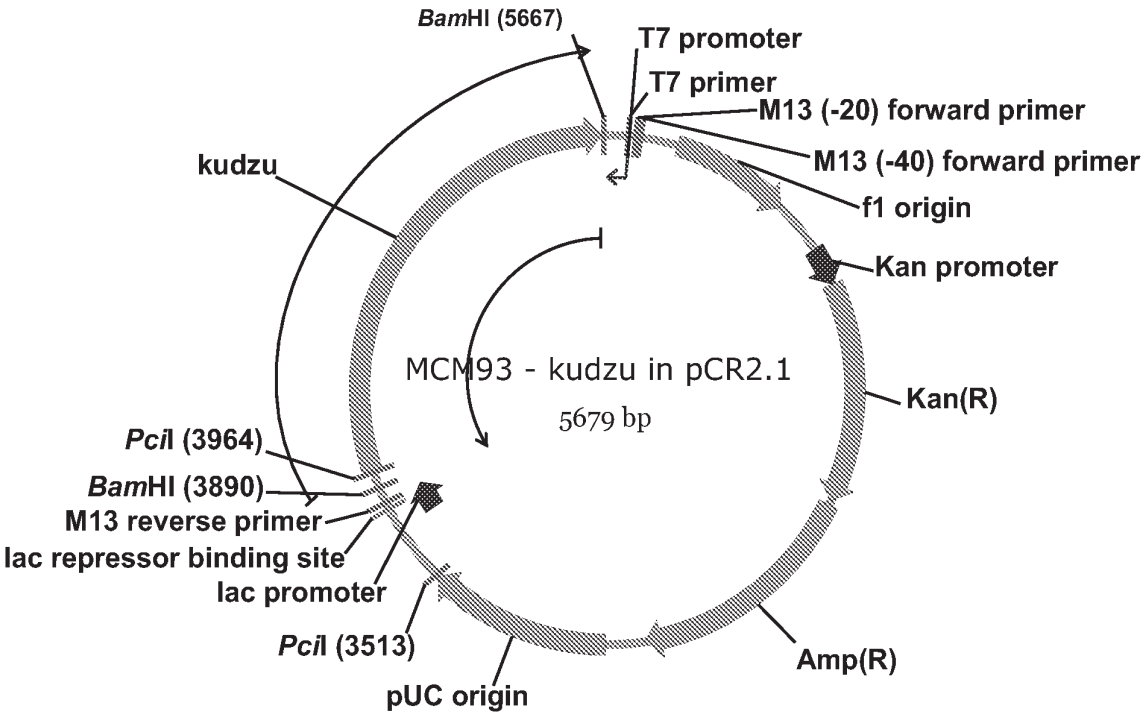

BamHI (5667)
T7 promoter
T7 primer
M13 (-20) forward primer
M13 (-40) forward primer
f1 origin
Kan promoter
Kan(R)
Amp(R)
pUC origin
PciI (3513)
lac promoter
lac repressor binding site
M13 reverse primer
BamHI (3890)
PciI (3964)
kudzu
MCM93 - kudzu in pCR2.1
5679 bp

Figure 137M

Plasmid MCM93 = pCR2.1-Kudzu
aagggcgaatactgcagatatccatcacactggcggccgctcgagcatgcatctagagggcccaattcgccctatagtgagtc
gtattacaattcactggccgtcgttttacaacgtcgtgactgggaaaaccctggcgttacccaacttaatcgccttgcagcacatcc
ccctttcgccagctggcgtaatagcgaagaggcccgcaccgatcgcccttcccaacagttgcgcagcctgaatggcgaatgga
cgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagcgtgaccgctacacttgccagcgccctagcgc
ccgctcctttcgctttcttcccttcctttctcgccacgttcgccggctttccccgtcaagctctaaatcgggggctccctttagggttccga
tttagtgctttacggcacctcgaccccaaaaaacttgattagggtgatggttcacgtagtgggccatcgccctgatagacggtttttc
gccctttgacgttggagtccacgttctttaatagtggactcttgttccaaactggaacaacactcaaccctatctcggtctattcttttga
tttataagggattttgccgatttcggcctattggttaaaaaatgagctgatttaacaaaaatttaacgcgaattttaacaaaattcagg
gcgcaagggctgctaaaggaagcggaacacgtagaaagccagtccgcagaaacggtgctgaccccggatgaatgtcagct
actgggctatctggacaagggaaaacgcaagcgcaaagagaaagcaggtagcttgcagtgggcttacatggcgatagctag
actgggcggttttatggacagcaagcgaaccggaattgccagctggggcgccctctggtaaggttgggaagccctgcaaagta
aactggatggctttcttgccgccaaggatctgatggcgcaggggatcaagatctgatcaagagacaggatgaggatcgtttcgc
atgattgaacaagatggattgcacgcaggttctccggccgcttgggtggagaggctattcggctatgactgggcacaacagaca
atcggctgctctgatgccgccgtgttccggctgtcagcgcaggggcgcccggttctttttgtcaagaccgacctgtccggtgccctg
aatgaactgcaggacgaggcagcgcggctatcgtggctggccacgacgggcgttccttgcgcagctgtgctcgacgttgtcact
gaagcgggaagggactggctgctattgggcgaagtgccggggcaggatcCcctgtcatcccaccttgctcctgccgagaaag
tatccatcatggctgatgcaatgcggcggctgcatacgcttgatccggctacctgcccattcgaccaccaagcgaaacatcgcat
cgagcgagcacgtactcggatggaagccggtcttgtcgatcaggatgatctggacgaagagcatcaggggctcgcgccagcc
gaactgttcgccaggctcaaggcgcgcatgcccgacggcgaggatctcgtcgtgacccatggcgatgcctgcttgccgaatatc
atggtggaaaatggccgcttttctggattcatcgactgtggccggctgggtgtggcggaccgctatcaggacatagcgttggctac
ccgtgatattgctgaagagcttggcggcgaatgggctgaccgcttcctcgtgctttacggtatcgccgctcccgattcgcagcgcat
cgccttctatcgccttcttgacgagttcttctgaattgaaaaaggaagagtatgagtattcaacatttccgtgtcgcccttattccctttttt
gcggcattttgccttcctgtttttgctcacccagaaacgctggtgaaagtaaaagatgctgaagatcagttgggtgcacgagtgggt
tacatcgaactggatctcaacagcggtaagatccttgagagttttcgccccgaagaacgttttccaatgatgagcacttttaaagttc
tgctatgtggcgcggtattatcccgtattgacgccgggcaagagcaactcggtcgccgcatacactattctcagaatgacttggttg
agtactcaccagtcacagaaaagcatcttacggatggcatgacagtaagagaattatgcagtgctgccataaccatgagtgata
acactgcggccaacttacttctgacaacgatcggaggaccgaaggagctaaccgcttttttgcacaacatgggggatcatgtaa
ctcgccttgatcgttgggaaccggagctgaatgaagccataccaaacgacgagcgtgacaccacgatgcctgtagcaatggc
aacaacgttgcgcaaactattaactggcgaactacttactctagcttcccggcaacaattaatagactggatggaggcggataa
agttgcaggaccacttctgcgctcggcccttccggctggctggtttattgctgataaatctggagccggtgagcgtgggtctcgcgg
tatcattgcagcactggggccagatggtaagccctcccgtatcgtagttatctacacgacggggagtcaggcaactatggatgaa
cgaaatagacagatcgctgagataggtgcctcactgattaagcattggtaactgtcagaccaagtttactcatatatactttagattg
atttaaaacttcatttttaatttaaaaggatctaggtgaagatccttttgataatctcatgaccaaaatcccttaacgtgagttttcgttcc
actgagcgtcagaccccgtagaaaagatcaaaggatcttcttgagatcctttttttctgcgcgtaatctgctgcttgcaaacaaaaa
aaccaccgctaccagcggtggtttgtttgccggatcaagagctaccaactctttttccgaaggtaactggcttcagcagagcgca
gataccaaatactgttcttctagtgtagccgtagttaggccaccacttcaagaactctgtagcaccgcctacatacctcgctctgcta
atcctgttaccagtggctgctgccagtggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccggataaggcgca
gcggtcgggctgaacgggggttcgtgcacacagcccagcttggagcgaacgacctacaccgaactgagatacctacagcg
tgagctatgagaaagcgccacgcttcccgaagggagaaaggcggacaggtatccggtaagcggcagggtcggaacagga
gagcgcacgagggagcttccagggggaaacgcctggtatctttatagtcctgtcgggtttcgccacctctgacttgagcgtcgattt
ttgtgatgctcgtcaggggggcggagcctatggaaaaacgccagcaacgcggccttttacggttcctggccttttgctggccttttg
ctcacatgttctttcctgcgttatcccctgattctgtggataaccgtattaccgcctttgagtgagctgataccgctcgccgcagccga
acgaccgagcgcagcgagtcagtgagcgaggaagcggaagagcgcccaatacgcaaaccgcctctccccgcgcgttggc
cgattcattaatgcagctggcacgacaggtttcccgactggaaagcgggcagtgagcgcaacgcaattaatgtgagttagctca
ctcattaggcaccccaggctttacactttatgcttccggctcgtatgttgtgtggaattgtgagcggataacaatttcacacaggaaa
cagctatgaccatgattacgccaagcttggtaccgagctcggatccactagtaacggccgccagtgtgctggaattcgcccttgat
catgcattcgcccttaggaggtaaaaaaacatgtgtgcgacctcttctcaatttactcagattaccgagcataattcccgtcgttccg
caaactatcagccaaacctgtggaatttcgaattcctgcaatccctggagaacgacctg

Figure 137N

aaagtggaaaagctggaggagaaagcgaccaaactggaggaagaagttcgctgcatgatcaaccgtgtagacaccca
gccgctgtccctgctggagctgatcgacgatgtgcagcgcctgggtctgacctacaaatttgaaaaagacatcatta
aagccctggaaaacatcgtactgctggacgaaaacaaaaagaacaaatctgacctgcacgcaaccgctctgtctttc
cgtctgctgcgtcagcacggtttcgaggtttctcaggatgtttttgagcgtttcaaggataaagaaggtggtttcag
cggtgaactgaaaggtgacgtccaaggcctgctgagcctgtatgaagcgtcttacctgggtttcgagggtgagaacc
tgctggaggaggcgcgtacctttccatcacccacctgaagaacaacctgaaagaaggcattaataccaaggttgca
gaacaagtgagccacgccctggaactgccatatcaccagcgtctgcaccgtctggaggcacgttggttcctggataa
atacgaaccgaaagaaccgcatcaccagctgctgctggagctggcgaagctggattttaacatggtacagaccctgc
accagaaagagctgcaagatctgtcccgctggtggaccgagatgggcctggctagcaaactggattttgtacgcgac
cgcctgatggaagtttatttctgggcactgggtatggcgccagacccgcagtttggtgaatgtcgcaaagctgttac
taaaatgtttggtctggtgacgatcatcgatgacgtgtatgacgtttatggcactctggacgaactgcaactgttca
ccgatgctgtagagcgctgggacgttaacgctattaacaccctgccggactatatgaaactgtgtttcctggcactg
tacaacaccgttaacgacacgtcctattctattctgaaagagaaaggtcataacaacctgtcctatctgacgaaaag
ctggcgtgaactgtgcaaagcctttctgcaagaggcgaaatggtccaacaacaaaattatcccggctttctccaagt
acctggaaaacgccagcgtttcctcctccggtgtagcgctgctggcgccgtcttacttttccgtatgccagcagcag
gaagacatctccgaccacgcgctgcgttccctgaccgacttccatggtctggtgcgttctagctgcgttatcttccg
cctgtgcaacgatctggccacctctgcggcggagctggaacgtggcgagactaccaattctatcattagctacatgc
acgaaaacgatggtaccagcgaggaacaggcccgcgaagaactgcgtaaactgatcgacgccgaatggaaaaagatg
aatcgtgaacgcgttagcgactccaccctgctgcctaaagcgttcatggaaatcgcagttaacatggcacgtgtttc
ccactgcacctaccagtatggcgatggtctgggtcgcccagactacgcgactgaaaaccgcatcaaactgctgctga
ttgacccttttcccgattaaccagctgatgtatgtctaactgcagggatccgtcgaccg

(SEQ ID NO:36)

Figure 137O

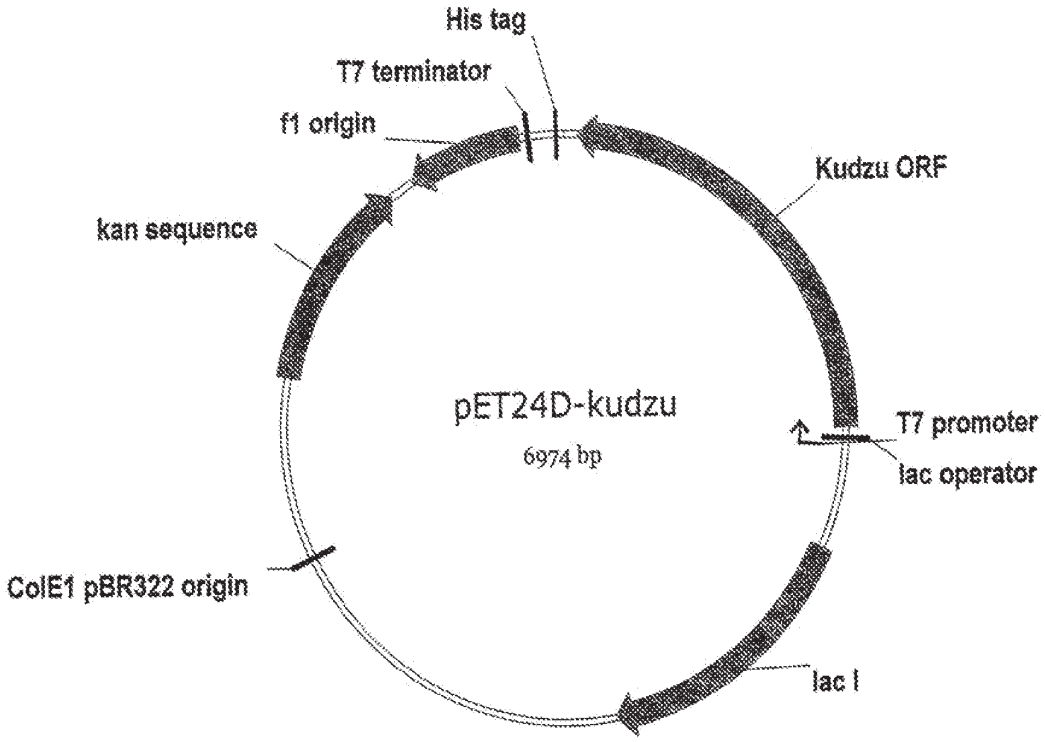

His tag
T7 terminator
f1 origin
Kudzu ORF
kan sequence
pET24D-kudzu
6974 bp
T7 promoter
lac operator
ColE1 pBR322 origin
lac I

Figure 137P

pET24D-Kudzu Kudzu IspS ORF 48-1742 (complementary)

gtgcggccgcaagcttgtcgacggagctcgaattcggatccctgcagttagacatacatcagctggttaatcgggaa
agggtcaatcagcagcagtttgatgcggttttcagtcgcgtagtctgggcgacccagaccatcgccatactggtagg
tgcagtgggaaacacgtgccatgttaactgcgatttccatgaacgctttaggcagcagggtggagtcgctaacgcgt
tcacgattcatctttttccattcggcgtcgatcagtttacgcagttcttcgcgggcctgttcctcgctggtaccatc
gttttcgtgcatgtagctaatgatagaattggtagtctcgccacgttccagctccgccgcagaggtggccagatcgt
tgcacaggcggaagataacgcagctagaacgcaccagaccatggaagtcggtcagggaacgcagcgcgtggtcggag
atgtcttcctgctgctggcatacggaaaagtaagacggcgccagcagcgctacaccggaggaggaaacgctggcgtt
ttccaggtacttggagaaagccgggataatttttgttgttggaccatttcgcctcttgcagaaaggctttgcacagtt
cacgccagcttttcgtcagataggacaggttgttatgacctttctctttcagaatagaataggacgtgtcgttaacg
gtgttgtacagtgccaggaaacacagtttcatatagtccggcagggtgttaatagcgttaacgtcccagcgctctac
agcatcggtgaacagttgcagttcgtccagagtgccataaacgtcatacacgtcatcgatgatcgtcaccagaccaa
acattttagtaacagctttgcgacattcaccaaactgcgggtctggcgccatacccagtgcccagaaataaacttcc
atcaggcggtcgcgtacaaaatccagtttgctagccaggcccatctcggtccaccagcgggacagatcttgcagctc
tttctggtgcagggtctgtaccatgttaaaatccagcttcgccagctccagcagcagctggtgatgcggttctttcg
gttcgtatttatccaggaaccaacgtgcctccagacggtgcagacgctggtgatatggcagttccagggcgtggctc
acttgttctgcaaccttggtattaatgccttctttcaggttgttcttcaggtgggtgatggaaaaggtacgcgcctc
ctccagcaggttctcaccctcgaaacccaggtaagacgcttcatacaggctcagcaggccttggacgtcacctttca
gttcaccgctgaaaccaccttctttatccttgaaacgctcaaaaacatcctgagaaacctcgaaaccgtgctgacgc
agcagacggaaagacagagcggttgcgtgcaggtcagatttgttctttttgttttcgtccagcagtacgatgttttc
cagggctttaatgatgtctttttcaaatttgtaggtcagacccaggcgctgcacatcgtcgatcagctccagcaggg
acagcggctgggtgtctacacggttgatcatgcagcgaacttcttcctccagtttggtcgctttctcctccagcttt
tccactttcaggtcgttctccagggattgcaggaattcgaaattccacaggtttggctgatagtttgcggaacgacg
ggaattatgctcggtaatctgagtaaattgagaagaggtcgcacacatggtatatctccttcttaaagttaaacaaa
attatttctagaggggaattgttatccgctcacaattcccctatagtgagtcgtattaatttcgcgggatcgagatc
tcgatcctctacgccggacgcatcgtggccggcatcaccggcgccacaggtgcggttgctggcgcctatatcgccga
catcaccgatggggaagatcgggctcgccacttcgggctcatgagcgcttgtttcggcgtgggtatggtggcaggcc
ccgtggccgggggactgttgggcgccatctccttgcatgcaccattccttgcggcggcggtgctcaacggcctcaac
ctactactgggctgcttcctaatgcaggagtcgcataagggagagcgtcgagatcccggacaccatcgaatggcgca
aaacctttcgcggtatggcatgatagcgcccggaagagagtcaattcagggtggtgaatgtgaaaccagtaacgtta
tacgatgtcgcagagtatgccggtgtctcttatcagaccgtttcccgcgtggtgaaccaggccagccacgtttctgc
gaaaacgcgggaaaaagtggaagcggcgatggcggagctgaattacattcccaaccgcgtggcacaacaactggcgg
gcaaacagtcgttgctgattggcgttgccacctccagtctggccctgcacgcgccgtcgcaaattgtcgcggcgatt
aaatctcgcgccgatcaactgggtgccagcgtggtggtgtcgatggtagaacgaagcggcgtcgaagcctgtaaagc
ggcggtgcacaatcttctcgcgcaacgcgtcagtgggctgatcattaactatccgctggatgaccaggatgccattg
ctgtggaagctgcctgcactaatgttccggcgttatttcttgatgtctctgaccagacacccatcaacagtattatt
ttctcccatgaagacggtacgcgactgggcgtggagcatctggtcgcattgggtcaccagcaaatcgcgctgttagc
gggcccattaagttctgtctcggcgcgtctgcgtctggctggctggcataaatatctcactcgcaatcaaattcagc
cgatagcggaacgggaaggcgactggagtgccatgtccggttttcaacaaaccatgcaaatgctgaatgagggcatc
gttcccactgcgatgctggttgccaacgatcagatggcgctgggcgcaatgcgcgccattaccgagtccgggctgcg
cgttggtgcggatatctcggtagtgggatacgacgataccgaagacagctcatgttatatcccgccgttaaccacca
tcaaacaggattttcgcctgctggggcaaaccagcgtggaccgcttgctgcaactctctcagggccaggcggtgaag
ggcaatcagctgttgcccgtctcactggtgaaaagaaaaaccaccctggcgcccaatacgcaaaccgcctctccccg
cgcgttggccgattcattaatgcagctggcacgacaggtttcccgactggaaagcgggcagtgagcgcaacgcaatt
aatgtaagttagctcactcattaggcaccgggatctcgaccgatgcccttgagagccttcaacccagtcagctcctt
ccggtgggcgcggggcatgactatcgtcgccgcacttatgactgtcttctttatcatgcaactcgtaggacaggtgc
cggcagcgctctgggtcattttcggcgaggaccgctttcgctggagcgcgacgatgatcggcctgtcgcttgcggta
ttcggaatcttgcacgccctcgctcaagccttcgtcactggtcccgccaccaaacgtttcggcgagaagcaggccat
tatcgccggcatggcggccccacgggtgcgcatgatcgtgctcctgtcgttgaggacccggctaggctggcggggtt
gccttactggttagcagaatgaatcaccgatacgcgagcgaacgtgaagcgactgctgctgcaaaacgtctgcgacc
tgagcaacaacatgaatggtcttcggtttccgtgtttcgtaaagtctggaaacgcggaagtcagcgccctgcaccat
tatgttccggatctgcatcgcaggatgctgctggctaccctgtggaacacctacatctgtattaacgaagcgctggc
attgaccctgagtgatttttctctggtcccgccgcatccataccgccagttgtttaccctcacaacgttccagtaac
cgggcatgttcatcatcagtaacccgtatcgtgagcatcctctctcgtttcatcggtatcattacccccatgaacag

Figure 137Q

aaatccccttacacggaggcatcagtgaccaaacaggaaaaaaccgcccttaacatggcccgctttatcagaagcc
agacattaacgcttctggagaaactcaacgagctggacgcggatgaacaggcagacatctgtgaatcgcttcacgac
cacgctgatgagctttaccgcagctgcctcgcgcgtttcggtgatgacggtgaaaacctctgacacatgcagctccc
ggagacggtcacagcttgtctgtaagcggatgccgggagcagacaagcccgtcagggcgcgtcagcgggtgttggcg
ggtgtcggggcgcagccatgacccagtcacgtagcgatagcggagtgtatactggcttaactatgcggcatcagagc
agattgtactgagagtgcaccatatatgcggtgtgaaataccgcacagatgcgtaaggagaaaataccgcatcaggc
gctcttccgcttcctcgctcactgactcgctgcgctcggtcgttcggctgcggcgagcggtatcagctcactcaaag
gcggtaatacggttatccacagaatcaggggataacgcaggaaagaacatgtgagcaaaaggccagcaaaaggccag
gaaccgtaaaaaggccgcgttgctggcgtttttccataggctccgccccctgacgagcatcacaaaaatcgacgct
caagtcagaggtggcgaaacccgacaggactataaagataccaggcgtttccccctggaagctccctcgtgcgctct
cctgttccgaccctgccgcttaccggatacctgtccgcctttctcccttcgggaagcgtggcgctttctcatagctc
acgctgtaggtatctcagttcggtgtaggtcgttcgctccaagctgggctgtgtgcacgaaccccccgttcagcccg
accgctgcgccttatccggtaactatcgtcttgagtccaacccggtaagacacgacttatcgccactggcagcagcc
actggtaacaggattagcagagcgaggtatgtaggcggtgctacagagttcttgaagtggtggcctaactacggcta
cactagaaggacagtatttggtatctgcgctctgctgaagccagttaccttcggaaaaagagttggtagctcttgat
ccggcaaacaaaccaccgctggtagcggtggtttttttgtttgcaagcagcagattacgcgcagaaaaaaggatct
caagaagatcctttgatcttttctacggggtctgacgctcagtggaacgaaaactcacgttaagggattttggtcat
gaacaataaaactgtctgcttacataaacagtaatacaaggggtgttatgagccatattcaacgggaaacgtcttgc
tctaggccgcgattaaattccaacatggatgctgatttatatgggtataaatgggctcgcgataatgtcgggcaatc
aggtgcgacaatctatcgattgtatgggaagcccgatgcgccagagttgtttctgaaacatggcaaaggtagcgttg
ccaatgatgttacagatgagatggtcagactaaactggctgacggaatttatgcctcttccgaccatcaagcatttt
atccgtactcctgatgatgcatggttactcaccactgcgatccccgggaaaacagcattccaggtattagaagaata
tcctgattcaggtgaaaatattgttgatgcgctggcagtgttcctgcgccggttgcattcgattcctgtttgtaatt
gtccttttaacagcgatcgcgtatttcgtctcgctcaggcgcaatcacgaatgaataacggtttggttgatgcgagt
gattttgatgacgagcgtaatggctggcctgttgaacaagtctggaaagaaatgcataaacttttgccattctcacc
ggattcagtcgtcactcatggtgatttctcacttgataaccttatttttgacgaggggaaattaataggttgtattg
atgttggacgagtcggaatcgcagaccgataccaggatcttgccatcctatggaactgcctcggtgagttttctcct
tcattacagaaacggctttttcaaaaatatggtattgataatcctgatatgaataaattgcagtttcatttgatgct
cgatgagtttttctaagaattaattcatgagcggatacatatttgaatgtatttagaaaaataaacaaataggggtt
ccgcgcacatttccccgaaaagtgccacctgaaattgtaaacgttaatattttgttaaaattcgcgttaaatttttg
ttaaatcagctcatttttttaaccaataggccgaaatcggcaaaatcccttataaatcaaaagaatagaccgagatag
ggttgagtgttgttccagtttggaacaagagtccactattaaagaacgtggactccaacgtcaaagggcgaaaaacc
gtctatcagggcgatggcccactacgtgaaccatcaccctaatcaagttttttggggtcgaggtgccgtaaagcact
aaatcggaaccctaaagggagcccccgatttagagcttgacggggaaagccggcgaacgtggcgagaaaggaaggga
agaaagcgaaaggagcgggcgctagggcgctggcaagtgtagcggtcacgctgcgcgtaaccaccacacccgccgcg
cttaatgcgccgctacagggcgcgtcccattcgccaatccggatatagttcctcctttcagcaaaaaacccctcaag
acccgtttagaggccccaaggggttatgctagttattgctcagcggtggcagcagccaactcagcttcctttcgggc
tttgttagcagccggatctcagtggtggtggtggtggtgctcga

(SEQ ID NO:37)

Figure 138

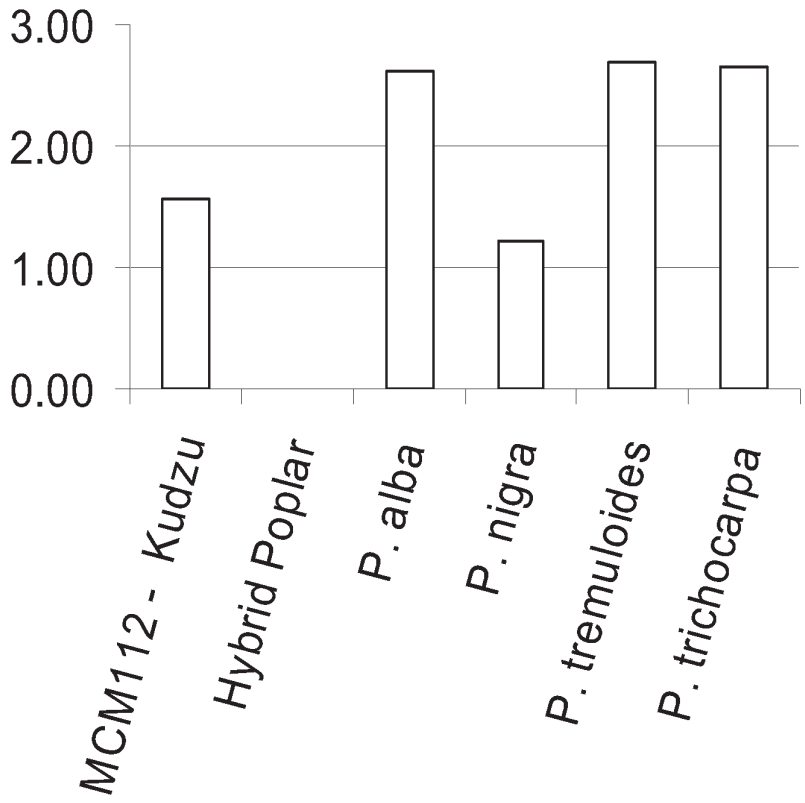

3.00
2.00
1.00
0.00
MCM112 - Kudzu
Hybrid Poplar
P. alba
P. nigra
P. tremuloides
P. trichocarpa

Figure 139

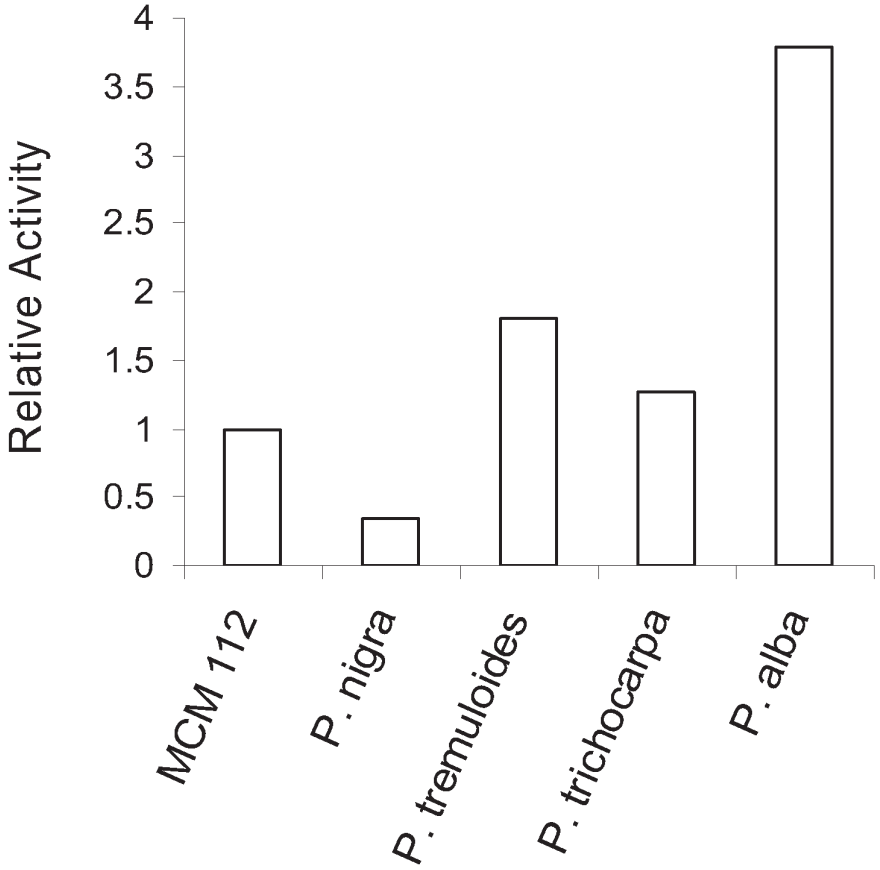

Relative Activity
4
3.5
3
2.5
2
1.5
1
0.5
0
MCM 112
P. nigra
P. tremuloides
P. trichocarpa
P. alba

Figure 140

DNA2.0

Plasmid Map

pDONR221:19430 - hybrid_HGS

Only single cutters are shown in the map, for a more complete list see table.

pDONR221 is a Gateway® vector

Original Author

DNA2.0, Inc.

1430 OBrien Drive, Suite E

Menlo Park, CA 94025-1436

1-877-DNA-TOGO (Toll free) 1-650-853-8351 (Fax)

info@dna20.com

www.dna20.com

Feature Map

- insert:19430 - Start:668 End:2387
- Kan - Start:2657 End:3466
- pUC-ori - Start:3586 End:4260

Restriction Map

Name	Sequence	Cut Positions
AclI	AACGTT	364,1655
AhdI	GACNNNNGTC	911,1138,3848
ApaI	GGGCCC	567
ApaLI	GTGCAC	3943
AsiSI	GCGATCGC	3092
AvaI	CYCGRG	560
BamHI	GGATCC	2376
BbsI	GAAGAC	437(C)
BsmBI	CGTCTC	3038
BsrDI	GCAATG	632,2039,2425(C),2580(C)
BstBI	TTCGAA	931
BstXI	CCANNNNNNTGG	754,1157
BtsI	GCAGTG	214,3030,2943(C)
ClaI	ATCGAT	2158
EcoRI	GAATTC	669,2382
EcoRV	GATATC	1855,2560
HpaI	GTTAAC	681,2248
MluI	ACGCGT	230,3561
NheI	GCTAGC	239,505
NruI	TCGCGA	2739
PvuI	CGATCG	3082
PvuII	CAGCTG	174,2495
XbaI	TCTAGA	723,971

No Cuts. AccB5I, AgeI, AscI, AvrII, BglI, BglII, BsaI, BspEI, EagI, FseI, HindIII, KasI, KpnI, MfeI, NcoI, NdeI, NotI, PacI, PstI, SacI, SacII, SalI, SanDI, SfiI, SnaBI, SpeI, SphI, XhoI, XmaI

DNA2.0 Inc.
1430 OBrien Drive, Suite E
Menlo Park, CA 94025

1-877-DNA-TOGO (Toll free)
1-650-853-8351 (Phone)
1-650-853-8351 (Fax)

info@dna20.com
www.dna20.com

Figure 141

gaattcaaaatgtgtgcaacttcatcccaattcactcaaatcacagagcataattctagacgttcagctaactac
caaccaaatctgtggaattttgaatttcttcaatcccttgaaaatgatttgaaagtggaaaagttggaggaaaaa
gccacaaaactagaggaagaagttagatgtatgataaacagagtagatacacaacctctgtcactactaga
attgattgacgatgtccagaggctgggtttaacatataagttcgaaaaggatataatcaaagccttagaaaac
atagtccttctagatgaaaacaagaagaataagtctgacttgcacgcaaccgctctgagttttagattgctgag
acaacatggttttgaagtaagtcaagatgtgtttgaaaggttcaaagacaaagagggaggattctcaggaga
attaaagggagatgtgcagggtctgttgtcattgtacgaggccagttatttggggtttgaaggggaaaatctact
agaggaggccagaaccttctctataacccatctgaagaataacttgaaagaaggcatcaatacaaaagtgg
ctgaacaagtttcacatgcattggaattgccctaccaccaaagacttcatagacttgaagccagatggtttttgg
acaagtatgaaccaaaggagcctcaccatcaacttttattggaattagcaaaactggattttaacatggttcag
acattacaccagaaagaattgcaggacctatcaagatggtggacggagatgggtttagccagcaagttagat
ttcgttagagatagattgatggaagtttacttttgggcactgggaatggcaccagatcctcaatttggtgaatgtag
aaaggcagttacaaagatgtttggtctagtaacaatcattgatgatgtttatgatgtgtacggaactttggatgaat
tacaactattcaccgacgcagttgaacgttgggatgtaaacgcaataaacacgttgcctgattatatgaagctgt
gttttctggcattgtacaacacagtcaatgacacttcttactccattttaaaggagaaagggcataacaatctatc
ctatttgacaaaatcatggagggagttatgcaaagcattccttcaagaagctaagtggtctaacaataagataa
tcccagcattctccaagtatcttgaaaacgcttccgtatcctcctccggtgtggccctactagcaccatcatattttt
ccgtctgccagcagcaggaagatatctctgatcatgctttgagatccttaacagattttcatggtctagtcagatc
ctcttgcgtgattttcagattgtgcaatgatttggctacttcagccgcagagttagagaggggtgaaaccacgaa
ctcaattattagttatatgcacgagaatgatggaacatccgaagaacaagcccgtgaagaattaagaaaact
gatcgatgctgaatggaagaagatgaatagagaaagagtttccgacagcactttgctgcctaaggcattcatg
gagatagctgttaacatggctagggtttcacactgtacataccaatacggggacggtcttggaaggcccgact
acgccactgaaaatagaattaaactgctactgattgatcctttccccattaaccagttaatgtacgtgtaataggg
atccgaattc

(SEQ ID NO:38)

Figure 142A

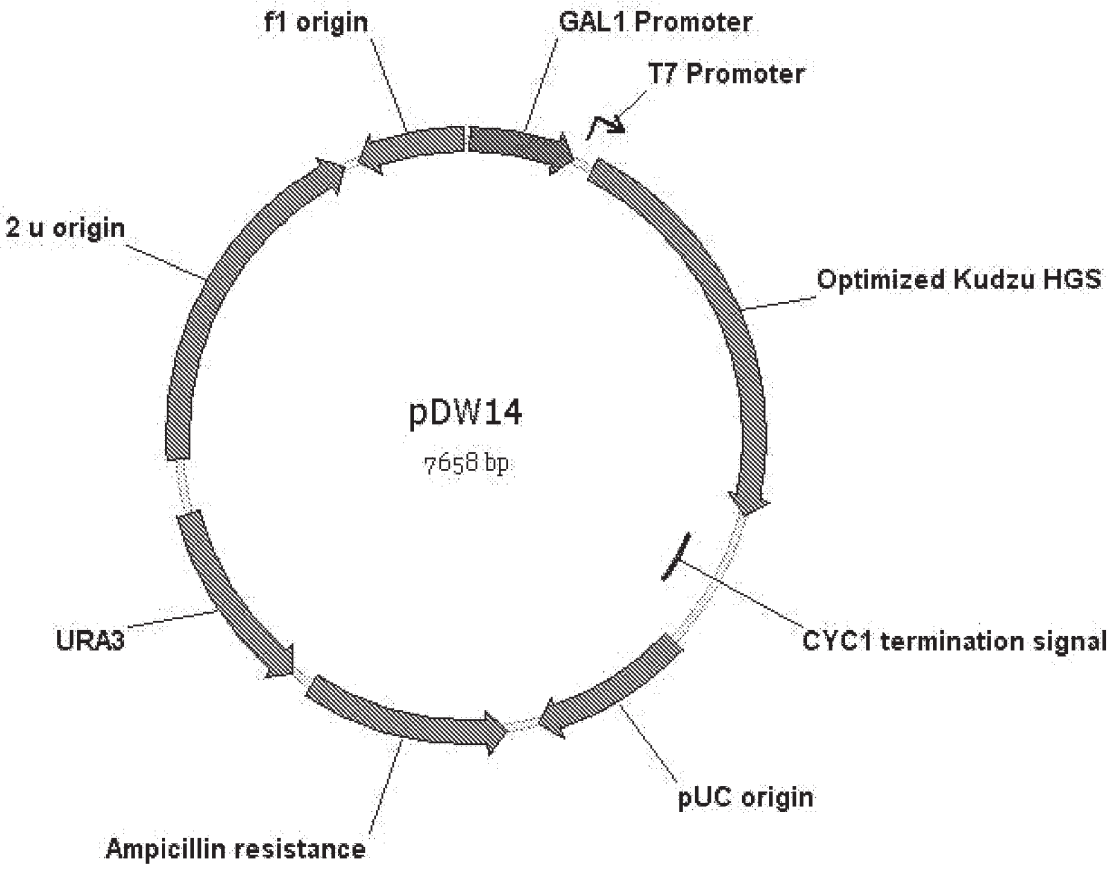

f1 origin
GAL1 Promoter
T7 Promoter
2 u origin
Optimized Kudzu HGS
pDW14
7658 bp
URA3
CYC1 termination signal
pUC origin
Ampicillin resistance

Figure 142B

acggattagaagccgccgagcgggtgacagccctccgaaggaagactctcctccgtgcgtcctcgtcttcaccggtcg
cgttcctgaaacgcagatgtgcctcgcgccgcactgctccgaacaataaagattctacaatactagcttttatggttatga
agaggaaaaattggcagtaacctggccccacaaaccttcaaatgaacgaatcaaattaacaaccataggatgataa
tgcgattagttttttagccttatttctggggtaattaatcagcgaagcgatgatttttgatctattaacagatatataaatgcaaa
aactgcataaccactttaactaatactttcaacattttcggtttgtattacttcttattcaaatgtaataaaagtatcaacaaaa
aattgttaatatacctctatactttaacgtcaaggagaaaaaaccccggatcggactactagcagctgtaatacgactca
ctatagggaatattaagctatcaaacaagtttgtacaaaaaagcaggctgaattcaaaatgtgtgcaacttcatcccaat
tcactcaaatcacagagcataattctagacgttcagctaactaccaaccaaatctgtggaattttgaatttcttcaatccctt
gaaaatgatttgaaagtggaaaagttggaggaaaaagccacaaaactagaggaagaagttagatgtatgataaac
agagtagatacacaacctctgtcactactagaattgattgacgatgtccagaggctgggtttaacatataagttcgaaaa
ggatataatcaaagccttagaaaacatagtccttctagatgaaaacaagaagaataagtctgacttgcacgcaaccg
ctctgagttttagattgctgagacaacatggttttgaagtaagtcaagatgtgtttgaaaggttcaaagacaaagaggga
ggattctcaggagaattaaagggagatgtgcagggtctgttgtcattgtacgaggccagttatttggggtttgaaggggа
aaatctactagaggaggccagaaccttctctataacccatctgaagaataacttgaaagaaggcatcaatacaaaag
tggctgaacaagtttcacatgcattggaattgccctaccaccaaagacttcatagacttgaagccagatggtttttggaca
agtatgaaccaaaggagcctcaccatcaacttttattggaattagcaaaactggattttaacatggttcagacattacacc
agaaagaattgcaggacctatcaagatggtggacggagatgggtttagccagcaagttagatttcgttagagatagatt
gatggaagtttacttttgggcactgggaatggcaccagatcctcaatttggtgaatgtagaaaggcagttacaaagatgtt
tggtctagtaacaatcattgatgatgtttatgatgtgtacggaactttggatgaattacaactattcaccgacgcagttgaac
gttgggatgtaaacgcaataaacacgttgcctgattatatgaagctgtgttttctggcattgtacaacacagtcaatgaca
cttcttactccattttaaaggagaaagggcataacaatctatcctatttgacaaaatcatggagggagttatgcaaagcat
tccttcaagaagctaagtggtctaacaataagataatcccagcattctccaagtatcttgaaaacgcttccgtatcctcctc
cggtgtggccctactagcaccatcatatttttccgtctgccagcagcaggaagatatctctgatcatgctttgagatccttaa
cagattttcatggtctagtcagatcctcttgcgtgattttcagattgtgcaatgatttggctacttcagccgcagagttagaga
ggggtgaaaccacgaactcaattattagttatatgcacgagaatgatggaacatccgaagaacaagcccgtgaaga
attaagaaaactgatcgatgctgaatggaagaagatgaatagagaaagagtttccgacagcactttgctgcctaaagc
attcatggagatagctgttaacatggctagggtttcacactgtacataccaatacggggacggtcttggaaggcccgact
acgccactgaaaatagaattaaactgctactgattgatcctttccccattaaccagttaatgtacgtgtaatagggatccg
aattcacccagctttcttgtacaaagtggttcgatctagagggcccttcgaaggtaagcctatccctaaccctctcctcggt
ctcgattctacgcgtaccggtcatcatcaccatcaccattgagtttaaacccgctgatcctagagggccgcatcatgtaat
tagttatgtcacgcttacattcacgccctccccccacatccgctctaaccgaaaaggaaggagttagacaacctgaagt
ctaggtccctatttatttttttatagttatgttagtattaagaacgttatttatatttcaaatttttctttttttttctgtacagacgcgtgta
cgcatgtaacattatactgaaaaccttgcttgagaaggttttgggacgctcgaaggctttaatttgcaagctgcggccctg
cattaatgaatcggccaacgcgcggggagaggcggtttgcgtattgggcgctcttccgcttcctcgctcactgactcgct
gcgctcggtcgttcggctgcggcgagcggtatcagctcactcaaaggcggtaatacggttatccacagaatcagggg
ataacgcaggaaagaacatgtgagcaaaaggccagcaaaagcccaggaaccgtaaaaaggccgcgttgctggc
gtttttccataggctccgcccccctgacgagcatcacaaaaatcgacgctcaagtcagaggtggcgaaacccgacag
gactataaagataccaggcgtttcccccctggaagctccctcgtgcgctctcctgttccgaccctgccgcttaccggatacc
tgtccgcctttctcccttcgggaagcgtggcgctttctatagctcacgctgtaggtatctcagttcggtgtaggtcgttcgctc
caagctgggctgtgtgcacgaacccccccgttcagcccgaccgctgcgccttatccggtaactatcgtcttgagtccaac
ccggtaagacacgacttatcgccactggcagcagccactggtaacaggattagcagagcgaggtatgtaggcggtg
ctacagagttcttgaagtggtggcctaactacggctacactagaaggacagtatttggtatctgcgctctgctgaagcca
gttaccttcggaaaaagagttggtagctcttgatccggcaaacaaaccaccgctggtagcggtggtttttttgtttgcaagc
agcagattacgcgcagaaaaaaaggatctcaagaagatcctttgatcttttctacggggtctgacgctcagtggaacg
aaaactcacgttaagggattttggtcatgagattatcaaaaaggatcttcacctagatccttttaaattaaaaatgaagtttt
aaatcaatctaaagtatatatgagtaaacttggtctgacagttaccaatgcttaatcagtgaggcacctatctcagcgatct
gtctatttcgttcatccatagttgcctgactccccgtcgtgtagataactacgatacgggagcgcttaccatctggccccag
tgctgcaatgataccgcgagacccacgctcaccggctccagatt

Figure 142C

tatcagcaataaaccagccagccggaagggccgagcgcagaagtggtcctgcaactttatccgcctccatccagtctat
taattgttgccgggaagctagagtaagtagttcgccagttaatagtttgcgcaacgttgttggcattgctacaggcatcgtgg
tgtcactctcgtcgtttggtatggcttcattcagctccggttcccaacgatcaaggcgagttacatgatcccccatgttgtgca
aaaaagcggttagctccttcggtcctccgatcgttgtcagaagtaagttggccgcagtgttatcactcatggttatggcagc
actgcataattctcttactgtcatgccatccgtaagatgcttttctgtgactggtgagtactcaaccaagtcattctgagaatag
tgtatgcggcgaccgagttgctcttgcccggcgtcaatacgggataatagtgtatcacatagcagaactttaaaagtgctc
atcattggaaaacgttcttcggggcgaaaactctcaaggatcttaccgctgttgagatccagttcgatgtaacccactcgtg
cacccaactgatcttcagcatcttttactttcaccagcgtttctgggtgagcaaaaacaggaaggcaaaatgccgcaaaa
aagggaataagggcgacacggaaatgttgaatactcatactcttccttttcaatgggtaataactgatataattaaattgaa
gctctaatttgtgagtttagtatacatgcatttacttataatacagttttttagttttgctggccgcatcttctcaaatatgcttcccag
cctgcttttctgtaacgttcaccctctaccttagcatcccttcccttttgcaaatagtcctcttccaacaataataatgtcagatcct
gtagagaccacatcatccacggttctatactgttgacccaatgcgtctcccttgtcatctaaacccacaccgggtgtcataat
caaccaatcgtaaccttcatctcttccacccatgtctctttgagcaataaagccgataacaaaatctttgtcgctcttcgcaat
gtcaacagtacccttagtatattctccagtagatagggagcccttgcatgacaattctgctaacatcaaaaggcctctaggt
tcctttgttacttcttctgccgcctgcttcaaaccgctaacaatacctgggcccaccacaccgtgtgcattcgtaatgtctgccc
attctgctattctgtatacacccgcagagtactgcaatttgactgtattaccaatgtcagcaaattttctgtcttcgaagagtaa
aaaattgtacttggcggataatgcctttagcggcttaactgtgccctccatggaaaaatcagtcaagatatccacatgtgtttt
tagtaaacaaattttgggacctaatgcttcaactaactccagtaattccttggtggtacgaacatccaatgaagcacacaa
gtttgtttgcttttcgtgcatgatattaaatagcttggcagcaacaggactaggatgagtagcagcacgttccttatatgtagct
ttcgacatgatttatcttcgtttcctgcaggtttttgttctgtgcagttgggttaagaatactgggcaatttcatgtttcttcaacacta
catatgcgtatatataccaatctaagtctgtgctccttccttcgttcttccttctgttcggagattaccgaatcaaaaaaatttcaa
agaaaccgaaatcaaaaaaaagaataaaaaaaaaatgatgaattgaattgaaaagctagcttatcgatgataagctgt
caaagatgagaattaattccacggactatagactatactagatactccgtctactgtacgatacacttccgctcaggtccttg
tcctttaacgaggccttaccactcttttgttactctattgatccagctcagcaaaggcagtgtgatctaagattctatcttcgcga
tgtagtaaaactagctagaccgagaaagagactagaaatgcaaaaggcacttctacaatggctgccatcattattatcc
gatgtgacgctgcagcttctcaatgatattcgaatacgctttgaggagatacagcctaatatccgacaaactgttttacagat
ttacgatcgtacttgttacccatcattgaattttgaacatccgaacctgggagttttccctgaaacagatagtatatttgaacct
gtataatatatatagtctagcgctttacggaagacaatgtatgtatttcggttcctggagaaactattgcatctattgcatagg
taatcttgcacgtcgcatccccggttcattttctgcgtttccatcttgcacttcaatagcatatctttgttaacgaagcatctgtgct
tcattttgtagaacaaaaatgcaacgcgagagcgctaatttttcaaacaaagaatctgagctgcatttttacagaacagaa
atgcaacgcgaaagcgctattttaccaacgaagaatctgtgcttcatttttgtaaaacaaaaatgcaacgcgacgagagc
gctaatttttcaaacaaagaatctgagctgcatttttacagaacagaaatgcaacgcgagagcgctatttttaccaacaaa
gaatctatacttctttttttgttctacaaaaatgcatcccgagagcgctatttttctaacaaagcatcttagattacttttttttctccttt
gtgcgctctataatgcagtctcttgataacttttgcactgtaggtccgttaaggttagaagaaggctactttggtgtctattttctc
ttccataaaaaaagcctgactccacttcccgcgtttactgattactagcgaagctgcgggtgcatttttttcaagataaaggc
atccccgattatattctataccgatgtggattgcgcatactttgtgaacagaaagtgatagcgttgatgattcttcattggtcag
aaaattatgaacggtttcttctattttgtctctatatactacgtataggaaatgtttacattttcgtattgttttcgattcactctatgaa
tagttcttactacaatttttttgtctaaagagtaatactagagataaacataaaaaatgtagaggtcgagtttagatgcaagtt
caaggagcgaaaggtggatgggtaggttatatagggatatagcacagagatatatagcaaagagatactttgagcaat
gtttgtggaagcggtattcgcaatgggaagctccaccccggttgataatcagaaaagccccaaaaacaggaagattgt
ataagcaaatatttaaattgtaaacgttaatattttgttaaaattcgcgttaaatttttgttaaatcagctcatttttttaacgaatag
cccgaaatcggcaaaatcccttataaatcaaaagaatagaccgagatagggttgagtgttgttccagtttccaacaaga
gtccactattaaagaacgtggactccaacgtcaaagggcgaaaaagggtctatcagggcgatggcccactacgtgaa
ccatcaccctaatcaagtttttttggggtcgaggtgccgtaaagcagtaaatcggaagggtaaacggatgcccccatttag
agcttgacggggaaagccggcgaacgtggcgagaaaggaagggaagaaagcgaaaggagcgggggctagggc
ggtgggaagtgtaggggtcacgctgggcgtaaccaccacacccgccgcgcttaatggggcgctacagggcgcgtgg
ggatgatccactagt

(SEQ ID NO:39)

Figure 143

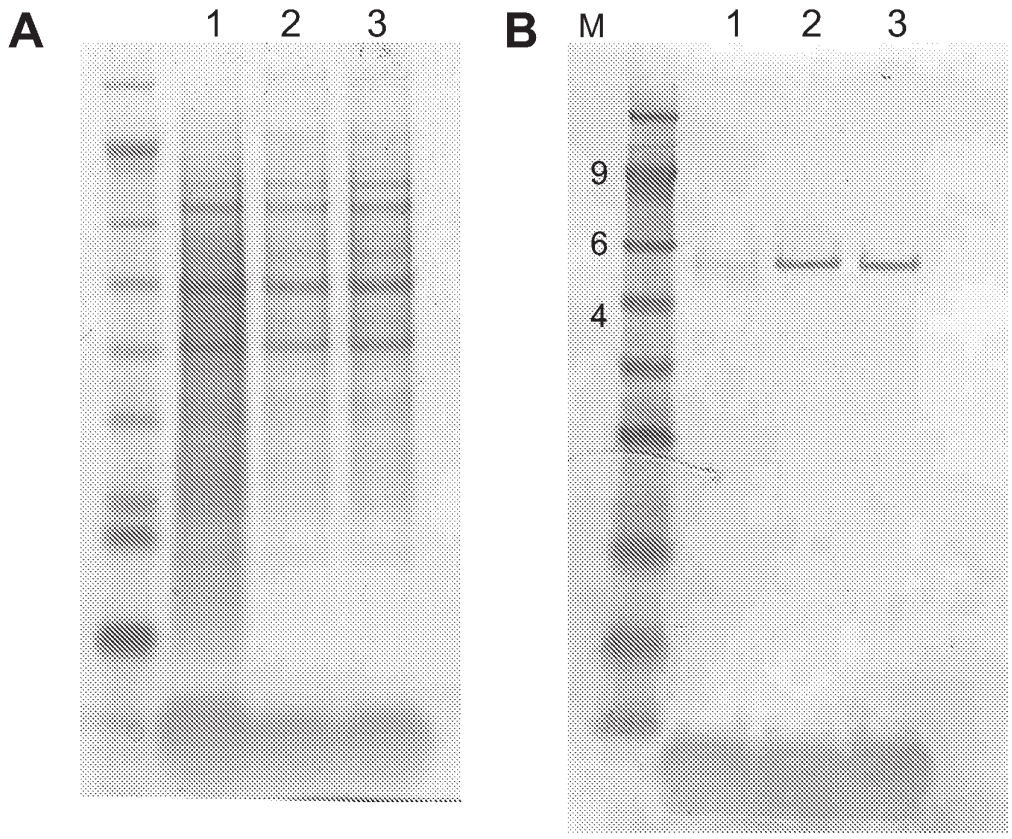
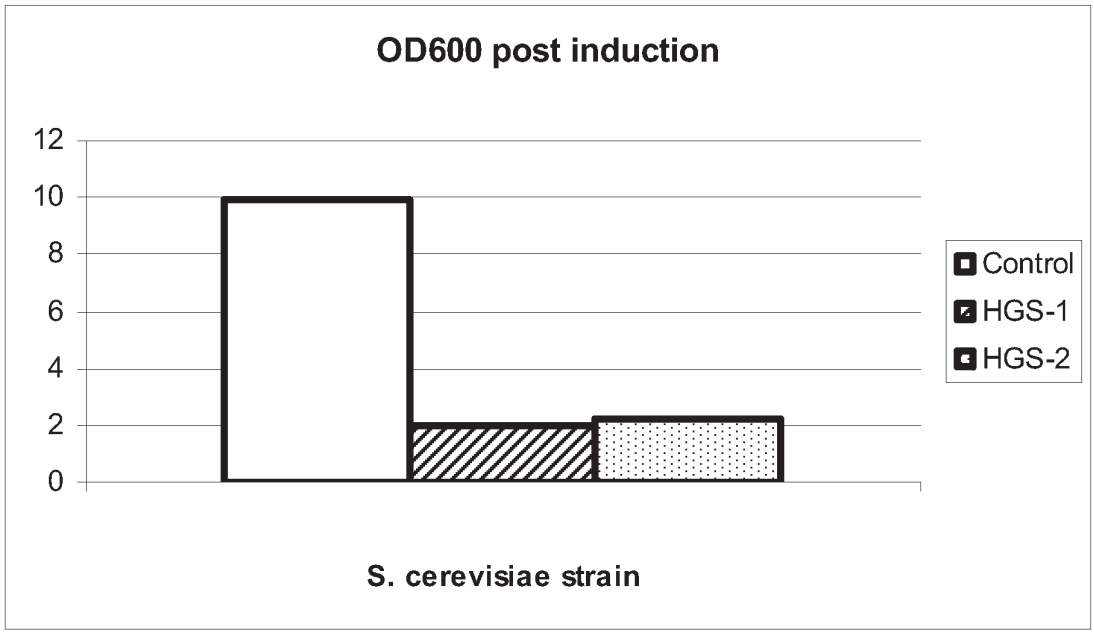
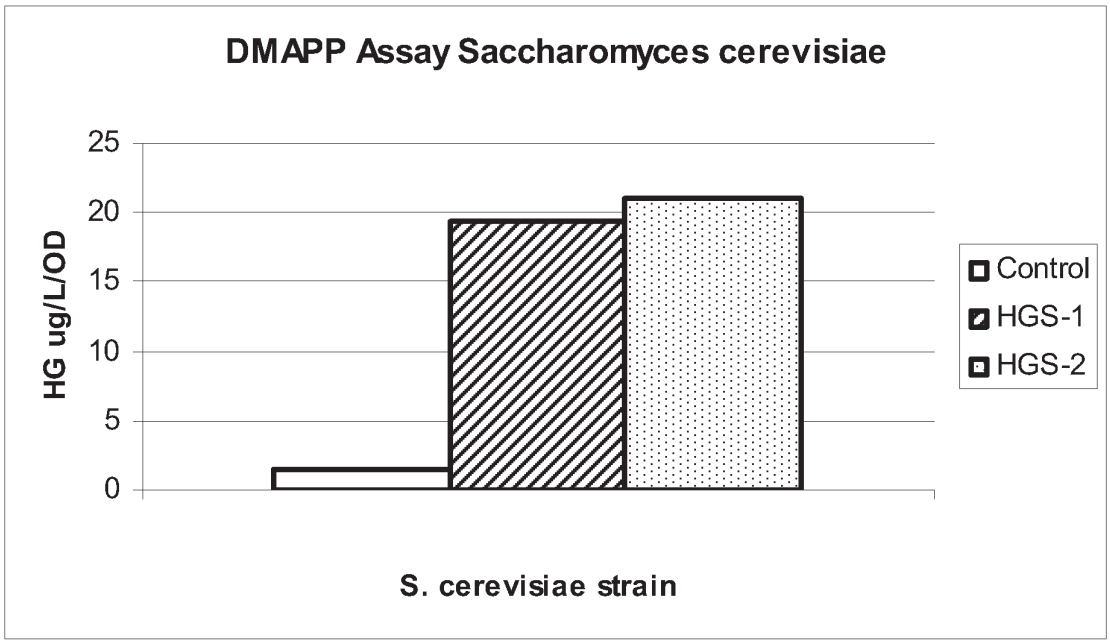


Figure 144

A



B



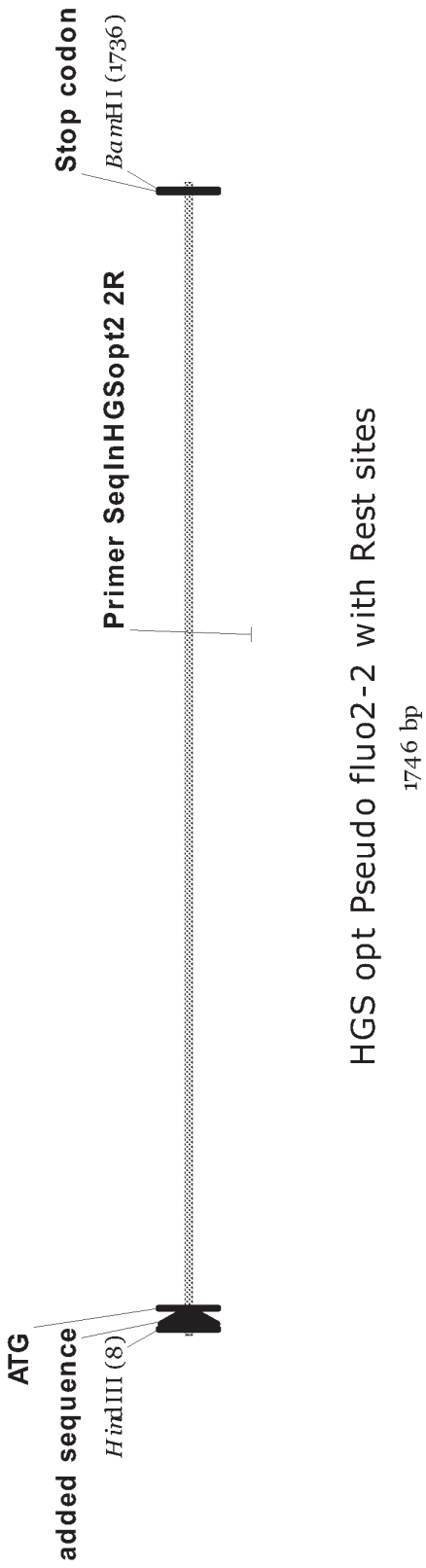

Stop codon
BamHI (1736)
Primer SeqInHGSopt2 2R
HGS opt Pseudo flu02-2 with Rest sites
1746 bp
ATG
added sequence
HindIII (8)

Figure 145A

Figure 145B

catcttaagcttgtttaactttaagaaggagatatacatatgtgcgccaccagcagccagttcacccagatca
ccgagcataatagccgtcggtccgcgaactaccagcccaacctgtggaacttcgagttcctgcagagcctg
gaaaacgacctgaaggtggagaagctcgaagagaaggccaccaagctggaggaggaggtgcgttgca
tgatcaaccgggtggacacccagcccctgagcctgctggagctcatcgacgacgtgcagcgcctgggcct
gacctacaagtttgagaaagatatcatcaaggcgctggagaacatcgtcctgctggacgagaataagaag
aacaaaagcgatctgcacgcgaccgccctgagcttccgcctgctgcggcagcatggctttgaggtgagcc
aggacgtgttcgagcgcttcaaggacaaagaaggggcttctccggggaactgaagggtgacgtgcagg
gcctgctgagcctgtacgaggccagctatctcggtttcgaaggcgaaaatctgctggaggaggcccgtacc
ttcagcatcacccatctgaagaacaacctcaaggaggggatcaacacgaaggtggccgagcaggtgtcc
cacgcgctggagctgccgtatcatcaacgcctgcaccgcctggaggcgcggtggtttctggacaagtacga
acccaaggagccgcatcaccagctgctgctggaactggccaaactcgatttcaacatggtccagaccctg
caccaaaaagagctgcaggacctgagccggtggtggaccgagatgggcctcgccagcaagctggatttc
gtgcgggaccgcctgatggaagtgtacttctgggcgctgggcatggcgccggacccgcagttcggcgaat
gccgcaaggccgtcaccaagatgttcggtctggtcaccattatcgatgacgtctatgacgtgtacggtaccct
ggacgaactgcagctcttcaccgacgcggtggaacgctgggacgtgaacgccatcaacacgctgcccga
ctatatgaagctgtgcttcctggccctgtacaacaccgtgaacgacacgtcctactccatcctgaaggagaa
gggccacaataacctgagctatctgaccaaaagctggcgcgaactgtgcaaggccttcctgcaagaagcc
aagtggagcaataacaagatcatccccgccttcagcaagtacctggagaacgccagcgtgtcctccagcg
gggtcgcgctgctggcgccgagctacttctcggtctgccagcagcaggaagatatctcggaccacgccctc
cgctccctgaccgacttccacggcctggtgcgctcgtcctgcgtgatctttcggctgtgcaacgatctggcgac
ctcggcggcggaactcgaacgcggcgaaaccaccaacagcatcatcagctacatgcacgagaacgac
ggcacgagcgaggaacaggcccgcgaagagctgcgcaagctgatcgacgccgagtggaagaaaatg
aaccgcgagcgcgtgtcggacagcaccctgctgccgaaggcgttcatggagatcgccgtgaacatggcc
cgcgtgagccactgcacctaccaatatggggacgggctgggccgcccggattacgccaccgagaaccg
catcaagctgctgctcatcgacccgttccccatcaaccagctgatgtacgtgtgaggatcccgtaac

(SEQ ID NO:40)

Figure 146A

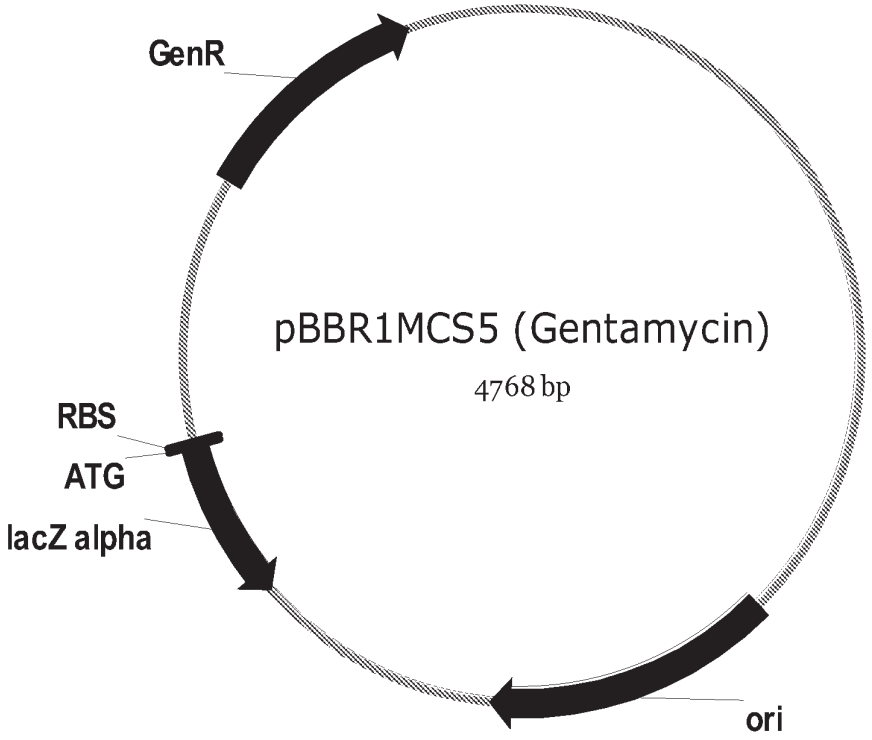


Figure 146B

ctcgggccgtctcttgggcttgatcggccttcttgcgcatctcacgcgctcctgcggcggcctgtagggcaggctcataccc
ctgccgaaccgcttttgtcagccggtcggccacggcttccggcgtctcaacgcgctttgagattcccagcttttcggccaat
ccctgcggtgcataggcgcgtggctcgaccgcttgcgggctgatggtgacgtggcccactggtggccgctccagggcct
cgtagaacgcctgaatgcgcgtgtgacgtgccttgctgccctcgatgccccgttgcagccctagatcggccacagcggc
cgcaaacgtggtctggtcgcgggtcatctgcgctttgttgccgatgaactccttggccgacagcctgccgtcctgcgtcagc
ggcaccacgaacgcggtcatgtgcgggctggtttcgtcacggtggatgctggccgtcacgatgcgatccgccccgtactt
gtccgccagccacttgtgcgccttctcgaagaacgccgcctgctgttcttggctggccgacttccaccattccgggctggcc
gtcatgacgtactcgaccgccaacacagcgtccttgcgccgcttctctggcagcaactcgcgcagtcggcccatcgcttc
atcggtgctgctggccgcccagtgctcgttctctggcgtcctgctggcgtcagcgttgggcgtctcgcgctcgcggtaggcg
tgcttgagactggccgccacgttgcccattttcgccagcttcttgcatcgcatgatcgcgtatgccgccatgcctgcccctcc
cttttggtgtccaaccggctcgacgggggcagcgcaaggcggtgcctccggcgggccactcaatgcttgagtatactca
ctagactttgcttcgcaaagtcgtgaccgcctacggcggctgcggcgccctacgggcttgctctccgggcttcgccctgcg
cggtcgctgcgctcccttgccagcccgtggatatgtggacgatggccgcgagcggccaccggctggctcgcttcgctcg
gcccgtggacaaccctgctggacaagctgatggacaggctgcgcctgcccacgagcttgaccacagggattgcccac
cggctacccagccttcgaccacatacccaccggctccaactgcgcggcctgcggccttgccccatcaatttttttaattttct
ctggggaaaagcctccggcctgcggcctgcgcgcttcgcttgccggttggacaccaagtggaaggcgggtcaaggctc
gcgcagcgaccgcgcagcggcttggccttgacgcgcctggaacgacccaagcctatgcgagtgggggcagtcgaag
gcgaagcccgcccgcctgccccccgagcctcacggcggcgagtgcgggggttccaaggggcagcgccaccttgg
gcaaggccgaaggccgcgcagtcgatcaacaagccccggaggggccacttttgccggaggggagccgcgccga
aggcgtgggggaaccccgcaggggtgcccttctttgggcaccaaagaactagatatagggcgaaatgcgaaagactt
aaaaatcaacaacttaaaaaaggggggtacgcaacagctcattgcggcacccccgcaatagctcattgcgtaggtta
aagaaaatctgtaattgactgccacttttacgcaacgcataattgttgtcgcgctgccgaaaagttgcagctgattgcgcat
ggtgccgcaaccgtgcggcaccctaccgcatggagataagcatggccacgcagtccagagaaatcggcattcaagc
caagaacaagcccggtcactgggtgcaaacggaacgcaaagcgcatgaggcgtgggccgggcttattgcgaggaa
acccacggcggcaatgctgctgcatcacctcgtggcgcagatgggccaccagaacgccgtggtggtcagccagaag
acactttccaagctcatcggacgttctttgcggacggtccaatacgcagtcaaggacttggtggccgagcgctggatctcc
gtcgtgaagctcaacggccccggcaccgtgtcggcctacgtggtcaatgaccgcgtggcgtggggccagccccgcga
ccagttgcgcctgtcggtgttcagtgccgccgtggtggttgatcacgacgaccaggacgaatcgctgttggggcatggcg
acctgcgccgcatcccgaccctgtatccgggcgagcagcaactaccgaccggccccggcgaggagccgcccagcc
agcccggcattccgggcatggaaccagacctgccagccttgaccgaaacggaggaatgggaacggcgcgggcagc
agcgcctgccgatgcccgatgagccgtgttttctggacgatggcgagccgttggagccgccgacacgggtcacgctgc
cgcgccggtagcacttgggttgcgcagcaacccgtaagtgcgctgttccagactatcggctgtagccgcctcgccgccct
ataccttgtctgcctccccgcgttgcgtcgcggtgcatggagccgggccacctcgacctgaatggaagccggcggcacc
tcgctaacggattcaccgtttttatcaggctctgggaggcagaataaatgatcatatcgtcaattattacctccacggggag
agcctgagcaaactggcctcaggcatttgagaagcacacggtcacactgcttccggtagtcaataaaccggtaaacca
gcaatagacataagcggctatttaacgaccctgccctgaaccgacgaccgggtcgaatttgctttcgaatttctgccattca
tccgcttattatcacttattcaggcgtagcaccaggcgtttaagggcaccaataactgccttaaaaaaattacgccccgcc
ctgccactcatcgcagtcggcctattggttaaaaaatgagctgatttaacaaaaatttaacgcgaattttaacaaaatatta
acgcttacaatttccattcgccattcaggctgcgcaactgttgggaagggcgatcggtgcgggcctcttcgctattacgcca
gctggcgaaaggggatgtgctgcaaggcgattaagttgggtaacgccagggttttcccagtcacgacgttgtaaaacg
acggccagtgagcgcgcgtaatacgactcactatagggcgaattggagctccaccgcggtggcggccgctctagaact
agtggatcccccgggctgcaggaattcgatatcaagcttatcgataccgtcgacctcgaggggggcccggtacccag
cttttgttcccttagtgagggttaattgcgcgcttggcgtaatcatggtcatagctgtttcctgtgtgaaattgttatccgctcaca
attccacacaacatacgagccggaagcataaagtgtaaagcctggggtgcctaatgagtgagctaactcacattaattg
cgttgcgctcactgcccgctttccagtcgggaaacctgtcgtgccagctgcattaatgaatcggccaacgcgcggggag
aggcggtttgcgtattgggcgcatgcataaaaactgttgtaattcattaagcattctgccgacatggaagccatcacaaac
ggcatgatgaacctgaatcgccagcggcatcagcac

Figure 146C

cttgtcgccttgcgtataatatttgcccatggacgcacaccgtggaaacggatgaaggcacgaacccagttgaca
taagcctgttcggttcgtaaactgtaatgcaagtagcgtatgcgctcacgcaactggtccagaaccttgaccgaac
gcagcggtggtaacggcgcagtggcggttttcatggcttgttatgactgtttttttgtacagtctatgcctcgggcatcc
aagcagcaagcgcgttacgccgtgggtcgatgtttgatgttatggagcagcaacgatgttacgcagcagcaacg
atgttacgcagcagggcagtcgccctaaaacaaagttaggtggctcaagtatgggcatcattcgcacatgtaggc
tcggccctgaccaagtcaaatccatgcgggctgctcttgatcttttcggtcgtgagttcggagacgtagccacctact
cccaacatcagccggactccgattacctcgggaacttgctccgtagtaagacattcatcgcgcttgctgccttcgac
caagaagcggttgttggcgctctcgcggcttacgttctgcccaggtttgagcagccgcgtagtgagatctatatctat
gatctcgcagtctccggcgagcaccggaggcagggcattgccaccgcgctcatcaatctcctcaagcatgaggc
caacgcgcttggtgcttatgtgatctacgtgcaagcagattacggtgacgatcccgcagtggctctctatacaaagt
tgggcatacgggaagaagtgatgcactttgatatcgacccaagtaccgccacctaacaattcgttcaagccgag
atcggcttcccggccgcggagttgttcggtaaattgtcacaacgccgccaggtggcacttttcggggaaatgtgcg
cgcccgcgttcctgctggcgctgggcctgtttctggcgctggacttcccgctgttccgtcagcagcttttcgcccacgg
ccttgatgatcgcggcggccttggcctgcatatcccgattcaacggccccagggcgtccagaacgggcttcaggc
gctcccgaaggt

(SEQ ID NO:41)

Figure 147A

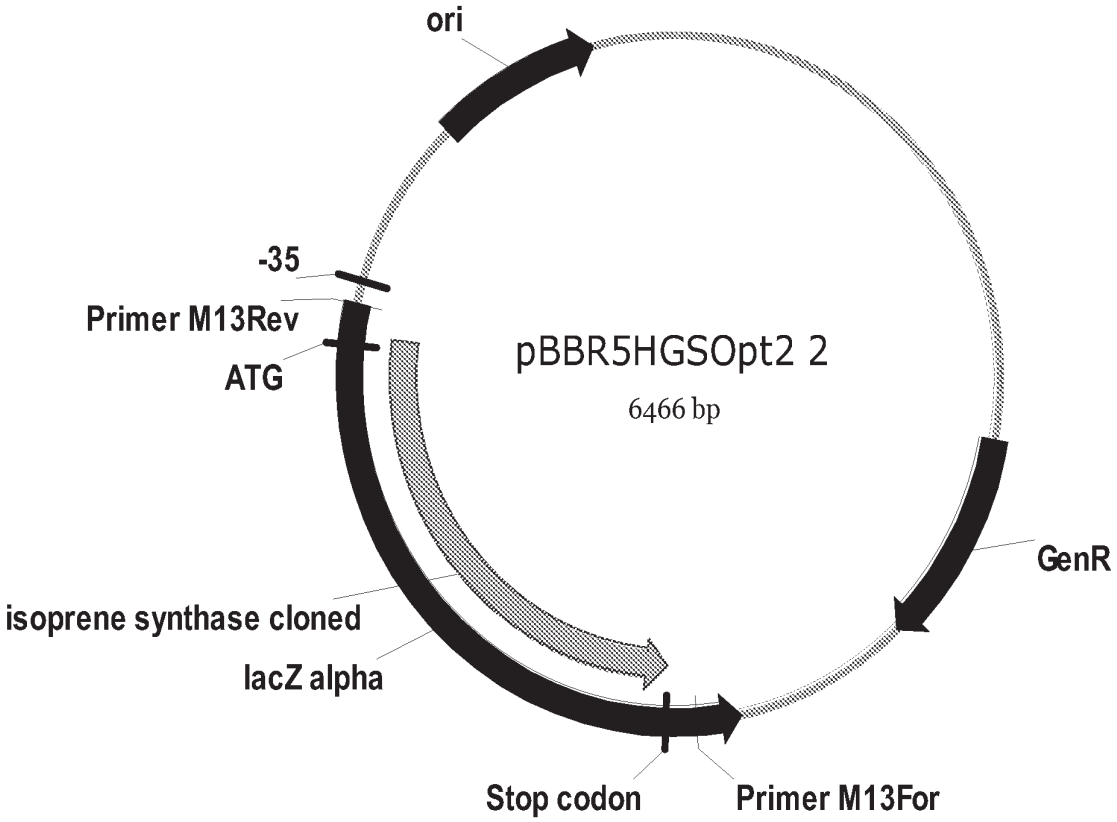

ori
-35
Primer M13Rev
ATG
pBBR5HGSOpt2 2
6466 bp
GenR
isoprene synthase cloned
lacZ alpha
Stop codon
Primer M13For

Figure 147B

ctcgggccgtctcttgggcttgatcggccttcttgcgcatctcacgcgctcctgcggcggcctgtagggcaggctcatacc
cctgccgaaccgcttttgtcagccggtcggccacggcttccggcgtctcaacgcgctttgagattcccagcttttcggcca
atccctgcggtgcataggcgcgtggctcgaccgcttgcgggctgatggtgacgtggcccactggtggccgctccaggg
cctcgtagaacgcctgaatgcgcgtgtgacgtgccttgctgccctcgatgccccgttgcagccctagatcggccacagc
ggccgcaaacgtggtctggtcgcgggtcatctgcgctttgttgccgatgaactccttggccgacagcctgccgtcctgcgt
cagcggcaccacgaacgcggtcatgtgcgggctggtttcgtcacggtggatgctggccgtcacgatgcgatccgccc
cgtacttgtccgccagccacttgtgcgccttctcgaagaacgccgcctgctgttcttggctggccgacttccaccattccgg
gctggccgtcatgacgtactcgaccgccaacacagcgtccttgcgccgcttctctggcagcaactcgcgcagtcggcc
catcgcttcatcggtgctgctggccgcccagtgctcgttctctggcgtcctgctggcgtcagcgttgggcgtctcgcgctcg
cggtaggcgtgcttgagactggccgccacgttgcccattttcgccagcttcttgcatcgcatgatcgcgtatgccgccatg
cctgcccctccctttggtgtccaaccggctcgacgggggcagcgcaaggcggtgcctccggcgggccactcaatgct
tgagtatactcactagactttgcttcgcaaagtcgtgaccgcctacggcggctgcggcgccctacgggcttgctctccgg
gcttcgccctgcgcggtcgctgcgctcccttgccagcccgtggatatgtggacgatggccgcgagcggccaccggctg
gctcgcttcgctcggcccgtggacaaccctgctggacaagctgatggacaggctgcgcctgcccacgagcttgacca
cagggattgcccaccggctacccagccttcgaccacatacccaccggctccaactgcgcggcctgcggccttgcccc
atcaatttttttaattttctctggggaaaagcctccggcctgcggcctgcgcgcttcgcttgccggttggacaccaagtgga
aggcgggtcaaggctcgcgcagcgaccgcgcagcggcttggccttgacgcgcctggaacgacccaagcctatgcg
agtgggggcagtcgaaggcgaagcccgcccgcctgccccccgagcctcacggcggcgagtgcgggggttccaag
ggggcagcgccaccttgggcaaggccgaaggccgcgcagtcgatcaacaagccccggaggggccacttttgccg
gagggggagccgcgccgaaggcgtgggggaaccccgcaggggtgcccttctttgggcaccaaagaactagatata
gggcgaaatgcgaaagacttaaaaatcaacaacttaaaaaaggggggtacgcaacagctcattgcggcacccccc
gcaatagctcattgcgtaggttaaagaaaatctgtaattgactgccacttttacgcaacgcataattgttgtcgcgctgccg
aaaagttgcagctgattgcgcatggtgccgcaaccgtgcggcaccctaccgcatggagataagcatggccacgcagt
ccagagaaatcggcattcaagccaagaacaagcccggtcactgggtgcaaacggaacgcaaagcgcatgaggc
gtgggccgggcttattgcgaggaaacccacggcggcaatgctgctgcatcacctcgtggcgcagatgggccaccag
aacgccgtggtggtcagccagaagacactttccaagctcatcggacgttctttgcggacggtccaatacgcagtcaag
gacttggtggccgagcgctggatctccgtcgtgaagctcaacggccccggcaccgtgtcggcctacgtggtcaatgac
cgcgtggcgtggggccagccccgcgaccagttgcgcctgtcggtgttcagtgccgccgtggtggttgatcacgacgac
caggacgaatcgctgttggggcatggcgacctgcgccgcatcccgaccctgtatccgggcgagcagcaactaccga
ccggccccggcgaggagccgcccagccagcccggcattccgggcatggaaccagacctgccagccttgaccgaa
acggaggaatgggaacggcgcgggcagcagcgcctgccgatgcccgatgagccgtgttttctggacgatggcgag
ccgttggagccgccgacacgggtcacgctgccgcgccggtagcacttgggttgcgcagcaacccgtaagtgcgctgt
tccagactatcggctgtagccgcctcgccgccctataccttgtctgcctccccgcgttgcgtcgcggtgcatggagccgg
gccacctcgacctgaatggaagccggcggcacctcgctaacggattcaccgtttttatcaggctctgggaggcagaat
aaatgatcatatcgtcaattattacctccacggggagagcctgagcaaactggcctcaggcatttgagaagcacacgg
tcacactgcttccggtagtcaataaaccggtaaaccagcaatagacataagcggctatttaacgaccctgccctgaac
cgacgaccgggtcgaatttgctttcgaatttctgccattcatccgcttattatcacttattcaggcgtagcaccaggcgtttaa
gggcaccaataactgccttaaaaaaattacgccccgccctgccactcatcgcagtcggcctattggttaaaaaatgag
ctgatttaacaaaaatttaacgcgaattttaacaaaatattaacgcttacaatttccattcgccattcaggctgcgcaactgt
tgggaagggcgatcggtgcgggcctcttcgctattacgccagctggcgaaaggggatgtgctgcaaggcgattaag
ttgggtaacgccagggttttcccagtcacgacgttgtaaaacgacggccagtgagcgcgcgtaatacgactcactata
gggcgaattggagctccaccgcggtggcggccgctctagaactagtggatcctcacacgtacatcagctggttgatgg
ggaacgggtcgatgagcagcagcttgatgcggttctcggtggcgtaatccgggcggcccagcccgtccccatattggt
aggtgcagtggctcacgcgggccatgttcacggcgatctccatgaacgccttcggcagcagggtgctgtccgacacg
cgctcgcggttcattttcttccactcggcgtcgatcagcttgcgcagctcttcgcgggcctgttcctcgctcgtgccgtcgttct
cgtgcatgtagctgatgatgctgttggtggtttcgccgcgttcgagttccgccgccgaggtcgccagatcgttgcacagcc
gaaagatcacgcaggacgagcgcaccaggccgtggaagtcggtcagggagcggagggcgtggtccgagatatctt
cctg

Figure 147C

ctgctggcagaccgagaagtagctcggcgccagcagcgcgaccccgctggaggacacgctggcgttctccag
gtacttgctgaaggcggggatgatcttgttattgctccacttggcttcttgcaggaaggccttgcacagttcgcgcca
gcttttggtcagatagctcaggttattgtggcccttctccttcaggatggagtaggacgtgtcgttcacggtgttgtaca
gggccaggaagcacagcttcatatagtcgggcagcgtgttgatggcgttcacgtcccagcgttccaccgcgtcgg
tgaagagctgcagttcgtccagggtaccgtacacgtcatagacgtcatcgataatggtgaccagaccgaacatct
tggtgacggccttgcggcattcgccgaactgcgggtccggcgccatgcccagcgcccagaagtacacttccatc
aggcggtcccgcacgaaatccagcttgctggcgaggcccatctcggtccaccaccggctcaggtcctgcagctc
tttttggtgcagggtctggaccatgttgaaatcgagtttggccagttccagcagcagctggtgatgcggctccttgggt
tcgtacttgtccagaaaccaccgcgcctccaggcggtgcaggcgttgatgatacggcagctccagcgcgtggga
cacctgctcggccaccttcgtgttgatcccctccttgaggttgttcttcagatgggtgatgctgaaggtacgggcctcc
tccagcagattttcgccttcgaaaccgagatagctggcctcgtacaggctcagcaggccctgcacgtcacccttca
gttccccggagaagccccttctttgtccttgaagcgctcgaacacgtcctggctcacctcaaagccatgctgccg
cagcaggcggaagctcagggcggtcgcgtgcagatcgcttttgttcttcttattctcgtccagcaggacgatgttctc
cagcgccttgatgatatctttctcaaacttgtaggtcaggcccaggcgctgcacgtcgtcgatgagctccagcagg
ctcaggggctgggtgtccacccggttgatcatgcaacgcacctcctcctccagcttggtggccttctcttcgagcttct
ccaccttcaggtcgttttccaggctctgcaggaactcgaagttccacaggttgggctggtagttcgcggaccgacg
gctattatgctcggtgatctgggtgaactggctgctggtggcgcacatatgtatatctccttcttaaagttaaacaagct
tatcgataccgtcgacctcgaggggggggcccggtacccagcttttgttccctttagtgagggttaattgcgcgcttgg
cgtaatcatggtcatagctgtttcctgtgtgaaattgttatccgctcacaattccacacaacatacgagccggaagc
ataaagtgtaaagcctggggtgcctaatgagtgagctaactcacattaattgcgttgcgctcactgcccgctttcca
gtcgggaaacctgtcgtgccagctgcattaatgaatcggccaacgcgcggggagaggcggtttgcgtattgggc
gcatgcataaaaactgttgtaattcattaagcattctgccgacatggaagccatcacaaacggcatgatgaacctg
aatcgccagcggcatcagcaccttgtcgccttgcgtataatatttgcccatggacgcacaccgtggaaacggatg
aaggcacgaacccagttgacataagcctgttcggttcgtaaactgtaatgcaagtagcgtatgcgctcacgcaac
tggtccagaaccttgaccgaacgcagcggtggtaacggcgcagtggcggttttcatggcttgttatgactgtttttttgt
acagtctatgcctcgggcatccaagcagcaagcgcgttacgccgtgggtcgatgtttgatgttatggagcagcaa
cgatgttacgcagcagcaacgatgttacgcagcagggcagtcgccctaaaacaaagttaggtggctcaagtatg
ggcatcattcgcacatgtaggctcggccctgaccaagtcaaatccatgcgggctgctcttgatcttttcggtcgtgag
ttcggagacgtagccacctactcccaacatcagccggactccgattacctcgggaacttgctccgtagtaagaca
ttcatcgcgcttgctgccttcgaccaagaagcggttgttggcgctctcgcggcttacgttctgcccaggtttgagcag
ccgcgtagtgagatctatatctatgatctcgcagtctccggcgagcaccggaggcagggcattgccaccgcgctc
atcaatctcctcaagcatgaggccaacgcgcttggtgcttatgtgatctacgtgcaagcagattacggtgacgatc
ccgcagtggctctctatacaaagttgggcatacgggaagaagtgatgcactttgatatcgacccaagtaccgcca
cctaacaattcgttcaagccgagatcggcttcccggccgcggagttgttcggtaaattgtcacaacgccgccaggt
ggcacttttcggggaaatgtgcgcgcccgcgttcctgctggcgctgggcctgtttctggcgctggacttcccgctgttc
cgtcagcagcttttcgcccacggccttgatgatcgcggcggccttggcctgcatatcccgattcaacggccccagg
gcgtccagaacgggcttcaggcgctcccgaaggt

(SEQ ID NO:42)

Figure 148

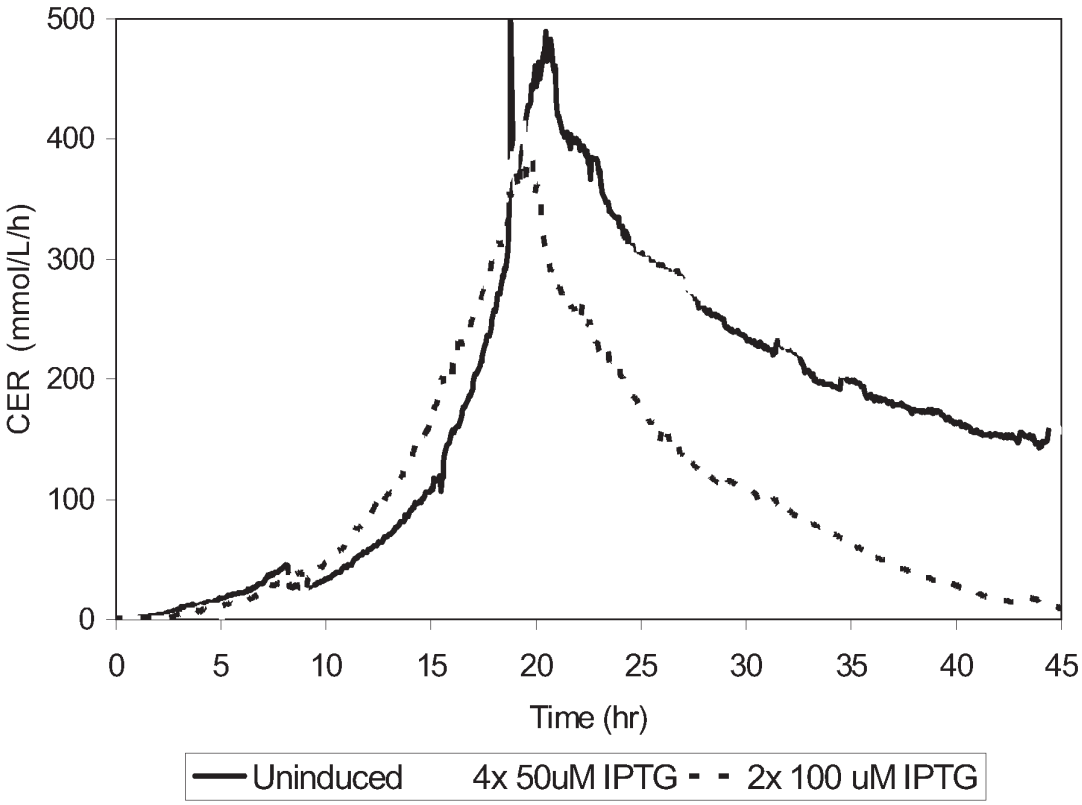

500
400
300
200
100
0
CER (mmol/L/h)
0
5
10
15
20
25
30
35
40
45
Time (hr)
Uninduced
4x 50uM IPTG
2x 100 uM IPTG

Figure 149

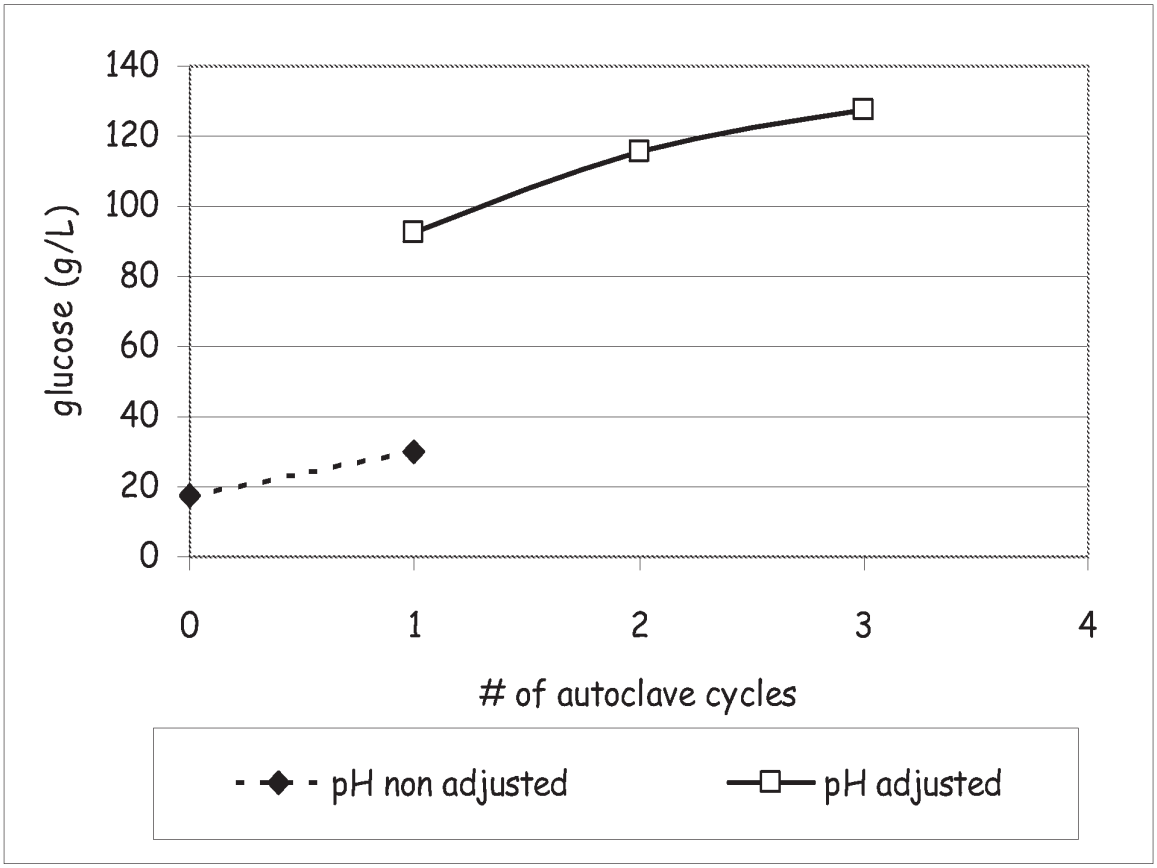

140
120
100
80
60
40
20
0
glucose (g/L)
0
1
2
3
4
of autoclave cycles
pH non adjusted
pH adjusted

Figure 150

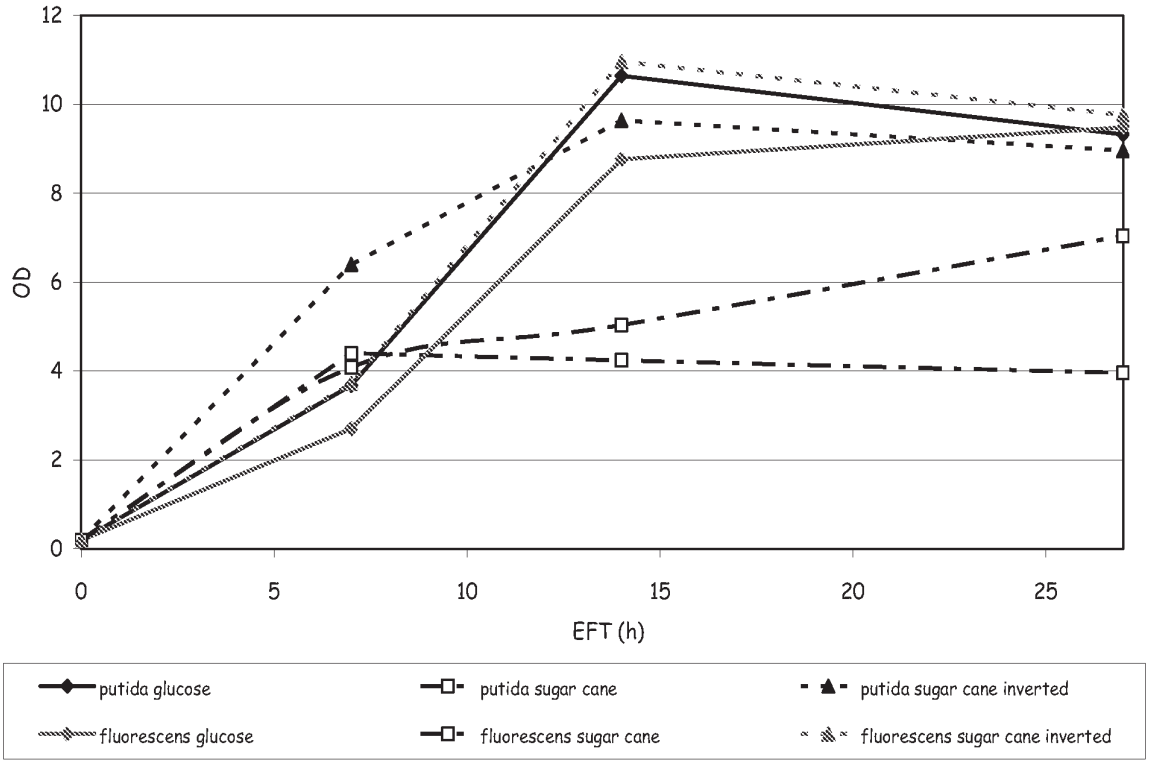

12
10
8
6
4
2
0
OD
0
5
10
15
20
25
EFT (h)
putida glucose
putida sugar cane
putida sugar cane inverted
fluorescens glucose
fluorescens sugar cane
fluorescens sugar cane inverted

Figure 151

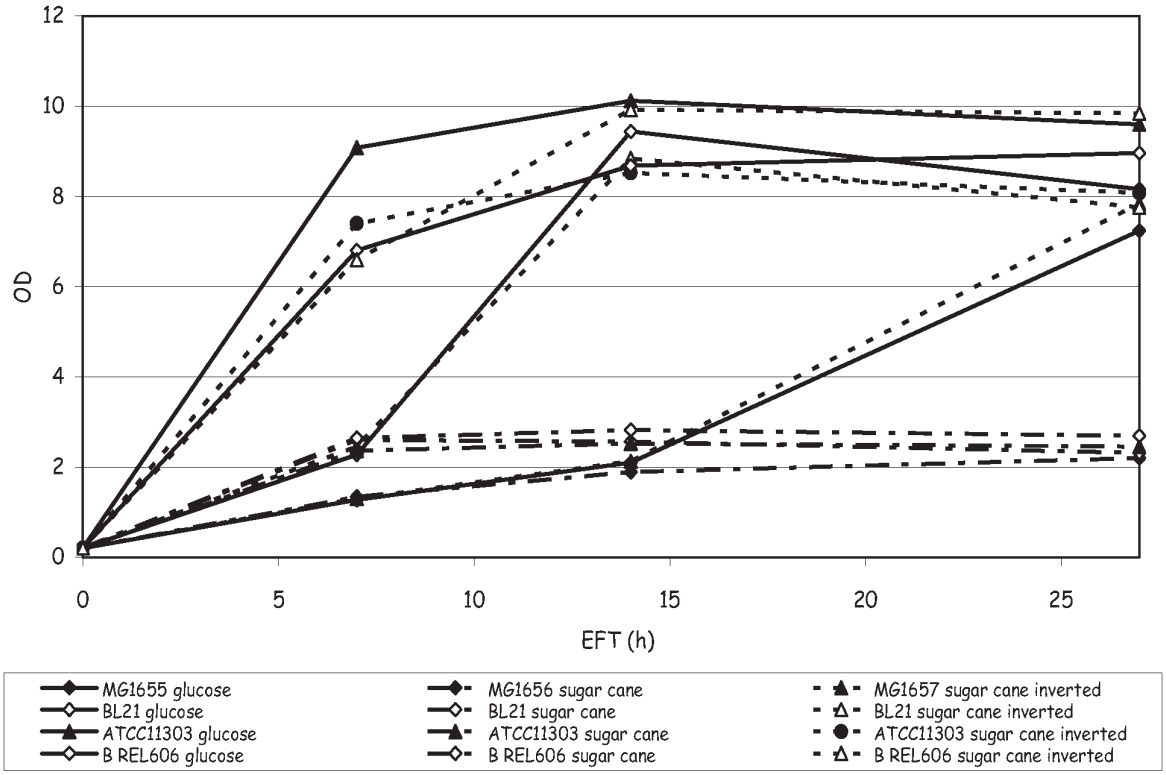

12
10
8
6
4
2
0
OD
0
5
10
15
20
25
EFT (h)
MG1655 glucose
BL21 glucose
ATCC11303 glucose
B REL606 glucose
MG1656 sugar cane
BL21 sugar cane
ATCC11303 sugar cane
B REL606 sugar cane
MG1657 sugar cane inverted
BL21 sugar cane inverted
ATCC11303 sugar cane inverted
B REL606 sugar cane inverted

Figure 152

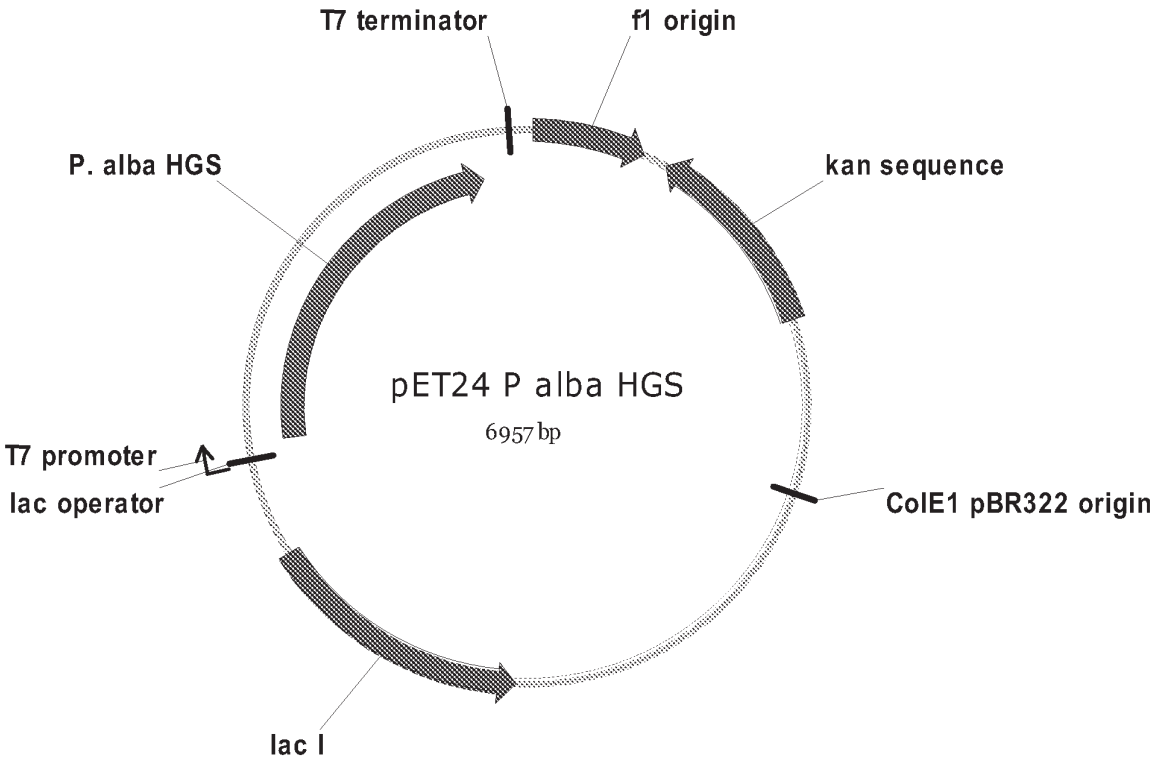

T7 terminator
f1 origin
P. alba HGS
kan sequence
pET24 P alba HGS
6957 bp
T7 promoter
lac operator
ColE1 pBR322 origin
lac I

Figure 153A

1-
tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagcgtgaccgctacacttg
ccagcgccctagcgcccgctcctttcgctttcttcccttcctttctcgccacgttcgccggctttccccgtcaagctctaaatcgg
gggctccctttagggttccgatttagtgctttacggcacctcgaccccaaaaaacttgattagggtgatggttcacgtagtggg
ccatcgccctgatagacggtttttcgcccttgacgttggagtccacgttctttaatagtggactcttgttccaaactggaacaac
actcaaccctatctcggtctattcttttgatttataagggattttgccgatttcggcctattggttaaaaaatgagctgatttaacaa
aaatttaacgcgaattttaacaaaatattaacgtttacaatttcaggtggcacttttcggggaaatgtgcgcggaaccccctattt
gtttatttttctaaatacattcaaatatgtatccgctcatgaattaattcttagaaaaactcatcgagcatcaaatgaaactgcaat
ttattcatatcaggattatcaataccatatttttgaaaaagccgtttctgtaatgaaggagaaaactcaccgaggcagttccata
ggatggcaagatcctggtatcggtctgcgattccgactcgtccaacatcaatacaacctattaatttcccctcgtcaaaaata
aggttatcaagtgagaaatcaccatgagtgacgactgaatccggtgagaatggcaaaagtttatgcatttctttccagacttgt
tcaacaggccagccattacgctcgtcatcaaaatcactcgcatcaaccaaaccgttattcattcgtgattgcgcctgagcga
gacgaaatacgcgatcgctgttaaaaggacaattacaaacaggaatcgaatgcaaccggcgcaggaacactgccagc
gcatcaacaatattttcacctgaatcaggatattcttctaatacctggaatgctgttttcccggggatcgcagtggtgagtaacc
atgcatcatcaggagtacggataaaatgcttgatggtcggaagaggcataaattccgtcagccagtttagtctgaccatctc
atctgtaacatcattggcaacgctacctttgccatgtttcagaaacaactctggcgcatcgggcttcccatacaatcgatagat
tgtcgcacctgattgcccgacattatcgcgagcccatttatacccatataaatcagcatccatgttggaatttaatcgcggccta
gagcaagacgtttcccgttgaatatggctcataacacccttgtattactgtttatgtaagcagacagttttattgttcatgaccaa
aatcccttaacgtgagttttcgttccactgagcgtcagaccccgtagaaaagatcaaaggatcttcttgagatcctttttttctgc
gcgtaatctgctgcttgcaaacaaaaaaaccaccgctaccagcggtggtttgtttgccggatcaagagctaccaactctttttt
ccgaaggtaactggcttcagcagagcgcagataccaaatactgtccttctagtgtagccgtagttaggccaccacttcaag
aactctgtagcaccgcctacatacctcgctctgctaatcctgttaccagtggctgctgccagtggcgataagtcgtgtcttacc
gggttggactcaagacgatagttaccggataaggcgcagcggtcgggctgaacgggggttcgtgcacacagcccagct
tggagcgaacgacctacaccgaactgagatacctacagcgtgagctatgagaaagcgccacgcttcccgaagggaga
aaggcggacaggtatccggtaagcggcagggtcggaacaggagagcgcacgagggagcttccagggggaaacgcc
tggtatctttatagtcctgtcgggtttcgccacctctgacttgagcgtcgatttttgtgatgctcgtcaggggggcggagcctatgg
aaaaacgccagcaacgcggccttttacggttcctggccttttgctggccttttgctcacatgttctttcctgcgttatcccctgatt
ctgtggataaccgtattaccgcctttgagtgagctgataccgctcgccgcagccgaacgaccgagcgcagcgagtcagtg
agcgaggaagcggaagagcgcctgatgcggtattttctccttacgcatctgtgcggtatttcacaccgcatatatggtgcact
ctcagtacaatctgctctgatgccgcatagttaagccagtatacactccgctatcgctacgtgactgggtcatggctgcgccc
cgacacccgccaacacccgctgacgcgccctgacgggcttgtctgctcccggcatccgcttacagacaagctgtgaccgt
ctccgggagctgcatgtgtcagaggttttcaccgtcatcaccgaaacgcgcgaggcagctgcggtaaagctcatcagcgt
ggtcgtgaagcgattcacagatgtctgcctgttcatccgcgtccagctcgttgagtttctccagaagcgttaatgtctggcttctg
ataaagcgggccatgttaagggcggttttttcctgtttggtcactgatgcctccgtgtaagggggatttctgttcatgggggtaat
gataccgatgaaacgagagaggatgctcacgatacgggttactgatgatgaacatgcccggttactggaacgttgtgagg
gtaaacaactggcggtatggatgcggcgggaccagagaaaaatcactcagggtcaatgccagcgcttcgttaatacaga
tgtaggtgttccacagggtagccagcagcatcctgcgatgcagatccggaacataatggtgcagggcgctgacttccgcgt
ttccagactttacgaaacacggaaaccgaagaccattcatgttgttgctcaggtcgcagacgttttgcagcagcagtcgcttc
acgttcgctcgcgtatcggtgattcattctgctaaccagtaaggcaaccccgccagcctagccgggtcctcaacgacagga
gcacgatcatgcgcacccgtggggccgccatgccggcgataatggcctgcttctcgccgaaacgtttggtggcgggacca
gtgacgaaggcttgagcgagggcgtgcaagattccgaataccgcaagcgacaggccgatcatcgtcgcgctccagcga
aagcggtcctcgccgaaaatgacccagagcgctgccggcacctgtcctacgagttgcatgataaagaagacagtcataa
gtgcggcgacgatagtcatgccccgcgcccaccggaaggagctgactgggttgaaggctctcaagggcatcggtcgag
atcccggtgcctaatgagtgagctaacttacattaattgcgttgcgctcactgcccgctttccagtcgggaaacctgtcgtgcc
agctgcattaatgaatcggccaacgcgcggggagaggcggtttgcgtattgggcgccagggtggtttttcttttcaccagtga
gacgggcaacagctgattgcccttcaccgcctggccctgagagagttgcagcaagcggtccacgctggtttgccccagca
ggcgaaaatcctgtttgatggtggttaacggcgggatataacatgagctgtcttcggtatcgtcgtatcccactaccgagatat
ccgcaccaacgcgcagcccggactcggtaatggcgcgcattgcgcccagcgccatctgatcgttggcaaccagcatcgc
agtgggaacgatgccctcattcagcatttgcatggtttgttgaaaaccggacatggcactccagtcgccttcccgttccgctat
cggctgaatttgattgcgagtgagatatttatgccag

Figure 153B

ccagccagacgcagacgcgccgagacagaacttaatgggcccgctaacagcgcgatttgctggtgacccaatgc
gaccagatgctccacgcccagtcgcgtaccgtcttcatgggagaaaataatactgttgatgggtgtctggtcagagac
atcaagaaataacgccggaacattagtgcaggcagcttccacagcaatggcatcctggtcatccagcggatagtta
atgatcagcccactgacgcgttgcgcgagaagattgtgcaccgccgctttacaggcttcgacgccgcttcgttctacca
tcgacaccaccacgctggcacccagttgatcggcgcgagatttaatcgccgcgacaatttgcgacggcgcgtgcag
ggccagactggaggtggcaacgccaatcagcaacgactgtttgcccgccagttgttgtgccacgcggttgggaatgt
aattcagctccgccatcgccgcttccacttttcccgcgttttcgcagaaacgtggctggcctggttcaccacgcgggaa
acggtctgataagagacaccggcatactctgcgacatcgtataacgttactggtttcacattcaccaccctgaattgact
ctcttccgggcgctatcatgccataccgcgaaaggttttgcgccattcgatggtgtccgggatctcgacgctctcccttat
gcgactcctgcattaggaagcagcccagtagtaggttgaggccgttgagcaccgccgccgcaaggaatggtgcat
gcaaggagatggcgcccaacagtcccccggccacggggcctgccaccatacccacgccgaaacaagcgctcat
gagcccgaagtggcgagcccgatcttccccatcggtgatgtcggcgatataggcgccagcaaccgcacctgtggc
gccggtgatgccggccacgatgcgtccggcgtagaggatcgagatctcgatcccgcgaaattaatacgactcactat
aggggaattgtgagcggataacaattcccctctagaaataattttgtttaactttaagaaggagatatacatatgcgttgt
agcgtgtccaccgaaaatgtgtctttcaccgaaactgaaaccgaagctcgtcgttctgcgaactacgaacctaacag
ctgggactatgattacctgctgtcctccgacacggacgagtccatcgaagtatacaaagacaaagcgaaaaagctg
gaagccgaagttcgtcgcgagattaataacgaaaaagcagaatttctgaccctgctggaactgattgacaacgtcca
gcgcctgggcctgggttaccgtttcgagtctgatatccgtggtgcgctggatcgcttcgtttcctccggcggcttcgatgc
ggtaaccaagacttccctgcacggtacggcactgtctttccgtctgctgcgtcaacacggttttgaggtttctcaggaag
cgttcagcggcttcaaagaccaaaacggcaacttcctggagaacctgaaggaagatatcaaagctatcctgagcct
gtacgaggccagcttcctggctctggaaggcgaaaacatcctggacgaggcgaaggttttcgcaatctctcatctga
aagaactgtctgaagaaaagatcggtaaagagctggcagaacaggtgaaccatgcactggaactgccactgcat
cgccgtactcagcgtctggaagcagtatggtctatcgaggcctaccgtaaaaaggaggacgcgaatcaggttctgct
ggagctggcaattctggattacaacatgatccagtctgtataccagcgtgatctgcgtgaaacgtcccgttggtggcgt
cgtgtgggtctggcgaccaaactgcactttgctcgtgaccgcctgattgagagcttctactgggccgtgggtgtagcatt
cgaaccgcaatactccgactgccgtaactccgtcgcaaaaatgttttctttcgtaaccattatcgacgatatctacgatgt
atacggcaccctggacgaactggagctgtttactgatgcagttgagcgttgggacgtaaacgccatcaacgacctgc
cggattacatgaaactgtgctttctggctctgtataacactattaacgaaatcgcctacgacaacctgaaagataaagg
tgagaacatcctgccgtatctgaccaaagcctgggctgacctgtgcaacgctttcctgcaagaagccaagtggctgta
caacaaatctactccgacctttgacgactacttcggcaacgcatggaaatcctcttctggcccgctgcaactggtgttcg
cttacttcgctgtcgtgcagaacattaaaaaggaagagatcgaaaacctgcaaaaataccatgacaccatctctcgt
ccttcccatatcttccgtctgtgcaatgacctggctagcgcgtctgcggaaattgcgcgtggtgaaaccgcaaatagcg
tttcttgttacatgcgcactaaaggtatctccgaagaactggctaccgaaagcgtgatgaatctgatcgatgaaacctg
gaaaaagatgaacaaggaaaaactgggtggtagcctgttcgcgaaaccgttcgtggaaaccgcgatcaacctgg
cacgtcaatctcactgcacttatcataacggcgacgcgcatacctctccggatgagctgacccgcaaacgcgttctgt
ctgtaatcactgaaccgattctgccgtttgaacgctaaggatccgaattcgagctccgtcgacaagcttgcggccgca
ctcgagcaccaccaccaccaccactgagatccggctgctaacaaagcccgaaaggaagctgagttggctgctgcc
accgctgagcaataactagcataaccccttggggcctctaaacgggtcttgaggggttttttgctgaaaggaggaact
atatccggat (SEQ ID NO:43)

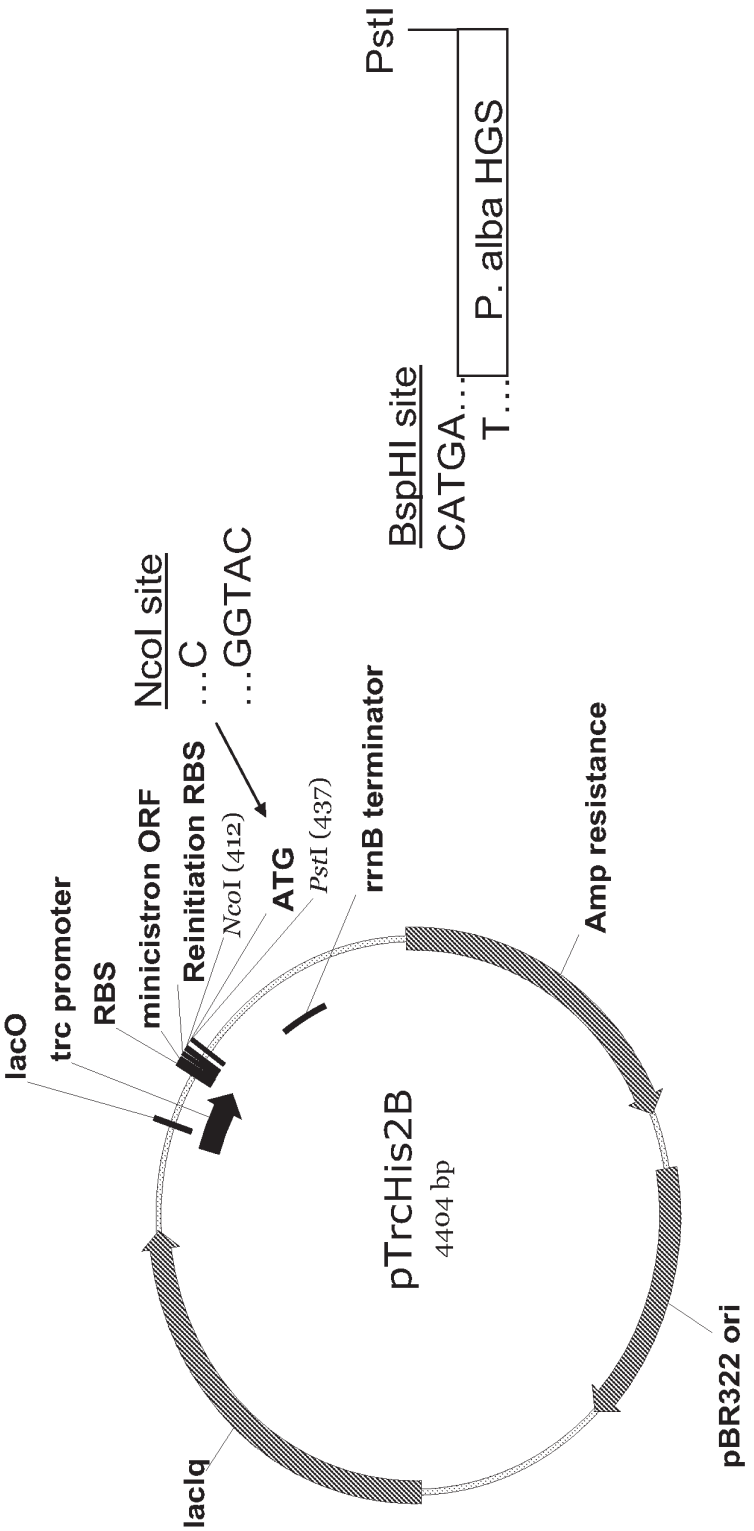

PstI
P. alba HGS
BspHI site
CATGA...
T...
NcoI site
...C
...GGTAC
lacO
trc promoter
RBS
minicistron ORF
Reinitiation RBS
NcoI (412)
ATG
PstI (437)
rrnB terminator
Amp resistance
pTrcHis2B
4404 bp
lacIq
pBR322 ori

Figure 154

Figure 155

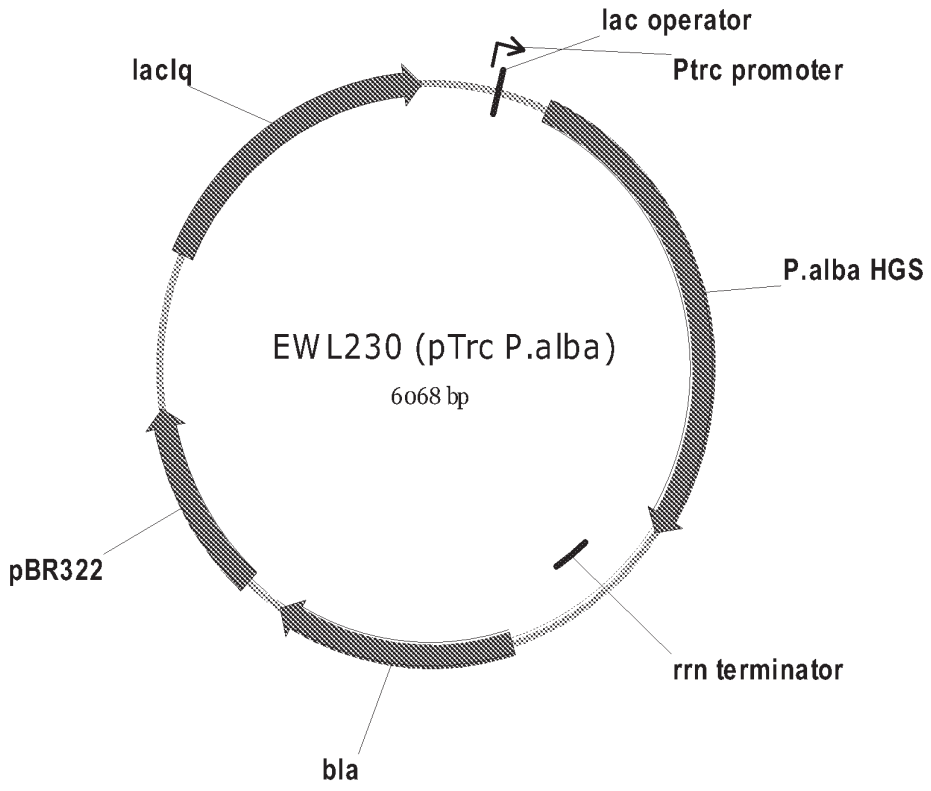

lac operator
Ptrc promoter
laclq
P.alba HGS
EWL230 (pTrc P.alba)
6068 bp
pBR322
rrn terminator
bla

Figure 156A

1-
gtttgacagcttatcatcgactgcacggtgcaccaatgcttctggcgtcaggcagccatcggaagctgtggtatggctgtgcag
gtcgtaaatcactgcataattcgtgtcgctcaaggcgcactcccgttctggataatgtttttgcgccgacatcataacggttctgg
caaatattctgaaatgagctgttgacaattaatcatccggctcgtataatgtgtggaattgtgagcggataacaatttcacacag
gaaacagcgccgctgagaaaaagcgaagcggcactgctctttaacaatttatcagacaatctgtgtgggcactcgaccgga
attatcgattaactttattattaaaaattaaagaggtatatattaatgtatcgattaaataaggaggaataaaccatgagatgtagc
gtgtccaccgaaaatgtgtctttcaccgaaactgaaaccgaagctcgtcgttctgcgaactacgaacctaacagctgggacta
tgattacctgctgtcctccgacacggacgagtccatcgaagtatacaaagacaaagcgaaaaagctggaagccgaagttc
gtcgcgagattaataacgaaaaagcagaatttctgaccctgctggaactgattgacaacgtccagcgcctgggcctgggtta
ccgtttcgagtctgatatccgtggtgcgctggatcgcttcgtttcctccggcggcttcgatgcggtaaccaagacttccctgcacg
gtacggcactgtctttccgtctgctgcgtcaacacggttttgaggtttctcaggaagcgttcagcggcttcaaagaccaaaacgg
caacttcctggagaacctgaaggaagatatcaaagctatcctgagcctgtacgaggccagcttcctggctctggaaggcgaa
aacatcctggacgaggcgaaggttttcgcaatctctcatctgaaagaactgtctgaagaaaagatcggtaaagagctggcag
aacaggtgaaccatgcactggaactgccactgcatcgccgtactcagcgtctggaagcagtatggtctatcgaggcctaccg
taaaaaggaggacgcgaatcaggttctgctggagctggcaattctggattacaacatgatccagtctgtataccagcgtgatct
gcgtgaaacgtcccgttggtggcgtcgtgtgggtctggcgaccaaactgcactttgctcgtgaccgcctgattgagagcttctac
tgggccgtgggtgtagcattcgaaccgcaatactccgactgccgtaactccgtcgcaaaaatgttttctttcgtaaccattatcga
cgatatctacgatgtatacggcaccctggacgaactggagctgtttactgatgcagttgagcgttgggacgtaaacgccatca
acgacctgccggattacatgaaactgtgctttctggctctgtataacactattaacgaaatcgcctacgacaacctgaaagata
aaggtgagaacatcctgccgtatctgaccaaagcctgggctgacctgtgcaacgctttcctgcaagaagccaagtggctgta
caacaaatctactccgacctttgacgactacttcggcaacgcatggaaatcctcttctggcccgctgcaactggtgttcgcttact
tcgctgtcgtgcagaacattaaaaaggaagagatcgaaaacctgcaaaaataccatgacaccatctctcgtccttcccatatc
ttccgtctgtgcaatgacctggctagcgcgtctgcggaaattgcgcgtggtgaaaccgcaaatagcgtttcttgttacatgcgca
ctaaaggtatctccgaagaactggctaccgaaagcgtgatgaatctgatcgatgaaacctggaaaaagatgaacaaggaa
aaactgggtggtagcctgttcgcgaaaccgttcgtggaaaccgcgatcaacctggcacgtcaatctcactgcacttatcataa
cggcgacgcgcatacctctccggatgagctgacccgcaaacgcgttctgtctgtaatcactgaaccgattctgccgtttgaacg
ctaactgcagctggtaccatatgggaattcgaagctttctagaacaaaaactcatctcagaagaggatctgaatagcgccgtc
gaccatcatcatcatcatcattgagtttaaacggtctccagcttggctgttttggcggatgagagaagattttcagcctgatacag
attaaatcagaacgcagaagcggtctgataaaacagaatttgcctggcggcagtagcgcggtggtcccacctgaccccatg
ccgaactcagaagtgaaacgccgtagcgccgatggtagtgtggggtctccccatgcgagagtagggaactgccaggcatc
aaataaaacgaaaggctcagtcgaaagactgggcctttcgttttatctgttgtttgtcggtgaacgctctcctgagtaggacaaat
ccgccgggagcggatttgaacgttgcgaagcaacggcccggagggtggcgggcaggacgcccgccataaactgccagg
catcaaattaagcagaaggccatcctgacggatggccttttgcgtttctacaaactctttttgtttatttttctaaatacattcaaatat
gtatccgctcatgagacaataaccctgataaatgcttcaataatattgaaaaaggaagagtatgagtattcaacatttccgtgtc
gcccttattcccttttttgcggcattttgccttcctgtttttgctcacccagaaacgctggtgaaagtaaaagatgctgaagatcagtt
gggtgcacgagtgggttacatcgaactggatctcaacagcggtaagatccttgagagttttcgccccgaagaacgttttccaat
gatgagcacttttaaagttctgctatgtggcgcggtattatcccgtgttgacgccgggcaagagcaactcggtcgccgcataca
ctattctcagaatgacttggttgagtactcaccagtcacagaaaagcatcttacggatggcatgacagtaagagaattatgcag
tgctgccataaccatgagtgataacactgcggccaacttacttctgacaacgatcggaggaccgaaggagctaaccgcttttttt
gcacaacatgggggatcatgtaactcgccttgatcgttgggaaccggagctgaatgaagccataccaaacgacgagcgtg
acaccacgatgcctgtagcaatggcaacaacgttgcgcaaactattaactggcgaactacttactctagcttcccggcaaca
attaatagactggatggaggcggataaagttgcaggaccacttctgcgctcggcccttccggctggctggtttattgctgataaa
tctggagccggtgagcgtgggtctcgcggtatcattgcagcactggggccagatggtaagccctcccgtatcgtagttatctac
acgacggggagtcaggcaactatggatgaacgaaatagacagatcgctgagataggtgcctcactgattaagcattggtaa
ctgtcagaccaagtttactcatatatactttagattgatttaaaacttcatttttaatttaaaaggatctaggtgaagatccttttgata
atctcatgaccaaaatcccttaacgtgagttttcgttccactgagcgtcagaccccgtagaaaagatcaaaggatcttcttgaga
tccttttttctgcgcgtaatctgctgcttgcaaacaaaaaaaccaccgctaccagcggtggtttgtttgccggatcaagagctac
caactctttttccgaaggtaactggcttcagcagagcgcagataccaaatactgtccttctagtgtagccgtagttaggccacca
cttcaagaactctgtagcaccgcctacatacctcgctctgctaatcctgttaccagtggctgc

Figure 156B

tgccagtggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccggataaggcgcagcggtcgggct
gaacgggggttcgtgcacacagcccagcttggagcgaacgacctacaccgaactgagatacctacagcgtgag
ctatgagaaagcgccacgcttcccgaagggagaaaggcggacaggtatccggtaagcggcagggtcggaacag
gagagcgcacgagggagcttccagggggaaacgcctggtatctttatagtcctgtcgggtttcgccacctctgacttg
agcgtcgatttttgtgatgctcgtcaggggggcggagcctatggaaaaacgccagcaacgcggccttttacggttcct
ggccttttgctggccttttgctcacatgttctttcctgcgttatcccctgattctgtggataaccgtattaccgcctttgagtgag
ctgataccgctcgccgcagccgaacgaccgagcgcagcgagtcagtgagcgaggaagcggaagagcgcctgat
gcggtattttctccttacgcatctgtgcggtatttcacaccgcatatggtgcactctcagtacaatctgctctgatgccgcat
agttaagccagtatacactccgctatcgctacgtgactgggtcatggctgcgccccgacacccgccaacacccgctg
acgcgccctgacgggcttgtctgctcccggcatccgcttacagacaagctgtgaccgtctccgggagctgcatgtgtc
agaggttttcaccgtcatcaccgaaacgcgcgaggcagcagatcaattcgcgcgcgaaggcgaagcggcatgca
tttacgttgacaccatcgaatggtgcaaaacctttcgcggtatggcatgatagcgcccggaagagagtcaattcaggg
tggtgaatgtgaaaccagtaacgttatacgatgtcgcagagtatgccggtgtctcttatcagaccgtttcccgcgtggtg
aaccaggccagccacgtttctgcgaaaacgcgggaaaaagtggaagcggcgatggcggagctgaattacattcc
caaccgcgtggcacaacaactggcgggcaaacagtcgttgctgattggcgttgccacctccagtctggccctgcac
gcgccgtcgcaaattgtcgcggcgattaaatctcgcgccgatcaactgggtgccagcgtggtggtgtcgatggtaga
acgaagcggcgtcgaagcctgtaaagcggcggtgcacaatcttctcgcgcaacgcgtcagtgggctgatcattaac
tatccgctggatgaccaggatgccattgctgtggaagctgcctgcactaatgttccggcgttatttcttgatgtctctgacc
agacacccatcaacagtattattttctcccatgaagacggtacgcgactgggcgtggagcatctggtcgcattgggtc
accagcaaatcgcgctgttagcgggcccattaagttctgtctcggcgcgtctgcgtctggctggctggcataaatatctc
actcgcaatcaaattcagccgatagcggaacgggaaggcgactggagtgccatgtccggttttcaacaaaccatgc
aaatgctgaatgagggcatcgttcccactgcgatgctggttgccaacgatcagatggcgctgggcgcaatgcgcgc
cattaccgagtccgggctgcgcgttggtgcggatatctcggtagtgggatacgacgataccgaagacagctcatgtta
tatcccgccgtcaaccaccatcaaacaggattttcgcctgctggggcaaaccagcgtggaccgcttgctgcaactctc
tcagggccaggcggtgaagggcaatcagctgttgcccgtctcactggtgaaaagaaaaaccaccctggcgcccaa
tacgcaaaccgcctctccccgcgcgttggccgattcattaatgcagctggcacgacaggtttcccgactggaaagcg
ggcagtgagcgcaacgcaattaatgtgagttagcgcgaattgatctg (SEQ ID NO:44)

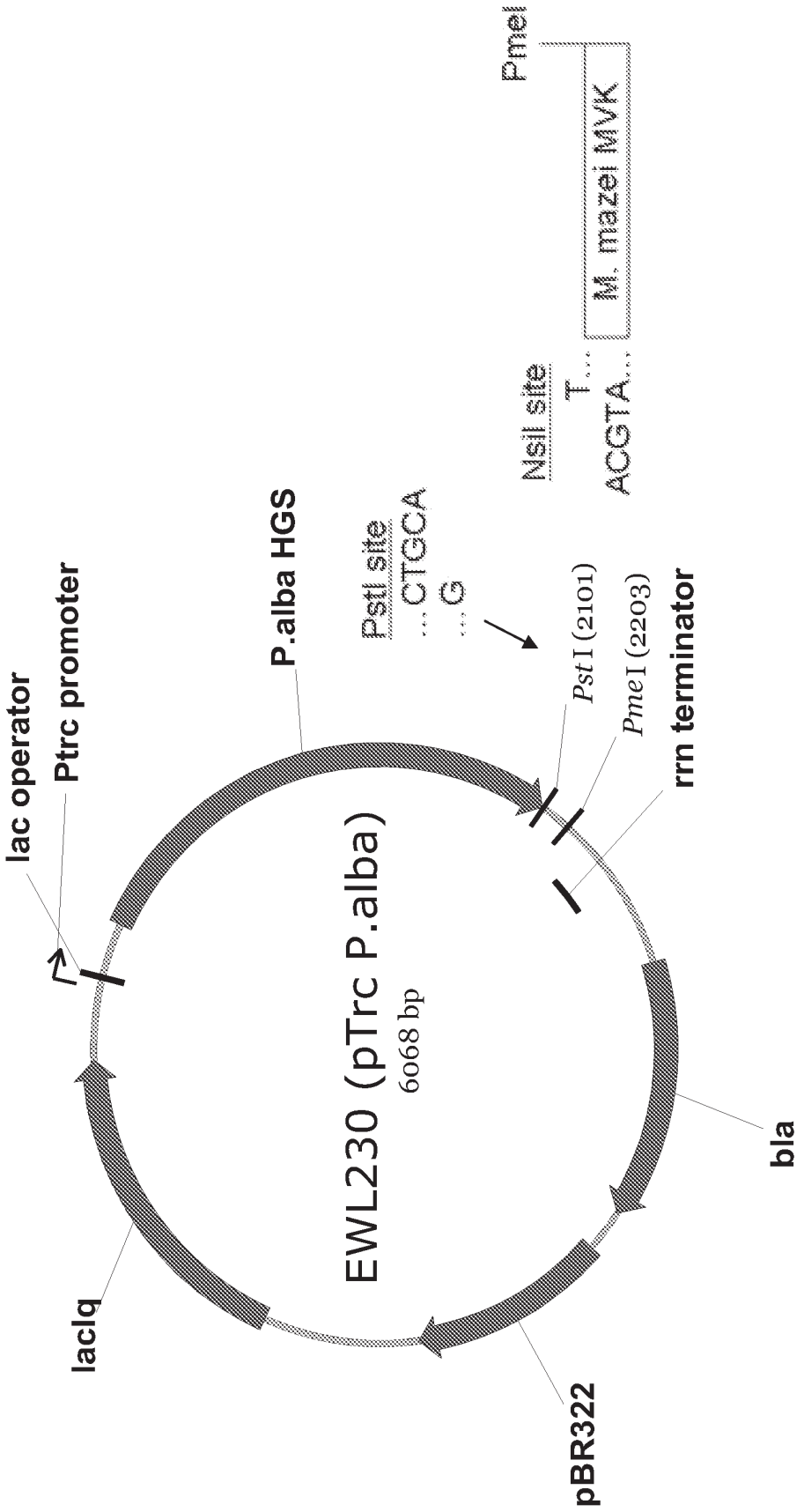

EWL230 (pTrc P.alba)
6068 bp
lac operator
Ptrc promoter
P.alba HGS
PstI site
...CTGCA
...G
PstI (2101)
PmeI (2203)
rrn terminator
NsiI site
T...
ACGTA...
PmeI
M. mazei MVK
bla
pBR322
laclq

Figure 157

Figure 158

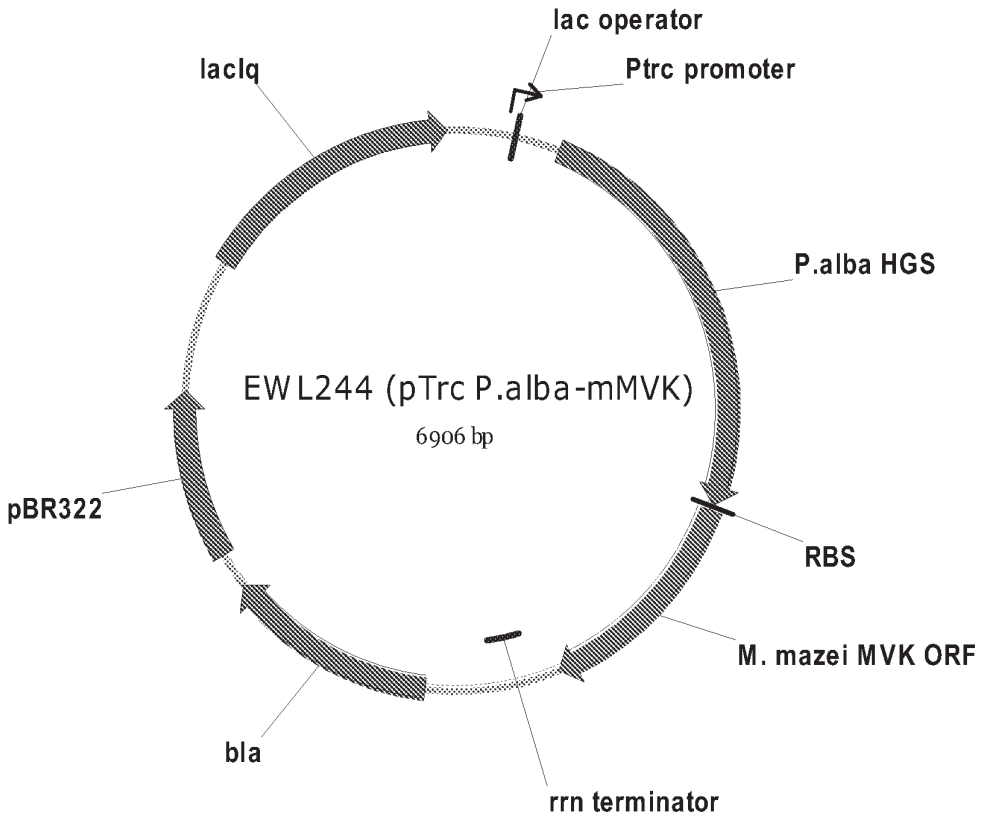

lac operator
laclq
Ptrc promoter
P.alba HGS
EWL244 (pTrc P.alba-mMVK)
6906 bp
pBR322
RBS
M. mazei MVK ORF
bla
rrn terminator

Figure 159A

1-
gtttgacagcttatcatcgactgcacggtgcaccaatgcttctggcgtcaggcagccatcggaagctgtggtatggctgtgcaggtcg
taaatcactgcataattcgtgtcgctcaaggcgcactcccgttctggataatgtttttgcgccgacatcataacggttctggcaaatatt
ctgaaatgagctgttgacaattaatcatccggctcgtataatgtgtggaattgtgagcggataacaatttcacacaggaaacagcgc
cgctgagaaaaagcgaagcggcactgctctttaacaatttatcagacaatctgtgtgggcactcgaccggaattatcgattaacttta
ttattaaaaattaaagaggtatatattaatgtatcgattaaataaggaggaataaaccatgagatgtagcgtgtccaccgaaaatgtg
tctttcaccgaaactgaaaccgaagctcgtcgttctgcgaactacgaacctaacagctgggactatgattacctgctgtcctccgaca
cggacgagtccatcgaagtatacaaagacaaagcgaaaaagctggaagccgaagttcgtcgcgagattaataacgaaaaagc
agaatttctgaccctgctggaactgattgacaacgtccagcgcctgggcctgggttaccgtttcgagtctgatatccgtggtgcgctgg
atcgcttcgtttcctccggcggcttcgatgcggtaaccaagacttccctgcacggtacggcactgtctttccgtctgctgcgtcaacac
ggttttgaggtttctcaggaagcgttcagcggcttcaaagaccaaaacggcaacttcctggagaacctgaaggaagatatcaaag
ctatcctgagcctgtacgaggccagcttcctggctctggaaggcgaaaacatcctggacgaggcgaaggttttcgcaatctctcatc
tgaaagaactgtctgaagaaaagatcggtaaagagctggcagaacaggtgaaccatgcactggaactgccactgcatcgccgt
actcagcgtctggaagcagtatggtctatcgaggcctaccgtaaaaaggaggacgcgaatcaggttctgctggagctggcaattct
ggattacaacatgatccagtctgtataccagcgtgatctgcgtgaaacgtcccgttggtggcgtcgtgtgggtctggcgaccaaactg
cactttgctcgtgaccgcctgattgagagcttctactgggccgtgggtgtagcattcgaaccgcaatactccgactgccgtaactccgt
cgcaaaaatgttttctttcgtaaccattatcgacgatatctacgatgtatacggcaccctggacgaactggagctgtttactgatgcagt
tgagcgttgggacgtaaacgccatcaacgacctgccggattacatgaaactgtgctttctggctctgtataacactattaacgaaatc
gcctacgacaacctgaaagataaaggtgagaacatcctgccgtatctgaccaaagcctgggctgacctgtgcaacgctttcctgc
aagaagccaagtggctgtacaacaaatctactccgacctttgacgactacttcggcaacgcatggaaatcctcttctggcccgctgc
aactggtgttcgcttacttcgctgtcgtgcagaacattaaaaaggaagagatcgaaaacctgcaaaaataccatgacaccatctctc
gtccttcccatatcttccgtctgtgcaatgacctggctagcgcgtctgcggaaattgcgcgtggtgaaaccgcaaatagcgtttcttgtt
acatgcgcactaaaggtatctccgaagaactggctaccgaaagcgtgatgaatctgatcgatgaaacctggaaaaagatgaaca
aggaaaaactgggtggtagcctgttcgcgaaaccgttcgtggaaaccgcgatcaacctggcacgtcaatctcactgcacttatcat
aacggcgacgcgcatacctctccggatgagctgacccgcaaacgcgttctgtctgtaatcactgaaccgattctgccgtttgaacgc
taactgcataaaggaggtaaaaaaacatggtatcctgttctgcgccgggtaagatttacctgttcggtgaacacgccgtagtttatgg
cgaaactgcaattgcgtgtgcggtggaactgcgtacccgtgttcgcgcggaactcaatgactctatcactattcagagccagatcgg
ccgcaccggtctggatttcgaaaagcacccttatgtgtctgcggtaattgagaaaatgcgcaaatctattcctattaacggtgttttcttg
accgtcgattccgacatcccggtgggctccggtctgggtagcagcgcagccgttactatcgcgtctattggtgcgctgaacgagctg
ttcggctttggcctcagcctgcaagaaatcgctaaactgggccacgaaatcgaaattaaagtacagggtgccgcgtccccaaccg
atacgtatgtttctaccttcggcggcgtggttaccatcccggaacgtcgcaaactgaaaactccggactgcggcattgtgattggcga
taccggcgttttctcctccaccaaagagttagtagctaacgtacgtcagctgcgcgaaagctacccggatttgatcgaaccgctgat
gacctctattggcaaaatctctcgtatcggcgaacaactggttctgtctggcgactacgcatccatcggccgcctgatgaacgtcaac
cagggtctcctggacgccctgggcgttaacatcttagaactgagccagctgatctattccgctcgtgcggcaggtgcgtttggcgcta
aaatcacgggcgctggcggcggtggctgtatggttgcgctgaccgctccggaaaaatgcaaccaagtggcagaagcggtagca
ggcgctggcggtaaagtgactatcactaaaccgaccgagcaaggtctgaaagtagattaaagtctagttaaagtttaaacggtctc
cagcttggctgttttggcggatgagagaagattttcagcctgatacagattaaatcagaacgcagaagcggtctgataaaacagaa
tttgcctggcggcagtagcgcggtggtcccacctgaccccatgccgaactcagaagtgaaacgccgtagcgccgatggtagtgtg
gggtctccccatgcgagagtagggaactgccaggcatcaaataaaacgaaaggctcagtcgaaagactgggcctttcgttttatct
gttgtttgtcggtgaacgctctcctgagtaggacaaatccgccgggagcggatttgaacgttgcgaagcaacggcccggagggtg
gcgggcaggacgcccgccataaactgccaggcatcaaattaagcagaaggccatcctgacggatggccttttgcgtttctacaa
actcttttgtttatttttctaaatacattcaaatatgtatccgctcatgagacaataaccctgataaatgcttcaataatattgaaaaagga
agagtatgagtattcaacatttccgtgtcgcccttattcccttttttgcggcattttgccttcctgtttttgctcacccagaaacgctggtgaa
agtaaaagatgctgaagatcagttgggtgcacgagtgggttacatcgaactggatctcaacagcggtaagatccttgagagttttcg
ccccgaagaacgttttccaatgatgagcacttttaaagttctgctatgtggcgcggtattatcccgtgttgacgccgggcaagagcaa
ctcggtcgccgcatacactattctcagaatgacttggttgagtactcaccagtcacagaaaagcatcttacggatggcatgacagta
agagaattatgcagtgctgccataaccatgagtgataacactgcggccaacttacttctgacaacg

Figure 159B

atcggaggaccgaaggagctaaccgctttttgcacaacatgggggatcatgtaactcgccttgatcgttgggaac
cggagctgaatgaagccataccaaacgacgagcgtgacaccacgatgcctgtagcaatggcaacaacgttgc
gcaaactattaactggcgaactacttactctagcttcccggcaacaattaatagactggatggaggcggataaagt
tgcaggaccacttctgcgctcggcccttccggctggctggtttattgctgataaatctggagccggtgagcgtgggtc
tcgcggtatcattgcagcactggggccagatggtaagccctcccgtatcgtagttatctacacgacggggagtca
ggcaactatggatgaacgaaatagacagatcgctgagataggtgcctcactgattaagcattggtaactgtcaga
ccaagtttactcatatatactttagattgatttaaaacttcatttttaatttaaaaggatctaggtgaagatccttttgataa
tctcatgaccaaaatcccttaacgtgagttttcgttccactgagcgtcagaccccgtagaaaagatcaaaggatctt
cttgagatcctttttttctgcgcgtaatctgctgcttgcaaacaaaaaaaccaccgctaccagcggtggtttgtttgccg
gatcaagagctaccaactctttttccgaaggtaactggcttcagcagagcgcagataccaaatactgtccttctagt
gtagccgtagttaggccaccacttcaagaactctgtagcaccgcctacatacctcgctctgctaatcctgttaccagt
ggctgctgccagtggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccggataaggcgcagcg
gtcgggctgaacgggggttcgtgcacacagcccagcttggagcgaacgacctacaccgaactgagatacct
acagcgtgagctatgagaaagcgccacgcttcccgaagggagaaaggcggacaggtatccggtaagcggca
gggtcggaacaggagagcgcacgagggagcttccagggggaaacgcctggtatctttatagtcctgtcgggtttc
gccacctctgacttgagcgtcgatttttgtgatgctcgtcaggggggcggagcctatggaaaaacgccagcaacg
cggccttttacggttcctggccttttgctggccttttgctcacatgttctttcctgcgttatcccctgattctgtggataaccg
tattaccgcctttgagtgagctgataccgctcgccgcagccgaacgaccgagcgcagcgagtcagtgagcgag
gaagcggaagagcgcctgatgcggtattttctccttacgcatctgtgcggtatttcacaccgcatatggtgcactctc
agtacaatctgctctgatgccgcatagttaagccagtatacactccgctatcgctacgtgactgggtcatggctgcg
ccccgacacccgccaacacccgctgacgcgccctgacgggcttgtctgctcccggcatccgcttacagacaag
ctgtgaccgtctccgggagctgcatgtgtcagaggttttcaccgtcatcaccgaaacgcgcgaggcagcagatca
attcgcgcgcgaaggcgaagcggcatgcatttacgttgacaccatcgaatggtgcaaaacctttcgcggtatggc
atgatagcgcccggaagagagtcaattcagggtggtgaatgtgaaaccagtaacgttatacgatgtcgcagagt
atgccggtgtctcttatcagaccgtttcccgcgtggtgaaccaggccagccacgtttctgcgaaaacgcgggaaa
aagtggaagcggcgatggcggagctgaattacattcccaaccgcgtggcacaacaactggcgggcaaacagt
cgttgctgattggcgttgccacctccagtctggccctgcacgcgccgtcgcaaattgtcgcggcgattaaatctcgc
gccgatcaactgggtgccagcgtggtggtgtcgatggtagaacgaagcggcgtcgaagcctgtaaagcggcg
gtgcacaatcttctcgcgcaacgcgtcagtgggctgatcattaactatccgctggatgaccaggatgccattgctgt
ggaagctgcctgcactaatgttccggcgttatttcttgatgtctctgaccagacacccatcaacagtattattttctccc
atgaagacggtacgcgactgggcgtggagcatctggtcgcattgggtcaccagcaaatcgcgctgttagcgggc
ccattaagttctgtctcggcgcgtctgcgtctggctggctggcataaatatctcactcgcaatcaaattcagccgata
gcggaacgggaaggcgactggagtgccatgtccggttttcaacaaaccatgcaaatgctgaatgagggcatcgt
tcccactgcgatgctggttgccaacgatcagatggcgctgggcgcaatgcgcgccattaccgagtccgggctgc
gcgttggtgcggatatctcggtagtgggatacgacgataccgaagacagctcatgttatatcccgccgtcaacca
ccatcaaacaggattttcgcctgctggggcaaaccagcgtggaccgcttgctgcaactctctcagggccaggcg
gtgaagggcaatcagctgttgcccgtctcactggtgaaaagaaaaaccaccctggcgcccaatacgcaaaccg
cctctccccgcgcgttggccgattcattaatgcagctggcacgacaggtttcccgactggaaagcgggcagtgag
cgcaacgcaattaatgtgagttagcgcgaattgatctg (SEQ ID NO:45)

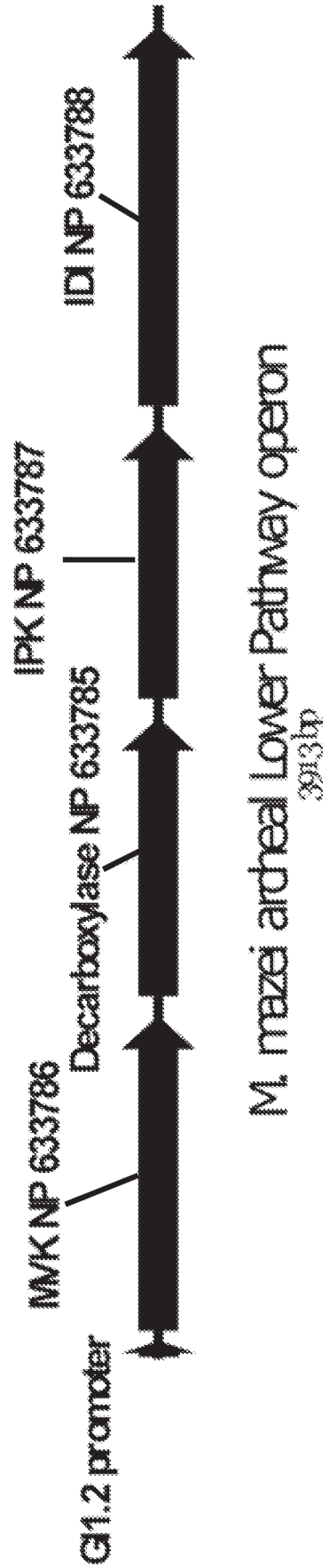

G1.2 promoter
MVK NP 633786
Decarboxylase NP 633785
IPK NP 633787
IDI NP 633788
M. mazei archeal Lower Pathway operon
3073bp

Figure 160A

Figure 160B

gcggccgcgcccttgacgatgccacatcctgagcaaataattcaaccactaattgtgagcggataacacaaggagga
aacagccatggtatcctgttctgcgccgggtaagatttacctgttcggtgaacacgccgtagtttatggcgaaactgcaatt
gcgtgtgcggtggaactgcgtacccgtgttcgcgcggaactcaatgactctatcactattcagagccagatcggccgcac
cggtctggatttcgaaaagcacccttatgtgtctgcggtaattgagaaaatgcgcaaatctattcctattaacggtgttttcttg
accgtcgattccgacatcccggtgggctccggtctgggtagcagcgcagccgttactatcgcgtctattggtgcgctgaac
gagctgttcggctttggcctcagcctgcaagaaatcgctaaactgggccacgaaatcgaaattaaagtacagggtgccg
cgtccccaaccgatacgtatgtttctaccttcggcggcgtggttaccatcccggaacgtcgcaaactgaaaactccggact
gcggcattgtgattggcgataccggcgttttctcctccaccaaagagttagtagctaacgtacgtcagctgcgcgaaagct
acccggatttgatcgaaccgctgatgacctctattggcaaaatctctcgtatcggcgaacaactggttctgtctggcgacta
cgcatccatcggccgcctgatgaacgtcaaccagggtctcctggacgccctgggcgttaacatcttagaactgagccag
ctgatctattccgctcgtgcggcaggtgcgtttggcgctaaaatcacgggcgctggcggcggtggctgtatggttgcgctg
accgctccggaaaaatgcaaccaagtggcagaagcggtagcaggcgctggcggtaaagtgactatcactaaaccga
ccgagcaaggtctgaaagtagattaagccttgacttaatagctgcttatttcgcccttatggtacctagtaggaggaaaaa
aacatggaaatgcgtcaaccggctgtcgcaggtcaattctacccactgcgttgcgagaacctggaaaacgaactgaaa
cgctgcttcgaaggcctggagatccgcgaacaagaagtgctgggcgcagtctgtccgcacgccggttatatgtactctgg
caaagttgcggcgcacgtctatgccactctgccggaagctgatacctacgtaatcttcggcccgaaccacaccggctac
ggtagccctgtctctgtgagccgtgaaacttggaagaccccgttgggcaatatcgatgttgacctggaactggcggacgg
cttcctgggttccatcgtagatgcggatgaactcggtcacaaatacgaacactctatcgaagttcagctgccgtttctgcaat
accgttttgaacgcgatttcaaaattctgccaatctgcatgggtatgcaagacgaagaaaccgcggtcgaagtaggtaac
ctgctggcggatctgatcagcgagtccggtaaacgtgctgtgatcatcgcaagctctgatttcacccactatgagacggct
gaacgtgccaaagaaatcgattccgaagttattgattctatcctgaactttgacatctctggcatgtacgatcgcctgtatcg
ccgtaacgcctctgtttgcggttacggcccgatcaccgctatgctgacggcaagcaaaaagctgggcggctctcgtgcg
actttgctgaaatacgcaaacagcggtgacgtgtccggtgataaagacgctgtggtgggctacgccgccatcatcgttga
gtaagctgattaaaggttgaacagataggatttcgtcatggatcctacaaggaggaaaaaaacatgaatgcttctaatga
accggtgattctgaaactgggtggctctgctattaccgacaaaggtgcctacgaaggcgtagttaaggaagctgatttgct
gcgcatcgcacaggaagttagcggtttccgtggcaagatgatcgtggttcatggtgctggtagcttcggccatacgtacgc
gaagaaatacggcctggaccgtaccttcgacccagagggcgcaattgttactcatgaatctgttaaaaagctcgcctcca
aagttgtaggtgctctgaatagcttcggcgtgcgtgctatcgcggtgcatcctatggactgcgcagtatgccgtaacggtcg
tatcgaaacgatgtatctggactccatcaagttaatgctggaaaaaggtctggtgccggttctgcacggcgacgtcgcaat
ggatattgaactgggcacttgtatcctgtccggtgatcaaatcgttccttacctggccaaagaactgggtatctcccgcctcg
gcctgggcagcgcagaggatggtgtgctggatatggagggcaaacctgtaccggaaatcaccccagaaactttcgaa
gagttccgccactgcatcggtggttctggttctactgatgtaaccggtggcatgctgggcaaagtgctggaacttctggaatt
gagcaaaaattcttccattactagctacattttcaacgctggtaaagcagacaacatctaccgctttctgaatggtgagtcc
atcggcactcgcatcagcccggacaagcgtgtttaagctagttattaacctaaatgctctaaaccagttatgagctctacaa
ggaggaaaaaaacatgattaacactaccagccgccgcaaaattgaacacctgaaactctgcgcagaatccccggttg
aagcgcgtcaggtatctgccggctttgaagacgttactctgatccaccgcgctttaccggagctgaacatggatgaactg
gacctcagcgttgatttcctgggtaaacgcatcaaagcgccgttcctgattgcgtctatcacgggtggtcacccagatacc
atcccggttaacgctgcgctggcagctgctgctgaggagctgggtgttggcatcggcgttggctctcagcgcgcggccatt
gatgatccgagccaggaagacagcttccgtgtagtgcgtgatgaagccccagatgcgtttgtttatggcaacgtcggcgc
agcacagatccgtcagtatggtgttgaaggtgttgaaaaactgatcgaaatgattgacgcagatgccttggcaatccacc
tgaactttctgcaagaagcggtccaaccggaaggtgaccgcgacgcgaccggttgcctggacatgattaccgaaatttg
ctctcagattaaaactccggtaatcgtgaaagaaaccggtgcaggcattagccgtgaagatgcgattctgttccagaaag
ctggcgtgagcgcaatcgacgttggcggcgcgggcggcacctcctgggctggcgtcgaggtctaccgtgctaaagaaa
gccgtgactctgttagcgagcgtttaggtgagctgttttgggatttcggcattccgacggtagcttctctgattgaatcccgcgt
ttccttgccgctgatcgcaaccggcggtatccgtaacggtctggacattgctaaaagcattgctctcggcgcaagcgctgc
cagcgccgctctgccgttcgttggtccgtccctggagggcaaagaatccgttgtacgtgtgctgagctgcatgctggaaga
atttaaagcagcaatgtttttgtgcggttgcggcaacatcaaaga

Figure 160C

cctgcacaactctccagtagtggtaactggttggacccgcgaatacctggagcagcgcggttttaacgttaagga
cctctccctgccgggcaacgctctgtaagcttcaacgcgtctacaaataaaaaaggcacgtcagatgacgtgcct
ttttttcttgtctaga
(SEQ ID NO:46)

Figure 161A

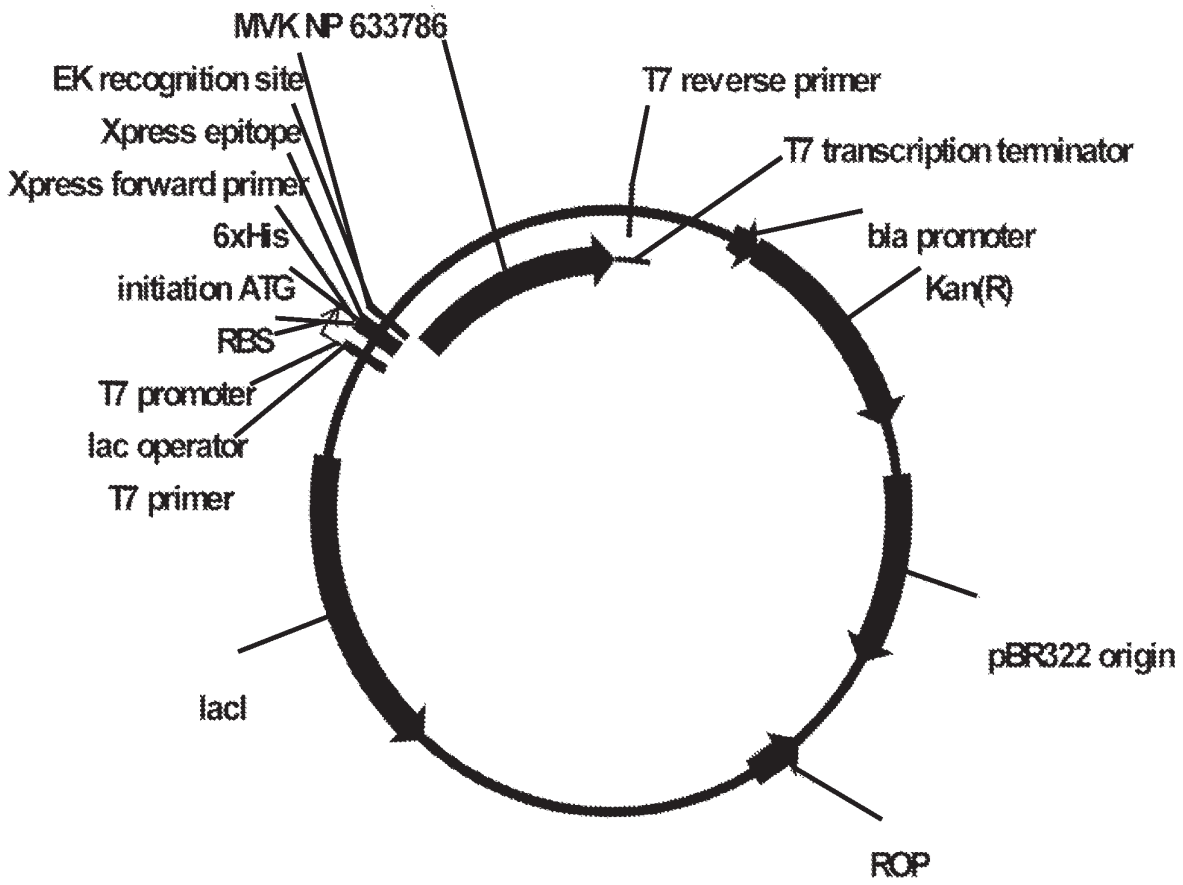

MVK NP 633786
EK recognition site
Xpress epitope
Xpress forward primer
6xHis
initiation ATG
RBS
T7 promoter
lac operator
T7 primer
lacI
T7 reverse primer
T7 transcription terminator
bla promoter
Kan(R)
pBR322 origin
ROP
MCM376 - MVK from M. mazei archeal Lowerin pET200D
6647bp

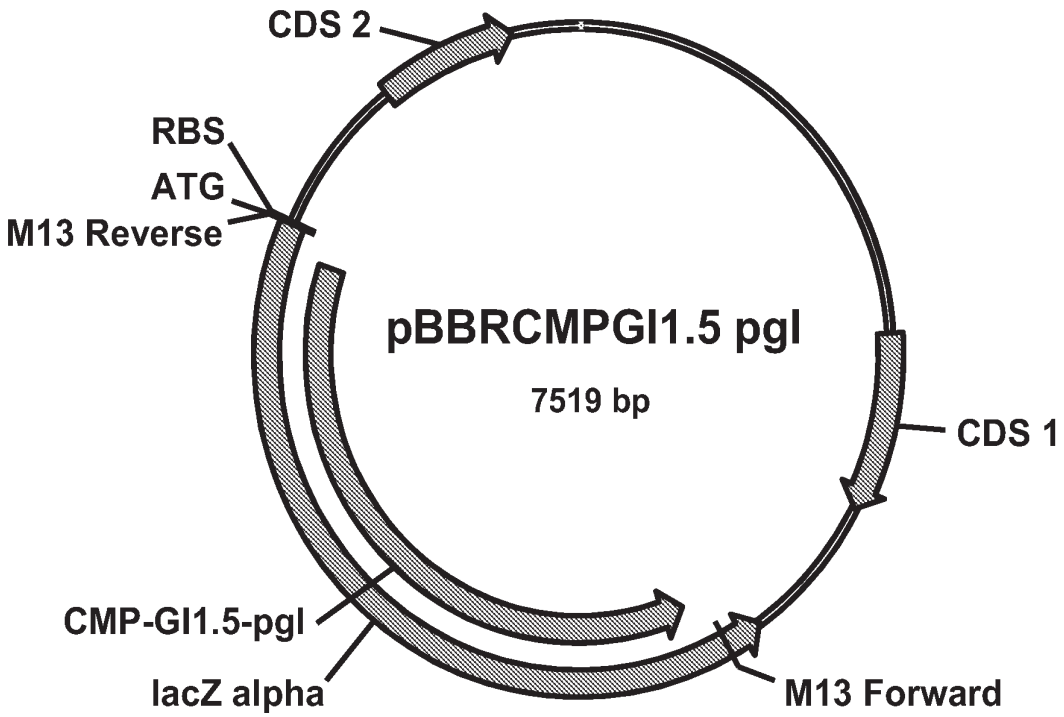
Figure 161B

aagggcgagctcaacgatccggctgctaacaaagcccgaaaggaagctgagttggctgctgccaccgctgagcaat
aactagcataaccccttggggcctctaaacgggtcttgaggagttttttgctgaaaggaggaactatatccggatatccc
gcaagaggcccggcagtaccggcataaccaagcctatgcctacagcatccagggtgacggtgccgaggatgacga
tgagcgcattgttagatttcatacacggtgcctgactgcgttagcaatttaactgtgataaactaccgcattaaagcttatcg
atgataagctgtcaaacatgagaattaattcttgaagacgaaagggcctcgtgatacgcctatttttataggttaatgtcat
gataataatggtttcttagacgtcaggtggcacttttcggggaaatgtgcgcggaacccctatttgtttatttttctaaatacatt
caaatatgtatccgctcatgagacaataaccctgataaatgcttcaataatattgaaaaaggaagagtatgattgaaca
agatggattgcacgcaggttctccggccgcttgggtggagaggctattcggctatgactgggcacaactgacaatcggc
tgctctgatgccgccgtgttccggctgtcagcgcaggggcgcccggttctttttgtcaagaccgacctgtccggtgccctg
aatgaactgcaggacgaggcagcgcggctatcgtggctggccacgacgggcgttccttgcgcagctgtgctcgacgtt
gtcactgaagcgggaagggactggctgctattgggcgaagtgccggggcaggatctcctgtcatctcaccttgctcctg
ccgagaaagtatccatcatggctgatgcaatgcggcggctgcatacgcttgatccggctacctgcccattcgaccacca
agcgaaacatcgcatcgagcgggcacgtactcggatggaagccggtcttgtcgatcaggatgatctggacgaagag
catcaggggctcgcgccagccgaactgttcgccaggctcaaggcgcgcatgcccgacggcgaggatctcgtcgtga
cacatggcgatgcctgcttgccgaatatcatggtggaaaatggccgcttttctggattcatcgactgtggccggctgggtgt
ggcggaccgctatcaggacatagcgttggctacccgtgatattgctgaagagcttggcggcgaatgggctgaccgcttc
ctcgtgctttacggtatcgccgctcccgattcgcagcgcatcgccttctatcgccttcttgacgagttcttctgagcgggactc
tggggttcgaaatgaccgaccaagcgacgcctaactgtcagaccaagtttactcatatatactttagattgatttaaaactt
cattttaatttaaaaggatctaggtgaagatccttttgataatctcatgaccaaaatcccttaacgtgagttttcgttccactg
agcgtcagaccccgtagaaaagatcaaaggatcttcttgagatccttttttctgcgcgtaatctgctgcttgcaaacaaaa
aaaccaccgctaccagcggtggtttgtttgccggatcaagagctaccaactctttttccgaaggtaactggcttcagcag
agcgcagataccaaatactgtccttctagtgtagccgtagttaggccaccacttcaagaactctgtagcaccgcctacat
acctcgctctgctaatcctgttaccagtggctgctgccagtggcgataagtcgtgtcttaccgggttggactcaagacgat
agttaccggataaggcgcagcggtcgggctgaacgggggttcgtgcacacagcccagcttggagcgaacgaccta
caccgaactgagatacctacagcgtgagctatgagaaagcgccacgcttcccgaagggagaaaggcggacaggt
atccggtaagcggcagggtcggaacaggagagcgcacgagggagcttccagggggaaacgcctggtatctttatag
tcctgtcgggtttcgccacctctgacttgagcgtcgatttttgtgatgctcgtcaggggggcggagcctatggaaaaacgc
cagcaacgcggccttttacggttcctggccttttgctggccttttgctcacatgttctttcctgcgttatcccctgattctgtggat
aaccgtattaccgcctttgagtgagctgataccgctcgccgcagccgaacgaccgagcgcagcgagtcagtgagcg
aggaagcggaagagcgcctgatgcggtattttctccttacgcatctgtgcggtatttcacaccgcaatggtgcactctcag
tacaatctgctctgatgccgcatagttaagccagtatacactccgctatcgctacgtgactgggtcatggctgcgccccga
cacccgccaacacccgctgacgcgccctgacgggcttgtctgctcccggcatccgcttacagacaagctgtgaccgtc
tccgggagctgcatgtgtcagaggttttcaccgtcatcaccgaaacgcgcgaggcagctgcggtaaagctcatcagcg
tggtcgtgaagcgattcacagatgtctgcctgttcatccgcgtccagctcgttgagtttctccagaagcgttaatgtctggctt
ctgataaagcgggccatgttaagggcggttttttcctgtttggtcactgatgcctccgtgtaagggggatttctgttcatgggg
gtaatgataccgatgaaacgagagaggatgctcacgatacgggttactgatgatgaacatgcccggttactggaacgtt
gtgagggtaaacaactggcggtatggatgcggcgggaccagagaaaaatcactcagggtcaatgccagcgcttcgtt
aatacagatgtaggtgttccacagggtagccagcagcatcctgcgatgcagatccggaacataatggtgcagggcgc
tgacttccgcgtttccagactttacgaaacacggaaaccgaagaccattcatgttgttgctcaggtcgcagacgttttgca
gcagcagtcgcttcacgttcgctcgcgtatcggtgattcattctgctaaccagtaaggcaaccccgccagcctagccgg
gtcctcaacgacaggagcacgatcatgcgcacccgtggccaggacccaacgctgcccgagatgcgccgcgtgcgg
ctgctggagatggcggacgcgatggatatgttctgccaagggttggtttgcgcattcacagttctccgcaagaattgattg
gctccaattcttggagtggtgaatccgttagcgaggtgccgccggcttccattcaggtcgaggtggcccggctccatgca
ccgcgacgcaacgcggggaggcagacaaggtatagggcggcgcctacaatccatgccaacccgttccatgtgctcg
ccgaggcggcataaatcgccgtgacgatcagcggtccaatgatcgaagttaggctggtaagagccgcgagcgatcct
tgaagctgtccctgatggtcgtcatctacctgcctggacagcatggcctgcaacgcgggcatcccgatgccgccggaa
gcgagaagaatcataatggggaaggccatccagcctcgcgtcgcgaacgccagcaagacgtagcccagcgcgt

Figure 161C

cggccgccatgccggcgataatggcctgcttctcgccgaaacgtttggtggcgggaccagtgacgaaggcttgag
cgagggcgtgcaagattccgaataccgcaagcgacaggccgatcatcgtcgcgctccagcgaaagcggtcctc
gccgaaaatgacccagagcgctgccggcacctgtcctacgagttgcatgataaagaagacagtcataagtgcgg
cgacgatagtcatgccccgcgcccaccggaaggagctgactgggttgaaggctctcaagggcatcggtcgagat
cccggtgcctaatgagtgagctaacttacattaattgcgttgcgctcactgcccgctttccagtcgggaaacctgtcgt
gccagctgcattaatgaatcggccaacgcgcggggagaggcggtttgcgtattgggcgccagggtggtttttctttttc
accagtgagacgggcaacagctgattgcccttcaccgcctggccctgagagagttgcagcaagcggtccacgct
ggtttgccccagcaggcgaaaatcctgtttgatggtggttaacggcgggatataacatgagctgtcttcggtatcgtcg
tatcccactaccgagatatccgcaccaacgcgcagcccggactcggtaatggcgcgcattgcgcccagcgccat
ctgatcgttggcaaccagcatcgcagtgggaacgatgccctcattcagcatttgcatggtttgttgaaaaccggacat
ggcactccagtcgccttcccgttccgctatcggctgaatttgattgcgagtgagatatttatgccagccagccagacg
cagacgcgccgagacagaacttaatgggcccgctaacagcgcgatttgctggtgacccaatgcgaccagatgct
ccacgcccagtcgcgtaccgtcttcatgggagaaaataatactgttgatgggtgtctggtcagagacatcaagaaat
aacgccggaacattagtgcaggcagcttccacagcaatggcatcctggtcatccagcggatagttaatgatcagcc
cactgacgcgttgcgcgagaagattgtgcaccgccgctttacaggcttcgacgccgcttcgttctaccatcgacacc
accacgctggcacccagttgatcggcgcgagatttaatcgccgcgacaatttgcgacggcgcgtgcagggccag
actggaggtggcaacgccaatcagcaacgactgtttgcccgccagttgttgtgccacgcggttgggaatgtaattca
gctccgccatcgccgcttccacttttcccgcgttttcgcagaaacgtggctggcctggttcaccacgcgggaaacgg
tctgataagagacaccggcatactctgcgacatcgtataacgttactggtttcacattcaccaccctgaattgactctct
tccgggcgctatcatgccataccgcgaaaggttttgcgccattcgatggtgtccgggatctcgacgctctcccttatgc
gactcctgcattaggaagcagcccagtagtaggttgaggccgttgagcaccgccgccgcaaggaatggtgcatg
caaggagatggcgcccaacagtcccccggccacggggcctgccaccatacccacgccgaaacaagcgctcat
gagcccgaagtggcgagcccgatcttccccatcggtgatgtcggcgatataggcgccagcaaccgcacctgtgg
cgccggtgatgccggccacgatgcgtccggcgtagaggatcgagatctcgatcccgcgaaattaatacgactcac
tatagggaattgtgagcggataacaattcccctctagaaataattttgtttaactttaagaaggagatatacatatgc
ggggttctcatcatcatcatcatcatggtatggctagcatgactggtggacagcaaatgggtcgggatctgtacgacg
atgacgataaggatcatcccttcaccatggtatcctgttctgcgccgggtaagatttacctgttcggtgaacacgccgt
agtttatggcgaaactgcaattgcgtgtgcggtggaactgcgtacccgtgttcgcgcggaactcaatgactctatcac
tattcagagccagatcggccgcaccggtctggatttcgaaaagcacccttatgtgtctgcggtaattgagaaaatgc
gcaaatctattcctattaacggtgttttcttgaccgtcgattccgacatcccggtgggctccggtctgggtagcagcgca
gccgttactatcgcgtctattggtgcgctgaacgagctgttcggctttggcctcagcctgcaagaaatcgctaaactgg
gccacgaaatcgaaattaaagtacagggtgccgcgtccccaaccgatacgtatgtttctaccttcggcggcgtggtt
accatcccggaacgtcgcaaactgaaaactccggactgcggcattgtgattggcgataccggcgttttctcctccac
caaagagttagtagctaacgtacgtcagctgcgcgaaagctacccggatttgatcgaaccgctgatgacctctattg
gcaaaatctctcgtatcggcgaacaactggttctgtctggcgactacgcatccatcggccgcctgatgaacgtcaac
cagggtctcctggacgccctgggcgttaacatcttagaactgagccagctgatctattccgctcgtgcggcaggtgc
gtttggcgctaaaatcacgggcgctggcggcggtggctgtatggttgcgctgaccgctccggaaaaatgcaaccca
agtggcagaagcggtagcaggcgctggcggtaaagtgactatcactaaaccgaccgagcaaggtctgaaagta
gattaa
(SEQ ID NO:47)

Figure 162



CDS 2: Gentamycin resistance gene; CDS: 1 *E. coli* replication protein

Figure 163A

1-
ctcgggccgtctcttgggcttgatcggccttcttgcgcatctcacgcgctcctgcggcggcctgtagggcaggctcatacccct
gccgaaccgcttttgtcagccggtcggccacggcttccggcgtctcaacgcgctttgagattcccagcttttcggccaatccct
gcggtgcataggcgcgtggctcgaccgcttgcgggctgatggtgacgtggcccactggtggccgctccagggcctcgtaga
acgcctgaatgcgcgtgtgacgtgccttgctgccctcgatgcccgttgcagccctagatcggccacagcggccgcaaacg
tggtctggtcgcgggtcatctgcgctttgttgccgatgaactccttggccgacagcctgccgtcctgcgtcagcggcaccacga
acgcggtcatgtgcgggctggtttcgtcacggtggatgctggccgtcacgatgcgatccgccccgtacttgtccgccagccac
ttgtgcgccttctcgaagaacgccgcctgctgttcttggctggccgacttccaccattccgggctggccgtcatgacgtactcga
ccgccaacacagcgtccttgcgccgcttctctggcagcaactcgcgcagtcggcccatcgcttcatcggtgctgctggccgc
ccagtgctcgttctctggcgtcctgctggcgtcagcgttgggcgtctcgcgctcgcggtaggcgtgcttgagactggccgccac
gttgcccatttttcgccagcttcttgcatcgcatgatcgcgtatgccgccatgcctgcccctccctttttggtgtccaaccggctcgac
gggggcagcgcaaggcggtgcctccggcgggccactcaatgcttgagtatactcactagactttgcttcgcaaagtcgtgac
cgcctacggcggctgcggcgccctacgggcttgctctccgggcttcgccctgcgcggtcgctgcgctcccttgccagcccgt
ggatatgtggacgatggccgcgagcggccaccggctggctcgcttcgctcggcccgtggacaaccctgctggacaagctg
atggacaggctgcgcctgcccacgagcttgaccacagggattgcccaccggctacccagccttcgaccacatacccaccg
gctccaactgcgcggcctgcggccttgccccatcaatttttttaattttctctggggaaaagcctccggcctgcggcctgcgcgc
ttcgcttgccggttggacaccaagtggaaggcgggtcaaggctcgcgcagcgaccgcgcagcggcttggccttgacgcgc
ctggaacgacccaagcctatgcgagtgggggcagtcgaaggcgaagcccgcccgcctgccccccgagcctcacggcg
gcgagtgcgggggttccaaggggcagcgccaccttgggcaaggccgaaggccgcgcagtcgatcaacaagccccgg
aggggccacttttgccggaggggggagccgcgccgaaggcgtgggggaaccccgcaggggtgcccttctttgggcacca
aagaactagatatagggcgaaatgcgaaagacttaaaaatcaacaacttaaaaaaggggggtacgcaacagctcattgc
ggcacccccccgcaatagctcattgcgtaggttaaagaaaatctgtaattgactgccacttttacgcaacgcataattgttgtcgc
gctgccgaaaagttgcagctgattgcgcatggtgccgcaaccgtgcggcaccctaccgcatggagataagcatggccacg
cagtccagagaaatcggcattcaagccaagaacaagcccggtcactgggtgcaaacggaacgcaaagcgcatgaggc
gtgggccgggcttattgcgaggaaacccacggcggcaatgctgctgcatcacctcgtggcgcagatgggccaccagaac
gccgtggtggtcagccagaagacactttccaagctcatcggacgttctttgcggacggtccaatacgcagtcaaggacttggt
ggccgagcgctggatctccgtcgtgaagctcaacggccccggcaccgtgtcggcctacgtggtcaatgaccgcgtggcgtg
gggccagccccgcgaccagttgcgcctgtcggtgttcagtgccgccgtggtggttgatcacgacgaccaggacgaatcgct
gttggggcatggcgacctgcgccgcatcccgaccctgtatccgggcgagcagcaactaccgaccggccccggcgagga
gccgcccagccagcccggcattccgggcatggaaccagacctgccagccttgaccgaaacggaggaatgggaacggc
gcgggcagcagcgcctgccgatgcccgatgagccgtgttttctggacgatggcgagccgttggagccgccgacacgggtc
acgctgccgcgccggtagcacttgggttgcgcagcaacccgtaagtgcgctgttccagactatcggctgtagccgcctcgcc
gccctataccttgtctgcctccccgcgttgcgtcgcggtgcatggagccgggccacctcgacctgaatggaagccggcggc
acctcgctaacggattcaccgtttttatcaggctctgggaggcagaataaatgatcatatcgtcaattattacctccacgggga
gagcctgagcaaactggcctcaggcatttgagaagcacacggtcacactgcttccggtagtcaataaaccggtaaaccag
caatagacataagcggctatttaacgaccctgccctgaaccgacgaccgggtcgaatttgctttcgaatttctgccattcatcc
gcttattatcacttattcaggcgtagcaccaggcgtttaagggcaccaataactgccttaaaaaaattacgccccgccctgcc
actcatcgcagtcggcctattggttaaaaaatgagctgatttaacaaaaatttaacgcgaattttaacaaaatattaacgcttac
aatttccattcgccattcaggctgcgcaactgttgggaagggcgatcggtgcgggcctcttcgctattacgccagctggcgaa
aggggatgtgctgcaaggcgattaagttgggtaacgccagggttttcccagtcacgacgttgtaaaacgacggccagtga
gcgcgcgtaatacgactcactatagggcgaattggagctccaccgcggtggcggccgctctagaactagtggatcccccg
ggctgcatgctcgagcggccgccagtgtgatggatatctgcagaattcgcccttcttgatatcttagtgtgcgttaaccaccacc
cacattggtccctgcccgaccgcatagcggccttttcatgcagtagcccctgctcgccaacaatttcgtataccgagatgtggt
gagatttttgcccggcggcaatcagatacttgccgctgtgatcaacattgaagccgcgcggctgggtttccgttggctggaag
ccttctttactcaacacgctgccatcttccgaaacgctgaaaacggtaatcaggctggcggtacggtcgcaggcgtataaatg
gcgaccatccggggtgatatgaatatcagccgcccaacgggtgtcggagaagttttccggcatcatatccagcgtctggaca
cattcgatattaccgtgcggatctttcagttcccagacatccactgagctgtttaactcattgacgcaatacgcatattgttcgtttg
gatggaataccatatgacgcgggccggcccttcaacggtggtcacttccgcagggtcctgcgccacgagatgaccatcat
cgctgaccgtaaacaggcaaatgcgatcctgctttaatgccggaacccacagcgtacggttgt

Figure 163B

ccggtgagatattggcggaatggcaaccgtccagcccctcgaccacatcgacgacgcccactggcaggccat
cttccagacgcgttacgctcacgttacccgcattgtaagaacctacaaagacaaactgcccctggtgatcggtgg
aaatatgcgtcggactacccggcagcgcagactctgcggcaaaggtcagtgcgccatcgtccggggcgatac
gatacgccaggacgcgaaactcagggcgaacaccaacatagagataacgtttgtccgggctgaccaccatcg
gctgcacctgccccggcacatcgacaacctgtgtcagcgtcagtgcgccttcatgattcagattccagacgtgaat
ttgctggctctcagggctggcgatataaactgtttgcttcatgaatgctcctttgggttacctccgggaaacgcggttg
atttgtttagtggttgaattatttgctcaggatgtggcatagtcaagggcgtgacggctcgctaatacaactcactata
gggctcgaggaagttcctatactttctagagaataggaacttccgcgccgcacacaaaaaccaacacacagat
catgaaaataaagctcttttattggtaccgaattcgccagggagctctcagacgtcgcttggtcggtctttattcgaac
cccagagtcccgcttacgccccgccctgccactcatcgcagtactgttgtaattcattaagcattctgccgacatgg
aagccatcacaaacggcatgatgaacctgaatcgccagcggcatcagcaccttgtcgccttgcgtataatatttg
cccatggtgaaaacgggggcgaagaagttgtccatattggccacgtttaaatcaaaactggtgaaactcaccca
gggattggctgagacgaaaaacatattctcaataaacccttagggaaataggccaggttttcaccgtaacacgc
cacatcttgcgaatatatgtgtagaaactgccggaaatcgtcgtggtattcactccagagcgatgaaaacgtttca
gtttgctcatggaaaacggtgtaacaagggtgaacactatcccatatcaccagctcaccgtctttcattgccatacg
gaattccggatgagcattcatcaggcgggcaagaatgtgaataaaggccggataaaacttgtgcttatttttctttac
ggtctttaaaaaggccgtaatatccagctgaacggtctggttataggtacattgagcaactgactgaaatgcctca
aaatgttctttacgatgccattgggatatatcaacggtggtatatccagtgatttttttctccatggtttagttcctcaccttg
tcgtattatactatgccgatatactatgccgatgattaattgtcaacacgtgctgctgcaggtcgaaaggcccggag
atgaggaagaggagaacagcgcggcagacgtgcgcttttgaagcgtgcagaatgccgggcctccggaggac
cttcgggcgcccgccccgcccctgagcccgcccctgagcccgcccccggacccacccccttcccagcctctgag
cccagaaagcgaaggagcaaagctgctattggccgctgccccaaaggcctacccgcttccattgctcagcggt
gctgtccatctgcacgagactagtgagacgtgctacttccatttgtcacgtcctgcacgacgcgagctgcggggcg
gggggaacttcctgactaggggaggagtggaaggtggcgcgaaggggccaccaaagaacggagccggtt
ggcgcctaccggtggatgtggaatgtgtgcgaggccagaggccacttgtgtagcgccaagtgcccagcggggc
tgctaaagcgcatgctccagactgccttgggaaaagcgcctcccctacccggtagaatgaagttcctatactttcta
gagaataggaacttcgcggccgcccttagtgagggttaattcaactgactgtaacagctaaaattagtcgcttttg
gcggtaagggcgaattccagcacactggcggccgttactagtggatccgagctcggtaccaagcttgatgcagg
aattcgatatcaagcttatcgataccgtcgacctcgaggggggcccggtacccagcttttgttccctttagtgagg
gttaattgcgcgcttggcgtaatcatggtcatagctgtttcctgtgtgaaattgttatccgctcacaattccacacaaca
tacgagccggaagcataaagtgtaaagcctggggtgcctaatgagtgagctaactcacattaattgcgttgcgct
cactgcccgctttccagtcgggaaacctgtcgtgccagctgcattaatgaatcggccaacgcgcggggagaggc
ggtttgcgtattgggcgcatgcataaaaactgttgtaattcattaagcattctgccgacatggaagccatcacaaac
ggcatgatgaacctgaatcgccagcggcatcagcaccttgtcgccttgcgtataatatttgcccatggacgcacac
cgtggaaacggatgaaggcacgaacccagttgacataagcctgttcggttcgtaaactgtaatgcaagtagcgt
atgcgctcacgcaactggtccagaaccttgaccgaacgcagcggtggtaacggcgcagtggcggttttcatggc
ttgttatgactgtttttttgtacagtctatgcctcgggcatccaagcagcaagcgcgttacgccgtgggtcgatgtttgat
gttatggagcagcaacgatgttacgcagcagcaacgatgttacgcagcagggcagtcgccctaaaacaaagtt
aggtggctcaagtatgggcatcattcgcacatgtaggctcggccctgaccaagtcaaatccatgcgggctgctctt
gatcttttcggtcgtgagttcggagacgtagccacctactcccaacatcagccggactccgattacctcgggaactt
gctccgtagtaagacattcatcgcgcttgctgccttcgaccaagaagcggttgttggcgctctcgcggcttacgttct
gcccaggtttgagcagccgcgtagtgagatctatatctatgatctcgcagtctccggcgagcaccggaggcagg
gcattgccaccgcgctcatcaatctcctcaagcatgaggccaacgcgcttggtgcttatgtgatctacgtgcaagc
agattacggtgacgatcccgcagtggctctctatacaaagttgggcatacgggaagaagtgatgcactttgatatc
gacccaagtaccgccacctaacaattcgttcaagccgagatcggcttcccggccgcggagttgttcggtaaattgt
cacaacgccgccaggtggcacttttcggggaaatgtgcgcgcccgcgttcctgctggcgctgggcctgtttctggc
gctggacttcccgctgttccgtcagcagcttttcgcccacggccttgatgatcgcggcggccttggcctgcatatccc
gattcaacggccccagggcgtccagaacgggcttcaggcgctcccgaaggt (SEQ ID NO:48)

Figure 164A

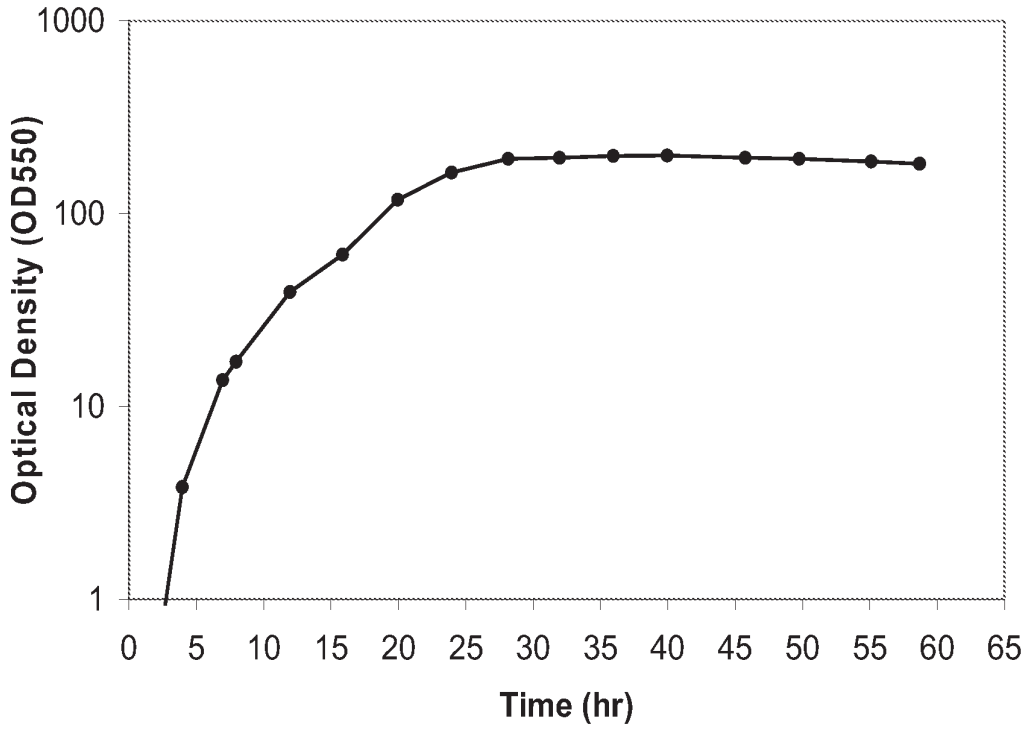

1000
100
10
1
Optical Density (OD550)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
Time (hr)

Figure 164B

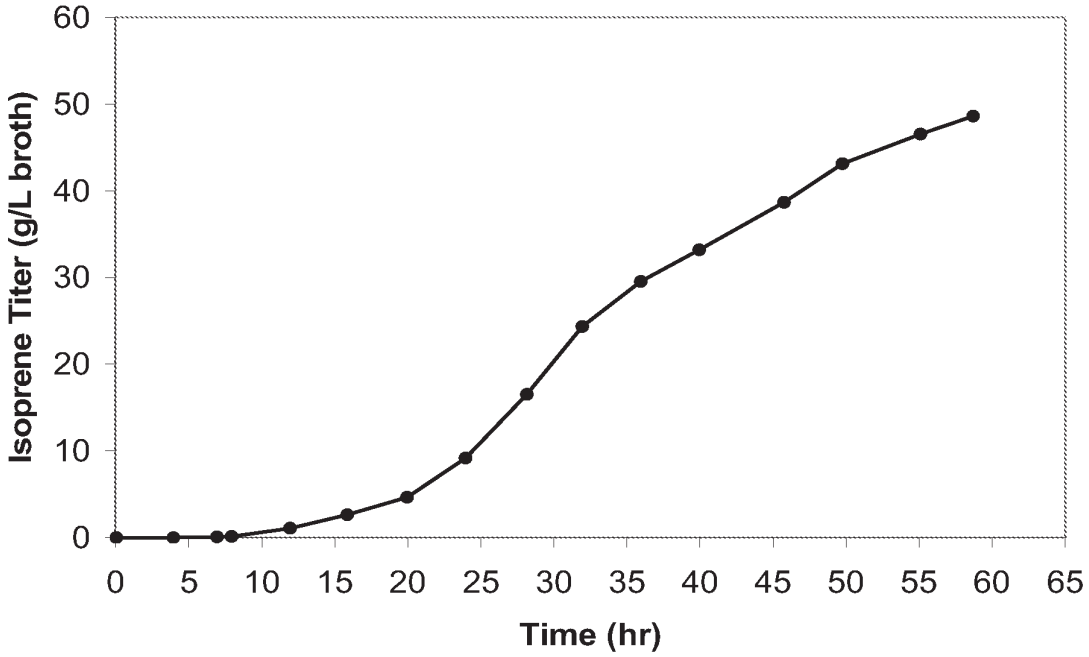

Isoprene Titer (g/L broth)
60
50
40
30
20
10
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65
Time (hr)

Figure 164C

Titer 78C

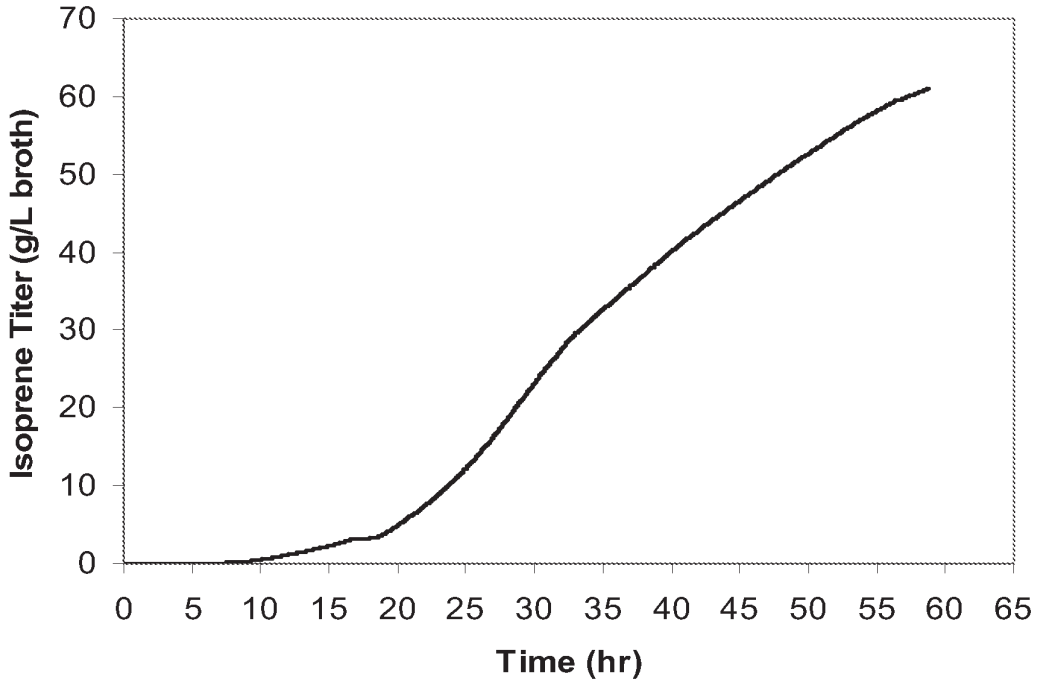


Figure 164D

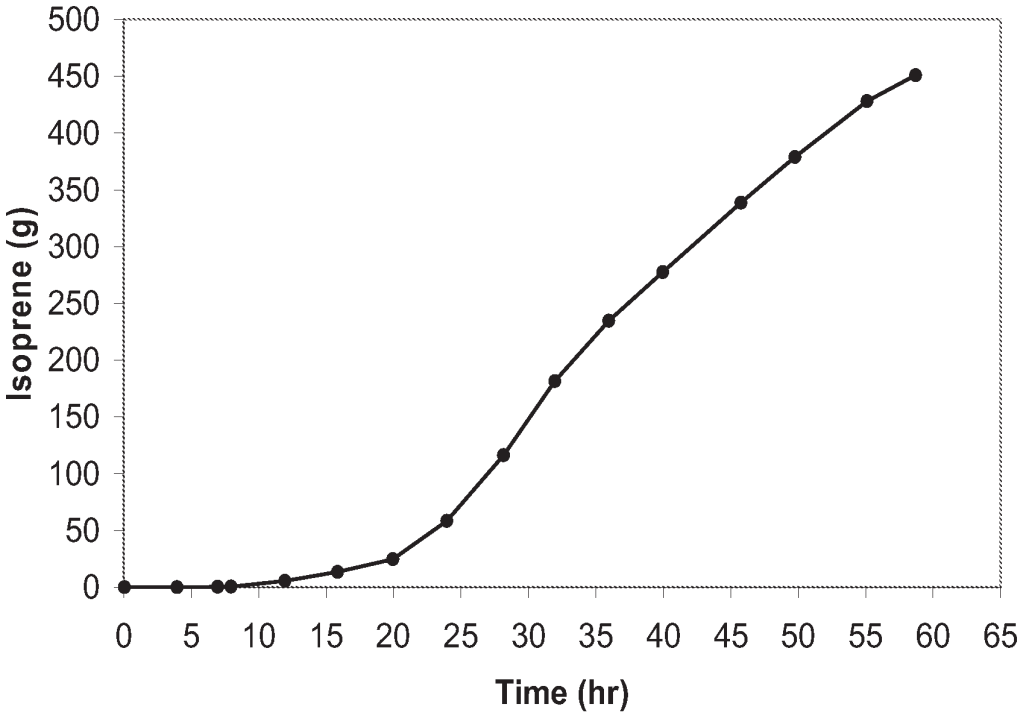

Isoprene (g)
500
450
400
350
300
250
200
150
100
50
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65
Time (hr)

Figure 164E

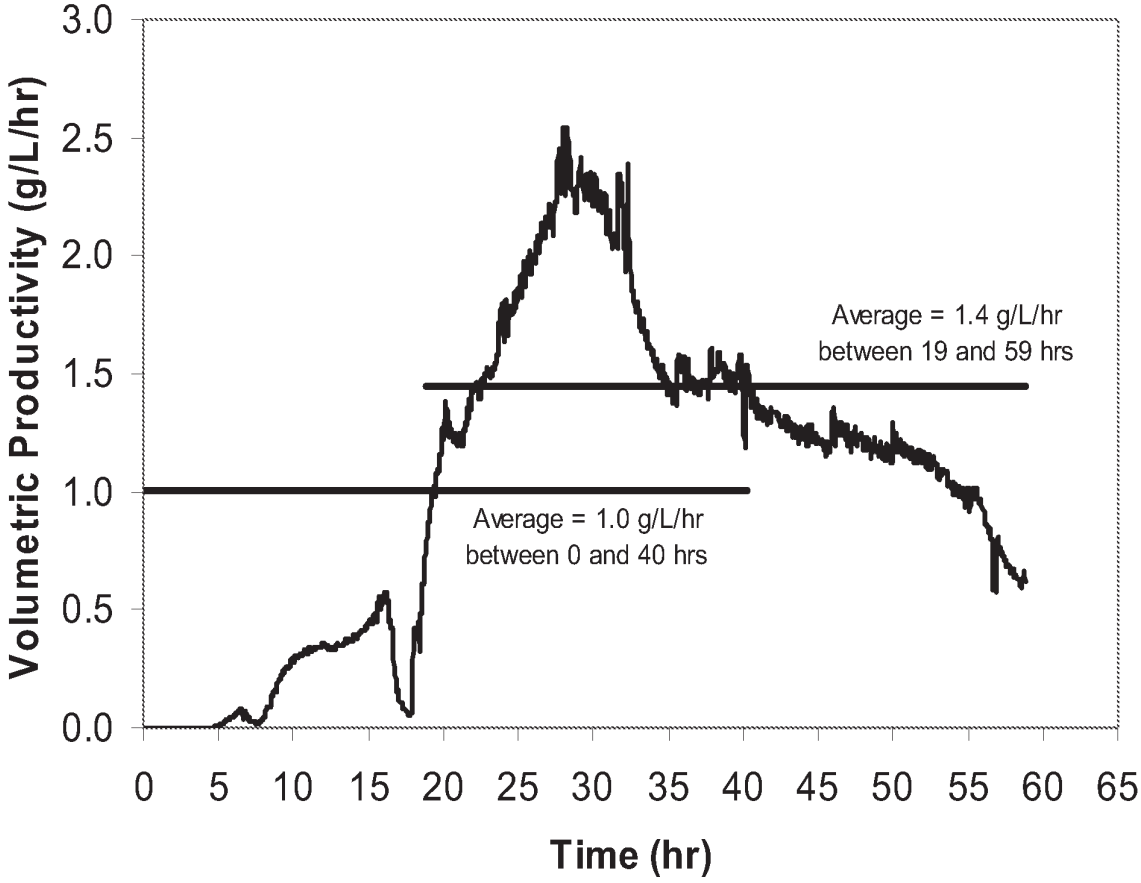

Volumetric Productivity (g/L/hr)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
Time (hr)
Average = 1.4 g/L/hr
between 19 and 59 hrs
Average = 1.0 g/L/hr
between 0 and 40 hrs

Figure 164F

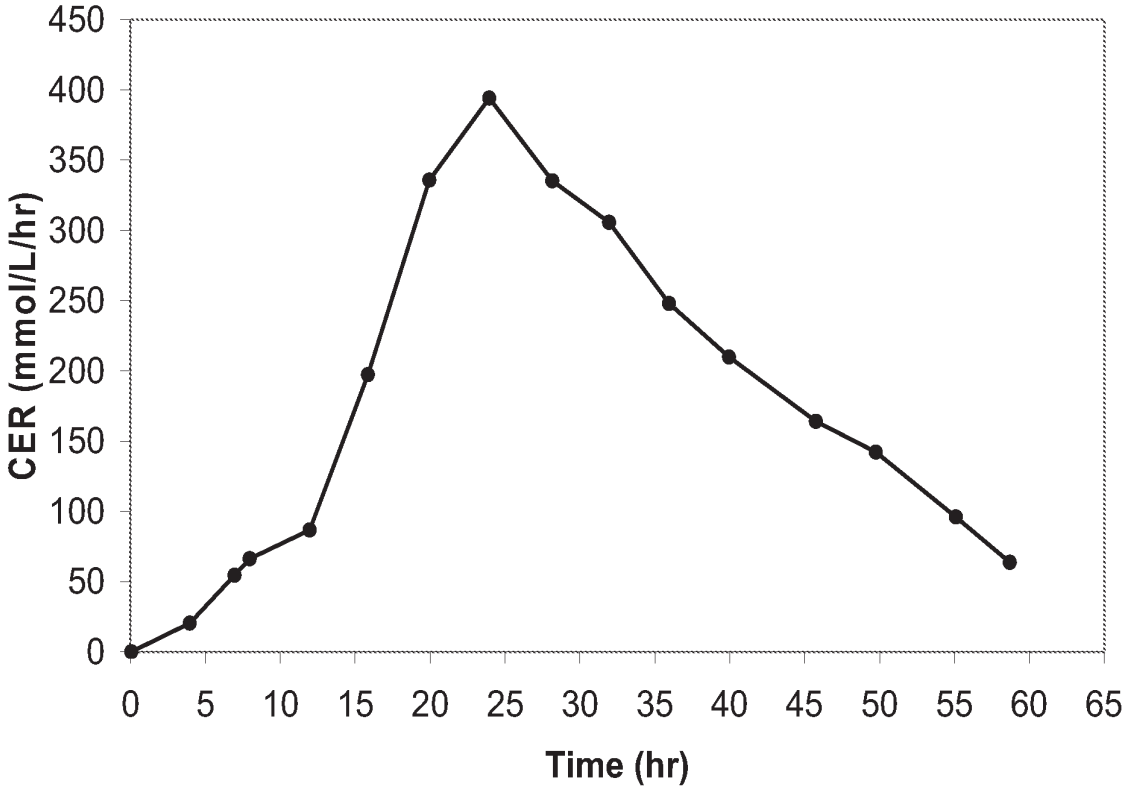

CER (mmol/L/hr)
450
400
350
300
250
200
150
100
50
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65
Time (hr)

Figure 165

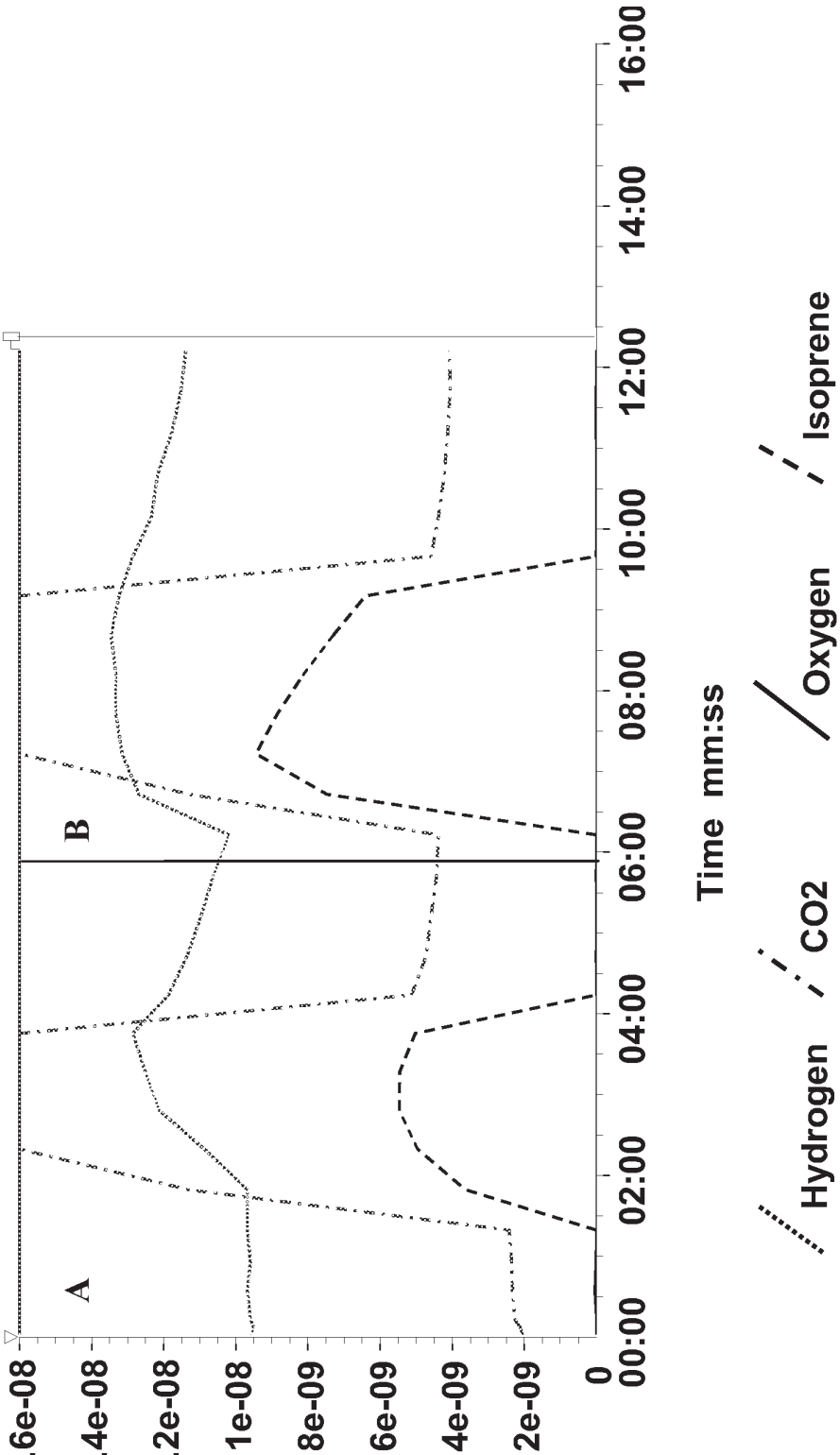
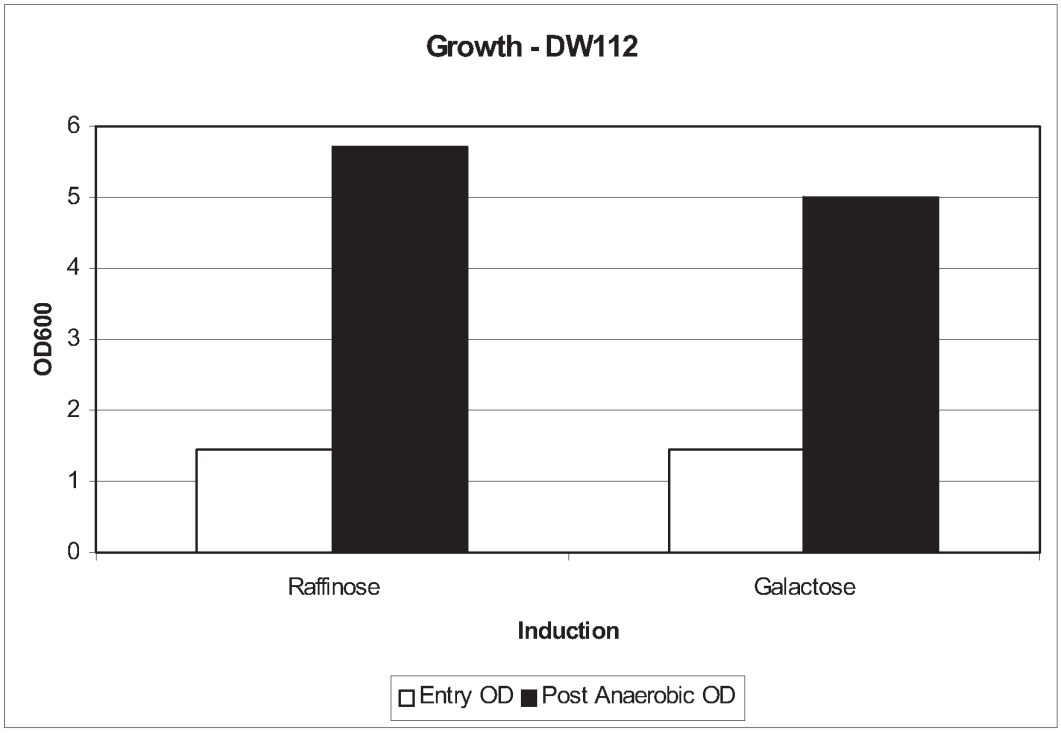
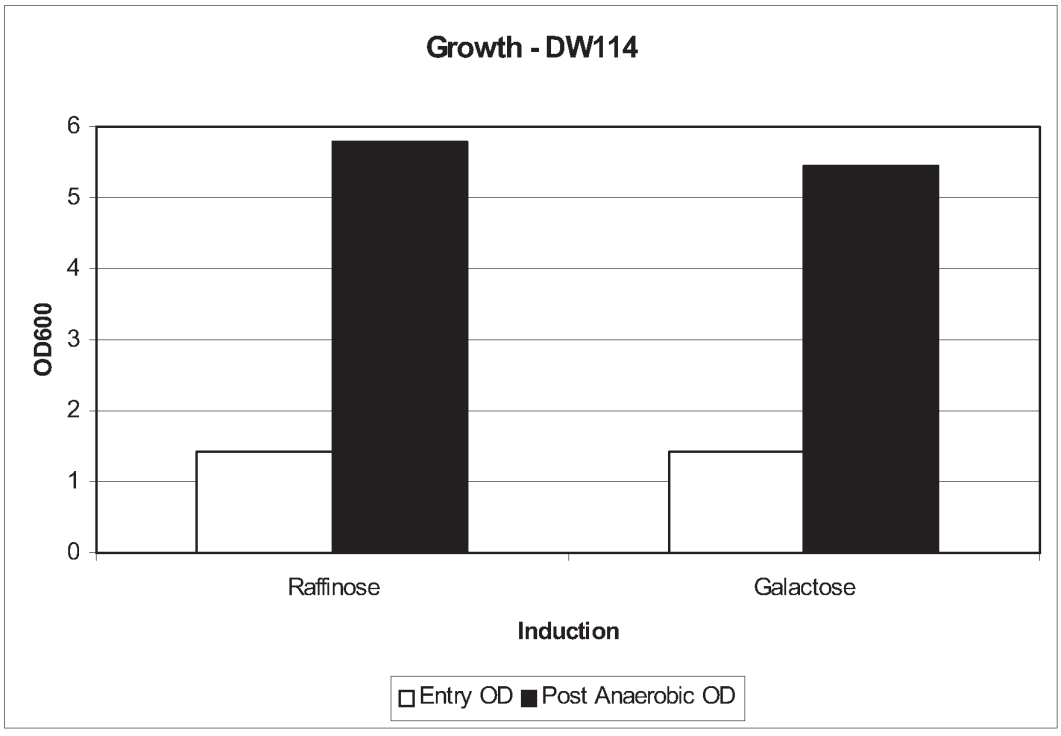

SEM : torr Faraday : torr
HAL 7 RC RGA 201 #12854
1.6e-08
1.4e-08
1.2e-08
1e-08
8e-09
6e-09
4e-09
2e-09
0
A
B
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
Time mm:ss
Hydrogen
CO2
Oxygen
Isoprene

Figure 166

A



B



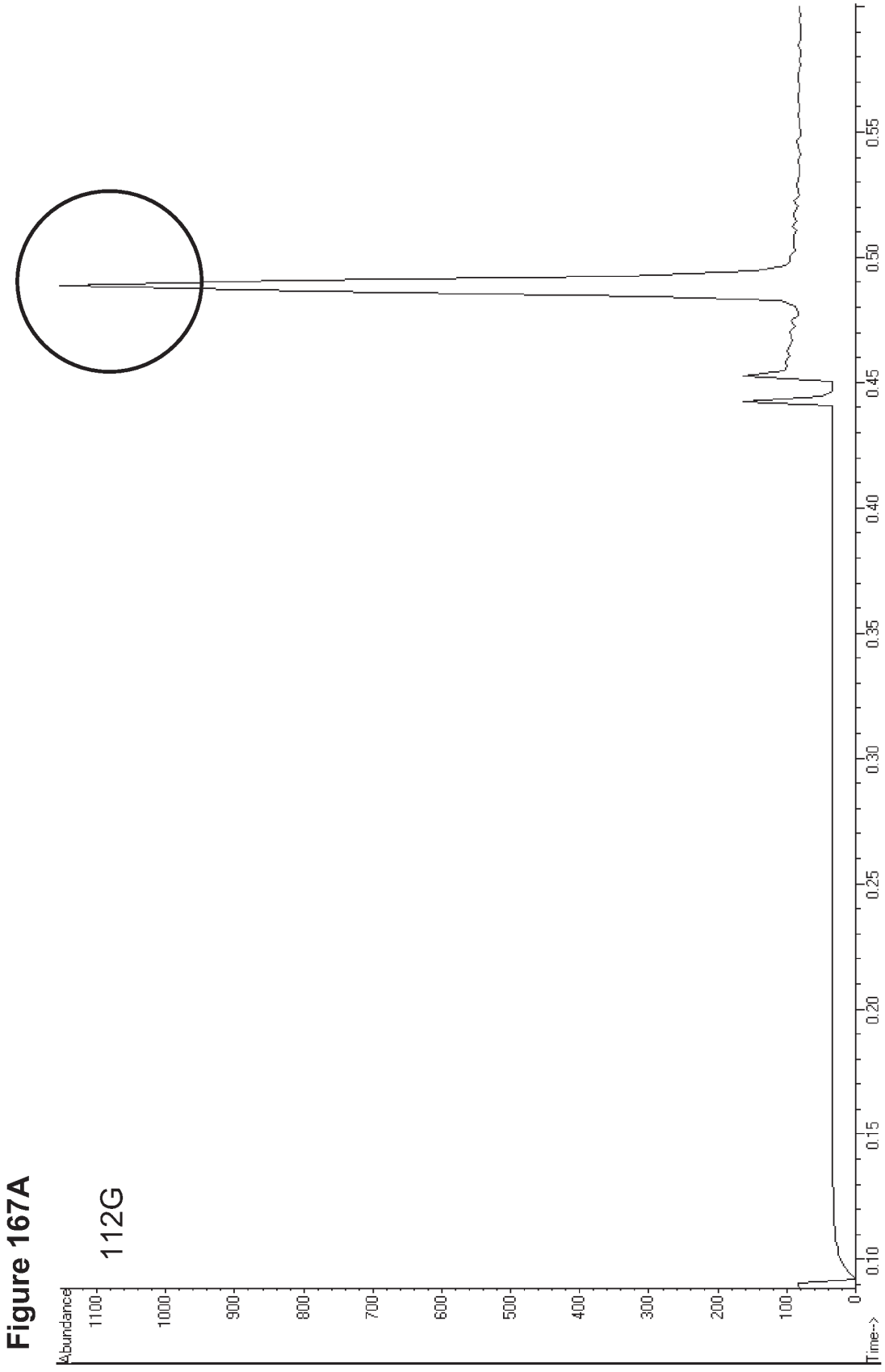

112G
Abundance
1100
1000
900
800
700
600
500
400
300
200
100
0
Time-->
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
0.55

Figure 167A

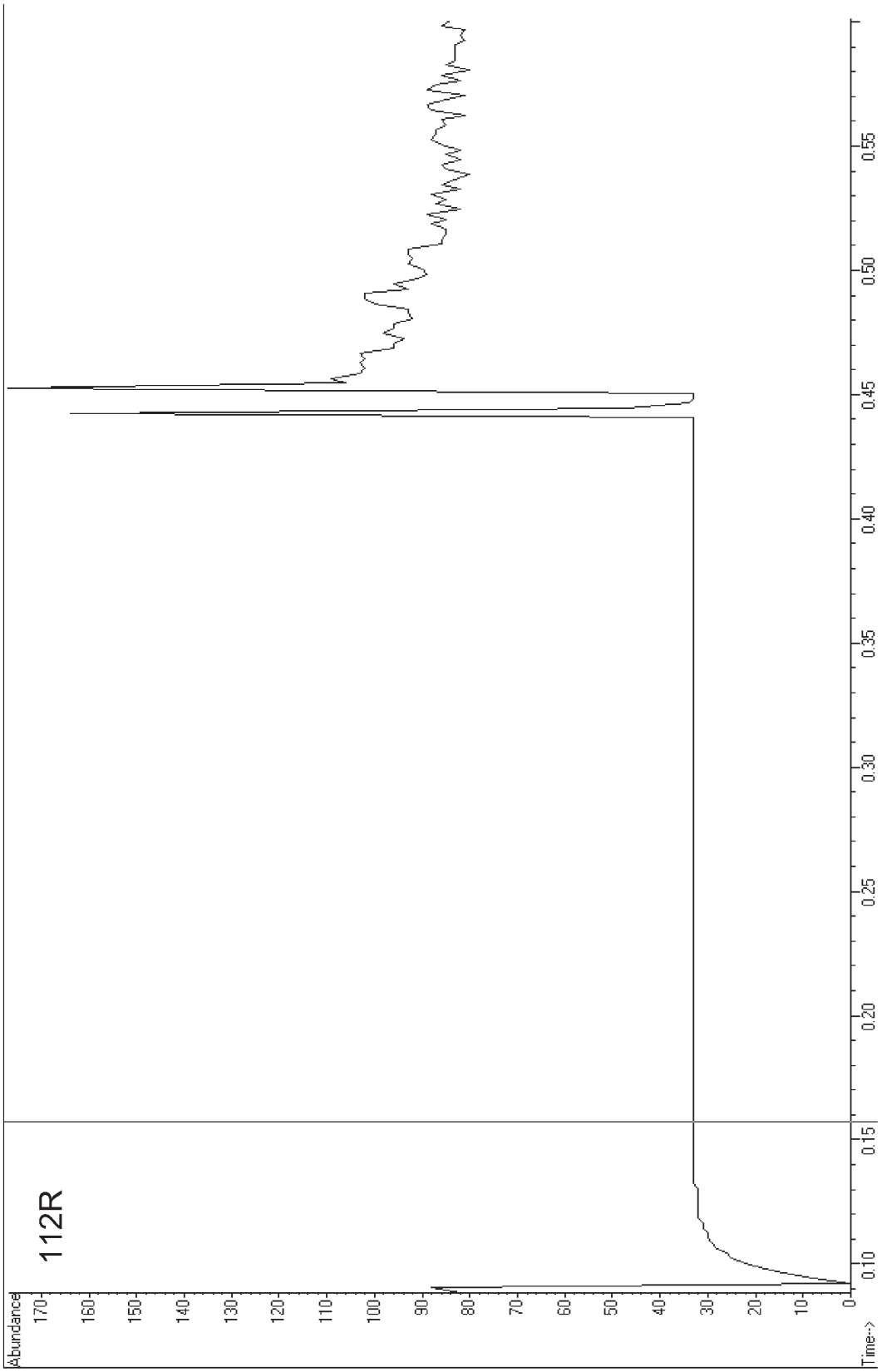

112R
Abundance
Time-->
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
0.55

Figure 167B

Figure 167C

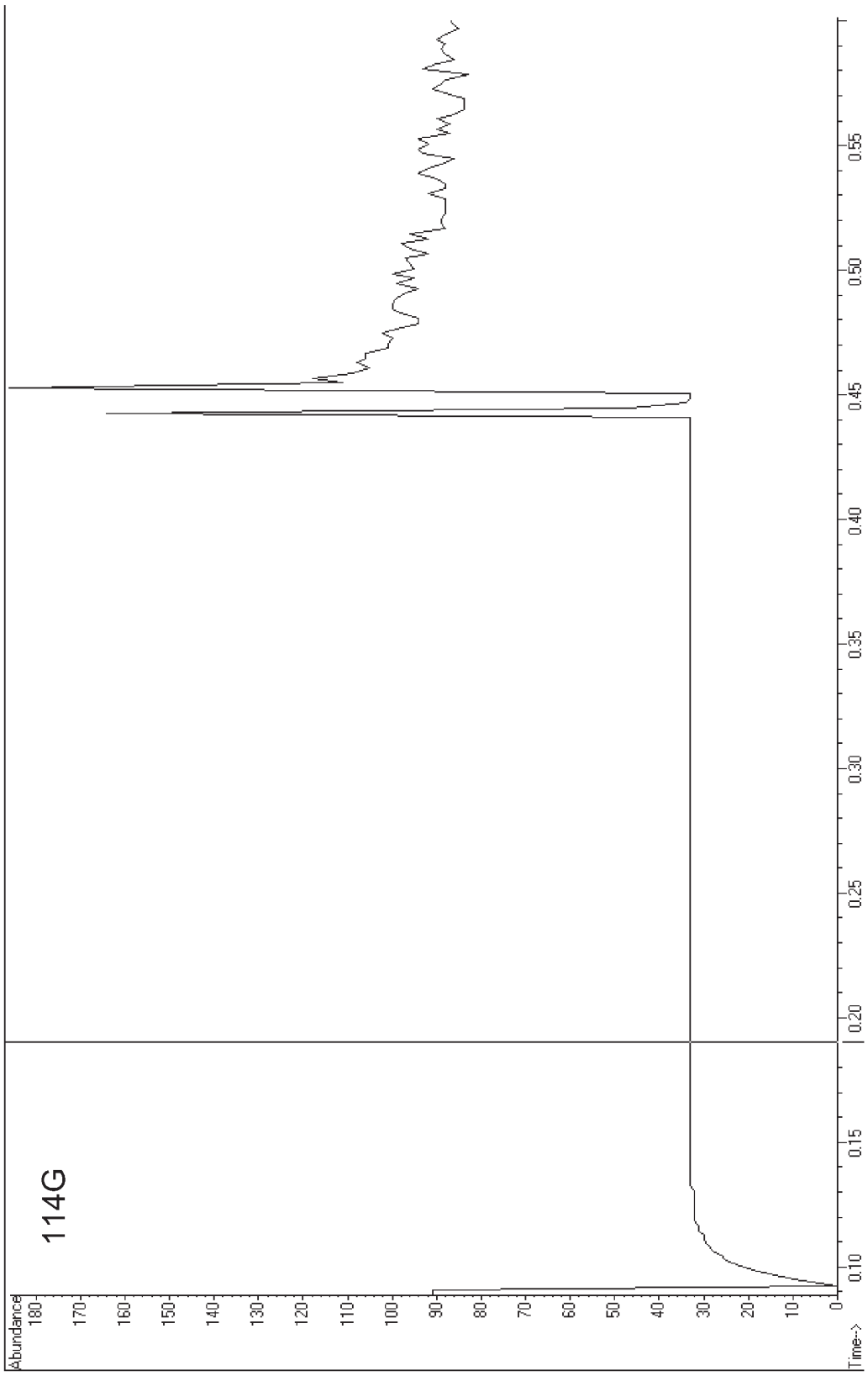

114G
Abundance
Time-->
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
0.55

Figure 167D

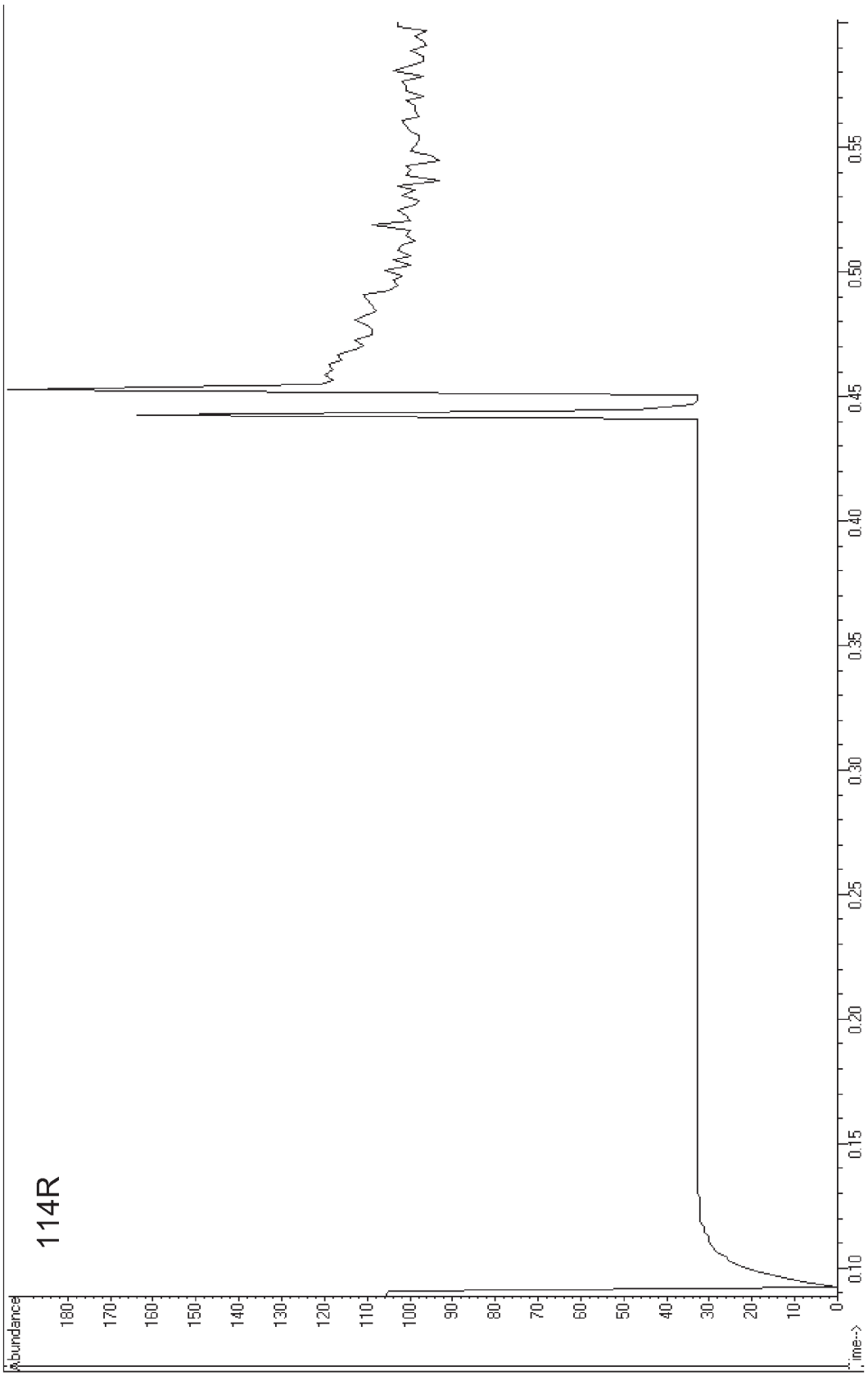

114R
Abundance
Time-->
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
0.55

Figure 168

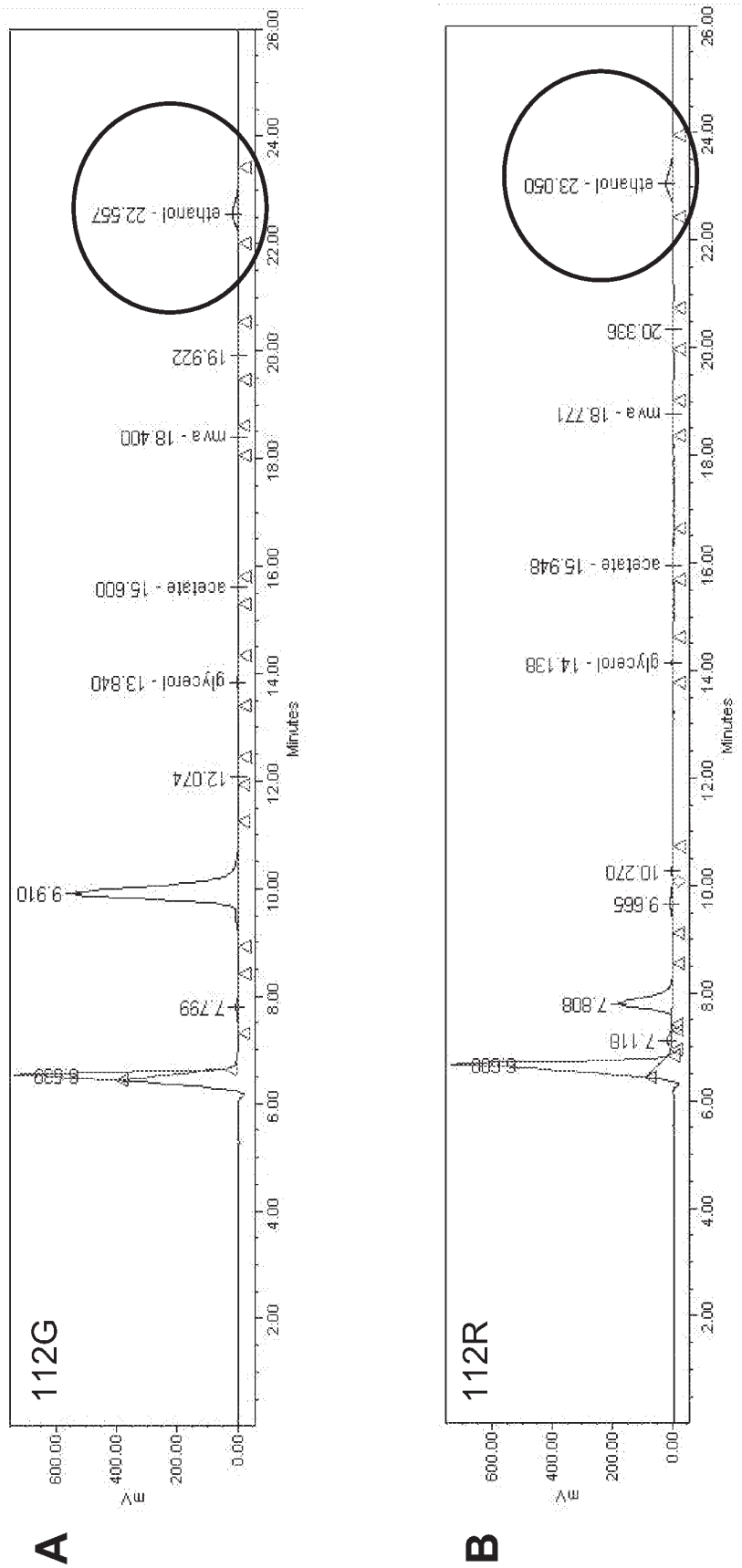

A
112G
mV
600.00
400.00
200.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
22.00
24.00
26.00
Minutes
6.839
7.799
9.910
12.074
glycerol - 13.840
acetate - 15.800
mva - 18.400
19.922
ethanol - 22.557
B
112R
mV
600.00
400.00
200.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
22.00
24.00
26.00
Minutes
6.508
7.118
7.808
9.665
10.270
glycerol - 14.138
acetate - 15.948
mva - 18.771
20.336
ethanol - 23.050

Figure 168

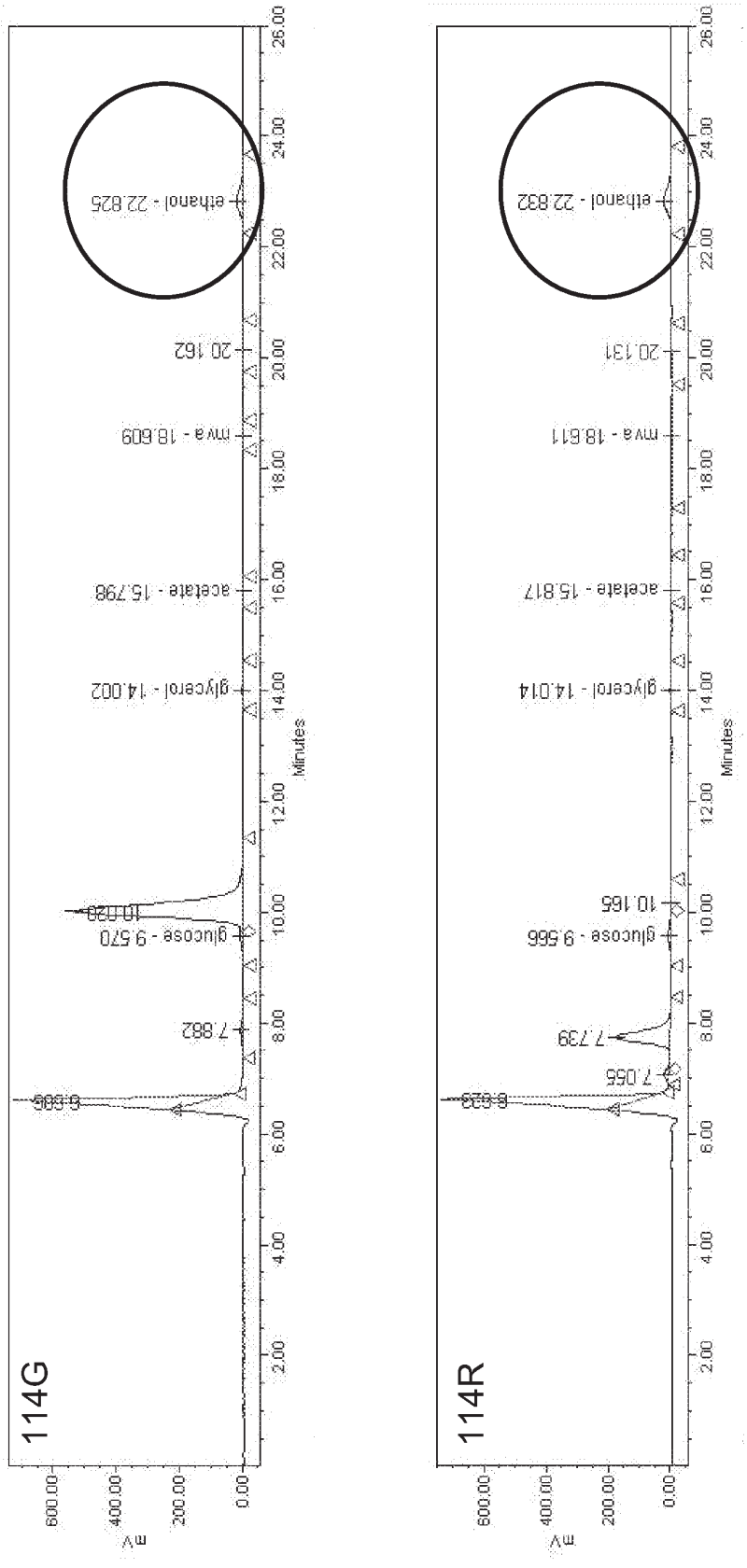
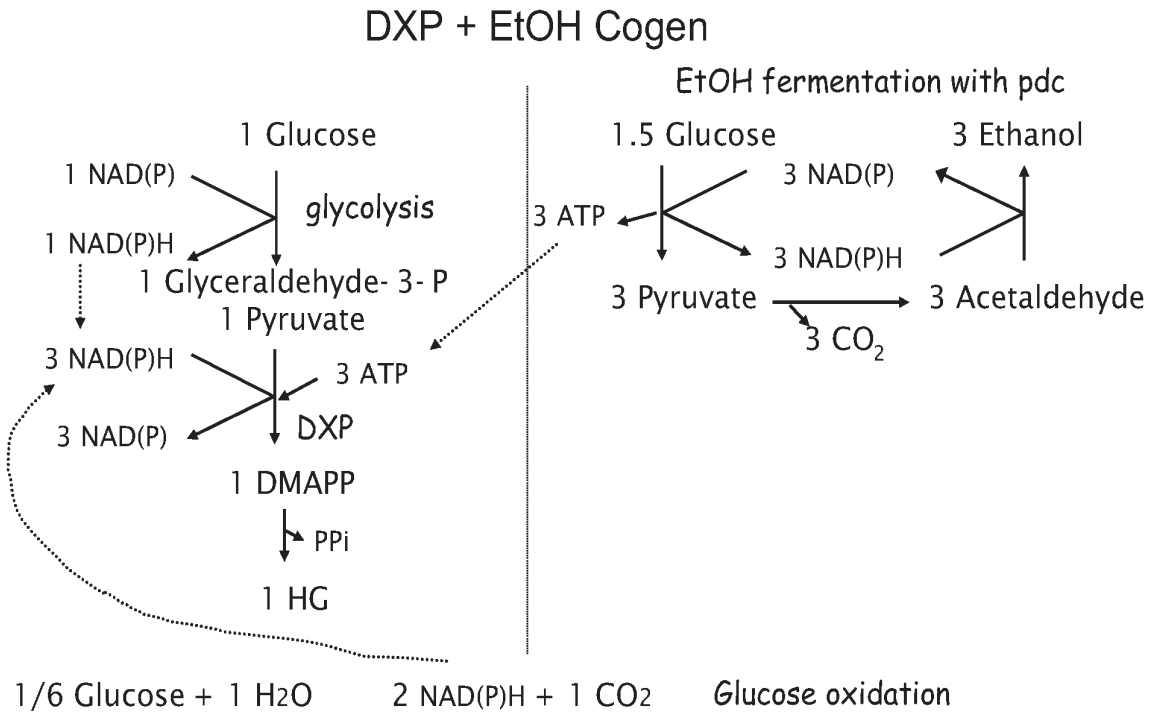

C
114G
mV
600.00
400.00
200.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
22.00
24.00
26.00
Minutes
6.586
7.882
glucose - 9.570
10.028
glycerol - 14.002
acetate - 15.798
mva - 18.609
20.162
ethanol - 22.825
D
114R
mV
600.00
400.00
200.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
22.00
24.00
26.00
Minutes
6.529
7.055
7.739
glucose - 9.566
10.165
glycerol - 14.014
acetate - 15.817
mva - 18.611
20.131
ethanol - 22.832

Figure 169



Sum: $\frac{16}{6}$ Glucose → 1 Isoprene + 4 CO2 + 3 EtOH

7/6 of glucose used for Isoprene and 9/6 used for EtOH

Figure 170

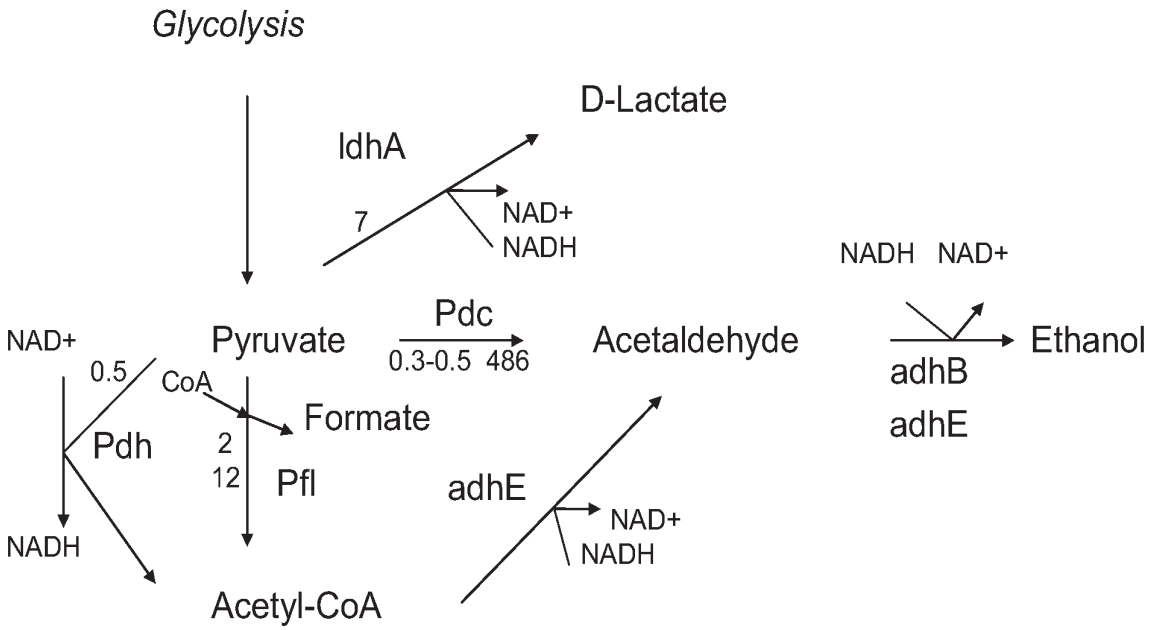

Glycolysis
D-Lactate
ldhA
7
NAD+
NADH
NADH NAD+
NAD+
Pyruvate
Pdc
0.3-0.5 486
Acetaldehyde
Ethanol
adhB
adhE
0.5
CoA
Formate
Pdh
2
12
Pfl
adhE
NAD+
NADH
NADH
Acetyl-CoA

Figure 171A

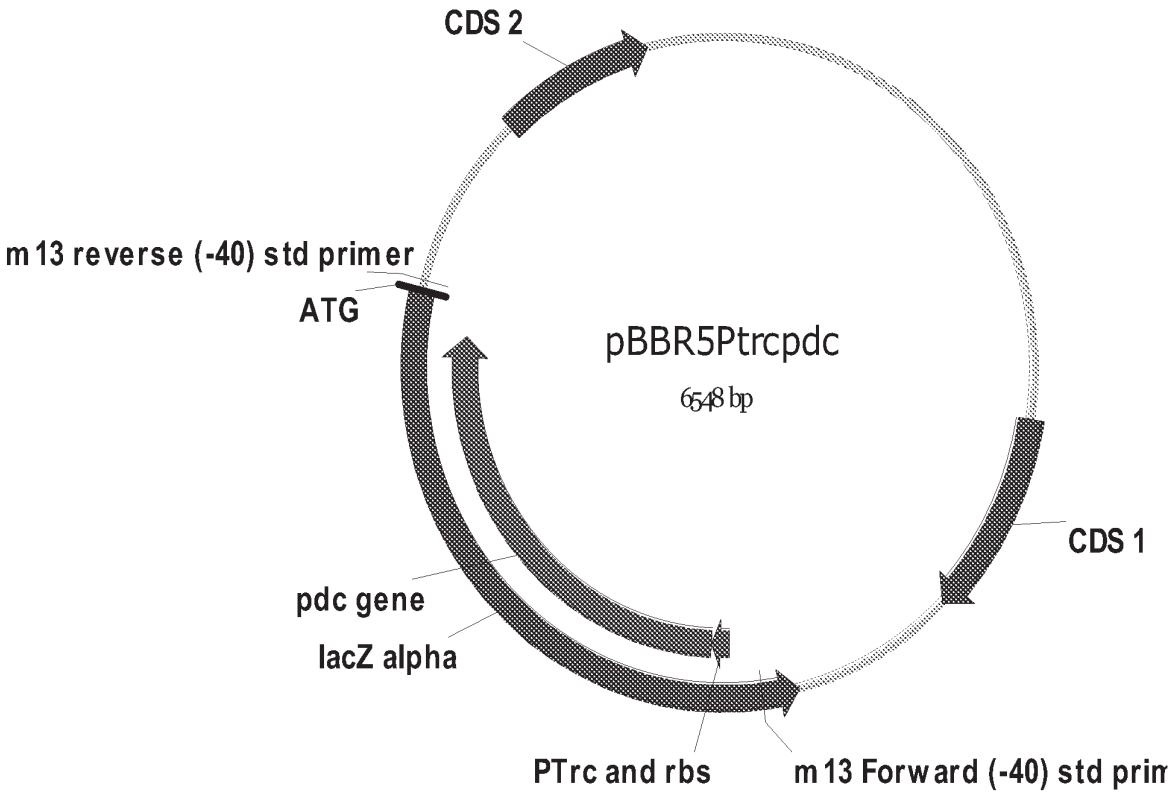

CDS 2
m13 reverse (-40) std primer
ATG
pBBR5Ptrcpdc
6548 bp
CDS 1
pdc gene
lacZ alpha
PTrc and rbs
m13 Forward (-40) std prim

Figure 171B

ctcgggccgtctcttgggcttgatcggccttcttgcgcatctcacgcgctcctgcggcggcctgtagggcaggctcat
acccctgccgaaccgcttttgtcagccggtcggccacggcttccggcgtctcaacgcgctttgagattcccagcttttc
ggccaatccctgcggtgcataggcgcgtggctcgaccgcttgcgggctgatggtgacgtggcccactggtggccgc
tccagggcctcgtagaacgcctgaatgcgcgtgtgacgtgccttgctgccctcgatgccccgttgcagccctagatc
ggccacagcggccgcaaacgtggtctggtcgcgggtcatctgcgctttgttgccgatgaactccttggccgacagcc
tgccgtcctgcgtcagcggcaccacgaacgcggtcatgtgcgggctggtttcgtcacggtggatgctggccgtcacg
atgcgatccgccccgtacttgtccgccagccacttgtgcgccttctcgaagaacgccgcctgctgttcttggctggcc
gacttccaccattccgggctggccgtcatgacgtactcgaccgccaacacagcgtccttgcgccgcttctctggcagc
aactcgcgcagtcggcccatcgcttcatcggtgctgctggccgcccagtgctcgttctctggcgtcctgctggcgtca
gcgttgggcgtctcgcgctcgcggtaggcgtgcttgagactggccgccacgttgcccattttcgccagcttcttgcatc
gcatgatcgcgtatgccgccatgcctgcccctccctttggtgtccaaccggctcgacgggggcagcgcaaggcggt
gcctccggcgggccactcaatgcttgagtatactcactagactttgcttcgcaaagtcgtgaccgcctacggcggctg
cggcgccctacgggcttgctctccgggcttcgccctgcgcggtcgctgcgctcccttgccagcccgtggatatgtgg
acgatggccgcgagcggccaccggctggctcgcttcgctcggcccgtggacaaccctgctggacaagctgatgga
caggctgcgcctgcccacgagcttgaccacagggattgcccaccggctacccagccttcgaccacatacccaccg
gctccaactgcgcggcctgcggccttgccccatcaatttttttaattttctctggggaaaagcctccggcctgcggcctg
cgcgcttcgcttgccggttggacaccaagtggaaggcgggtcaaggctcgcgcagcgaccgcgcagcggcttggc
cttgacgcgcctggaacgacccaagcctatgcgagtgggggcagtcgaaggcgaagcccgcccgcctgcccccc
gagcctcacggcggcgagtgcgggggttccaaggggcagcgccaccttgggcaaggccgaaggccgcgcagt
cgatcaacaagccccggaggggccacttttgccggaggggagccgcgccgaaggcgtgggggaaccccgca
ggggtgcccttctttgggcaccaaagaactagatatagggcgaaatgcgaaagacttaaaaatcaacaacttaaaaa
agggggtacgcaacagctcattgcggcacccccgcaatagctcattgcgtaggttaaagaaaatctgtaattgact
gccacttttacgcaacgcataattgttgtcgcgctgccgaaaagttgcagctgattgcgcatggtgccgcaaccgtgc
ggcaccctaccgcatggagataagcatggccacgcagtccagagaaatcggcattcaagccaagaacaagcccg
gtcactgggtgcaaacggaacgcaaagcgcatgaggcgtgggccgggcttattgcgaggaaacccacggcggca
atgctgctgcatcacctcgtggcgcagatgggccaccagaacgccgtggtggtcagccagaagacactttccaagc
tcatcggacgttctttgcggacggtccaatacgcagtcaaggacttggtggccgagcgctggatctccgtcgtgaagc
tcaacggccccggcaccgtgtcggcctacgtggtcaatgaccgcgtggcgtggggccagccccgcgaccagttgc
gcctgtcggtgttcagtgccgccgtggtggttgatcacgacgaccaggacgaatcgctgttggggcatggcgacctg
cgccgcatcccgaccctgtatccgggcgagcagcaactaccgaccggccccggcgaggagccgcccagccagc
ccggcattccgggcatggaaccagacctgccagccttgaccgaaacggaggaatgggaacggcgcgggcagca
gcgcctgccgatgcccgatgagccgtgttttctggacgatggcgagccgttggagccgccgacacgggtcacgctg
ccgcgccggtagcacttgggttgcgcagcaacccgtaagtgcgctgttccagactatcggctgtagccgcctcgccg
ccctataccttgtctgcctccccgcgttgcgtcgcggtgcatggagccgggccacctcgacctgaatggaagccggc
ggcacctcgctaacggattcaccgtttttatcaggctctgggaggcagaataaatgatcatatcgtcaattattacctcca
cggggagagcctgagcaaactggcctcaggcatttgagaagcacacggtcacactgcttccggtagtcaataaacc
ggtaaaccagcaatagacataagcggctatttaacgaccctgccctgaaccgacgaccgggtcgaatttgctttcgaa
tttctgccattcatccgcttattatcacttattcaggcgtagcaccaggcgtttaagggcaccaataactgccttaaaaaa
attacgccccgccctgccactcatcgcagtcggcctattggttaaaaaatgagctgatttaacaaaaatttaacgcgaat
tttaacaaaatattaa

Figure 171C

cgcttacaatttccattcgccattcaggctgcgcaactgttgggaagggcgatcggtgcgggcctcttcgctattacgccagct
ggcgaaaggggatgtgctgcaaggcgattaagttgggtaacgccagggttttcccagtcacgacgttgtaaaacgacggc
cagtgagcgcgcgtaatacgactcactatagggcgaattggagctccaccgcggtggcggccgctctagaactagtgttga
caattaatcatccggctcgtataatgtgtggaattgtgagcggataacaatttaggaggaaaaaaaaatgagttatactgtcggt
acctatttagcggagcggcttgtccagattggtctcaagcatcacttcgcagtcgcgggcgactacaacctcgtccttcttgac
aacctgcttttgaacaaaaacatggagcaggtttattgctgtaacgaactgaactgcggtttcagtgcagaaggttatgctcgtg
ccaaaggcgcagcagcagccgtcgttacctacagcgtcggtgcgctttccgcatttgatgctatcggtggcgcctatgcaga
aaaccttccggttatcctgatctccggtgctccgaacaacaatgatcacgctgctggtcacgtgttgcatcacgctcttggcaa
aaccgactatcactatcagttggaaatggccaagaacatcacggccgccgctgaagcgatttacaccccggaagaagctcc
ggctaaaatcgatcacgtgattaaaactgctcttcgtgagaagaagccggtttatctcgaaatcgcttgcaacattgcttccatg
ccctgcgccgctcctggaccggcaagcgcattgttcaatgacgaagccagcgacgaagcttctttgaatgcagcggttgaa
gaaaccctgaaattcatcgccaaccgcgacaaagttgccgtcctcgtcggcagcaagctgcgcgcagctggtgctgaagaa
gctgctgtcaaatttgctgatgctctcggtggcgcagttgctaccatggctgctgcaaaaagcttcttcccagaagaaaacccg
cattacatcggcacctcatggggtgaagtcagctatccgggcgttgaaaagacgatgaaagaagccgatgcggttatcgctc
tggctcctgtcttcaacgactactccaccactggttggacggatattcctgatcctaagaaactggttctcgctgaaccgcgttct
gtcgtcgttaacggcattcgcttccccagcgtccatctgaaagactatctgacccgtttggctcagaaagtttccaagaaaacc
ggtgcattggacttcttcaaatccctcaatgcaggtgaactgaagaaagccgctccggctgatccgagtgctccgttggtcaa
cgcagaaatcgcccgtcaggtcgaagctcttctgaccccgaacacgacggttattgctgaaaccggtgactcttggttcaatg
ctcagcgcatgaagctcccgaacggtgctcgcgttgaatatgaaatgcagtggggtcacattggttggtccgttcctgccgcc
ttcggttatgccgtcggtgctccggaacgtcgcaacatcctcatggttggtgatggttccttccagctgacggctcaggaagtc
gctcagatggttcgcctgaaactgccggttatcatcttcttgatcaataactatggttacaccatcgaagttatgatccatgatggt
ccgtacaacaacatcaagaactgggattatgccggtctgatggaagtgttcaacggtaacggtggttatgacagcggtgctg
gtaaaggcctgaaggctaaaaccggtggcgaactggcagaagctatcaaggttgctctggcaaacaccgacggcccaacc
ctgatcgaatgcttcatcggtcgtgaagactgcactgaagaattggtcaaatggggtaagcgcgttgctgccgccaacagcc
gtaagcctgttaacaagctcctctagtttttaaataaacctgcaggaattcgatatcaagcttatcgataccgtcgacctcgagg
gggggcccggtacccagcttttgttccctttagtgagggttaattgcgcgcttggcgtaatcatggtcatagctgtttcctgtgtg
aaattgttatccgctcacaattccacacaacatacgagccggaagcataaagtgtaaagcctggggtgcctaatgagtgagct
aactcacattaattgcgttgcgctcactgcccgctttccagtcgggaaacctgtcgtgccagctgcattaatgaatcggccaac
gcgcggggagaggcggtttgcgtattgggcgcatgcataaaaactgttgtaattcattaagcattctgccgacatggaagcca
tcacaaacggcatgatgaacctgaatcgccagcggcatcagcaccttgtcgccttgcgtataatatttgcccatggacgcaca
ccgtggaaacggatgaaggcacgaacccagttgacataagcctgttcggttcgtaaactgtaatgcaagtagcgtatgcgct
cacgcaactggtccagaaccttgaccgaacgcagcggtggtaacggcgcagtggcggttttcatggcttgttatgactgttttt
ttgtacagtctatgcctcgggcatccaagcagcaagcgcgttacgccgtgggtcgatgtttgatgttatggagcagcaacgat
gttacgcagcagcaacgatgttacgcagcagggcagtcgccctaaaacaaagttaggtggctcaagtatgggcatcattcgc
acatgtaggctcggccctgaccaagtcaaatccatgcgggctgctcttgatcttttcggtcgtgagttcggagacgtagccac
ctactcccaacatcagccggactccgattacctcgggaacttgctccgtagtaagacattcatcgcgcttgctgccttcgacca
agaagcggttgttggcgctctcgcggcttacgttctgcccaggtttgagcagccgcgtagtgagatctatatctatgatctcgc
agtctccggcgagcaccggaggcagggcattgccaccgcgctcatcaatctcctcaagcatgaggccaacgcgcttggtg
cttatgtgatctacgtgcaagcagattacggtgacgatcccgcagtggctctctatacaaagttgggcatacgggaagaagtg
atgcactttgatatcgacccaagtaccgccacctaacaattcgttcaagccgagatcggcttcccggccgcggagttgttcgg
taaattgtcacaacgccgccaggtggcacttttcggggaaatgtgcgcgcccgcgttcctgctggcgctgggcctgtttctgg
cgctggacttcccgctgttccgtcagcagcttttcgcccacggccttgatgatcgcggcggccttggcctgcatatcccgattc
aacggccccagggcgtccagaacgggcttcaggcgctcccgaaggt

(SEQ ID NO:148)

Figure 172A

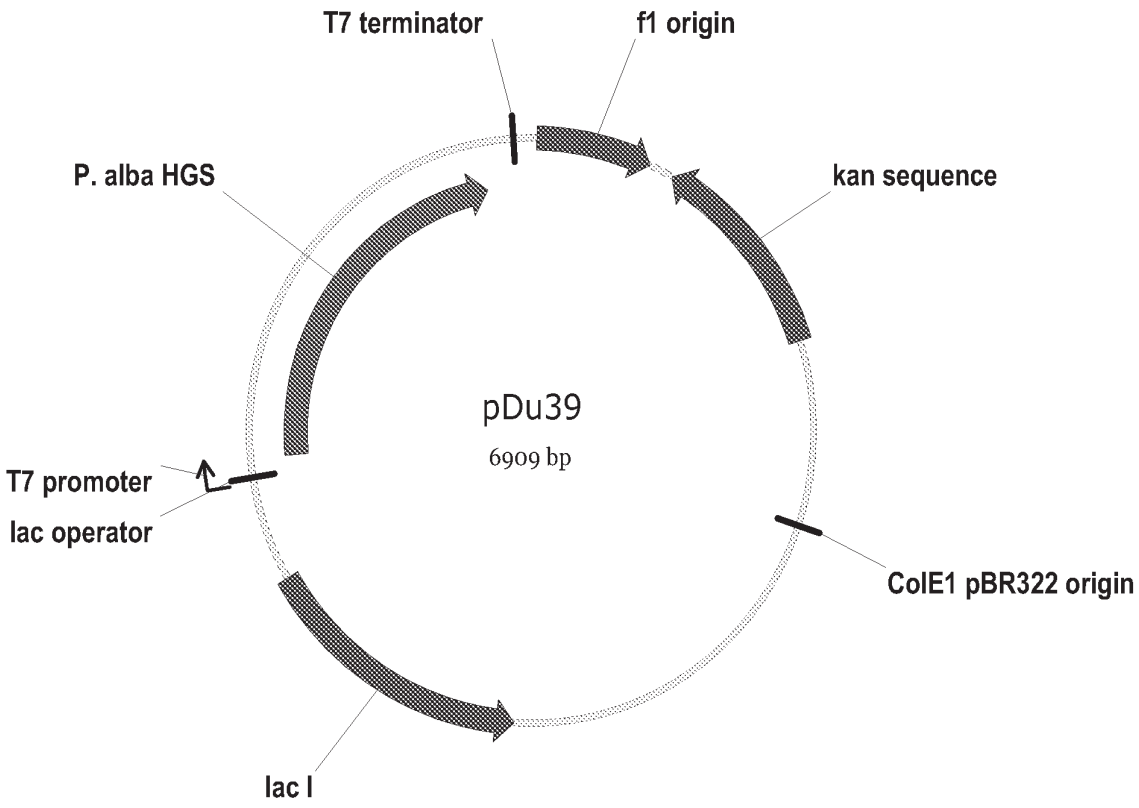

T7 terminator
f1 origin
P. alba HGS
kan sequence
pDu39
6909 bp
T7 promoter
lac operator
ColE1 pBR322 origin
lac I

Figure 172B

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagcgtgaccgctacacttg
ccagcgccctagcgcccgctcctttcgctttcttcccttcctttctcgccacgttcgccggctttccccgtcaagctctaaatcgg
gggctcccttttagggttccgatttagtgctttacggcacctcgaccccaaaaaacttgattagggtgatggttcacgtagtggg
ccatcgccctgatagacggtttttcgccctttgacgttggagtccacgttctttaatagtggactcttgttccaaactggaacaac
actcaaccctatctcggtctattcttttgatttataagggattttgccgatttcggcctattggttaaaaaatgagctgatttaacaaa
aatttaacgcgaattttaacaaaatattaacgtttacaatttcaggtggcacttttcggggaaatgtgcgcggaaccccctatttgtt
tatttttctaaatacattcaaatatgtatccgctcatgaattaattcttagaaaaactcatcgagcatcaaatgaaactgcaatttatt
catatcaggattatcaataccatatttttgaaaaagccgtttctgtaatgaaggagaaaactcaccgaggcagttccataggatg
gcaagatcctggtatcggtctgcgattccgactcgtccaacatcaatacaacctattaatttcccctcgtcaaaaataaggttatc
aagtgagaaatcaccatgagtgacgactgaatccggtgagaatggcaaaagtttatgcatttctttccagacttgttcaacagg
ccagccattacgctcgtcatcaaaatcactcgcatcaaccaaaccgttattcattcgtgattgcgcctgagcgagacgaaatac
gcgatcgctgttaaaaggacaattacaaacaggaatcgaatgcaaccggcgcaggaacactgccagcgcatcaacaatatt
ttcacctgaatcaggatattcttctaatacctggaatgctgttttcccggggatcgcagtggtgagtaaccatgcatcatcagga
gtacggataaaatgcttgatggtcggaagaggcataaattccgtcagccagtttagtctgaccatctcatctgtaacatcattgg
caacgctacctttgccatgtttcagaaacaactctggcgcatcgggcttcccatacaatcgatagattgtcgcacctgattgccc
gacattatcgcgagcccatttatacccatataaatcagcatccatgttggaatttaatcgcggcctagagcaagacgtttcccgt
tgaatatggctcataacacccttgtattactgtttatgtaagcagacagttttattgttcatgaccaaaatcccttaacgtgagtttt
cgttccactgagcgtcagaccccgtagaaaagatcaaaggatcttcttgagatccttttttctgcgcgtaatctgctgcttgcaa
acaaaaaaaccaccgctaccagcggtggtttgtttgccggatcaagagctaccaactctttttccgaaggtaactggcttcagc
agagcgcagataccaaatactgtccttctagtgtagccgtagttaggccaccacttcaagaactctgtagcaccgcctacatac
ctcgctctgctaatcctgttaccagtggctgctgccagtggcgataagtcgtgtcttaccgggttggactcaagacgatagttac
cggataaggcgcagcggtcgggctgaacgggggttcgtgcacacagcccagcttggagcgaacgacctacaccgaact
gagatacctacagcgtgagctatgagaaagcgccacgcttcccgaagggagaaaggcggacaggtatccggtaagcggc
agggtcggaacaggagagcgcacgagggagcttccagggggaaacgcctggtatctttatagtcctgtcgggtttcgccac
ctctgacttgagcgtcgatttttgtgatgctcgtcaggggggcggagcctatggaaaaacgccagcaacgcggccttttacg
gttcctggccttttgctggccttttgctcacatgttctttcctgcgttatcccctgattctgtggataaccgtattaccgcctttgagt
gagctgataccgctcgccgcagccgaacgaccgagcgcagcgagtcagtgagcgaggaagcggaagagcgcctgatgc
ggtattttctccttacgcatctgtgcggtatttcacaccgcatatatggtgcactctcagtacaatctgctctgatgccgcatagtt
aagccagtatacactccgctatcgctacgtgactgggtcatggctgcgccccgacacccgccaacacccgctgacgcgccc
tgacgggcttgtctgctcccggcatccgcttacagacaagctgtgaccgtctccgggagctgcatgtgtcagaggttttcacc
gtcatcaccgaaacgcgcgaggcagctgcggtaaagctcatcagcgtggtcgtgaagcgattcacagatgtctgcctgttca
tccgcgtccagctcgttgagtttctccagaagcgttaatgtctggcttctgataaagcgggccatgttaagggcggttttttcctg
tttggtcactgatgcctccgtgtaagggggatttctgttcatgggggtaatgataccgatgaaacgagagaggatgctcacgat
acgggttactgatgatgaacatgcccggttactggaacgttgtgagggtaaacaactggcggtatggatgcggcgggacca
gagaaaaatcactcagggtcaatgccagcgcttcgttaatacagatgtaggtgttccacagggtagccagcagcatcctgcg
atgcagatccggaacataatggtgcagggcgctgacttccgcgtttccagactttacgaaacacggaaaccgaagaccattc
atgttgttgctcaggtcgcagacgttttgcagcagcagtcgcttcacgttcgctcgcgtatcggtgattcattctgctaaccagt

Figure 172C

aaggcaaccccgccagcctagccgggtcctcaacgacaggagcacgatcatgcgcacccgtggggccgccatgccggc
gataatggcctgcttctcgccgaaacgtttggtggcgggaccagtgacgaaggcttgagcgagggcgtgcaagattccgaa
taccgcaagcgacaggccgatcatcgtcgcgctccagcgaaagcggtcctcgccgaaaatgacccagagcgctgccggc
acctgtcctacgagttgcatgataaagaagacagtcataagtgcggcgacgatagtcatgccccgcgcccaccggaagga
gctgactgggttgaaggctctcaagggcatcggtcgagatcccggtgcctaatgagtgagctaacttacattaattgcgttgc
gctcactgcccgctttccagtcgggaaacctgtcgtgccagctgcattaatgaatcggccaacgcgcggggagaggcggttt
gcgtattgggcgccagggtggtttttcttttcaccagtgagacgggcaacagctgattgcccttcaccgcctggccctgagag
agttgcagcaagcggtccacgctggtttgccccagcaggcgaaaatcctgtttgatggtggttaacggcgggatataacatg
agctgtcttcggtatcgtcgtatcccactaccgagatatccgcaccaacgcgcagcccggactcggtaatggcgcgcattgc
gcccagcgccatctgatcgttggcaaccagcatcgcagtgggaacgatgccctcattcagcatttgcatggtttgttgaaaac
cggacatggcactccagtcgccttcccgttccgctatcggctgaatttgattgcgagtgagatatttatgccagccagccagac
gcagacgcgccgagacagaacttaatgggcccgctaacagcgcgatttgctggtgacccaatgcgaccagatgctccacg
cccagtcgcgtaccgtcttcatgggagaaaataatactgttgatgggtgtctggtcagagacatcaagaaataacgccggaa
cattagtgcaggcagcttccacagcaatggcatcctggtcatccagcggatagttaatgatcagcccactgacgcgttgcgc
gagaagattgtgcaccgccgctttacaggcttcgacgccgcttcgttctaccatcgacaccaccacgctggcacccagttgat
cggcgcgagatttaatcgccgcgacaatttgcgacggcgcgtgcagggccagactggaggtggcaacgccaatcagcaa
cgactgtttgcccgccagttgttgtgccacgcggttgggaatgtaattcagctccgccatcgccgcttccacttttcccgcgttt
tcgcagaaacgtggctggcctggttcaccacgcgggaaacggtctgataagagacaccggcatactctgcgacatcgtata
acgttactggtttcacattcaccaccctgaattgactctcttccgggcgctatcatgccataccgcgaaaggttttgcgccattcg
atggtgtccgggatctcgacgctctcccttatgcgactcctgcattaggaagcagcccagtagtaggttgaggccgttgagca
ccgccgccgcaaggaatggtgcatgcaaggagatggcgcccaacagtcccccggccacggggcctgccaccatacccca
cgccgaaacaagcgctcatgagcccgaagtggcgagcccgatcttccccatcggtgatgtcggcgatataggcgccagca
accgcacctgtggcgccggtgatgccggccacgatgcgtccggcgtagaggatcgagatctcgatcccgcgaaattaatac
gactcactataggggaattgtgagcggataacaattcccctctagaaataattttgtttaactttaagaaggagatatacatatgg
aagctcgtcgttctgcgaactacgaacctaacagctgggactatgattacctgctgtcctccgacacggacgagtccatcgaa
gtatacaaagacaaagcgaaaaagctggaagccgaagttcgtcgcgagattaataacgaaaaagcagaatttctgaccctg
ctggaactgattgacaacgtccagcgcctgggcctgggttaccgtttcgagtctgatatccgtggtgcgctggatcgcttcgttt
cctccggcggcttcgatgcggtaaccaagacttccctgcacggtacggcactgtctttccgtctgctgcgtcaacacggttttg
aggtttctcaggaagcgttcagcggcttcaaagaccaaaacggcaacttcctggagaacctgaaggaagatatcaaagctat
cctgagcctgtacgaggccagcttcctggctctggaaggcgaaaacatcctggacgaggcgaaggttttcgcaatctctcat
ctgaaagaactgtctgaagaaaagatcggtaaagagctggcagaacaggtgaaccatgcactggaactgccactgcatcgc
cgtactcagcgtctggaagcagtatggtctatcgaggcctaccgtaaaaaggaggacgcgaatcaggttctgctggagctg
gcaattctggattacaacatgatccagtctgtataccagcgtgatctgcgtgaaacgtcccgttggtggcgtcgtgtgggtctg
gcgaccaaactgcactttgctcgtgaccgcctgattgagagcttctactgggccgtgggtgtagcattcgaaccgcaatactc
cgactgccgtaactccgtcgcaaaaatgttttctttcgtaaccattatcgacgatatctacgatgtatacggcaccctggacgaa
ctggagctgtttactgatgcagttgagcgttgggacgtaaacgccatcaacgacctgccggattacatgaaactgtgctttctg
gctctgtataacactattaacgaaatcgcctacgacaacctgaaagataaaggtga

Figure 172D

gaacatcctgccgtatctgaccaaagcctgggctgacctgtgcaacgctttcctgcaagaagccaagtggctgtacaacaaa
tctactccgacctttgacgactacttcggcaacgcatggaaatcctcttctggcccgctgcaactggtgttcgcttacttcgctgt
cgtgcagaacattaaaaaggaagagatcgaaaacctgcaaaaataccatgacaccatctctcgtccttcccatatcttccgtct
gtgcaatgacctggctagcgcgtctgcggaaattgcgcgtggtgaaaccgcaaatagcgtttcttgttacatgcgcactaaag
gtatctccgaagaactggctaccgaaagcgtgatgaatctgatcgatgaaacctggaaaaagatgaacaaggaaaaactgg
gtggtagcctgttcgcgaaaccgttcgtggaaaccgcgatcaacctggcacgtcaatctcactgcacttatcataacggcgac
gcgcatacctctccggatgagctgacccgcaaacgcgttctgtctgtaatcactgaaccgattctgccgtttgaacgctaagg
atccgaattcgagctccgtcgacaagcttgcggccgcactcgagcaccaccaccaccaccactgagatccggctgctaaca
aagcccgaaaggaagctgagttggctgctgccaccgctgagcaataactagcataaccccttggggcctctaaacgggtctt
gaggggttttttgctgaaaggaggaactatatccggat

(SEQ ID NO: 151)

Figure 173

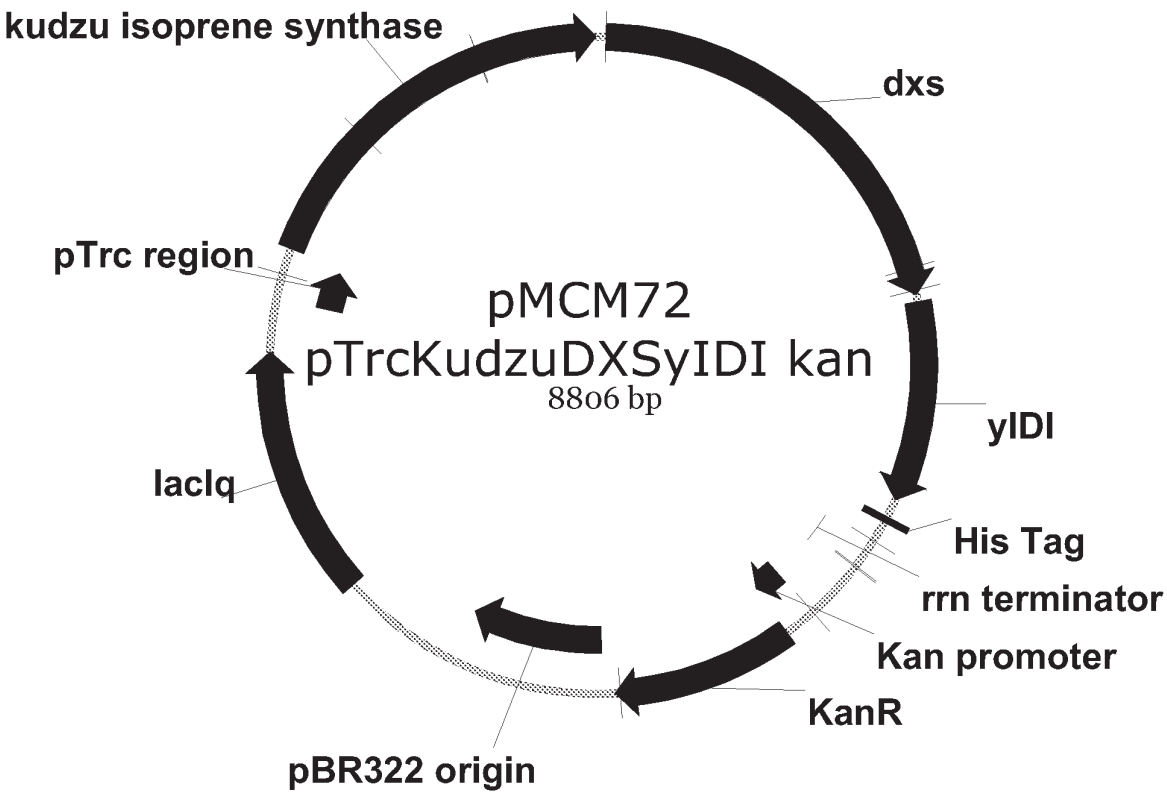

kudzu isoprene synthase
dxs
pTrc region
pMCM72
pTrcKudzuDXSyIDI kan
8806 bp
yIDI
laclq
His Tag
rrn terminator
Kan promoter
KanR
pBR322 origin

Figure 174A

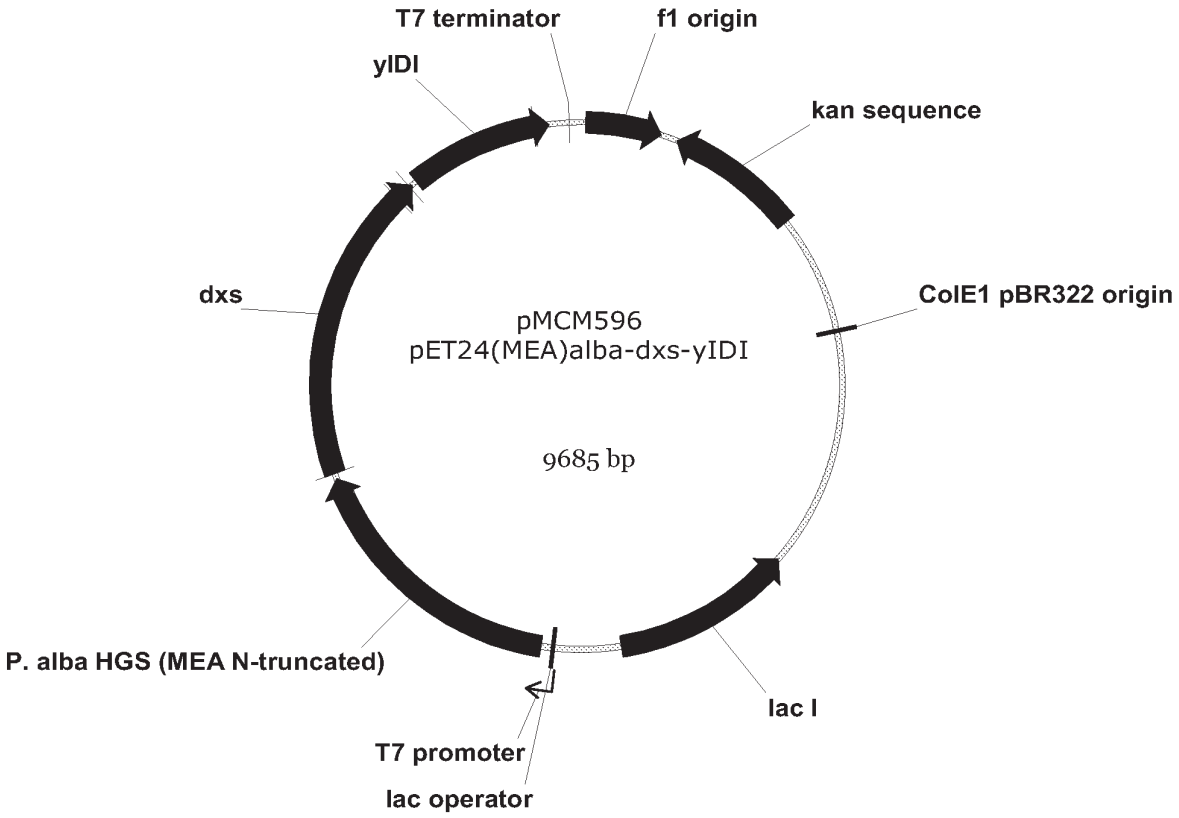

T7 terminator
f1 origin
yIDI
kan sequence
dxs
ColE1 pBR322 origin
pMCM596
pET24(MEA)alba-dxs-yIDI
9685 bp
P. alba HGS (MEA N-truncated)
lac I
T7 promoter
lac operator

Figure 174B

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagcgtgaccgctacactt
gccagcgccctagcgcccgctcctttcgctttcttcccttcctttctcgccacgttcgccggctttccccgtcaagctctaaatc
gggggctccctttagggttccgatttagtgctttacggcacctcgaccccaaaaaacttgattagggtgatggttcacgtagt
gggccatcgccctgatagacggtttttcgccctttgacgttggagtccacgttctttaatagtggactcttgttccaaactggaa
caacactcaaccctatctcggtctattcttttgatttataagggattttgccgatttcggcctattggttaaaaaatgagctgattta
acaaaaatttaacgcgaattttaacaaaatattaacgtttacaatttcaggtggcacttttcggggaaatgtgcgcggaacccc
tatttgtttatttttctaaatacattcaaatatgtatccgctcatgaattaattcttagaaaaactcatcgagcatcaaatgaaactg
caatttattcatatcaggattatcaataccatatttttgaaaaagccgtttctgtaatgaaggagaaaactcaccgaggcagttc
cataggatggcaagatcctggtatcggtctgcgattccgactcgtccaacatcaatacaacctattaatttcccctcgtcaaaa
ataaggttatcaagtgagaaatcaccatgagtgacgactgaatccggtgagaatggcaaaagtttatgcatttctttccagact
tgttcaacaggccagccattacgctcgtcatcaaaatcactcgcatcaaccaaaccgttattcattcgtgattgcgcctgagc
gagacgaaatacgcgatcgctgttaaaaggacaattacaaacaggaatcgaatgcaaccggcgcaggaacactgccagc
gcatcaacaatattttcacctgaatcaggatattcttctaatacctggaatgctgttttcccggggatcgcagtggtgagtaacc
atgcatcatcaggagtacggataaaatgcttgatggtcggaagaggcataaattccgtcagccagtttagtctgaccatctca
tctgtaacatcattggcaacgctacctttgccatgtttcagaaacaactctggcgcatcgggcttcccatacaatcgatagatt
gtcgcacctgattgcccgacattatcgcgagcccatttatacccatataaatcagcatccatgttggaatttaatcgcggccta
gagcaagacgtttcccgttgaatatggctcataacacccttgtattactgtttatgtaagcagacagttttattgttcatgacca
aaatcccttaacgtgagttttcgttccactgagcgtcagaccccgtagaaaagatcaaaggatcttcttgagatcctttttttctg
cgcgtaatctgctgcttgcaaacaaaaaaaccaccgctaccagcggtggtttgtttgccggatcaagagctaccaactctttt
tccgaaggtaactggcttcagcagagcgcagataccaaatactgtccttctagtgtagccgtagttaggccaccacttcaag
aactctgtagcaccgcctacatacctcgctctgctaatcctgttaccagtggctgctgccagtggcgataagtcgtgtcttacc
gggttggactcaagacgatagttaccggataaggcgcagcggtcgggctgaacgggggttcgtgcacacagcccagct
tggagcgaacgacctacaccgaactgagatacctacagcgtgagctatgagaaagcgccacgcttcccgaagggagaa
aggcggacaggtatccggtaagcggcagggtcggaacaggagagcgcacgagggagcttccagggggaaacgcctg
gtatctttatagtcctgtcgggtttcgccacctctgacttgagcgtcgatttttgtgatgctcgtcaggggggcggagcctatg
gaaaaacgccagcaacgcggcctttttacggttcctggccttttgctggccttttgctcacatgttctttcctgcgttatcccctg
attctgtggataaccgtattaccgcctttgagtgagctgataccgctcgccgcagccgaacgaccgagcgcagcgagtca
gtgagcgaggaagcggaagagcgcctgatgcggtattttctccttacgcatctgtgcggtatttcacaccgcatatatggtg
cactctcagtacaatctgctctgatgccgcatagttaagccagtatacactccgctatcgctacgtgactgggtcatggctgc
gccccgacacccgccaacacccgctgacgcgccctgacgggcttgtctgctcccggcatccgcttacagacaagctgtg
accgtctccgggagctgcatgtgtcagaggttttcaccgtcatcaccgaaacgcgcgaggcagctgcggtaaagctcatc
agcgtggtcgtgaagcgattcacagatgtctgcctgttcatccgcgtccagctcgttgagtttctccagaagcgttaatgtctg
gcttctgataaagcgggccatgttaagggcggttttttcctgtttggtcactgatgcctccgtgtaagggggatttctgttcatg
ggggtaatgataccgatgaaacgagagaggatgctcacgatacgggttactgatgatgaacatgcccggttactggaacg
ttgtgagggtaaacaactggcggtatggatgcggcgggaccagagaaaaatcactcagggtcaatgccagcgcttcgtta
atacagatgtaggtgttccacagggtagccagcagcatcctgcgatgcagatccggaacataatggtgcagggcgctgac
ttccgcgtttccagactttacgaaacacggaaaccgaagaccattcatgttgttgctcaggtcgcagacgttttgcagcagca
gtcgcttcacgttcgctcgcgtatcggtgattcattctgctaaccagtaaggcaaccccgccagcctagccgggtcctcaac
gacaggagcacgatcatgcgcacccgtggggccgccatgccggcgataatggcctgcttctcgccgaaacgtttggtgg
cgggaccagtgacgaaggcttgagcgagggcgtgcaagattccgaa

Figure 174C

taccgcaagcgacaggccgatcatcgtcgcgctccagcgaaagcggtcctcgccgaaaatgacccagagcgctgccg
gcacctgtcctacgagttgcatgataaagaagacagtcataagtgcggcgacgatagtcatgccccgcgcccaccgga
aggagctgactgggttgaaggctctcaagggcatcggtcgagatcccggtgcctaatgagtgagctaacttacattaattg
cgttgcgctcactgcccgctttccagtcgggaaacctgtcgtgccagctgcattaatgaatcggccaacgcgcggggag
aggcggtttgcgtattgggcgccagggtggtttttcttttcaccagtgagacgggcaacagctgattgcccttcaccgcctg
gccctgagagagttgcagcaagcggtccacgctggtttgccccagcaggcgaaaatcctgtttgatggtggttaacggc
gggatataacatgagctgtcttcggtatcgtcgtatcccactaccgagatatccgcaccaacgcgcagcccggactcggt
aatggcgcgcattgcgcccagcgccatctgatcgttggcaaccagcatcgcagtgggaacgatgccctcattcagcattt
gcatggtttgttgaaaaccggacatggcactccagtcgccttcccgttccgctatcggctgaatttgattgcgagtgagata
tttatgccagccagccagacgcagacgcgccgagacagaacttaatgggcccgctaacagcgcgatttgctggtgacc
caatgcgaccagatgctccacgcccagtcgcgtaccgtcttcatgggagaaaataatactgttgatgggtgtctggtcaga
gacatcaagaaataacgccggaacattagtgcaggcagcttccacagcaatggcatcctggtcatccagcggatagtta
atgatcagcccactgacgcgttgcgcgagaagattgtgcaccgccgctttacaggcttcgacgccgcttcgttctaccatc
gacaccaccacgctggcacccagttgatcggcgcgagatttaatcgccgcgacaatttgcgacggcgcgtgcagggcc
agactggaggtggcaacgccaatcagcaacgactgtttgcccgccagttgttgtgccacgcggttgggaatgtaattcag
ctccgccatcgccgcttccacttttcccgcgttttcgcagaaacgtggctggcctggttcaccacgcgggaaacggtctg
ataagagacaccggcatactctgcgacatcgtataacgttactggtttcacattcaccaccctgaattgactctcttccgggc
gctatcatgccataccgcgaaaggttttgcgccattcgatggtgtccgggatctcgacgctctcccttatgcgactcctgca
ttaggaagcagcccagtagtaggttgaggccgttgagcaccgccgccgcaaggaatggtgcatgcaaggagatggcg
cccaacagtcccccggccacggggcctgccaccatacccacgccgaaacaagcgctcatgagcccgaagtggcgag
cccgatcttccccatcggtgatgtcggcgatataggcgccagcaaccgcacctgtggcgccggtgatgccggccacga
tgcgtccggcgtagaggatcgagatctcgatcccgcgaaattaatacgactcactataggggaattgtgagcggataaca
attcccctctagaaataattttgtttaactttaagaaggagatatacatatggaagctcgtcgttctgcgaactacgaacctaa
cagctgggactatgattacctgctgtcctccgacacggacgagtccatcgaagtatacaaagacaaagcgaaaaagctg
gaagccgaagttcgtcgcgagattaataacgaaaaagcagaatttctgaccctgctggaactgattgacaacgtccagcg
cctgggcctgggttaccgtttcgagtctgatatccgtggtgcgctggatcgcttcgtttcctccggcggcttcgatgcggta
accaagacttccctgcacggtacggcactgtctttccgtctgctgcgtcaacacggttttgaggtttctcaggaagcgttca
gcggcttcaaagaccaaaacggcaacttcctggagaacctgaaggaagatatcaaagctatcctgagcctgtacgaggc
cagcttcctggctctggaaggcgaaaacatcctggacgaggcgaaggttttcgcaatctctcatctgaaagaactgtctga
agaaaagatcggtaaagagctggcagaacaggtgaaccatgcactggaactgccactgcatcgccgtactcagcgtct
ggaagcagtatggtctatcgaggcctaccgtaaaaaggaggacgcgaatcaggttctgctggagctggcaattctggatt
acaacatgatccagtctgtataccagcgtgatctgcgtgaaacgtcccgttggtggcgtcgtgtgggtctggcgaccaaa
ctgcactttgctcgtgaccgcctgattgagagcttctactgggccgtgggtgtagcattcgaaccgcaatactccgactgc
cgtaactccgtcgcaaaaatgttttctttcgtaaccattatcgacgatatctacgatgtatacggcaccctggacgaactgga
gctgtttactgatgcagttgagcgttgggacgtaaacgccatcaacgacctgccggattacatgaaactgtgctttctggct
ctgtataacactattaacgaaatcgcctacgacaacctgaaagataaaggtgagaacatcctgccgtatctgaccaaagc
ctgggctgacctgtgcaacgctttcctgcaagaagccaagtggctgtacaacaaatctactccgacctttgacgactacttc
ggcaacgcatggaaatcctcttctggcccgctgcaactggtgttcgcttacttcgctgtcgtgcagaacattaaaaaggaa
gagatcgaaaacctgcaaaaataccatgacaccatctctcgtccttcccatatcttccgtctgtgcaatgacctggctagcg
cgtctgcggaaattgcgcgtggtgaaaccgcaaatagcgtttcttgttacatgcgcactaaaggtatctccgaagaactgg
ctaccgaaagcgtgatg

Figure 174D

aatctgatcgatgaaacctggaaaaagatgaacaaggaaaaactgggtggtagcctgttcgcgaaaccgttcgtggaaac
cgcgatcaacctggcacgtcaatctcactgcacttatcataacggcgacgcgcatacctctccggatgagctgacccgcaa
acgcgttctgtctgtaatcactgaaccgattctgccgtttgaacgctaaggatccattcgcccttaggaggtaaaaaaacatg
agttttgatattgccaaatacccgaccctggcactggtcgactccacccaggagttacgactgttgccgaaagagagtttac
cgaaactctgcgacgaactgcgccgctatttactcgacagcgtgagccgttccagcgggcacttcgcctccgggctgggc
acggtcgaactgaccgtggcgctgcactatgtctacaacaccccgtttgaccaattgatttgggatgtggggcatcaggctt
atccgcataaaattttgaccggacgccgcgacaaaatcggcaccatccgtcagaaaggcggtctgcacccgttcccgtgg
cgcggcgaaagcgaatatgacgtattaagcgtcgggcattcatcaacctccatcagtgccggaattggtattgcggttgctg
ccgaaaaagaaggcaaaaatcgccgcaccgtctgtgtcattggcgatggcgcgattaccgcaggcatggcgtttgaagc
gatgaatcacgcgggcgatatccgtcctgatatgctggtgattctcaacgacaatgaaatgtcgatttccgaaaatgtcggc
gcgctcaacaaccatctggcacagctgctttccggtaagctttactcttcactgcgcgaaggcgggaaaaaagttttctctgg
cgtgccgccaattaaagagctgctcaaacgcaccgaagaacatattaaaggcatggtagtgcctggcacgttgtttgaaga
gctgggctttaactacatcggcccggtggacggtcacgatgtgctggggcttatcaccacgctaaagaacatgcgcgacct
gaaaggcccgcagttcctgcatatcatgaccaaaaaaggtcgtggttatgaaccggcagaaaaagacccgatcactttcca
cgccgtgcctaaatttgatccctccagcggttgtttgccgaaaagtagcggcggtttgccgagctattcaaaaatctttggcg
actggttgtgcgaaacggcagcgaaagacaacaagctgatggcgattactccggcgatgcgtgaaggttccggcatggtc
gagttttcacgtaaattcccggatcgctacttcgacgtggcaattgccgagcaacacgcggtgaccttgctgcgggtctgg
cgattggtgggtacaaacccattgtcgcgatttactccactttcctgcaacgcgcctatgatcaggtgctgcatgacgtggcg
attcaaaagcttccggtcctgttcgccatcgaccgcgcgggcattgttggtgctgacggtcaaacccatcagggtgcttttga
tctctcttacctgcgctgcataccggaaatggtcattatgaccccgagcgatgaaaacgaatgtcgccagatgctctataccg
gctatcactataacgatggcccgtcagcggtgcgctacccgcgtggcaacgcggtcggcgtggaactgacgccgctgga
aaaactaccaattggcaaaggcattgtgaagcgtcgtggcgagaaactggcgatccttaactttggtacgctgatgccaga
agcggcgaaagtcgccgaatcgctgaacgccacgctggtcgatatgcgttttgtgaaaccgcttgatgaagcgttaattctg
gaaatggccgccagccatgaagcgctggtcaccgtagaagaaaacgccattatgggcggcgcaggcagcggcgtgaa
cgaagtgctgatggcccatcgtaaaccagtacccgtgctgaacattggcctgccggacttctttattccgcaaggaactcag
gaagaaatgcgcgccgaactcggcctcgatgccgctggtatggaagccaaaatcaaggcctggctggcataactgcatc
gcccttaggaggtaaaaaaaaatgactgccgacaacaatagtatgccccatggtgcagtatctagttacgccaaattagtgc
aaaaccaaacacctgaagacattttggaagagtttcctgaaattattccattacaacaaagacctaatacccgatctagtgag
acgtcaaatgacgaaagcggagaaacatgtttttctggtcatgatgaggagcaaattaagttaatgaatgaaaattgtattgttt
tggattgggacgataatgctattggtgccggtaccaagaaagtttgtcatttaatggaaaatattgaaaagggtttactacatc
gtgcattctccgtctttattttcaatgaacaaggtgaattacttttacaacaaagagccactgaaaaaataactttccctgatcttt
ggactaacacatgctgctctcatccactatgtattgatgacgaattaggtttgaagggtaagctagacgataagattaagggc
gctattactgcggcggtgagaaaactagatcatgaattaggtattccagaagatgaaactaagacaaggggtaagtttcactt
tttaaacagaatccattacatggcaccaagcaatgaaccatggggtgaacatgaaattgattacatcctatttttataagatcaa
cgctaaagaaaacttgactgtcaacccaaacgtcaatgaagttagagacttcaaatgggtttcaccaaatgatttgaaaacta
tgtttgctgacccaagttacaagtttacgccttggtttaagattatttgcgagaattacttattcaactggtgggagcaattagat
gacctttctgaagtggaaaatgacaggcaaattcatagaatgctataacaacgcgtcctgcagctggcggccgcactcgag
caccaccaccaccaccactgagatccggctgctaacaaagcccgaaaggaagctgagttggctgctgccaccgctgagc
aataactagcataaccccttggggcctctaaacgggtcttgaggggttttttgctgaaaggaggaactatatccggat

(SEQ ID NO:154)

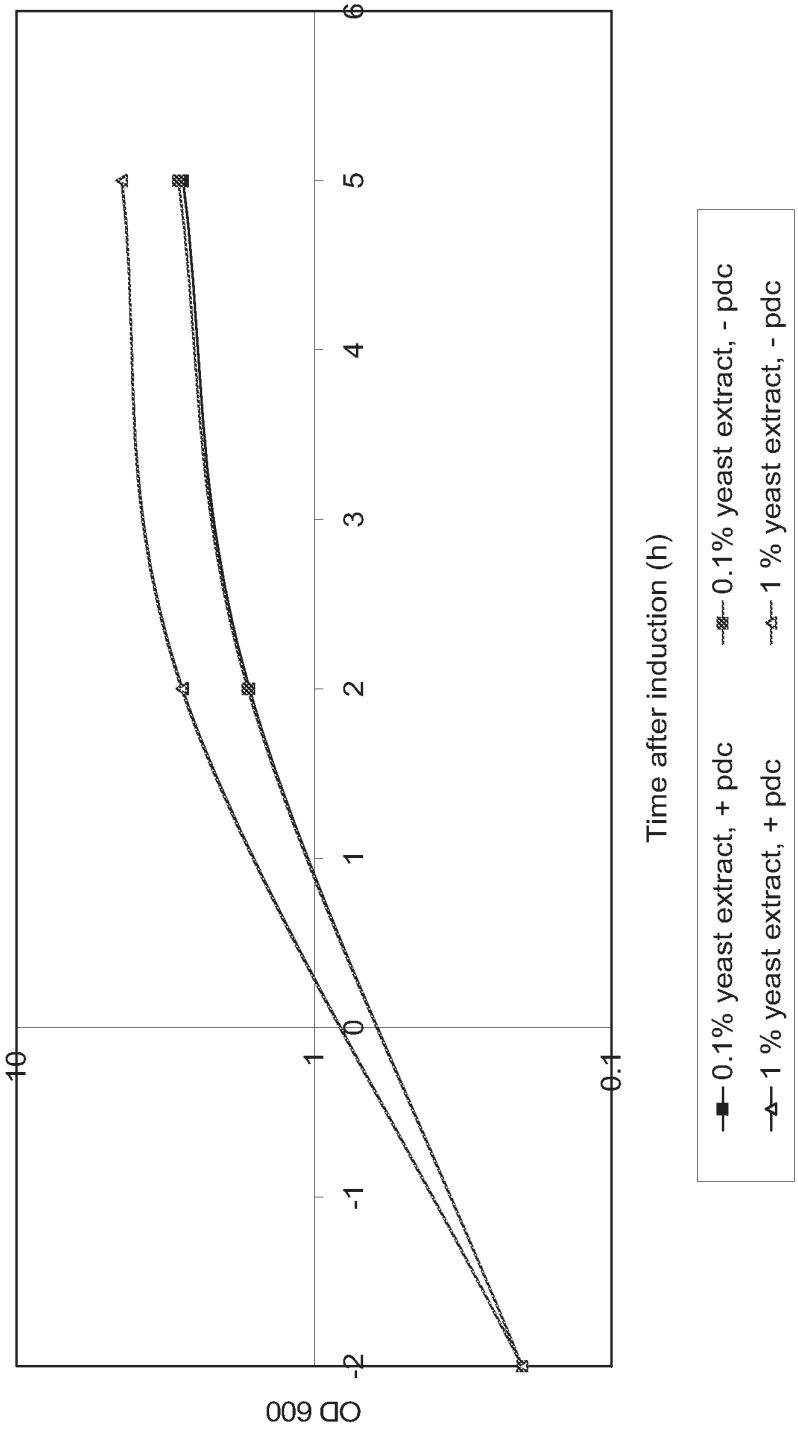
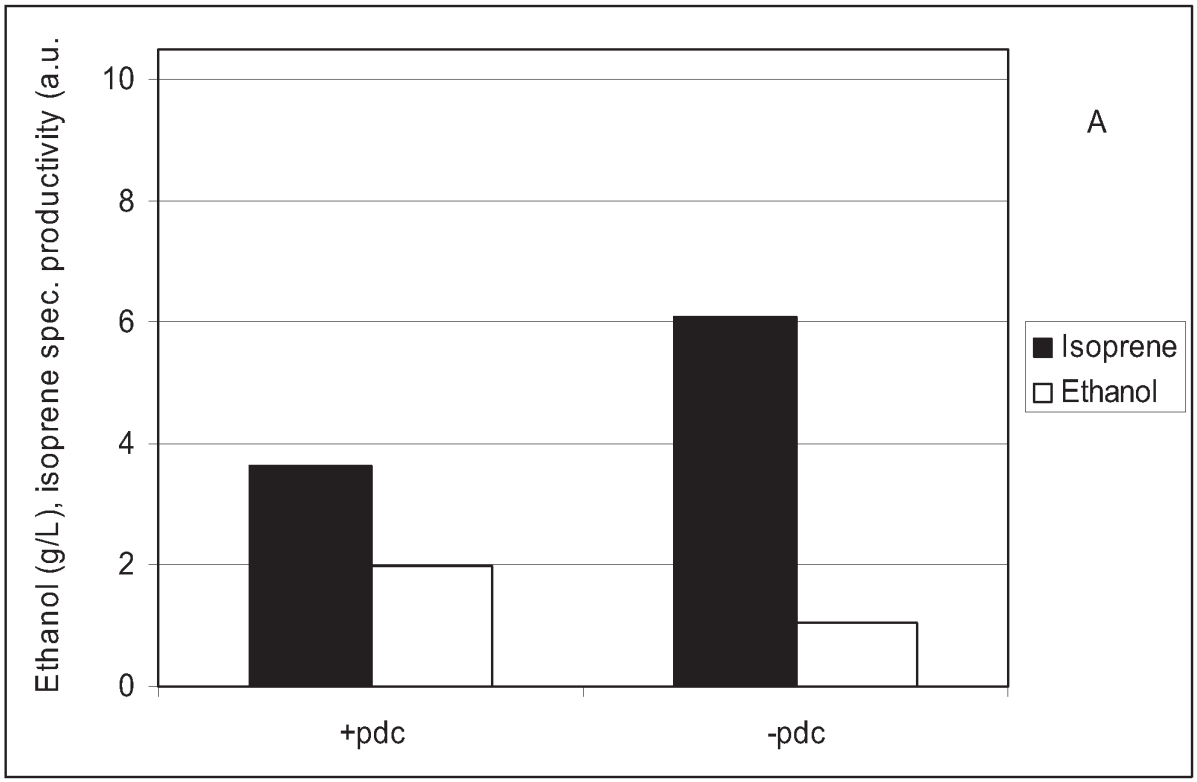

OD 600
10
1
0.1
-2
-1
0
1
2
3
4
5
6
Time after induction (h)
0.1% yeast extract, + pdc
1 % yeast extract, + pdc
0.1% yeast extract, - pdc
1 % yeast extract, - pdc

Figure 175

Figure 176


Ethanol (g/L), isoprene spec. productivity (a.u.
10
8
6
4
2
0
+pdc
-pdc
A
Isoprene
Ethanol

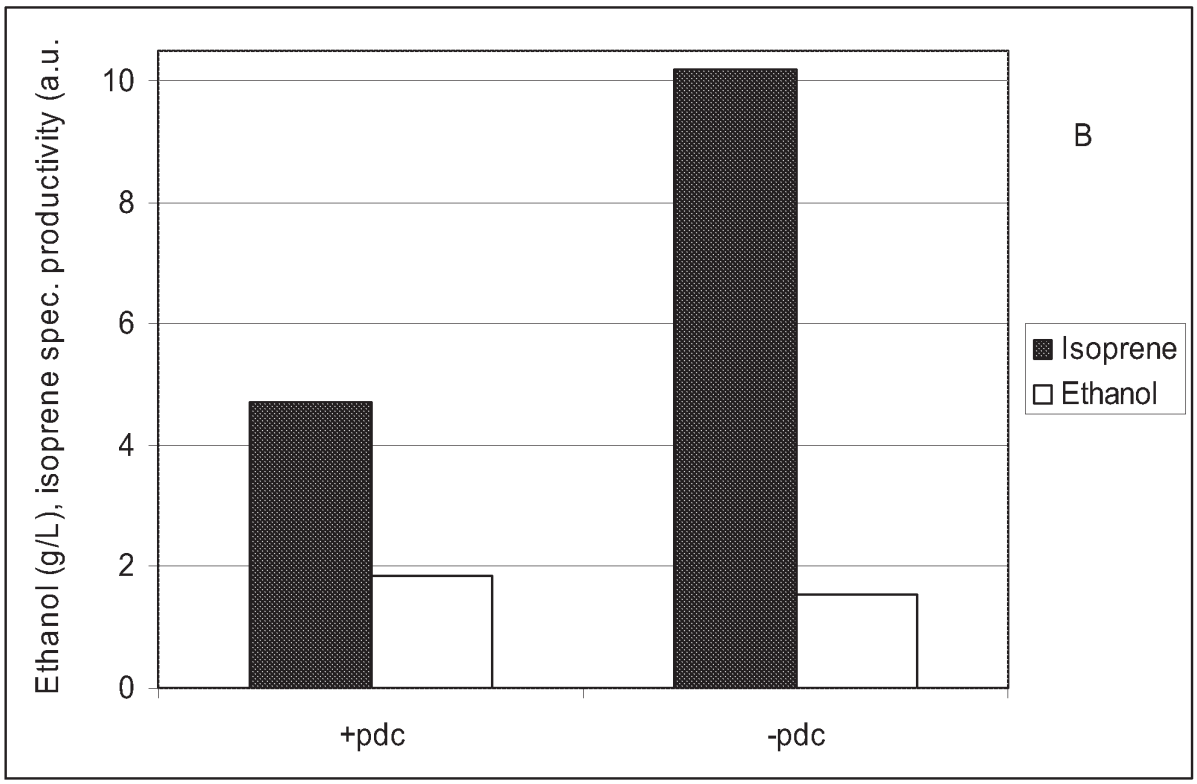

Ethanol (g/L), isoprene spec. productivity (a.u.
10
8
6
4
2
0
+pdc
-pdc
B
Isoprene
Ethanol

Figure 177

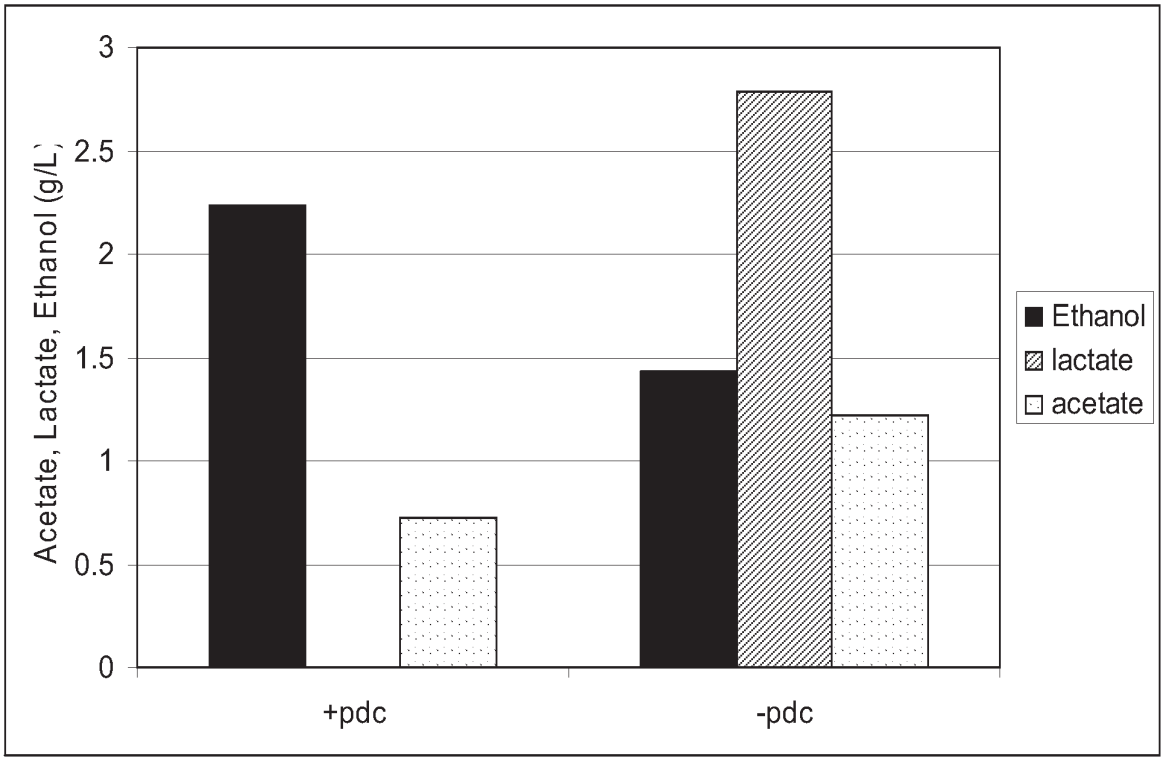

3
2.5
2
1.5
1
0.5
0
Acetate, Lactate, Ethanol (g/L)
+pdc
-pdc
Ethanol
lactate
acetate

Figure 178

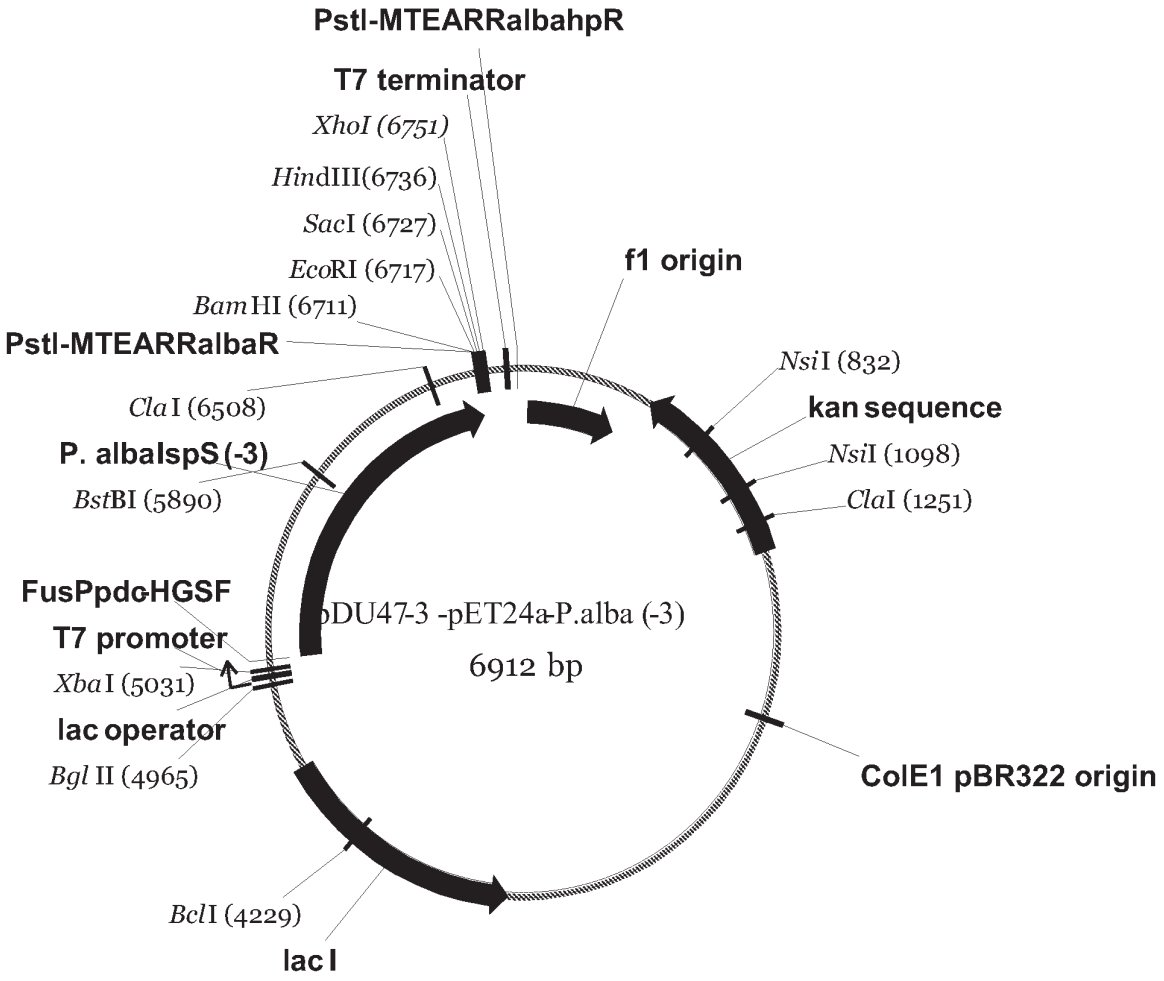

PstI-MTEARRalbahpR
T7 terminator
XhoI (6751)
HindIII(6736)
SacI (6727)
EcoRI (6717)
BamHI (6711)
PstI-MTEARRalbaR
ClaI (6508)
P. albaIspS(-3)
BstBI (5890)
FusPpdo-HGSF
T7 promoter
XbaI (5031)
lac operator
Bgl II (4965)
BclI (4229)
lacI
f1 origin
NsiI (832)
kan sequence
NsiI (1098)
ClaI (1251)
ColE1 pBR322 origin
DU47-3 -pET24a-P.alba (-3)
6912 bp

Figure 179A

tggcgaatgggacgcgccctgtagcggcgcattaagcgcggcgggtgtggtggttacgcgcagcgtgaccgctacacttgc
cagcgccctagcgcccgctcctttcgctttcttcccttcctttctcgccacgttcgccggctttccccgtcaagctctaaatcggg
ggctcccttagggttccgatttagtgctttacggcacctcgaccccaaaaaacttgattagggtgatggttcacgtagtgggcc
atcgccctgatagacggtttttcgccctttgacgttggagtccacgttctttaatagtggactcttgttccaaactggaacaacact
caaccctatctcggtctattcttttgatttataagggattttgccgatttcggcctattggttaaaaaatgagctgatttaacaaaaatt
taacgcgaattttaacaaaatattaacgtttacaatttcaggtggcacttttcggggaaatgtgcgcggaaccccctatttgtttatttt
tctaaatacattcaaatatgtatccgctcatgaattaattcttagaaaaactcatcgagcatcaaatgaaactgcaatttattcatat
caggattatcaataccatatttttgaaaaagccgtttctgtaatgaaggagaaaactcaccgaggcagttccataggatggcaa
gatcctggtatcggtctgcgattccgactcgtccaacatcaatacaacctattaatttcccctcgtcaaaaataaggttatcaagt
gagaaatcaccatgagtgacgactgaatccggtgagaatggcaaaagtttatgcatttctttccagacttgttcaacaggccag
ccattacgctcgtcatcaaaatcactcgcatcaaccaaaccgttattcattcgtgattgcgcctgagcgagacgaaatacgcga
tcgctgttaaaaggacaattacaaacaggaatcgaatgcaaccggcgcaggaacactgccagcgcatcaacaatattttcac
ctgaatcaggatattcttctaatacctggaatgctgttttcccggggatcgcagtggtgagtaaccatgcatcatcaggagtacg
gataaaatgcttgatggtcggaagaggcataaattccgtcagccagtttagtctgaccatctcatctgtaacatcattggcaacg
ctacctttgccatgtttcagaaacaactctggcgcatcgggcttcccatacaatcgatagattgtcgcacctgattgcccgacatt
atcgcgagcccatttatacccatataaatcagcatccatgttggaatttaatcgcggcctagagcaagacgtttcccgttgaatat
ggctcataacacccttgtattactgtttatgtaagcagacagttttattgttcatgaccaaaatcccttaacgtgagttttcgttcca
ctgagcgtcagaccccgtagaaaagatcaaaggatcttcttgagatcctttttttctgcgcgtaatctgctgcttgcaaacaaaaa
aaccaccgctaccagcggtggtttgtttgccggatcaagagctaccaactctttttccgaaggtaactggcttcagcagagcgc
agataccaaatactgtccttctagtgtagccgtagttaggccaccacttcaagaactctgtagcaccgcctacatacctcgctct
gctaatcctgttaccagtggctgctgccagtggcgataagtcgtgtcttaccgggttggactcaagacgatagttaccggataa
ggcgcagcggtcgggctgaacgggggttcgtgcacacagcccagcttggagcgaacgacctacaccgaactgagatac
ctacagcgtgagctatgagaaagcgccacgcttcccgaagggagaaaggcggacaggtatccggtaagcggcagggtcg
gaacaggagagcgcacgagggagcttccagggggaaacgcctggtatctttatagtcctgtcgggtttcgccacctctgactt
gagcgtcgatttttgtgatgctcgtcaggggggcggagcctatggaaaaacgccagcaacgcggcctttttacggttcctggc
cttttgctggccttttgctcacatgttctttcctgcgttatcccctgattctgtggataaccgtattaccgcctttgagtgagctgatac
cgctcgccgcagccgaacgaccgagcgcagcgagtcagtgagcgaggaagcggaagagcgcctgatgcggtattttctcc
ttacgcatctgtgcggtatttcacaccgcatatatggtgcactctcagtacaatctgctctgatgccgcatagttaagccagtata
cactccgctatcgctacgtgactgggtcatggctgcgccccgacacccgccaacacccgctgacgcgccctgacgggcttg
tctgctcccggcatccgcttacagacaagctgtgaccgtctccgggagctgcatgtgtcagaggttttcaccgtcatcaccgaa
acgcgcgaggcagctgcggtaaagctcatcagcgtggtcgtgaagcgattcacagatgtctgcctgttcatccgcgtccagct
cgttgagtttctccagaagcgttaatgtctggcttctgataaagcgggccatgttaagggcggttttttcctgtttggtcactgatgc
ctccgtgtaagggggatttctgttcatgggggtaatgataccgatgaaacgagagaggatgctcacgatacgggttactgatga
tgaacatgcccggttactggaacgttgtgagggtaaacaactggcggtatggatgcggcgggaccagagaaaaatcactca
gggtcaatgccagcgcttcgttaatacagatgtaggtgttccacagggtagccagcagcatcctgcgatgcagatccggaac
ataatggtgcagggcgctgacttccgcgtttccagactttacgaaacacggaaaccgaagaccattcatgttgttgctcaggtc
gcagacgttttgcagcagcagtcgcttcacgttcgctcgcgtatcggtgattcattctgctaaccagtaaggcaaccccgccag
cctagccgggtcctcaacgacaggagcacgatcatgcgcacccgtggggccgccatgccggcgataatggcctgcttctcg
ccgaaacgtttggtggcgggaccagtgacgaaggcttgagcgagggcgtgcaagattccgaataccgcaagcgacaggcc
gatcatcgtcgcgctccagcgaaagcggtcctcgccgaaaatgacccagagcgctgccggcacctgtcctacgagttgcat
gataaagaagacagtcataagtgcggcgacgatagtcatgccccgcgcccaccggaaggagctgactgggttgaaggctct
caagggcatcggtcgagatcccggtgcctaatgagtgagctaacttacattaattgcgttgcgctcactgcccgctttccagtc
gggaaacctgtcgtgccagctgcattaatgaatcggccaacgcgcggggagaggcggtttgcgtattgggcgccagggtgg
ttttttcttttcaccagtgagacgggcaacagctgattgcccttcaccgcctggccct

Figure 179B

Cagagagttgcagcaagcggtccacgctggtttgccccagcaggcgaaaatcctgtttgatggtggttaacggcgggatataac
atgagctgtcttcggtatcgtcgtatcccactaccgagatatccgcaccaacgcgcagcccggactcggtaatggcgcgcattgc
gcccagcgccatctgatcgttggcaaccagcatcgcagtgggaacgatgccctcattcagcatttgcatggtttgttgaaaaccgg
acatggcactccagtcgccttcccgttccgctatcggctgaatttgattgcgagtgagatatttatgccagccagccagacgcaga
cgcgccgagacagaacttaatgggcccgctaacagcgcgatttgctggtgacccaatgcgaccagatgctccacgcccagtcg
cgtaccgtcttcatgggagaaaataatactgttgatgggtgtctggtcagagacatcaagaaataacgccggaacattagtgcagg
cagcttccacagcaatggcatcctggtcatccagcggatagttaatgatcagcccactgacgcgttgcgcgagaagattgtgcac
cgccgctttacaggcttcgacgccgcttcgttctaccatcgacaccaccacgctggcacccagttgatcggcgcgagatttaatcg
ccgcgacaatttgcgacggcgcgtgcagggccagactggaggtggcaacgccaatcagcaacgactgtttgcccgccagttgtt
gtgccacgcggttgggaatgtaattcagctccgccatcgccgcttccacttttcccgcgttttcgcagaaacgtggctggcctggtt
caccacgcgggaaacggtctgataagagacaccggcatactctgcgacatcgtataacgttactggtttcacattcaccaccctga
attgactctcttccgggcgctatcatgccataccgcgaaaggttttgcgccattcgatggtgtccgggatctcgacgctctcccttat
gcgactcctgcattaggaagcagcccagtagtaggttgaggccgttgagcaccgccgccgcaaggaatggtgcatgcaaggag
atggcgcccaacagtcccccggccacggggcctgccaccatacccacgccgaaacaagcgctcatgagcccgaagtggcga
gcccgatcttccccatcggtgatgtcggcgatataggcgccagcaaccgcacctgtggcgccggtgatgccggccacgatgcgt
ccggcgtagaggatcgagatctcgatcccgcgaaattaatacgactcactataggggaattgtgagcggataacaattcccctcta
gaaataattttgtttaactttaagaaggagatatacatatgaccgaagctcgtcgttctgcgaactacgaacctaacagctgggacta
tgattacctgctgtcctccgacacggacgagtccatcgaagtatacaaagacaaagcgaaaaagctggaagccgaagttcgtcg
cgagattaataacgaaaaagcagaatttctgaccctgctggaactgattgacaacgtccagcgcctgggcctgggttaccgtttcg
agtctgatatccgtggtgcgctggatcgcttcgtttcctccggcggcttcgatgcggtaaccaagacttccctgcacggtacggca
ctgtctttccgtctgctgcgtcaacacggttttgaggtttctcaggaagcgttcagcggcttcaaagaccaaaacggcaacttcctg
gagaacctgaaggaagatatcaaagctatcctgagcctgtacgaggccagcttcctggctctggaaggcgaaaacatcctggac
gaggcgaaggttttcgcaatctctcatctgaaagaactgtctgaagaaaagatcggtaaagagctggcagaacaggtgaaccatg
cactggaactgccactgcatcgccgtactcagcgtctggaagcagtatggtctatcgaggcctaccgtaaaaaggaggacgcga
atcaggttctgctggagctggcaattctggattacaacatgatccagtctgtataccagcgtgatctgcgtgaaacgtcccgttggtg
gcgtcgtgtgggtctggcgaccaaactgcactttgctcgtgaccgcctgattgagagcttctactgggccgtgggtgtagcattcg
aaccgcaatactccgactgccgtaactccgtcgcaaaaatgttttctttcgtaaccattatcgacgatatctacgatgtatacggcac
cctggacgaactggagctgtttactgatgcagttgagcgttgggacgtaaacgccatcaacgacctgccggattacatgaaactgt
gctttctggctctgtataacactattaacgaaatcgcctacgacaacctgaaagataaaggtgagaacatcctgccgtatctgacca
aagcctgggctgacctgtgcaacgctttcctgcaagaagccaagtggctgtacaacaaatctactccgacctttgacgactacttc
ggcaacgcatggaaatcctcttctggcccgctgcaactggtgttcgcttacttcgctgtcgtgcagaacattaaaaaggaagagat
cgaaaacctgcaaaaataccatgacaccatctctcgtccttcccatatcttccgtctgtgcaatgacctggctagcgcgtctgcgga
aattgcgcgtggtgaaaccgcaaatagcgtttcttgttacatgcgcactaaaggtatctccgaagaactggctaccgaaagcgtga
tgaatctgatcgatgaaacctggaaaaagatgaacaaggaaaaactgggtggtagcctgttcgcgaaaccgttcgtggaaaccg
cgatcaacctggcacgtcaatctcactgcacttatcataacggcgacgcgcatacctctccggatgagctgacccgcaaacgcgt
tctgtctgtaatcactgaaccgattctgccgtttgaacgctaaggatccgaattcgagctccgtcgacaagcttgcggccgcactcg
agcaccaccaccaccaccactgagatccggctgctaacaaagcccgaaaggaagctgagttggctgctgccaccgctgagca
ataactagcataaccccttggggcctctaaacgggtcttgaggggtttttgctgaaaggaggaactatatccggat

(SEQ ID NO:159)

Figure 180

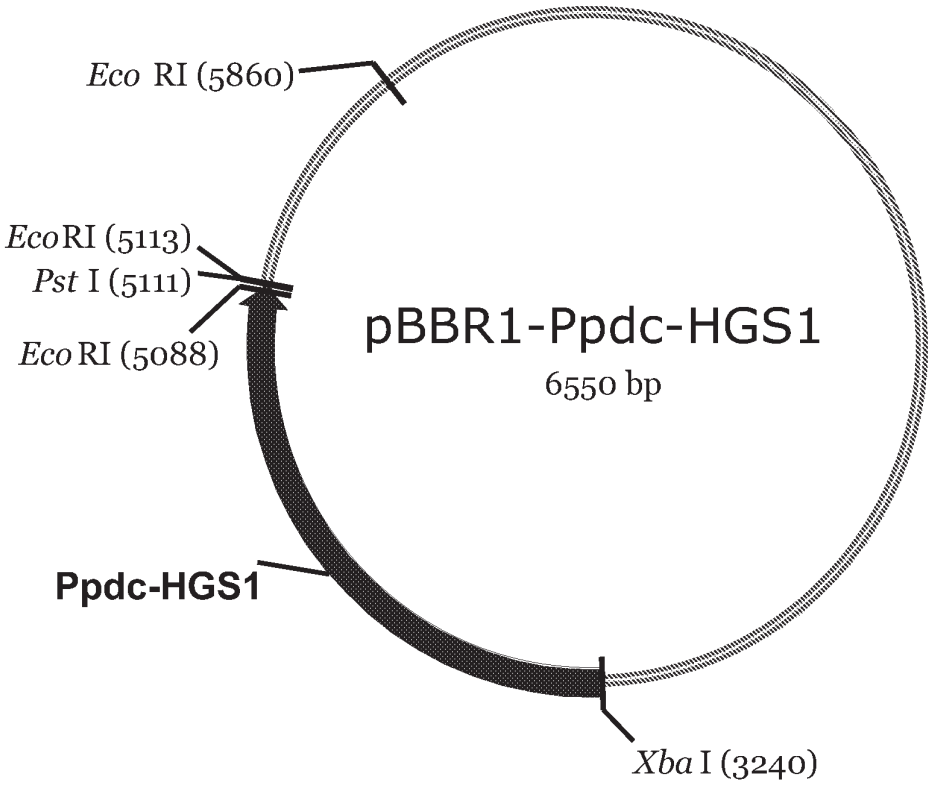

Eco RI (5860)
*Eco*RI (5113)
Pst I (5111)
Eco RI (5088)
pBBR1-Ppdc-HGS1
6550 bp
Ppdc-HGS1
Xba I (3240)

Figure 181A

gccctcgatgccccgttgcagccctagatcggccacagcggccgcaaacgtggtctggtcgcgggtcatctgcgctttgttgc
cgatgaactccttggccgacagcctgccgtcctgcgtcagcggcaccacgaacgcggtcatgtgcgggctggtttcgtcacg
gtggatgctggccgtcacgatgcgatccgccccgtacttgtccgccagccacttgtgcgccttctcgaagaacgccgcctgct
gttcttggctggccgacttccaccattccgggctggccgtcatgacgtactcgaccgccaacacagcgtccttgcgccgcttct
ctggcagcaactcgcgcagtcggcccatcgcttcatcggtgctgctggccgcccagtgctcgttctctggcgtcctgctggcg
tcagcgttgggcgtctcgcgctcgcggtaggcgtgcttgagactggccgccacgttgcccattttcgccagcttcttgcatcgc
atgatcgcgtatgccgccatgcctgcccctccctttggtgtccaaccggctcgacgggggcagcgcaaggcggtgcctccg
gcgggccactcaatgcttgagtatactcactagactttgcttcgcaaagtcgtgaccgcctacggcggctgcggcgccctacg
ggcttgctctccgggcttcgccctgcgcggtcgctgcgctcccttgccagcccgtggatatgtggacgatggccgcgagcgg
ccaccggctggctcgcttcgctcggcccgtggacaaccctgctggacaagctgatggacaggctgcgcctgcccacgagct
tgaccacagggattgcccaccggctacccagccttcgaccacatacccaccggctccaactgcgcggcctgcggccttgcc
ccatcaatttttttaattttctctggggaaaagcctccggcctgcggcctgcgcgcttcgcttgccggttggacaccaagtggaa
ggcgggtcaaggctcgcgcagcgaccgcgcagcggcttggccttgacgcgcctggaacgacccaagcctatgcgagtgg
gggcagtcgaaggcgaagcccgcccgcctgccccccgagcctcacggcggcgagtgcgggggttccaaggggggcagc
gccaccttgggcaaggccgaaggccgcgcagtcgatcaacaagccccggaggggccacttttgccggaggggggagccg
cgccgaaggcgtgggggaaccccgcaggggtgcccttctttgggcaccaaagaactagatatagggcgaaatgcgaaaga
cttaaaaatcaacaacttaaaaaaggggggtacgcaacagctcattgcggcacccccccgcaatagctcattgcgtaggttaaa
gaaaatctgtaattgactgccacttttacgcaacgcataattgttgtcgcgctgccgaaaagttgcagctgattgcgcatggtgc
cgcaaccgtgcggcaccctaccgcatggagataagcatggccacgcagtccagagaaatcggcattcaagccaagaacaa
gcccggtcactgggtgcaaacggaacgcaaagcgcatgaggcgtgggccgggcttattgcgaggaaacccacggcggca
atgctgctgcatcacctcgtggcgcagatgggccaccagaacgccgtggtggtcagccagaagacactttccaagctcatcg
gacgttctttgcggacggtccaatacgcagtcaaggacttggtggccgagcgctggatctccgtcgtgaagctcaacggccc
cggcaccgtgtcggcctacgtggtcaatgaccgcgtggcgtggggccagccccgcgaccagttgcgcctgtcggtgttcag
tgccgccgtggtggttgatcacgacgaccaggacgaatcgctgttggggcatggcgacctgcgccgcatcccgaccctgtat
ccgggcgagcagcaactaccgaccggccccggcgaggagccgcccagccagcccggcattccgggcatggaaccaga
cctgccagccttgaccgaaacggaggaatgggaacggcgcgggcagcagcgcctgccgatgcccgatgagccgtgttttct
ggacgatggcgagccgttggagccgccgacacgggtcacgctgccgcgccggtagcacttgggttgcgcagcaacccgta
agtgcgctgttccagactatcggctgtagccgcctcgccgccctataccttgtctgcctccccgcgttgcgtcgcggtgcatgg
agccgggccacctcgacctgaatggaagccggcggcacctcgctaacggattcaccgtttttatcaggctctgggaggcaga
ataaatgatcatatcgtcaattattacctccacggggagagcctgagcaaactggcctcaggcatttgagaagcacacggtca
cactgcttccggtagtcaataaaccggtaaaccagcaatagacataagcggctatttaacgaccctgccctgaaccgacgac
cgggtcgaatttgctttcgaatttctgccattcatccgcttattatcacttattcaggcgtagcaccaggcgtttaagggcaccaat
aactgccttaaaaaaattacgccccgccctgccactcatcgcagtcggcctattggttaaaaaatgagctgatttaacaaaaatt
taacgcgaattttaacaaaatattaacgcttacaatttccattcgccattcaggctgcgcaactgttgggaagggcgatcggtgc
gggcctcttcgctattacgccagctggcgaaaggggatgtgctgcaaggcgattaagttgggtaacgccagggttttcccag
tcacgacgttgtaaaacgacggccagtgagcgcgcgtaatacgactcactatagggcgaattggagctccaccgcggtggc
ggccgctctagagctcatgatcgcggcatgttctgatatttttcctctaaaaaagataaaaagtcttttcgcttcggcagaagagg
ttcatcatgaacaaaaattcggcatttttaaaaatgcctatagctaaatccggaacgacactttagaggtttctgggtcatcctgat
tcagacatagtgttttgaatatatggagtaagcaatgatgaccgaagctcgtcgttctgcgaactacgaacctaacagctggga
ctatgattacctgctgtcctccgacacggacgagtccatcgaagtatacaaagacaaagcgaaaaagctggaagccgaagtt
cgtcgcgagattaataacgaaaaagcagaatttctgaccctgctggaactgattgacaacgtccagcgcctgggcctgggtta
ccgtttcgagtctgatatccgtggtgcgctggatcgcttcgtttcctccggcggcttcgatgcggtaaccaagacttccctgcac
ggtacggcactgtctttccgtctgctgcgtcaacacggttttgaggtttctcaggaagcgttcag

Figure 181B

cggcttcaaagaccaaaacggcaacttcctggagaacctgaaggaagatatcaaagctatcctgagcctgtacgaggcc
agcttcctggctctggaaggcgaaaacatcctggacgaggcgaaggttttcgcaatctctcatctgaaagaactgtctgaa
gaaaagatcggtaaagagctggcagaacaggtgaaccatgcactggaactgccactgcatcgccgtactcagcgtctgg
aagcagtatggtctatcgaggcctaccgtaaaaaggaggacgcgaatcaggttctgctggagctggcaattctggattaca
acatgatccagtctgtataccagcgtgatctgcgtgaaacgtcccgttggtggcgtcgtgtgggtctggcgaccaaactgc
actttgctcgtgaccgcctgattgagagcttctactgggccgtgggtgtagcattcgaaccgcaatactccgactgccgtaa
ctccgtcgcaaaaatgttttctttcgtaaccattatcgacgatatctacgatgtatacggcaccctggacgaactggagctgtt
tactgatgcagttgagcgttgggacgtaaacgccatcaacgacctgccggattacatgaaactgtgctttctggctctgtata
acactattaacgaaatcgcctacgacaacctgaaagataaaggtgagaacatcctgccgtatctgaccaaagcctgggct
gacctgtgcaacgctttcctgcaagaagccaagtggctgtacaacaaatctactccgacctttgacgactacttcggcaac
gcatggaaatcctcttctggcccgctgcaactggtgttcgcttacttcgctgtcgtgcagaacattaaaaaggaagagatcg
aaaacctgcaaaaataccatgacaccatctctcgtccttcccatatcttccgtctgtgcaatgacctggctagcgcgtctgcg
gaaattgcgcgtggtgaaaccgcaaatagcgtttcttgttacatgcgcactaaaggtatctccgaagaactggctaccgaa
agcgtgatgaatctgatcgatgaaacctggaaaaagatgaacaaggaaaaactgggtggtagcctgttcgcgaaaccgtt
cgtggaaaccgcgatcaacctggcacgtcaatctcactgcacttatcataacggcgacgcgcatacctctccggatgagc
tgacccgcaaacgcgttctgtctgtaatcactgaaccgattctgccgtttgaacgctaaggatccgaattcgagctccgtcg
acctgcaggaattcgatatcaagcttatcgataccgtcgacctcgaggggggggcccggtacccagcttttgttccctttagt
gagggttaattgcgcgcttggcgtaatcatggtcatagctgtttcctgtgtgaaattgttatccgctcacaattccacacaaca
tacgagccggaagcataaagtgtaaagcctggggtgcctaatgagtgagctaactcacattaattgcgttgcgctcactgc
ccgctttccagtcgggaaacctgtcgtgccagctgcattaatgaatcggccaacgcgcggggagaggcggtttgcgtatt
gggcgcatgcataaaaactgttgtaattcattaagcattctgccgacatggaagccatcacaaacggcatgatgaacctga
atcgccagcggcatcagcaccttgtcgccttgcgtataatatttgcccatggtgaaaacgggggcgaagaagttgtccata
ttggccacgtttaaatcaaaactggtgaaactcacccagggattggctgagacgaaaaacatattctcaataaaccctttag
ggaaataggccaggttttcaccgtaacacgccacatcttgcgaatatatgtgtagaaactgccggaaatcgtcgtggtattc
actccagagcgatgaaaacgtttcagtttgctcatggaaaacggtgtaacaagggtgaacactatcccatatcaccagctc
accgtctttcattgccatacggaattccggatgagcattcatcaggcgggcaagaatgtgaataaaggccggataaaactt
gtgcttatttttctttacggtctttaaaaaggccgtaatatccagctgaacggtctggttataggtacattgagcaactgactga
aatgcctcaaaatgttctttacgatgccattgggatatatcaacggtggtatatccagtgatttttttctccattttagcttccttag
ctcctgaaaatctcgataactcaaaaaatacgcccggtagtgatcttatttcattatggtgaaagttggaacctcttacgtgcc
gatcaacgtctcattttcgccaaaagttggcccagggcttcccggtatcaacagggacaccaggatttatttattctgcgaa
gtgatcttccgtcacaggtatttattcgaagacgaaagggcctcgtgatacgcctatttttataggttaatgtcatgataataat
ggtttcttagacgtcaggtggcacttttcggggaaatgtgcgcgcccgcgttcctgctggcgctgggcctgtttctggcgct
ggacttcccgctgttccgtcagcagcttttcgcccacggccttgatgatcgcggcggccttggcctgcatatcccgattcaa
cggccccagggcgtccagaacgggcttcaggcgctcccgaaggtctcgggccgtctcttgggcttgatcggccttcttgc
gcatctcacgcgctcctgcggcggcctgtagggcaggctcataccctgccgaaccgcttttgtcagccggtcggccac
ggcttccggcgtctcaacgcgctttgagattcccagcttttcggccaatccctgcggtgcataggcgcgtggctcgaccgc
ttgcgggctgatggtgacgtggcccactggtggccgctccagggcctcgtagaacgcctgaatgcgcgtgtgacgtgcct
tgct

(SEQ ID NO:160)

Figure 182

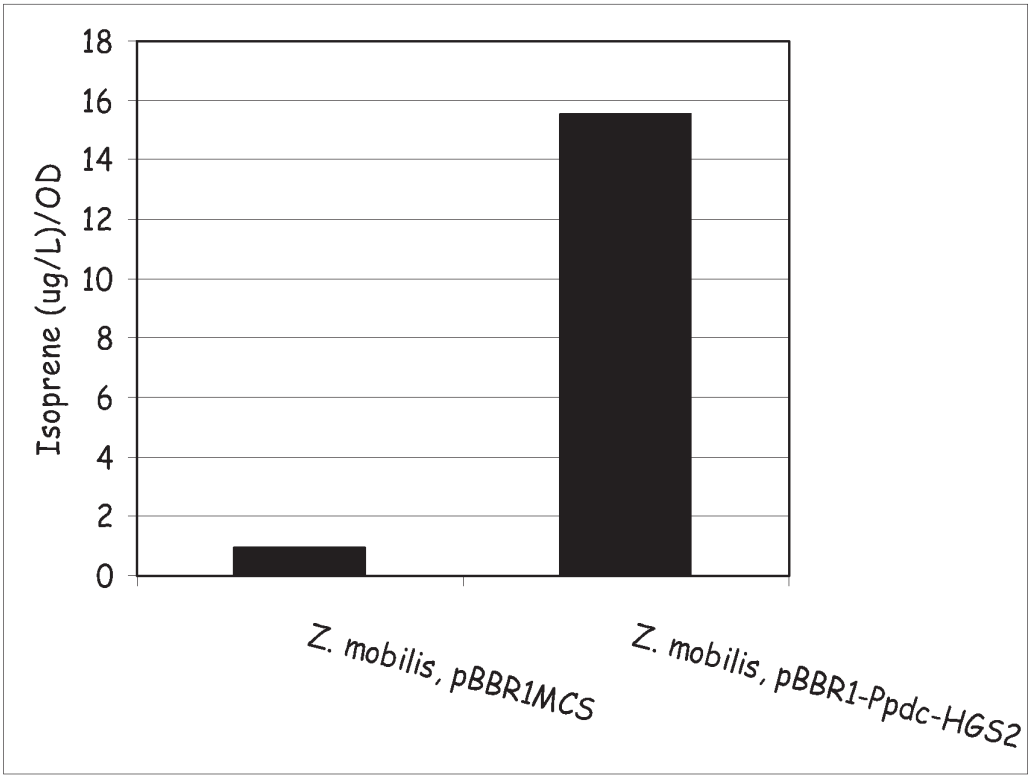

18
16
14
12
10
8
6
4
2
0
Isoprene (ug/L)/OD
Z. mobilis, pBBR1MCS
Z. mobilis, pBBR1-Ppdc-HGS2

Figure 183A

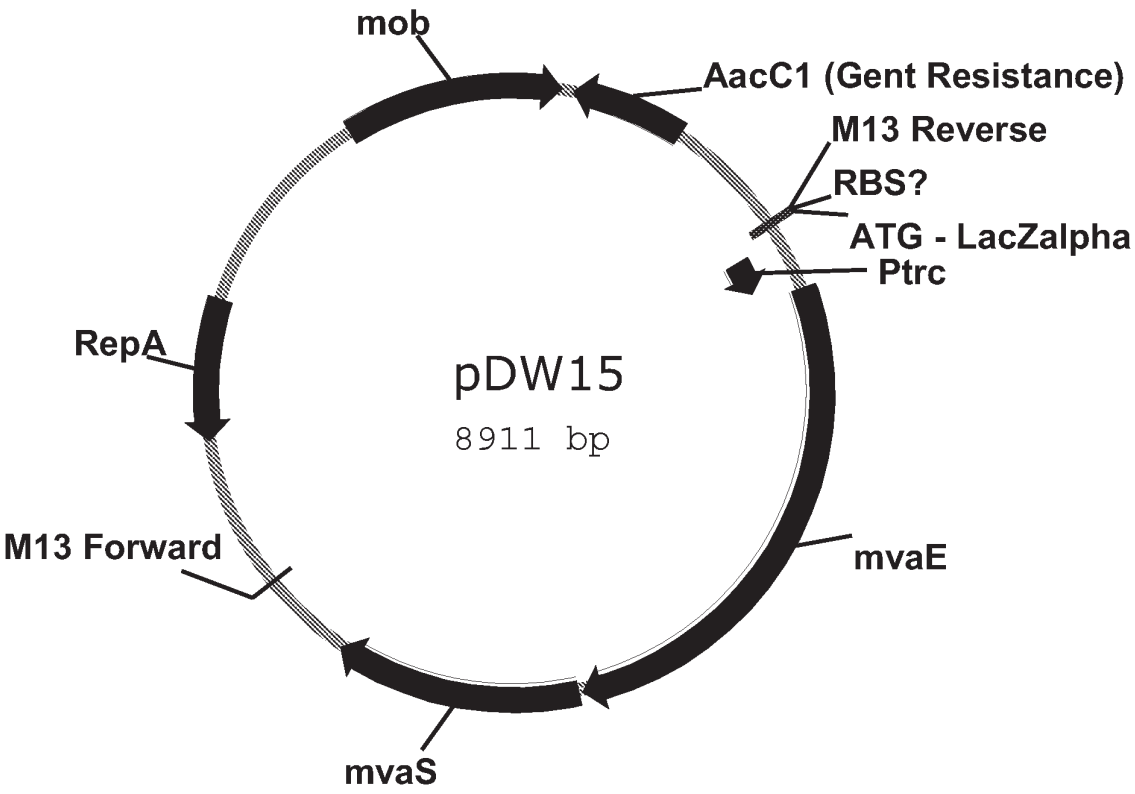

mob
AacC1 (Gent Resistance)
M13 Reverse
RBS?
ATG - LacZalpha
Ptrc
RepA
pDW15
8911 bp
M13 Forward
mvaE
mvaS

Figure 183B

accttcgggagcgcctgaagcccgttctggacgccctggggccgttgaatcgggatatgcaggccaaggccgccgcgat
catcaaggccgtgggcgaaaagctgctgacggaacagcgggaagtccagcgccagaaacaggcccagcgccagcag
gaacgcgggcgcgcacatttccccgaaaagtgccacctggcggcgttgtgacaatttaccgaacaactccgcggccggg
aagccgatctcggcttgaacgaattgttaggtggcggtacttgggtcgatatcaaagtgcatcacttcttcccgtatgcccaa
ctttgtatagagagccactgcgggatcgtcaccgtaatctgcttgcacgtagatcacataagcaccaagcgcgttggcctca
tgcttgaggagattgatgagcgcggtggcaatgccctgcctccggtgctcgccggagactgcgagatcatagatatagatc
tcactacgcggctgctcaaacctgggcagaacgtaagccgcgagagcgccaacaaccgcttcttggtcgaaggcagcaa
gcgcgatgaatgtcttactacggagcaagttcccgaggtaatcggagtccggctgatgttgggagtaggtggctacgtctc
cgaactcacgaccgaaaagatcaagagcagcccgcatggatttgacttggtcagggccgagcctacatgtgcgaatgatg
cccatacttgagccacctaactttgttttagggcgactgccctgctgcgtaacatcgttgctgctgcgtaacatcgttgctgctc
cataacatcaaacatcgacccacggcgtaacgcgcttgctgcttggatgcccgaggcatagactgtacaaaaaaacagtc
ataacaagccatgaaaaccgccactgcgccgttaccaccgctgcgttcggtcaaggttctggaccagttgcgtgagcgcat
acgctacttgcattacagtttacgaaccgaacaggcttatgtcaactgggttcgtgccttcatccgtttccacggtgtgcgtcc
atgggcaaatattatacgcaaggcgacaaggtgctgatgccgctggcgattcaggttcatcatgccgtttgtgatggcttcca
tgtcggcagaatgcttaatgaattacaacagtttttatgcatgcgcccaatacgcaaaccgcctctccccgcgcgttggccga
ttcattaatgcagctggcacgacaggtttcccgactggaaagcgggcagtgagcgcaacgcaattaatgtgagttagctca
ctcattaggcaccccaggctttacactttatgcttccggctcgtatgttgtgtggaattgtgagcggataacaatttcacacagg
aaacagctatgaccatgattacgccaagcgcgcaattaaccctcactaaagggaacaaaagctgggtaccgggccccccc
ctcgagctgttgacaattaatcatccggctcgtataatgtgtggaattgtgagcggataacaatttcacacaggaaacagcgc
cgctgagaaaaagcgaagcggcactgctctttaacaatttatcagacaatctgtgtgggcactcgaccggaattatcgatta
actttattattaaaaattaaagaggtatatattaatgtatcgattaaataaggaggaataaaccatggatccgagctcaggaggt
aaaaaaacatgaaaacagtagttattattgatgcattacgaacaccaattggaaaatataaaggcagcttaagtcaagtaagt
gccgtagacttaggaacacatgttacaacacaacttttaaaaagacattccactatttctgaagaaattgatcaagtaatctttg
gaaatgttttacaagctggaaatggccaaaatcccgcacgacaaatagcaataaacagcggtttgtctcatgaaattcccgc
aatgacggttaatgaggtctgcggatcaggaatgaaggccgttattttggcgaaacaattgattcaattaggagaagcggaa
gttttaattgctggcgggattgagaatatgtcccaagcacctaaattacaacgttttaattacgaaacagaaagctacgatgcg
ccttttctagtatgatgtatgatggattaacggatgcctttagtggtcaggcaatgggcttaactgctgaaaatgtggccgaaa
agtatcatgtaactagagaagagcaagatcaattttctgtacattcacaattaaaagcagctcaagcacaagcagaagggat
attcgctgacgaaatagccccattagaagtatcaggaacgcttgtggagaaagatgaagggattcgccctaattcgagcgtt
gagaagctaggaacgcttaaaacagtttttaaagaagacggtactgtaacagcagggaatgcatcaaccattaatgatggg
gcttctgctttgattattgcttcacaagaatatgccgaagcacacggtcttccttatttagctattattcgagacagtgtggaagt
cggtattgatccagcctatatgggaatttcgccgattaaagccattcaaaaactgttagcgcgcaatcaacttactacggaag
aaattgatctgtatgaaatcaacgaagcatttgcagcaacttcaatcgtggtccaaagagaactggctttaccagaggaaaa
ggtcaacatttatggtggcggtatt

Figure 183C

tcattaggtcatgcgattggtgccacaggtgctcgtttattaacgagtttaagttatcaattaaatcaaaaagaaaagaaatat
ggagtggcttctttatgtatcggcggtggcttaggactcgctatgctactagagagacctcagcaaaaaaaaaacagccg
attttatcaaatgagtcctgaggaacgcctggcttctcttcttaatgaaggccagatttctgctgatacaaaaaaagaatttga
aaatacggctttatcttcgcagattgccaatcatatgattgaaaatcaaatcagtgaaacagaagtgccgatgggcgttggc
ttacatttaacagtggacgaaactgattatttggtaccaatggcgacagaagagccctcagttattgcggctttgagtaatgg
tgcaaaaatagcacaaggatttaaaacagtgaatcaacaacgcttaatgcgtggacaaatcgtttttacgatgttgcagat
cccgagtcattgattgataaactacaagtaagagaagcggaagtttttcaacaagcagagttaagttatccatctatcgttaa
acggggcggcggcttaagagatttgcaatatcgtacttttgatgaatcatttgtatctgtcgacttttagtagatgttaaggat
gcaatgggggcaaatatcgttaacgctatgttggaaggtgtggccgagttgttccgtgaatggtttgcggagcaaaagatt
ttattcagtattttaagtaattatgccacggagtcggttgttacgatgaaaacggctattccagtttcacgtttaagtaagggga
gcaatggccgggaaattgctgaaaaaattgttttagcttcacgctatgcttcattagatccttatcgggcagtcacgcataac
aaaggaatcatgaatggcattgaagctgtagttttagctacaggaaatgatacacgcgctgttagcgcttcttgtcatgctttt
gcggtgaaggaaggtcgctaccaaggcttgactagttggacgctggatggcgaacaactaattggtgaaatttcagttcc
gcttgctttagccacggttggcggtgccacaaaagtcttacctaaatctcaagcagctgctgatttgttagcagtgacggat
gcaaaagaactaagtcgagtagtagcggctgttggtttggcacaaaatttagcggcgttacgggccttagtctctgaagga
attcaaaaaggacacatggctctacaagcacgttctttagcgatgacggtcggagctactggtaaagaagttgaggcagt
cgctcaacaattaaaacgtcaaaaaacgatgaaccaagaccgagccatggctattttaaatgatttaagaaaacaataaag
gaggtaaaaaaacatgacaattgggattgataaaattagtttttttgtgccccccttattatattgatatgacggcactggctga
agccagaaatgtagaccctggaaaatttcatattggtattgggcaagaccaaatggcggtgaacccaatcagccaagata
ttgtgacatttgcagccaatgccgcagaagcgatcttgaccaaagaagataaagaggccattgatatggtgattgtcggg
actgagtccagtatcgatgagtcaaaagcggccgcagttgtcttacatcgtttaatggggattcaacctttcgctcgctctttc
gaaatcaaggaagcttgttacggagcaacagcaggcttacagttagctaagaatcacgtagccttacatccagataaaaa
agtcttggtcgtagcggcagatattgcaaaatatggcttaaattctggcggtgagcctacacaaggagctggggcggttg
caatgttagttgctagtgaaccgcgcattttggctttaaaagaggataatgtgatgctgacgcaagatatctatgacttttggc
gtccaacaggccacccgtatcctatggtcgatggtcctttgtcaaacgaaacctacatccaatcttttgcccaagtctggga
tgaacataaaaaacgaaccggtcttgattttgcagattatgatgctttagcgttccatattccttacacaaaaatgggcaaaa
aagccttattagcaaaaatctccgaccaaactgaagcagaacaggaacgaattttagcccgttatgaagaaagtatcgtct
atagtcgtcgcgtaggaaacttgtatacgggttcactttatctgggactcatttccctttagaaaatgcaacgactttaaccg
caggcaatcaaattggtttattcagttatggttctggtgctgtcgctgaatttttcactggtgaattagtagctggttatcaaaat
catttacaaaaagaaactcatttagcactgctggataatcggacagaactttctatcgctgaatatgaagccatgtttgcaga
aactttagacacagacattgatcaaacgttagaagatgaattaaaatatagtatttctgctattaataataccgttcgttcttatc
gaaactaaagatctgcagctggtaccatatgggaattcgaagcttgggcccgaacaaaaactcatctcagaagaggatct
gaatagcgccgtcgaccatcatcatcatcatcattgagtttaaacggtctccagcttggctgttttggcggatgagagaaga
ttttcagcctgatacagattaaatcagaacgcagaagcggtctgataaaacagaatttgcctggcggcagtagcgcggtg
gtcccacctgaccccatgccgaactcagaagtgaaacgccgtagcgccgatggtagtgtggggtctccccatgcgaga
gtagggaactgccaggcatcaaataaaacgaaaggctcagtcgaaagactgggcctttctagagcggccgccaccgc
ggtggagctccaattcgccctatagtgagtcgtattacgcgcgctcactggccgtcgttttacaacgtcgtgactgggaaa
accctggcgttacccaacttaatcgccttgcagcacatcccccctttcgccagctggcgtaatagcgaagaggcccgcacc
gatcgcccttcccaacagtt

Figure 183D

gcgcagcctgaatggcgaatggaaattgtaagcgttaatattttgttaaaattcgcgttaaatttttgttaaatcagctcatttttttaa
ccaataggccgactgcgatgagtggcagggcggggcgtaatttttttaaggcagttattggtgcccttaaacgcctggtgcta
cgcctgaataagtgataataagcggatgaatggcagaaattcgaaagcaaattcgacccggtcgtcggttcagggcagggt
cgttaaatagccgcttatgtctattgctggtttaccggtttattgactaccggaagcagtgtgaccgtgtgcttctcaaatgcctga
ggccagtttgctcaggctctccccgtggaggtaataattgacgatatgatcatttattctgcctcccagagcctgataaaaacgg
tgaatccgttagcgaggtgccgccggcttccattcaggtcgaggtggcccggctccatgcaccgcgacgcaacgcgggga
ggcagacaaggtatagggcggcgaggcggctacagccgatagtctggaacagcgcacttacgggttgctgcgcaaccca
agtgctaccggcgcggcagcgtgacccgtgtcggcggctccaacggctcgccatcgtccagaaaacacggctcatcggg
catcggcaggcgctgctgcccgcgccgttcccattcctccgtttcggtcaaggctggcaggtctggttccatgcccggaatg
ccgggctggctgggcggctcctcgccggggccggtcggtagttgctgctcgcccggatacagggtcgggatgcggcgca
ggtcgccatgccccaacagcgattcgtcctggtcgtcgtgatcaaccaccacggcggcactgaacaccgacaggcgcaac
tggtcgcggggctggccccacgccacgcggtcattgaccacgtaggccgacacggtgccggggccgttgagcttcacga
cggagatccagcgctcggccaccaagtccttgactgcgtattggaccgtccgcaaagaacgtccgatgagcttggaaagtg
tcttctggctgaccaccacggcgttctggtggcccatctgcgccacgaggtgatgcagcagcattgccgccgtgggtttcctc
gcaataagcccggcccacgcctcatgcgctttgcgttccgtttgcacccagtgaccgggcttgttcttggcttgaatgccgattt
ctctggactgcgtggccatgcttatctccatgcggtagggtgccgcacggttgcggcaccatgcgcaatcagctgcaacttttt
cggcagcgcgacaacaattatgcgttgcgtaaaagtggcagtcaattacagattttctttaacctacgcaatgagctattgcgg
ggggtgccgcaatgagctgttgcgtacccccctttttaagttgttgatttttaagtctttcgcatttcgccctatatctagttctttgg
tgcccaaagaagggcacccctgcggggttcccccacgccttcggcgcggctcccccctccggcaaaaagtggcccctccg
gggcttgttgatcgactgcgcggccttcggccttgcccaaggtggcgctgccccctttggaaccccccgcactcgccgccgtg
aggctcgggggggcaggcgggcgggcttcgccttcgactgcccccactcgcataggcttgggtcgttccaggcgcgtcaag
gccaagccgctgcgcggtcgctgcgcgagccttgacccgccttccacttggtgtccaaccggcaagcgaagcgcgcagg
ccgcaggccggaggcttttccccagagaaaattaaaaaaattgatggggcaaggccgcaggccgcgcagttggagccggt
gggtatgtggtcgaaggctgggtagccggtgggcaatccctgtggtcaagctcgtgggcaggcgcagcctgtccatcagct
tgtccagcagggttgtccacgggccgagcgaagcgagccagccggtggccgctcgcggccatcgtccacatatccacgg
gctggcaagggagcgcagcgaccgcgcagggcgaagcccggagagcaagcccgtagggcgccgcagccgccgtagg
cggtcacgactttgcgaagcaaagtctagtgagtatactcaagcattgagtggcccgccggaggcaccgccttgcgctgcc
cccgtcgagccggttggacaccaaaagggaggggcaggcatggcggcatacgcgatcatgcgatgcaagaagctggcg
aaaatgggcaacgtggcggccagtctcaagcacgcctaccgcgagcgcgagacgcccaacgctgacgccagcaggacg
ccagagaacgagcactgggcggccagcagcaccgatgaagcgatgggccgactgcgcgagttgctgccagagaagcg
gcgcaaggacgctgtgttggcggtcgagtacgtcatgacggccagcccggaatggtggaagtcggccagccaagaacag
caggcggcgttcttcgagaaggcgcacaagtggctggcggacaagtacggggcggatcgcatcgtgacggccagcatcc
accgtgacgaaaccagcccgcacatgaccgcgttcgtggtgccgctgacgcaggacggcaggctgtcggccaaggagtt
catcggcaacaaagcgcagatgacccgcgaccagaccacgtttgcggccgctgtggccgatctagggctgcaacggggc
atcgagggcagcaaggcacgtcacacgcgcattcaggcgttctacgaggccctggagcggccaccagtgggccacgtca
ccatcagcccgcaagcggtcgagccacgcgcctatgcaccgcagggattggccgaaaagctgggaatctcaaagcgcgtt
gagacgccggaagccgtggccgaccggctgacaaaagcggttcggcaggggtatgagcctgccctacaggccgccgca
ggagcgcgtgagatgcgcaagaaggccgatcaagcccaagagacggcccgag

(SEQ ID NO:161)

Figure 184A

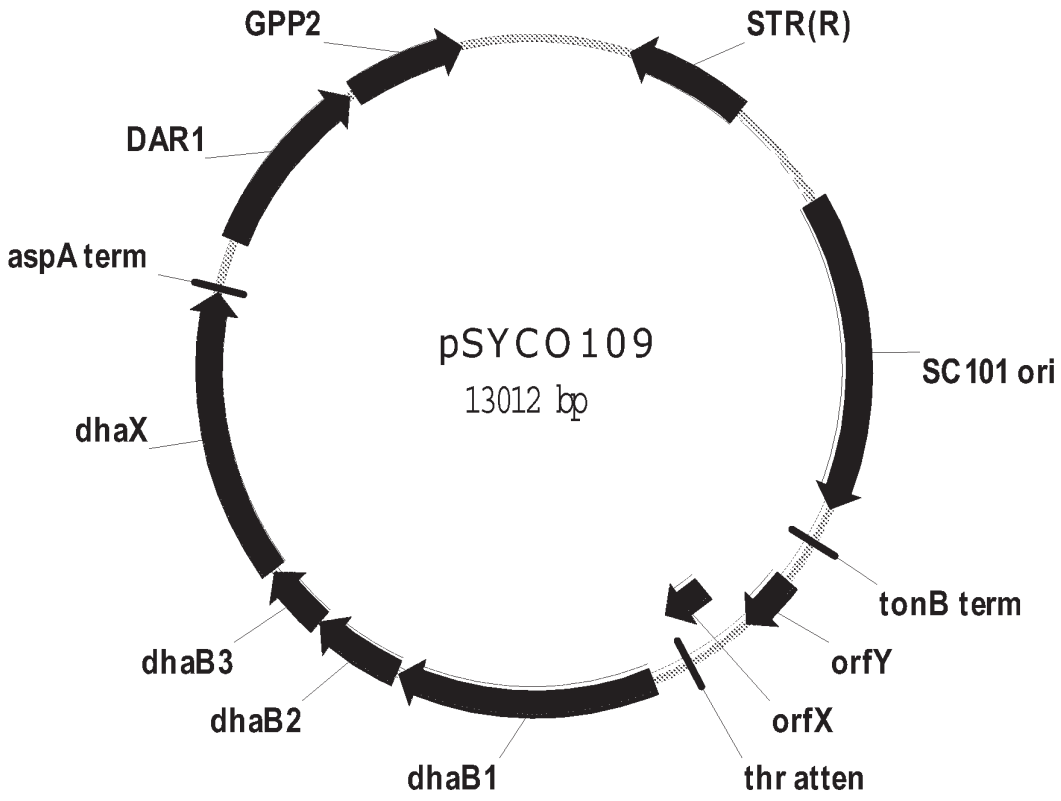

GPP2
STR(R)
DAR1
aspA term
pSYCO109
13012 bp
SC101 ori
dhaX
tonB term
orfY
dhaB3
orfX
dhaB2
thr atten
dhaB1

Figure 184B

ctagagtatacatttaaatggtaccctctagtcaaggccttaagtgagtcgtattacggactggccgtcgttttacaacgtcgt
gactgggaaaaccctggcgttacccaacttaatcgccttgcagcacatccccctttcgccagctggcgtaatagcgaaga
ggcccgcaccgatcgcccttcccaacagttgcgcagcctgaatggcgaatggcgcctgatgcggtattttctccttacgc
atctgtgcggtatttcacaccgcatatggtgcactctcagtacaatctgctctgatgccgcatagttaagccagccccgaca
cccgccaacacccgctgacgagcttagtaaagccctcgctagattttaatgcggatgttgcgattacttcgccaactattgc
gataacaagaaaaagccagcctttcatgatatatctcccaatttgtgtagggcttattatgcacgcttaaaaataataaaagc
agacttgacctgatagtttggctgtgagcaattatgtgcttagtgcatctaacgcttgagttaagccgcgccgcgaagcgg
cgtcggcttgaacgaattgttagacattatttgccgactaccttggtgatctcgcctttcacgtagtggacaaattcttccaact
gatctgcgcgcgaggccaagcgatcttcttcttgtccaagataagcctgtctagcttcaagtatgacgggctgatactggg
ccggcaggcgctccattgcccagtcggcagcgacatccttcggcgcgattttgccggttactgcgctgtaccaaatgcgg
gacaacgtaagcactacatttcgctcatcgccagcccagtcgggcggcgagttccatagcgttaaggtttcatttagcgcc
tcaaatagatcctgttcaggaaccggatcaaagagttcctccgccgctggacctaccaaggcaacgctatgttctcttgctt
ttgtcagcaagatagccagatcaatgtcgatcgtggctggctcgaagatacctgcaagaatgtcattgcgctgccattctcc
aaattgcagttcgcgcttagctggataacgccacggaatgatgtcgtcgtgcacaacaatggtgacttctacagcgcgga
gaatctcgctctctccaggggaagccgaagtttccaaaaggtcgttgatcaaagctcgccgcgttgtttcatcaagccttac
ggtcaccgtaaccagcaaatcaatatcactgtgtggcttcaggccgccatccactgcggagccgtacaaatgtacggcc
agcaacgtcggttcgagatggcgctcgatgacgccaactacctctgatagttgagtcgatacttcggcgatcaccgcttcc
ctcatgatgtttaactttgttttagggcgactgccctgctgcgtaacatcgttgctgctccataacatcaaacatcgacccacg
gcgtaacgcgcttgctgcttggatgcccgaggcatagactgtaccccaaaaaaacagtcataacaagccatgaaaaccg
ccactgcgccgttaccaccgctgcgttcggtcaaggttctggaccagttgcgtgagcgcatacgctacttgcattacagct
tacgaaccgaacaggcttatgtccactgggttcgtgccttcatccgtttccacggtgtgcgtcacccggcaaccttgggca
gcagcgaagtcgaggcatttctgtcctggctggcgaacgagcgcaaggtttcggtctccacgcatcgtcaggcattggc
ggccttgctgttcttctacggcaaggtgctgtgcacggatctgccctggcttcaggagatcggaagacctcggccgtcgc
ggcgcttgccggtggtgctgaccccggatgaagtggttcgcatcctcggttttctggaaggcgagcatcgtttgttcgccc
agcttctgtatggaacgggcatgcggatcagtgagggtttgcaactgcgggtcaaggatctggatttcgatcacggcacg
atcatcgtgcgggagggcaagggctccaaggatcgggccttgatgttacccgagagcttggcacccagcctgcgcgag
caggggaattaattcccacgggttttgctgcccgcaaacgggctgttctggtgttgctagtttgttatcagaatcgcagatcc
ggcttcagccggtttgccggctgaaagcgctatttcttccagaattgccatgatttttttccccacgggaggcgtcactggct
cccgtgttgtcggcagctttgattcgataagcagcatcgcctgtttcaggctgtctatgtgtgactgttgagctgtaacaagtt
gtctcaggtgttcaatttcatgttctagttgctttgttttactggtttcacctgttctattaggtgttacatgctgttcatctgttacat
tgtcgatctgttcatggtgaacagctttgaatgcaccaaaaactcgtaaaagctctgatgtatctatctttttttacaccgttttca
tctgtgcatatggacagttttcccttgatatgtaacggtgaacagttgttctacttttgtttgttagtcttgatgcttcactgatag
atacaagagccataagaacctcagatccttccgtatttagccagtatgttctctagtgtggttcgttgtttttgcgtgagccatg
agaacgaaccattgagatcatacttactttgcatgtcactcaaaaattttgcctcaaaactggtgagctg

Figure 184C

aatttttgcagttaaagcatcgtgtagtgtttttcttagtccgttatgtaggtaggaatctgatgtaatggttgttggtattttgtcaccat
tcatttttatctggttgttctcaagttcggttacgagatccatttgtctatctagttcaacttggaaaatcaacgtatcagtcgggcgg
cctcgcttatcaaccaccaatttcatattgctgtaagtgtttaaatctttacttattggtttcaaaacccattggttaagccttttaaactc
atggtagttatttttcaagcattaacatgaacttaaattcatcaaggctaatctctatatttgccttgtgagttttcttttgtgttagttctttt
aataaccactcataaatcctcatagagtatttgttttcaaaagacttaacatgttccagattatattttatgaatttttttaactggaaaa
gataaggcaatatctcttcactaaaaactaattctaatttttcgcttgagaacttggcatagtttgtccactggaaaatctcaaagcct
ttaaccaaaggattcctgatttccacagttctcgtcatcagctctctggttgctttagctaatacaccataagcattttccctactgat
gttcatcatctgagcgtattggttataagtgaacgataccgtccgttctttccttgtagggttttcaatcgtggggttgagtagtgcca
cacagcataaaattagcttggtttcatgctccgttaagtcatagcgactaatcgctagttcatttgctttgaaaacaactaattcaga
catacatctcaattggtctaggtgattttaatcactataccaattgagatgggctagtcaatgataattactagtccttttcctttgagtt
gtgggtatctgtaaattctgctagacctttgctggaaaacttgtaaattctgctagaccctctgtaaattccgctagacctttgtgtgt
ttttttgtttatattcaagtggttataatttatagaataaagaaagaataaaaaaagataaaaagaatagatcccagccctgtgtata
actcactactttagtcagttccgcagtattacaaaaggatgtcgcaaacgctgtttgctcctctacaaaacagaccttaaaacccta
aaggcttaagtagcaccctcgcaagctcgggcaaatcgctgaatattccttttgtctccgaccatcaggcacctgagtcgctgtc
tttttcgtgacattcagttcgctgcgctcacggctctggcagtgaatgggggtaaatggcactacaggcgccttttatggattcatg
caaggaaactacccataatacaagaaaagcccgtcacgggcttctcagggcgttttatggcgggtctgctatgtggtgctatctg
actttttgctgttcagcagttcctgccctctgattttccagtctgaccacttcggattatcccgtgacaggtcattcagactggctaat
gcacccagtaaggcagcggtatcatcaacaggcttacccgtcttactgtcgggaattcatttaaatagtcaaaagcctccgacc
ggaggcttttgactgctaggcgatctgtgctgtttgccacggtatgcagcaccagcgcgagattatgggctcgcacgctcgact
gtcggacgggggcactggaacgagaagtcaggcgagccgtcacgcccttgacaatgccacatcctgagcaaataattcaac
cactaaacaaatcaaccgcgtttcccggaggtaaccaagcttgcgggagagaatgatgaacaagagccaacaagttcagaca
atcaccctggccgccgcccagcaaatggcggcggcggtggaaaaaaaagccactgagatcaacgtggcggtggtgttttcc
gtagttgaccgcggaggcaacacgctgcttatccagcggatggacgaggccttcgtctccagctgcgatatttccctgaataaa
gcctggagcgcctgcagcctgaagcaaggtacccatgaaattacgtcagcggtccagccaggacaatctctgtacggtctgc
agctaaccaaccaacagcgaattattatttttggcggcggcctgccagttatttttaatgagcaggtaattggcgccgtcggcgtt
agcggcggtacggtcgagcaggatcaattattagcccagtgcgccctggattgtttttccgcattataacctgaagcgagaagg
tatattatgagctatcgtatgttccgccaggcattctgagtgttaacgaggggaccgtcatgtcgctttcaccgccaggcgtacgc
ctgttttacgatccgcgcgggcaccatgccggcgccatcaatgagctgtgctgggggctggaggagcaggggtcccctgc
cagaccataacctatgacggaggcggtgacgccgctgcgctgggcgccctggcggccagaagctcgcccctgcgggtggg
tatcgggctcagcgcgtccggcgagatagccctcactcatgcccagctgccggcggacgcgccgctggctaccggacacgt
caccgatagcgacgatcaactgcgtacgctcggcgccaacgccgggcagctggttaaagtcctgccgttaagtgagagaaa
ctgaactggcctagcaaacacagaaaaaagcccgcacctgacagtgcgggctttttttttcctaggcgatctgtgctgtttgcca
cggtatgcagcaccagcgcgagattatgggctcgcacgctcgactgtcggacgggggcactggaacgagaagtcaggcga
gccgtcacgcccttgacaatgccacatcctgagcaaataattcaaccactaaacaaatcaaccgcgtttcccggaggtaacca
agcttcacctttgagccgatgaacaatgaaaagatcaaaacgatttgcagtactggcccagcgccccgtcaatcaggacggg
ctgattggcgagtggcctgaagaggggctgatcgccatg

Figure 184D

gacagccccttgacccggtctcttcagtaaaagtggacaacggtctgatcgtcgaactggacggcaaacgccgggacc
agtttgacatgatcgaccgatttatcgccgattacgcgatcaacgttgagcgcacagagcaggcaatgcgcctggaggc
ggtggaaatagcccgtatgctggtggatattcacgtcagccgggaggagatcattgccatcactaccgccatcacgccg
gccaaagcggtcgaggtgatggcgcagatgaacgtggtggagatgatgatggcgctgcagaagatgcgtgcccgccg
gacccccctccaaccagtgccacgtcaccaatctcaaagataatccggtgcagattgccgctgacgccgccgaggccgg
gatccgcggcttctcagaacaggagaccacggtcggtatcgcgcgctacgcgccgtttaacgccctggcgctgttggtc
ggttcgcagtgcggccgccccggcgtgttgacgcagtgctcggtggaagaggccaccgagctggagctgggcatgcg
tggcttaaccagctacgccgagacggtgtcggtctacggcaccgaagcggtatttaccgacggcgatgatacgccgtgg
tcaaaggcgttcctcgcctcggcctacgcctcccgcgggttgaaaatgcgctacacctccggcaccggatccgaagcg
ctgatgggctattcggagagcaagtcgatgctctacctcgaatcgcgctgcatcttcattactaaaggcgccggggttcag
ggactgcaaaacggcgcggtgagctgtatcggcatgaccggcgctgtgccgtcgggcattcgggcggtgctggcgga
aaacctgatcgcctctatgctcgacctcgaagtggcgtccgccaacgaccagactttctcccactcggatattcgccgcac
cgcgcgcaccctgatgcagatgctgccgggcaccgactttattttctccggctacagcgcggtgccgaactacgacaac
atgttcgccggctcgaacttcgatgcggaagattttgatgattacaacatcctgcagcgtgacctgatggttgacggcggc
ctgcgtccggtgaccgaggcggaaaccattgccattcgccagaaagcggcgcgggcgatccaggcggttttccgcga
gctggggctgccgccaatcgccgacgaggaggtggaggccgccacctacgcgcacggcagcaacgagatgccgcc
gcgtaacgtggtggaggatctgagtgcggtggaagagatgatgaagcgcaacatcaccggcctcgatattgtcggcgc
gctgagccgcagcggctttgaggatatcgccagcaatattctcaatatgctgcgccagcgggtcaccggcgattacctgc
agacctcggccattctcgatcggcagttcgaggtggtgagtgcggtcaacgacatcaatgactatcaggggccgggcac
cggctatcgcatctctgccgaacgctgggcggagatcaaaaatattccgggcgtggttcagcccgacaccattgaataa
ggcggtattcctgtgcaacagacaacccaaattcagccctcttttaccctgaaaacccgcgagggcggggtagcttctgc
cgatgaacgcgccgatgaagtggtgatcggcgtcggccctgccttcgataaacaccagcatcacactctgatcgatatgc
cccatggcgcgatcctcaaagagctgattgccggggtggaagaagaggggcttcacgcccgggtggtgcgcattctgc
gcacgtccgacgtctcctttatggcctgggatgcggccaacctgagcggctcggggatcggcatcggtatccagtcgaa
ggggaccacggtcatccatcagcgcgatctgctgccgctcagcaacctggagctgttctcccaggcgccgctgctgac
gctggagacctaccggcagattggcaaaaacgctgcgcgctatgcgcgcaaagagtcaccttcgccggtgccggtggt
gaacgatcagatggtgcggccgaaatttatggccaaagccgcgctatttcatatcaaagagaccaaacatgtggtgcag
gacgccgagcccgtcaccctgcacatcgacttagtaagggagtgaccatgagcgagaaaaccatgcgcgtgcaggatt
atccgttagccacccgctgcccggagcatatcctgacgcctaccggcaaaccattgaccgatattaccctcgagaaggtg
ctctctggcgaggtgggcccgcaggatgtgcggatctcccgccagacccttgagtaccaggcgcagattgccgagcag
atgcagcgccatgcggtggcgcgcaatttccgccgcgcggcggagcttatcgccattcctgacgagcgcattctggcta
tctataacgcgctgcgcccgttccgctcctcgcaggcggagctgctggcgatcgccgacgagctggagcacacctggc
atgcgacagtgaatgccgcctttgtccgggagtcggcggaagtgtatcagcagcggcataagctgcgtaaaggaagcta
agcggaggtcagcatgccgttaatagccgggattgatatcggcaacgccaccaccgaggtggcgctggcgtccgacta
cccgcaggcgagggcgtttgttgccagcgggatcgtcgcgacgacgggcatgaaagggacgcgggac

Figure 184E

aatatcgccgggaccctcgccgcgctggagcaggccctggcgaaaacaccgtggtcgatgagcgatgtctctcgcat
ctatcttaacgaagccgcgccggtgattggcgatgtggcgatggagaccatcaccgagaccattatcaccgaatcgac
catgatcggtcataacccgcagacgccgggcggggtgggcgttggcgtggggacgactatcgccctcgggcggctg
gcgacgctgccggcggcgcagtatgccgaggggtggatcgtactgattgacgacgccgtcgatttccttgacgccgtg
tggtggctcaatgaggcgctcgaccgggggatcaacgtggtggcggcgatcctcaaaaaggacgacggcgtgctgg
tgaacaaccgcctgcgtaaaaccctgccggtggtggatgaagtgacgctgctggagcaggtccccgaggggtaatg
gcggcggtggaagtggccgcgccgggccaggtggtgcggatcctgtcgaatccctacgggatcgccaccttcttcgg
gctaagcccggaagagacccaggccatcgtccccatcgcccgcgccctgattggcaaccgttccgcggtggtgctca
agaccccgcaggggatgtgcagtcgcgggtgatcccggcgggcaacctctacattagcggcgaaaagcgccgcg
gagaggccgatgtcgccgagggcgcggaagccatcatgcaggcgatgagcgcctgcgctccggtacgcgacatcc
gcggcgaaccgggcacccacgccggcggcatgcttgagcgggtgcgcaaggtaatggcgtccctgaccggccatg
agatgagcgcgatatacatccaggatctgctggcggtggatacgtttattccgcgcaaggtgcagggcgggatggccg
gcgagtgcgccatggagaatgccgtcgggatggcggcgatggtgaaagcggatcgtctgcaaatgcaggttatcgcc
cgcgaactgagcgcccgactgcagaccgaggtggtggtgggcggcgtggaggccaacatggccatcgccggggc
gttaaccactcccggctgtgcggcgccgctggcgatcctcgacctcggcgccggctcgacggatgcggcgatcgtca
acgcggaggggcagataacggcggtccatctcgccggggcggggaatatggtcagcctgttgattaaaaccgagct
gggcctcgaggatctttcgctggcggaagcgataaaaaaatacccgctggccaaagtggaaagcctgttcagtattcgt
cacgagaatggcgcggtggagttctttcgggaagccctcagcccggcggtgttcgccaaagtggtgtacatcaagga
gggcgaactggtgccgatcgataacgccagcccgctggaaaaaattcgtctcgtgcgccggcaggcgaaagagaaa
gtgtttgtcaccaactgcctgcgcgcgctgcgccaggtctcacccggcggttccattcgcgatatcgcctttgtggtgct
ggtgggcggctcatcgctggactttgagatcccgcagcttatcacggaagccttgtcgcactatggcgtggtcgccgg
gcagggcaatattcggggaacagaagggccgcgcaatgcggtcgccaccgggctgctactggccggtcaggcgaa
ttaaacgggcgctcgcgccagcctctaggtacaaataaaaaaggcacgtcagatgacgtgccttttttcttgtctagcgt
gcaccaatgcttctggcgtcaggcagccatcggaagctgtggtatggctgtgcaggtcgtaaatcactgcataattcgtg
tcgctcaaggcgcactcccgttctggataatgtttttgcgccgacatcataacggttctggcaaatattctgaaatgagct
gttgacaattaatcatccggctcgtataatgtgtggaattgtgagcggataacaatttcacacaggaaacagaccatgact
agtaaggaggacaattccatggctgctgctgctgatagattaaacttaacttccggccacttgaatgctggtagaaagag
aagttcctcttctgtttctttgaaggctgccgaaaagcctttcaaggttactgtgattggatctggtaactggggtactactat
tgccaaggtggttgccgaaaattgtaagggatacccagaagttttcgctccaatagtacaaatgtgggtgttcgaagaag
agatcaatggtgaaaaattgactgaaatcataaatactagacatcaaaacgtgaaatacttgcctggcatcactctacccg
acaatttggttgctaatccagacttgattgattcagtcaaggatgtcgacatcatcgttttcaacattccacatcaatttttgcc
ccgtatctgtagccaattgaaaggtcatgttgattcacacgtcagagctatctcctgtctaaagggttttgaagttggtgcta
aaggtgtccaattgctatcctcttacatcactgaggaactaggtattcaatgtggtgctctatctggtgctaacattgccacc
gaagtcgctcaagaacactggtctgaaacaacagttgcttaccacattccaaaggatttcagaggcgagggcaaggac
gtcgaccataaggttctaaagg

Figure 184F

ccttgttccacagaccttacttccacgttagtgtcatcgaagatgttgctggtatctccatctgtggtgctttgaagaacgttgt
tgccttaggttgtggtttcgtcgaaggtctaggctggggtaacaacgcttctgctgccatccaaagagtcggtttgggtgag
atcatcagattcggtcaaatgtttttcccagaatctagagaagaaacatactaccaagagtctgctggtgttgctgatttgatc
accacctgcgctggtggtagaaacgtcaaggttgctaggctaatggctacttctggtaaggacgcctgggaatgtgaaaa
ggagttgttgaatggccaatccgctcaaggtttaattacctgcaaagaagttcacgaatggttggaaacatgtggctctgtc
gaagacttcccattatttgaagccgtataccaaatcgtttacaacaactacccaatgaagaacctgccggacatgattgaag
aattagatctacatgaagattagatttattggatccaggaaacagactagaattatgggattgactactaaacctctatctttg
aaagttaacgccgctttgttcgacgtcgacggtaccattatcatctctcaaccagccattgctgcattctggagggatttcgg
taaggacaaaccttatttcgatgctgaacacgttatccaagtctcgcatggttggagaacgtttgatgccattgctaagttcg
ctccagactttgccaatgaagagtatgttaacaaattagaagctgaaattccggtcaagtacggtgaaaaatccattgaagt
cccaggtgcagttaagctgtgcaacgctttgaacgctctaccaaaagagaaatgggctgtggcaacttccggtacccgtg
atatggcacaaaaatggttcgagcatctgggaatcaggagaccaaagtacttcattaccgctaatgatgtcaaacagggta
agcctcatccagaaccatatctgaagggcaggaatggcttaggatatccgatcaatgagcaagacccttccaaatctaag
gtagtagtatttgaagacgctccagcaggtattgccgccggaaaagccgccggttgtaagatcattggtattgccactactt
tcgacttggacttcctaaaggaaaaaggctgtgacatcattgtcaaaaaccacgaatccatcagagttggcggctacaatg
ccgaaacagacgaagttgaattcatttttgacgactacttatatgctaaggacgatctgttgaaatggtaacccgggctgca
ggcatgcaagcttggctgttttggcggatgagagaagattttcagcctgatacagattaaatcagaacgcagaagcggtct
gataaaacagaatttgcctggcggcagtagcgcggtggtcccacctgaccccatgccgaactcagaagtgaaacgccg
tagcgccgatggtagtgtggggtctccccatgcgagagtagggaactgccaggcatcaaataaaacgaaaggctcagt
cgaaagactgggcctttcgttttatctgttgtttgtcggtgaacgctctcctgagtaggacaaatccgccgggagcggattt
gaacgttgcgaagcaacggcccggagggtggcgggcaggacgcccgccataaactgccaggcatcaaattaagcag
aaggccatcctgacggatggccttttgcgtttctacaaactccagctggatcgggcg

(SEQ ID NO:162)

Figure 185A

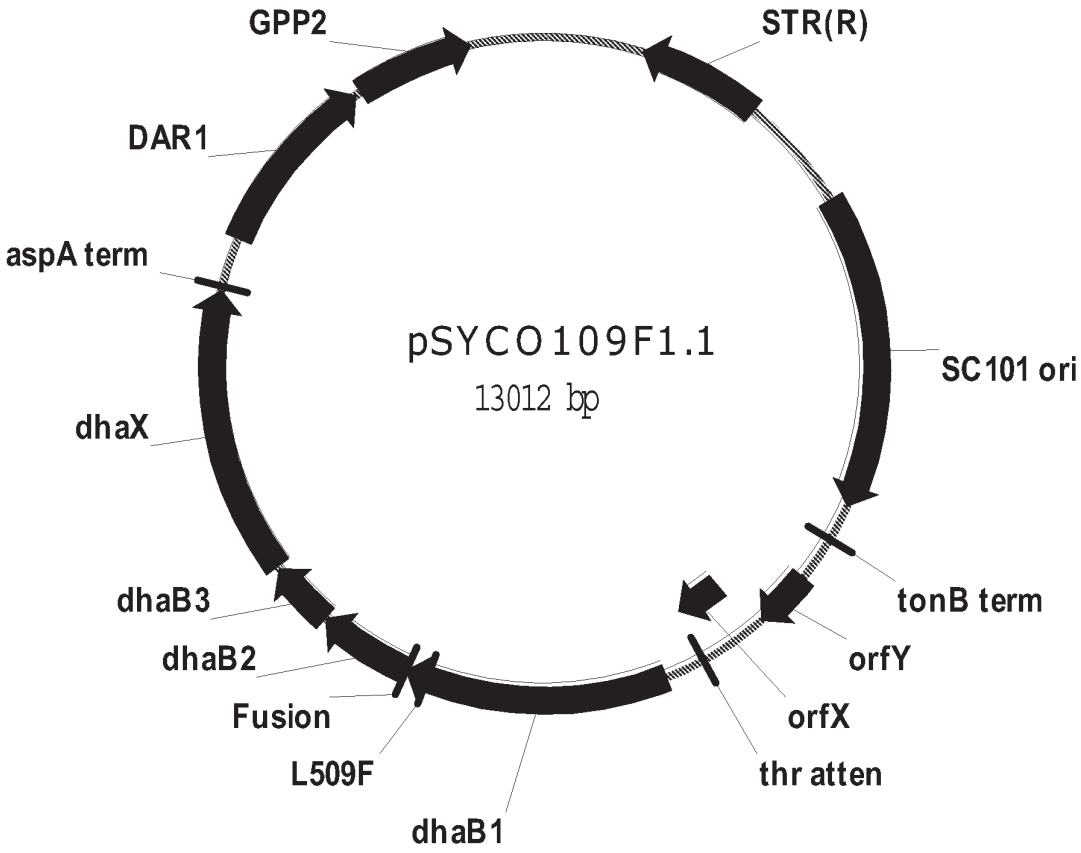

GPP2
STR(R)
DAR1
aspA term
pSYCO109F1.1
13012 bp
SC101 ori
dhaX
tonB term
dhaB3
orfY
dhaB2
orfX
Fusion
thr atten
L509F
dhaB1

Figure 185B

ctagagtatacatttaaatggtaccctctagtcaaggccttaagtgagtcgtattacggactggccgtcgttttacaacgt
cgtgactgggaaaaccctggcgttacccaacttaatcgccttgcagcacatccccctttcgccagctggcgtaatagc
gaagaggcccgcaccgatcgcccttcccaacagttgcgcagcctgaatggcgaatggcgcctgatgcggtattttct
ccttacgcatctgtgcggtatttcacaccgcatatggtgcactctcagtacaatctgctctgatgccgcatagttaagcca
gccccgacacccgccaacacccgctgacgagcttagtaaagccctcgctagattttaatgcggatgttgcgattacttc
gccaactattgcgataacaagaaaaagccagcctttcatgatatatctcccaatttgtgtagggcttattatgcacgctta
aaaataataaaagcagacttgacctgatagtttggctgtgagcaattatgtgcttagtgcatctaacgcttgagttaagcc
gcgccgcgaagcggcgtcggcttgaacgaattgttagacattatttgccgactaccttggtgatctcgcctttcacgta
gtggacaaattcttccaactgatctgcgcgcgaggccaagcgatcttcttcttgtccaagataagcctgtctagcttcaa
gtatgacgggctgatactgggccggcaggcgctccattgcccagtcggcagcgacatccttcggcgcgattttgccg
gttactgcgctgtaccaaatgcgggacaacgtaagcactacatttcgctcatcgccagcccagtcgggcggcgagtt
ccatagcgttaaggtttcatttagcgcctcaaatagatcctgttcaggaaccggatcaaagagttcctccgccgctgga
cctaccaaggcaacgctatgttctcttgcttttgtcagcaagatagccagatcaatgtcgatcgtggctggctcgaagat
acctgcaagaatgtcattgcgctgccattctccaaattgcagttcgcgcttagctggataacgccacggaatgatgtcg
tcgtgcacaacaatggtgacttctacagcgcggagaatctcgctctctccaggggaagccgaagtttccaaaaggtc
gttgatcaaagctcgccgcgttgtttcatcaagccttacggtcaccgtaaccagcaaatcaatatcactgtgtggcttca
ggccgccatccactgcggagccgtacaaatgtacggccagcaacgtcggttcgagatggcgctcgatgacgccaa
ctacctctgatagttgagtcgatacttcggcgatcaccgcttccctcatgatgtttaactttgttttagggcgactgccctg
ctgcgtaacatcgttgctgctccataacatcaaacatcgacccacggcgtaacgcgcttgctgcttggatgcccgagg
catagactgtaccccaaaaaaacagtcataacaagccatgaaaaccgccactgcgccgttaccaccgctgcgttcgg
tcaaggttctggaccagttgcgtgagcgcatacgctacttgcattacagcttacgaaccgaacaggcttatgtccactg
ggttcgtgccttcatccgtttccacggtgtgcgtcacccggcaaccttgggcagcagcgaagtcgaggcatttctgtcc
tggctggcgaacgagcgcaaggtttcggtctccacgcatcgtcaggcattggcggccttgctgttcttctacggcaag
gtgctgtgcacggatctgccctggcttcaggagatcggaagacctcggccgtcgcggcgcttgccggtggtgctga
ccccggatgaagtggttcgcatcctcggttttctggaaggcgagcatcgtttgttcgcccagcttctgtatggaacggg
catgcggatcagtgagggtttgcaactgcgggtcaaggatctggatttcgatcacggcacgatcatcgtgcgggagg
gcaagggctccaaggatcgggccttgatgttacccgagagcttggcacccagcctgcgcgagcaggggaattaatt
cccacgggttttgctgcccgcaaacgggctgttctggtgttgctagtttgttatcagaatcgcagatccggcttcagccg
gtttgccggctgaaagcgctatttcttccagaattgccatgatttttttccccacgggaggcgtcactggctcccgtgttgt
cggcagctttgattcgataagcagcatcgcctgtttcaggctgtctatgtgtgactgttgagctgtaacaagttgtctcag
gtgttcaatttcatgttctagttgctttgttttactggtttcacctgttctattaggtgttacatgctgttcatctgttacattgtcg
atctgttcatggtgaacagctttgaatgcaccaaaaactcgtaaaagctc

Figure 185C

tgatgtatctatctttttttacaccgttttcatctgtgcatatggacagttttccctttgatatgtaacggtgaacagttgttctac
ttttgtttgttagtcttgatgcttcactgatagatacaagagccataagaacctcagatccttccgtatttagccagtatgttc
tctagtgtggttcgttgtttttgcgtgagccatgagaacgaaccattgagatcatacttactttgcatgtcactcaaaaattt
tgcctcaaaactggtgagctgaatttttgcagttaaagcatcgtgtagtgtttttcttagtccgttatgtaggtaggaatctg
atgtaatggttgttggtattttgtcaccattcatttttatctggttgttctcaagttcggttacgagatccatttgtctatctagtt
caacttggaaaatcaacgtatcagtcgggcggcctcgcttatcaaccaccaatttcatattgctgtaagtgtttaaatcttt
acttattggtttcaaaacccattggttaagccttttaaactcatggtagttatttttcaagcattaacatgaacttaaattcatca
aggctaatctctatatttgccttgtgagttttcttttgtgttagttcttttaataaccactcataaatcctcatagagtatttgtttt
caaaagacttaacatgttccagattatattttatgaatttttttaactggaaaagataaggcaatatctcttcactaaaaacta
attctaatttttcgcttgagaacttggcatagtttgtccactggaaaatctcaaagcctttaaccaaaggattcctgatttcc
acagttctcgtcatcagctctctggttgctttagctaatacaccataagcattttccctactgatgttcatcatctgagcgta
ttggttataagtgaacgataccgtccgttctttccttgtagggttttcaatcgtggggttgagtagtgccacacagcataa
aattagcttggtttcatgctccgttaagtcatagcgactaatcgctagttcatttgctttgaaaacaactaattcagacatac
atctcaattggtctaggtgattttaatcactataccaattgagatgggctagtcaatgataattactagtccttttccttttgag
ttgtgggtatctgtaaattctgctagacctttgctggaaaacttgtaaattctgctagaccctctgtaaattccgctagacct
ttgtgtgttttttttgtttatattcaagtggttataatttatagaataaagaaagaataaaaaaagataaaaagaatagatccc
agccctgtgtataactcactactttagtcagttccgcagtattacaaaaggatgtcgcaaacgctgtttgctcctctacaa
aacagaccttaaaaccctaaaggcttaagtagcaccctcgcaagctcgggcaaatcgctgaatattccttttgtctccg
accatcaggcacctgagtcgctgtctttttcgtgacattcagttcgctgcgctcacggctctggcagtgaatgggggta
aatggcactacaggcgccttttatggattcatgcaaggaaactacccataatacaagaaaagcccgtcacgggcttct
cagggcgttttatggcgggtctgctatgtggtgctatctgactttttgctgttcagcagttcctgccctctgattttccagtct
gaccacttcggattatcccgtgacaggtcattcagactggctaatgcacccagtaaggcagcggtatcatcaacaggc
ttacccgtcttactgtcgggaattcatttaaatagtcaaaagcctccgaccggaggcttttgactgctaggcgatctgtgc
tgtttgccacggtatgcagcaccagcgcgagattatgggctcgcacgctcgactgtcggacgggggcactggaacg
agaagtcaggcgagccgtcacgcccttgacaatgccacatcctgagcaaataattcaaccactaaacaaatcaaccg
cgtttcccggaggtaaccaagcttgcgggagagaatgatgaacaagagccaacaagttcagacaatcaccctggcc
gccgcccagcaaatggcggcggcggtggaaaaaaaagccactgagatcaacgtggcggtggtgttttccgtagttg
accgcggaggcaacacgctgcttatccagcggatggacgaggccttcgtctccagctgcgatatttccctgaataaa
gcctggagcgcctgcagcctgaagcaaggtacccatgaaattacgtcagcggtccagccaggacaatctctgtacg
gtctgcagctaaccaaccaacagcgaattattatttttggcggcggcctgccagttatttttaatgagcaggtaattggc
gccgtcggcgttagcggcggtacggtcgagcaggatcaattattagcccagtgcgccctggattgtttttccgcattat
aacctgaagcgagaaggtatattatgagctatcgtatgttccgccaggcattctgagtgttaacgaggggaccgtcatg
tcgctttcaccgccaggcgtacgcctgttttacgatccgcgcgggcaccatgccggcgccatcaatgagctgtgctg
ggggctggaggagcaggggtcccctgccagaccataacctatgacggaggcggtgacgccgctgcgctgggc
gccctggcggccagaagctcgcccctgcgggtgggtatcgggctcagcgcgtccggcgagatagc

Figure 185D

cctcactcatgcccagctgccggcggacgcgccgctggctaccggacacgtcaccgatagcgacgatcaactgc
gtacgctcggcgccaacgccgggcagctggttaaagtcctgccgttaagtgagagaaactgaactggcctagcaa
acacagaaaaaagcccgcacctgacagtgcgggctttttttttcctaggcgatctgtgctgtttgccacggtatgcag
caccagcgcgagattatgggctcgcacgctcgactgtcggacgggggcactggaacgagaagtcaggcgagcc
gtcacgcccttgacaatgccacatcctgagcaaataattcaaccactaaacaaatcaaccgcgtttcccggaggtaa
ccaagcttcacctttgagccgatgaacaatgaaaagatcaaaacgatttgcagtactggcccagcgccccgtcaat
caggacgggctgattggcgagtggcctgaagaggggctgatcgccatggacagccccttgacccggtctcttca
gtaaaagtggacaacggtctgatcgtcgaactggacggcaaacgccgggaccagtttgacatgatcgaccgattta
tcgccgattacgcgatcaacgttgagcgcacagagcaggcaatgcgcctggaggcggtggaaatagcccgtatg
ctggtggatattcacgtcagccgggaggagatcattgccatcactaccgccatcacgccggccaaagcggtcgag
gtgatggcgcagatgaacgtggtggagatgatgatggcgctgcagaagatgcgtgcccgccggacccccctccaa
ccagtgccacgtcaccaatctcaaagataatccggtgcagattgccgctgacgccgccgaggccgggatccgcg
gcttctcagaacaggagaccacggtcggtatcgcgcgctacgcgccgtttaacgccctggcgctgttggtcggttc
gcagtgcggccgccccggcgtgttgacgcagtgctcggtggaagaggccaccgagctggagctgggcatgcgt
ggcttaaccagctacgccgagacggtgtcggtctacggcaccgaagcggtatttaccgacggcgatgatacgccg
tggtcaaaggcgttcctcgcctcggcctacgcctcccgcgggttgaaaatgcgctacacctccggcaccggatcc
gaagcgctgatgggctattcggagagcaagtcgatgctctacctcgaatcgcgctgcatcttcattactaaaggcgc
cggggttcagggactgcaaaacggcgcggtgagctgtatcggcatgaccggcgctgtgccgtcgggcattcggg
cggtgctggcggaaaacctgatcgcctctatgctcgacctcgaagtggcgtccgccaacgaccagactttctccca
ctcggatattcgccgcaccgcgcgcaccctgatgcagatgctgccgggcaccgactttattttctccggctacagcg
cggtgccgaactacgacaacatgttcgccggctcgaacttcgatgcggaagattttgatgattacaacatcctgcag
cgtgacctgatggttgacggcggcctgcgtccggtgaccgaggcggaaaccattgccattcgccagaaagcggc
gcgggcgatccaggcggttttccgcgagctggggctgccgccaatcgccgacgaggaggtggaggccgccacc
tacgcgcacggcagcaacgagatgccgccgcgtaacgtggtggaggatctgagtgcggtggaagagatgatga
agcgcaacatcaccggcctcgatattgtcggcgcgctgagccgcagcggctttgaggatatcgccagcaatattct
caatatgctgcgccagcgggtcaccggcgattacctgcagacctcggccattttcgatcggcagttcgaggtggtg
agtgcggtcaacgacatcaatgactatcaggggccgggcaccggctatcgcatctctgccgaacgctgggcgga
gatcaaaaatattccgggcgtggttcagcccgacaccattgaacaaggcggtattcctgtgcaacagacaacccaa
attcagccctcttttaccctgaaaacccgcgagggcggggtagcttctgccgatgaacgcgccgatgaagtggtga
tcggcgtcggccctgccttcgataaacaccagcatcacactctgatcgatatgccccatggcgcgatcctcaaaga
gctgattgccggggtggaagaagaggggcttcacgcccgggtggtgcgcattctgcgcacgtccgacgtctccttt
atggcctgggatgcggccaacctgagcggctcggggatcggcatcggtatccagtcgaaggggaccacggtcat
ccatcagcgcgatctgctgccgctcagcaacctggagctgttctcccaggcgccgctgctgacgctggagaccta
ccggcagattggcaaaaacgctgcgcgctatgcgcgcaaagagtcaccttcgccggtgccggtggtgaacgatc
agatggtgcggccgaaatttatggccaaagccgcgctatttcatatcaaagagaccaaacatgtggtgcaggacgc
cgagcccgtcaccctgcacatcgacttagtaaggg

Figure 185E

agtgaccatgagcgagaaaaccatgcgcgtgcaggattatccgttagccacccgctgcccggagcatatcctgacg
cctaccggcaaaccattgaccgatattaccctcgagaaggtgctctctggcgaggtgggcccgcaggatgtgcggat
ctcccgccagacccttgagtaccaggcgcagattgccgagcagatgcagcgccatgcggtggcgcgcaatttccgc
cgcgcggcggagcttatcgccattcctgacgagcgcattctggctatctataacgcgctgcgcccgttccgctcctcg
caggcggagctgctggcgatcgccgacgagctggagcacacctggcatgcgacagtgaatgccgcctttgtccgg
gagtcggcggaagtgtatcagcagcggcataagctgcgtaaaggaagctaagcggaggtcagcatgccgttaatag
ccgggattgatatcggcaacgccaccaccgaggtggcgctggcgtccgactacccgcaggcgagggcgtttgttgc
cagcgggatcgtcgcgacgacgggcatgaaagggacgcgggacaatatcgccgggaccctcgccgcgctggag
caggccctggcgaaaacaccgtggtcgatgagcgatgtctctcgcatctatcttaacgaagccgcgccggtgattgg
cgatgtggcgatggagaccatcaccgagaccattatcaccgaatcgaccatgatcggtcataacccgcagacgccg
ggcggggtgggcgttggcgtggggacgactatcgccctcgggcggctggcgacgctgccggcggcgcagtatgc
cgaggggtggatcgtactgattgacgacgccgtcgatttccttgacgccgtgtggtggctcaatgaggcgctcgacc
gggggatcaacgtggtggcggcgatcctcaaaaaggacgacggcgtgctggtgaacaaccgcctgcgtaaaaccc
tgccggtggtggatgaagtgacgctgctggagcaggtccccgaggggtaatggcggcggtggaagtggccgcg
ccgggccaggtggtgcggatcctgtcgaatccctacgggatcgccaccttcttcgggctaagcccggaagagaccc
aggccatcgtccccatcgcccgcgccctgattggcaaccgttccgcggtggtgctcaagaccccgcaggggatgt
gcagtcgcgggtgatcccggcgggcaacctctacattagcggcgaaaagcgccgcggagaggccgatgtcgccg
agggcgcggaagccatcatgcaggcgatgagcgcctgcgctccggtacgcgacatccgcggcgaaccgggcac
ccacgccggcggcatgcttgagcgggtgcgcaaggtaatggcgtccctgaccggccatgagatgagcgcgatata
catccaggatctgctggcggtggatacgtttattccgcgcaaggtgcagggcgggatggccggcgagtgcgccatg
gagaatgccgtcgggatggcggcgatggtgaaagcggatcgtctgcaaatgcaggttatcgcccgcgaactgagc
gcccgactgcagaccgaggtggtggtgggcggcgtggaggccaacatggccatcgccggggcgttaaccactcc
cggctgtgcggcgccgctggcgatcctcgacctcggcgccggctcgacggatgcggcgatcgtcaacgcggagg
ggcagataacggcggtccatctcgccggggcggggaatatggtcagcctgttgattaaaaccgagctgggcctcga
ggatctttcgctggcggaagcgataaaaaaatacccgctggccaaagtggaaagcctgttcagtattcgtcacgaga
atggcgcggtggagttctttcgggaagccctcagcccggcggtgttcgccaaagtggtgtacatcaaggagggcga
actggtgccgatcgataacgccagcccgctggaaaaaattcgtctcgtgcgccggcaggcgaaagagaaagtgttt
gtcaccaactgcctgcgcgcgctgcgccaggtctcacccggcggttccattcgcgatatcgcctttgtggtgctggtg
ggcggctcatcgctggactttgagatcccgcagcttatcacggaagccttgtcgcactatggcgtggtcgccgggca
gggcaatattcggggaacagaagggccgcgcaatgcggtcgccaccgggctgctactggccggtcaggcgaatta
aacgggcgctcgcgccagcctctaggtacaaataaaaaaggcacgtcagatgacgtgccttttttcttgtctagcgtgc
accaatgcttctggcgtcaggcagccatcggaagctgtggtatggctgtgcaggtcgtaaatcactgcataattcgtgt
cgctcaaggcgcactcccgttctggataatgttttttgcgccgacatcataacggttctggcaaatattctgaaatgagct
gttgacaattaatcatccggctcgtataatgtgtggaattgtgagcggataacaatttc

Figure 185F

acacaggaaacagaccatgactagtaaggaggacaattccatggctgctgctgctgatagattaaacttaacttccgg
ccacttgaatgctggtagaaagagaagttcctcttctgtttctttgaaggctgccgaaaagcctttcaaggttactgtgatt
ggatctggtaactggggtactactattgccaaggtggttgccgaaaattgtaagggatacccagaagttttcgctccaa
tagtacaaatgtgggtgttcgaagaagagatcaatggtgaaaaattgactgaaatcataaatactagacatcaaaacgt
gaaatacttgcctggcatcactctacccgacaatttggttgctaatccagacttgattgattcagtcaaggatgtcgacat
catcgttttcaacattccacatcaatttttgccccgtatctgtagccaattgaaaggtcatgttgattcacacgtcagagct
atctcctgtctaaagggttttgaagttggtgctaaaggtgtccaattgctatcctcttacatcactgaggaactaggtattc
aatgtggtgctctatctggtgctaacattgccaccgaagtcgctcaagaacactggtctgaaacaacagttgcttacca
cattccaaaggatttcagaggcgagggcaaggacgtcgaccataaggttctaaaggccttgttccacagaccttactt
ccacgttagtgtcatcgaagatgttgctggtatctccatctgtggtgctttgaagaacgttgttgccttaggttgtggtttcg
tcgaaggtctaggctggggtaacaacgcttctgctgccatccaaagagtcggtttgggtgagatcatcagattcggtc
aaatgtttttcccagaatctagagaagaaacatactaccaagagtctgctggtgttgctgatttgatcaccacctgcgct
ggtggtagaaacgtcaaggttgctaggctaatggctacttctggtaaggacgcctgggaatgtgaaaaggagttgttg
aatggccaatccgctcaaggtttaattacctgcaaagaagttcacgaatggttggaaacatgtggctctgtcgaagact
tcccattatttgaagccgtataccaaatcgtttacaacaactacccaatgaagaacctgccggacatgattgaagaatta
gatctacatgaagattagatttattggatccaggaaacagactagaattatgggattgactactaaacctctatctttgaa
agttaacgccgctttgttcgacgtcgacggtaccattatcatctctcaaccagccattgctgcattctggagggatttcgg
taaggacaaaccttatttcgatgctgaacacgttatccaagtctcgcatggttggagaacgtttgatgccattgctaagtt
cgctccagactttgccaatgaagagtatgttaacaaattagaagctgaaattccggtcaagtacggtgaaaaatccatt
gaagtcccaggtgcagttaagctgtgcaacgctttgaacgctctaccaaaagagaaatgggctgtggcaacttccggt
acccgtgatatggcacaaaaatggttcgagcatctgggaatcaggagaccaaagtacttcattaccgctaatgatgtc
aaacagggtaagcctcatccagaaccatatctgaagggcaggaatggcttaggatatccgatcaatgagcaagacc
cttccaaatctaaggtagtagtatttgaagacgctccagcaggtattgccgccggaaaagccgccggttgtaagatcat
tggtattgccactactttcgacttggacttcctaaaggaaaaaggctgtgacatcattgtcaaaaaccacgaatccatca
gagttggcggctacaatgccgaaacagacgaagttgaattcatttttgacgactacttatatgctaaggacgatctgttg
aaatggtaacccgggctgcaggcatgcaagcttggctgttttggcggatgagagaagattttcagcctgatacagatt
aaatcagaacgcagaagcggtctgataaaacagaatttgcctggcggcagtagcgcggtggtcccacctgacccca
tgccgaactcagaagtgaaacgccgtagcgccgatggtagtgtggggtctccccatgcgagagtagggaactgcca
ggcatcaaataaaacgaaaggctcagtcgaaagactgggcctttcgttttatctgttgtttgtcggtgaacgctctcctg
agtaggacaaatccgccgggagcggatttgaacgttgcgaagcaacggcccggagggtggcgggcaggacgcc
cgccataaactgccaggcatcaaattaagcagaaggccatcctgacggatggccttttgcgtttctacaaactccagc
tggatcgggcg (SEQ ID NO:163)

Figure 186

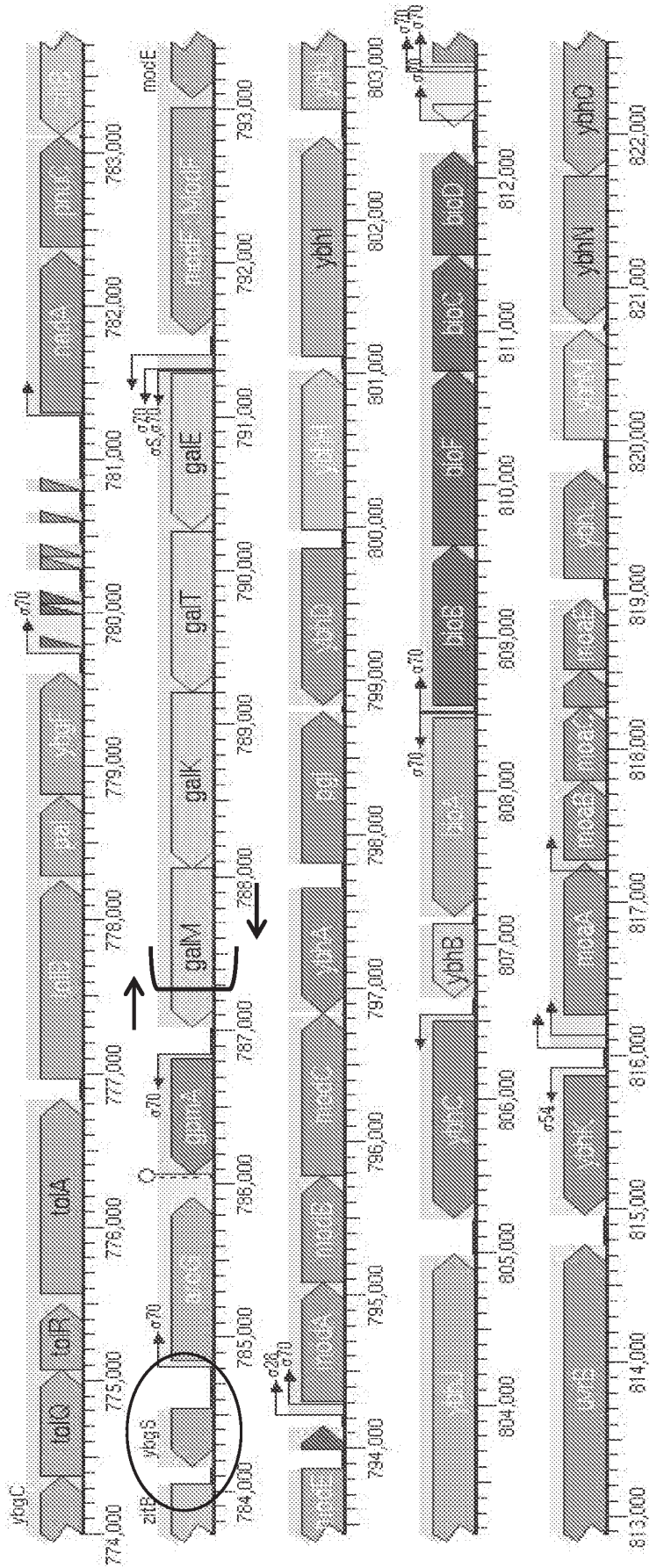

ybgC
tolQ
tolR
tolA
ybgS
galM
galK
galT
galE
mocE
ybhJ
ybhB
ybhG
ybhO
ybhN
σ70
σ54
σ28
σ32

Figure 187A

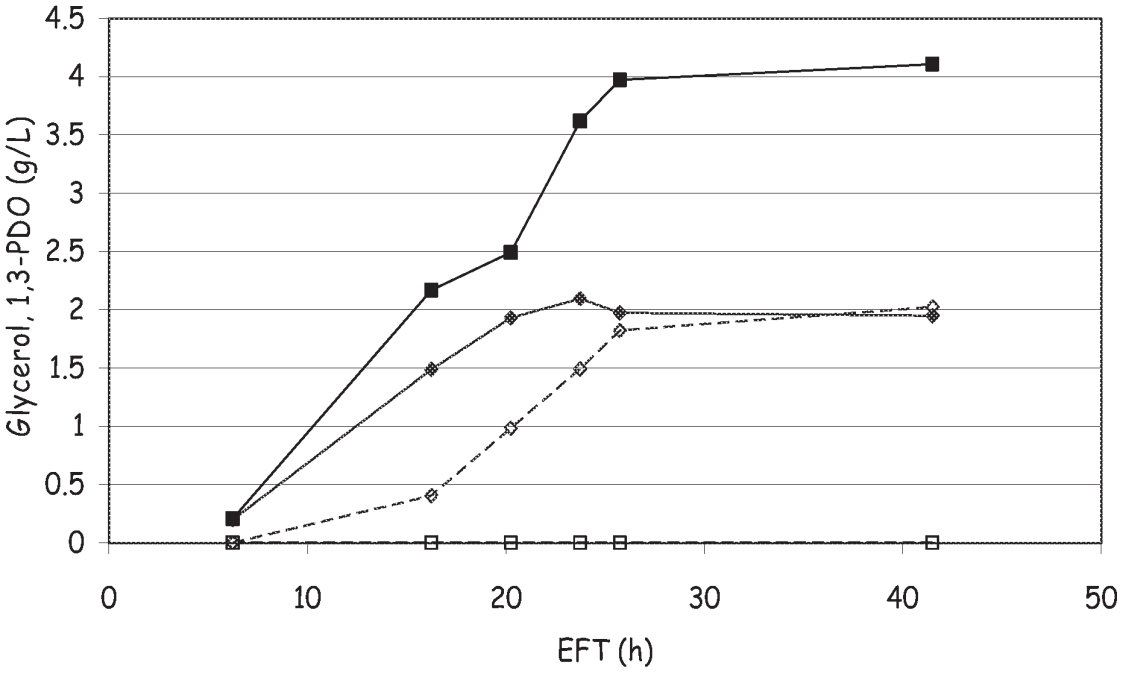


Figure 187B

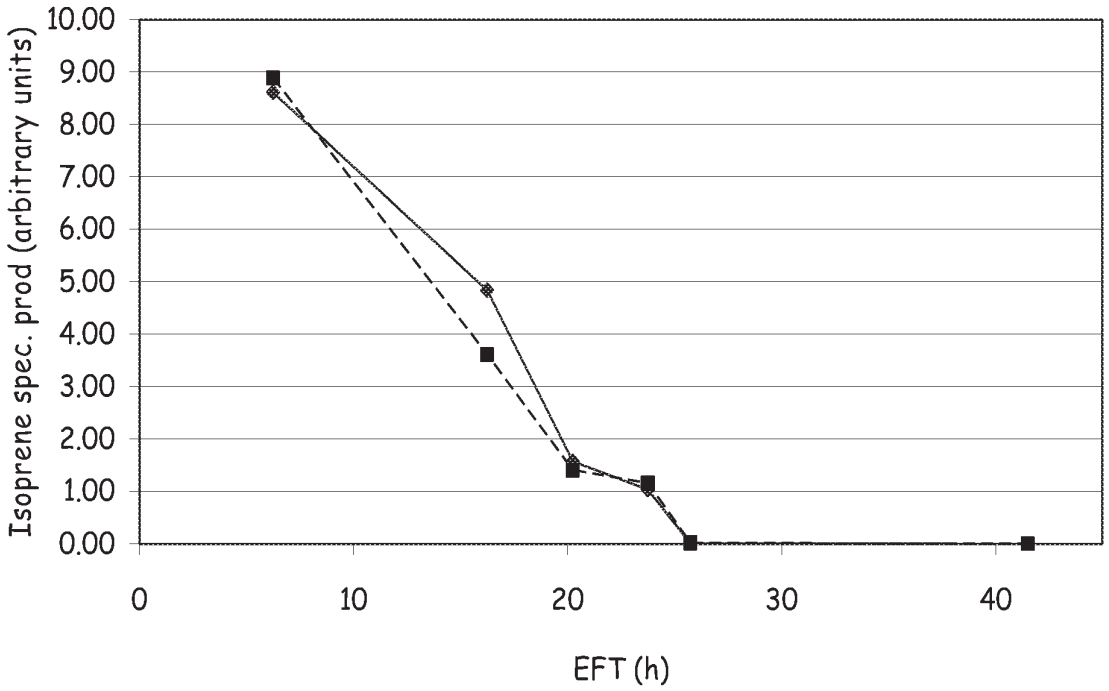

Isoprene spec. prod (arbitrary units)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0
10
20
30
40
EFT (h)

Figure 187C

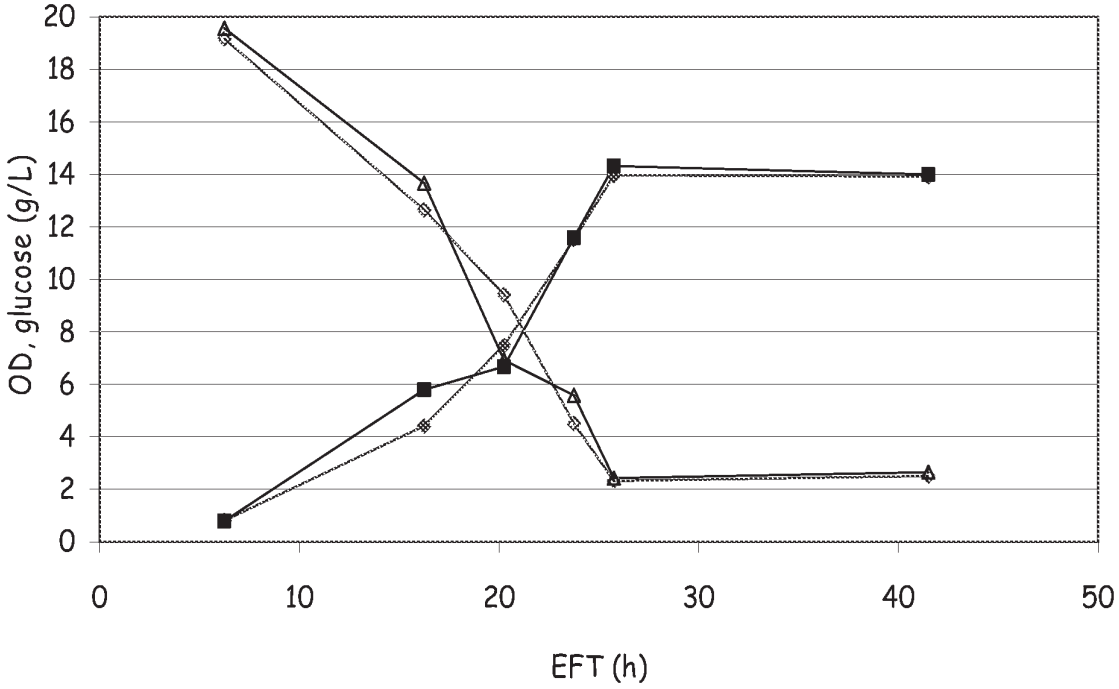


Figure 187D

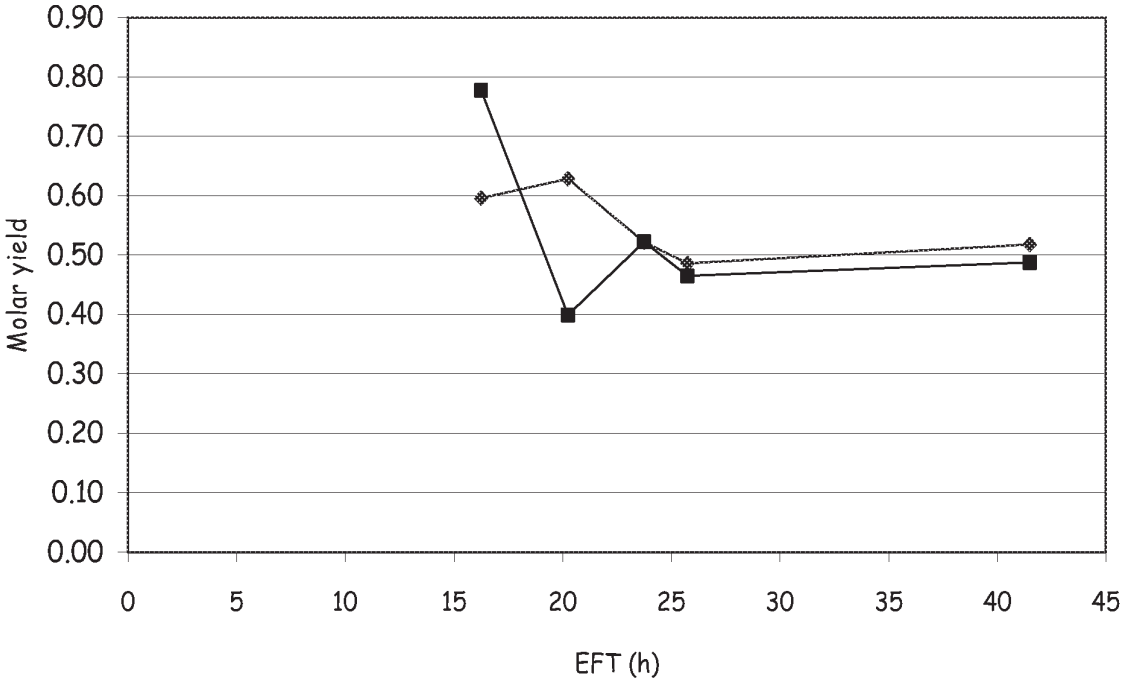

0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Molar yield
0
5
10
15
20
25
30
35
40
45
EFT (h)

Figure 188

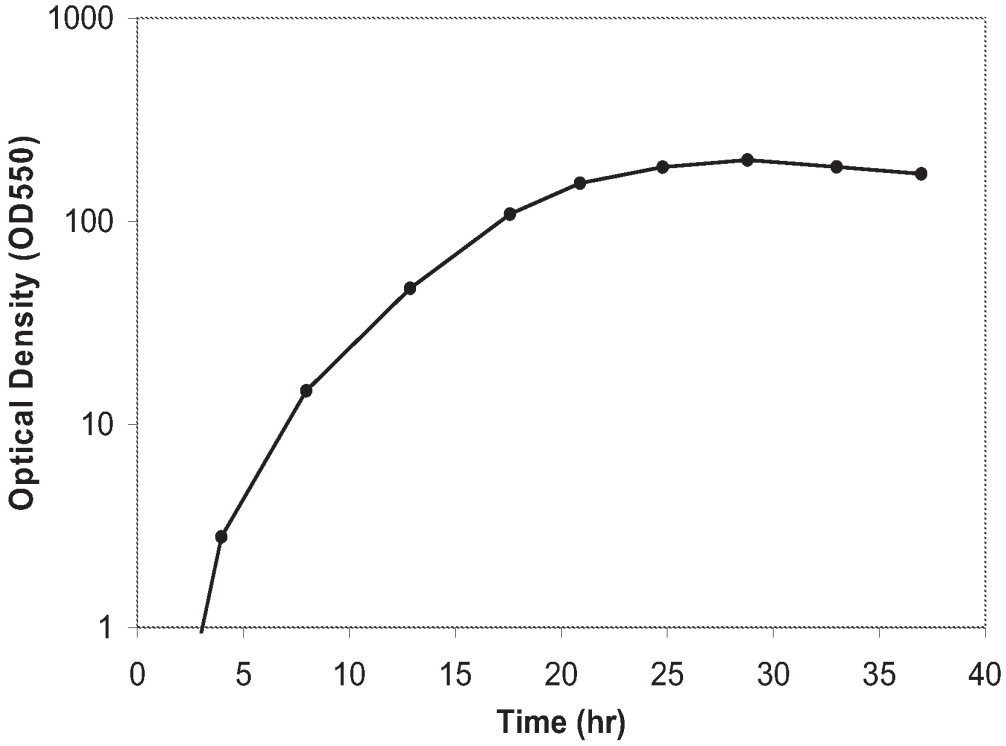

1000
100
10
1
Optical Density (OD550)
0
5
10
15
20
25
30
35
40
Time (hr)

Figure 189

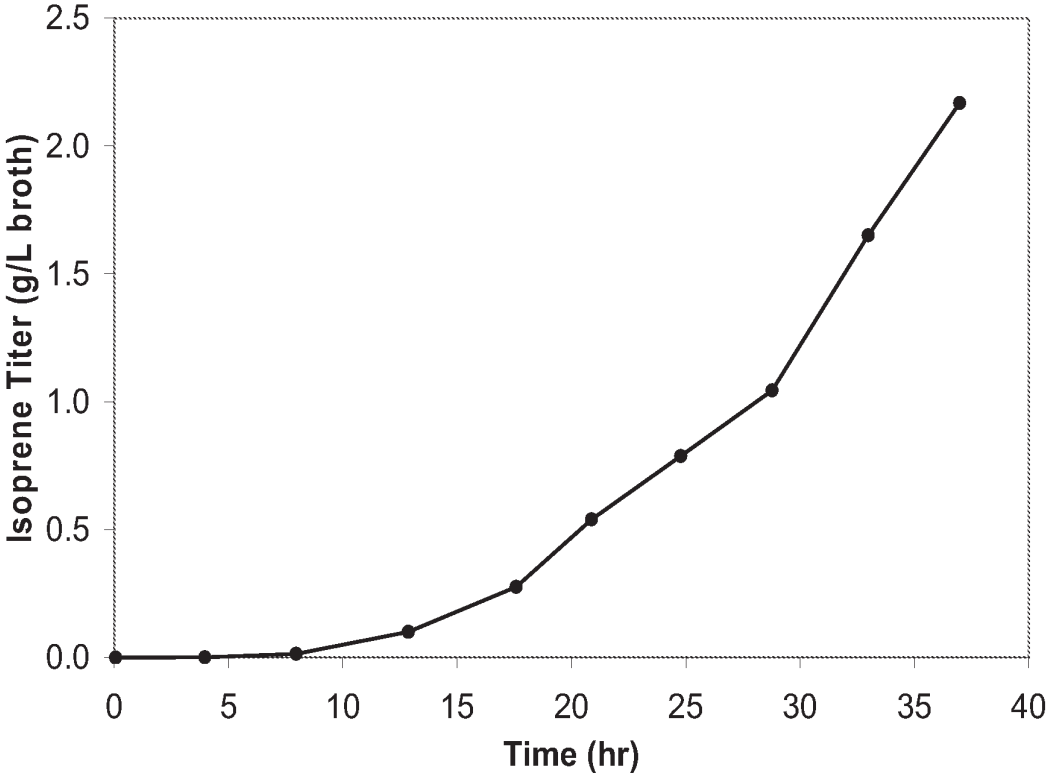

Isoprene Titer (g/L broth)
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
Time (hr)

Figure 190

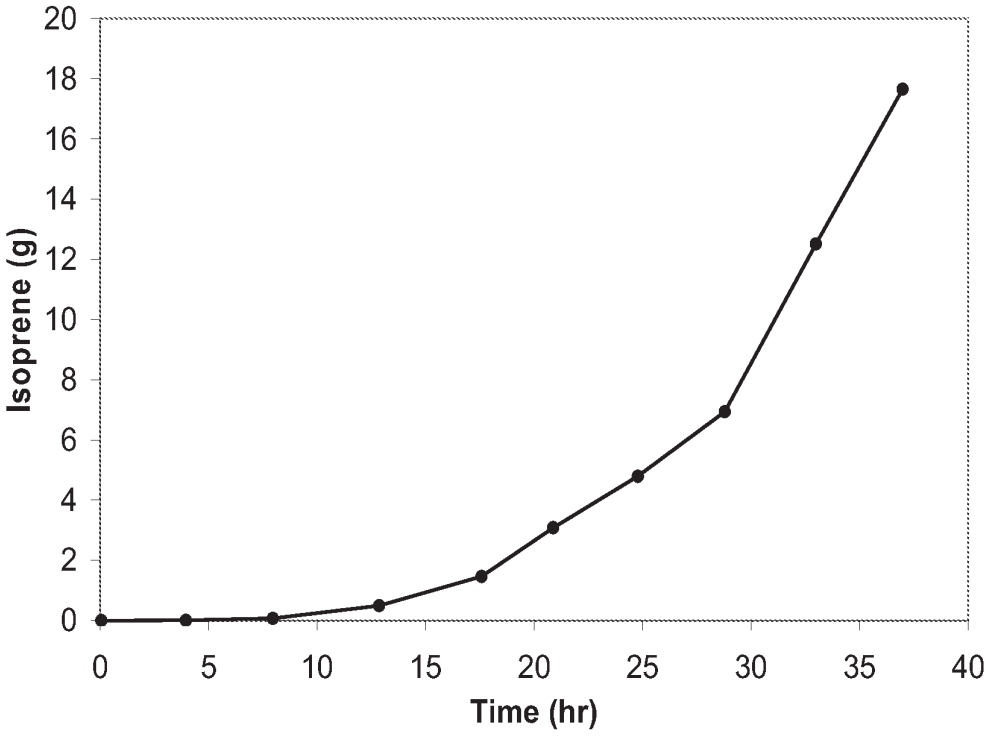


Figure 191

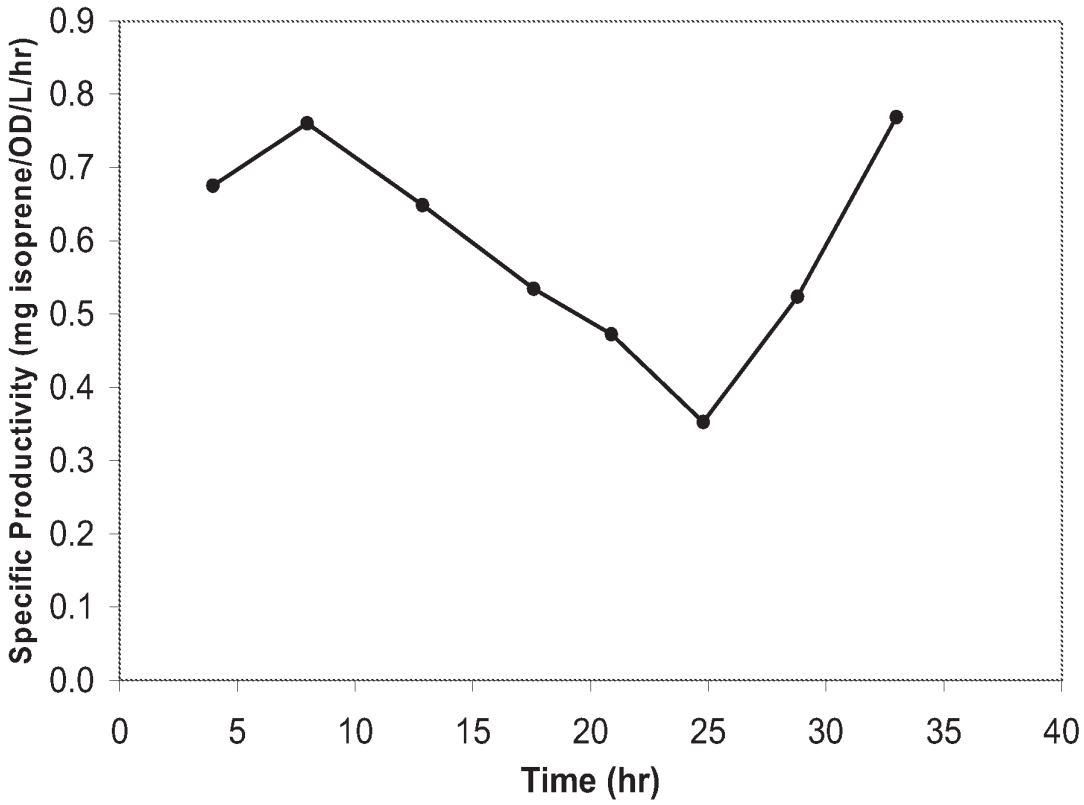

Specific Productivity (mg isoprene/OD/L/hr)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
35
40
Time (hr)

Figure 192

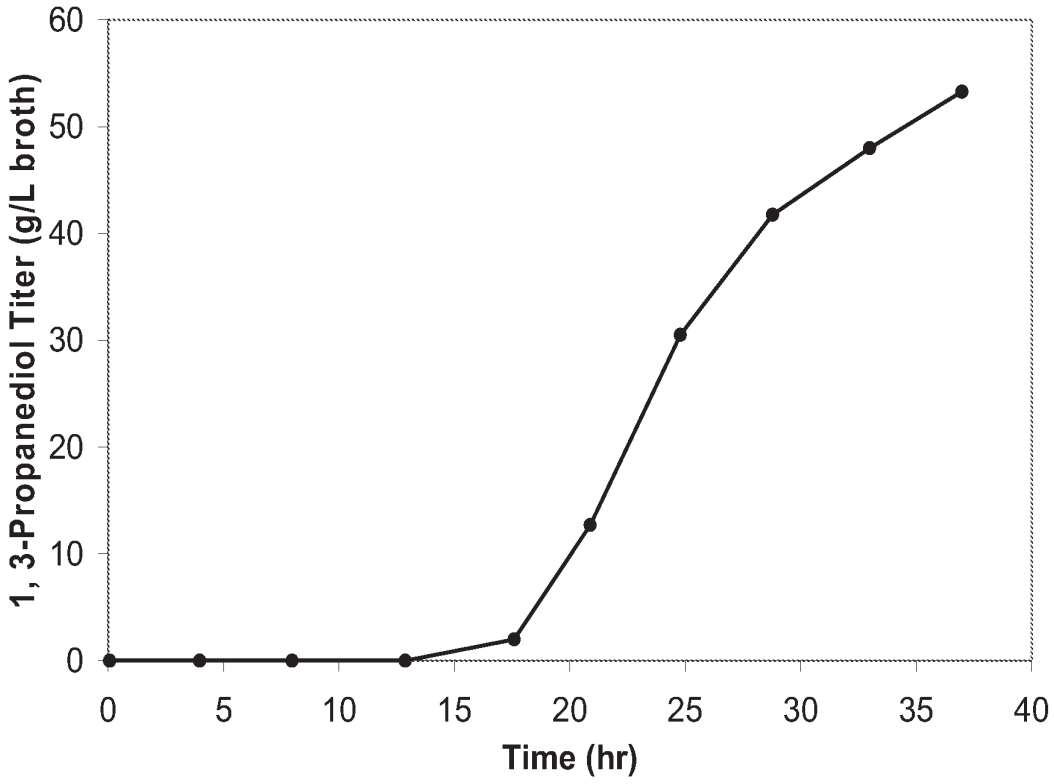

1, 3-Propanediol Titer (g/L broth)
60
50
40
30
20
10
0
0
5
10
15
20
25
30
35
40
Time (hr)

Figure 193

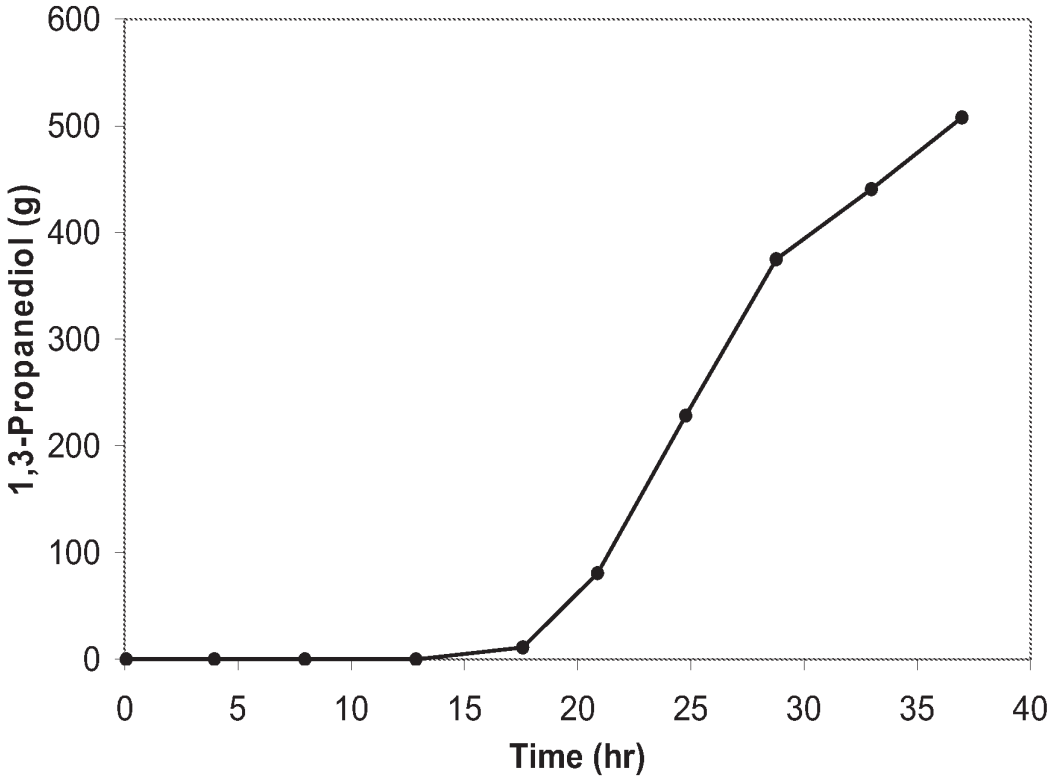

600
500
400
300
200
100
0
1,3-Propanediol (g)
0
5
10
15
20
25
30
35
40
Time (hr)

Figure 194

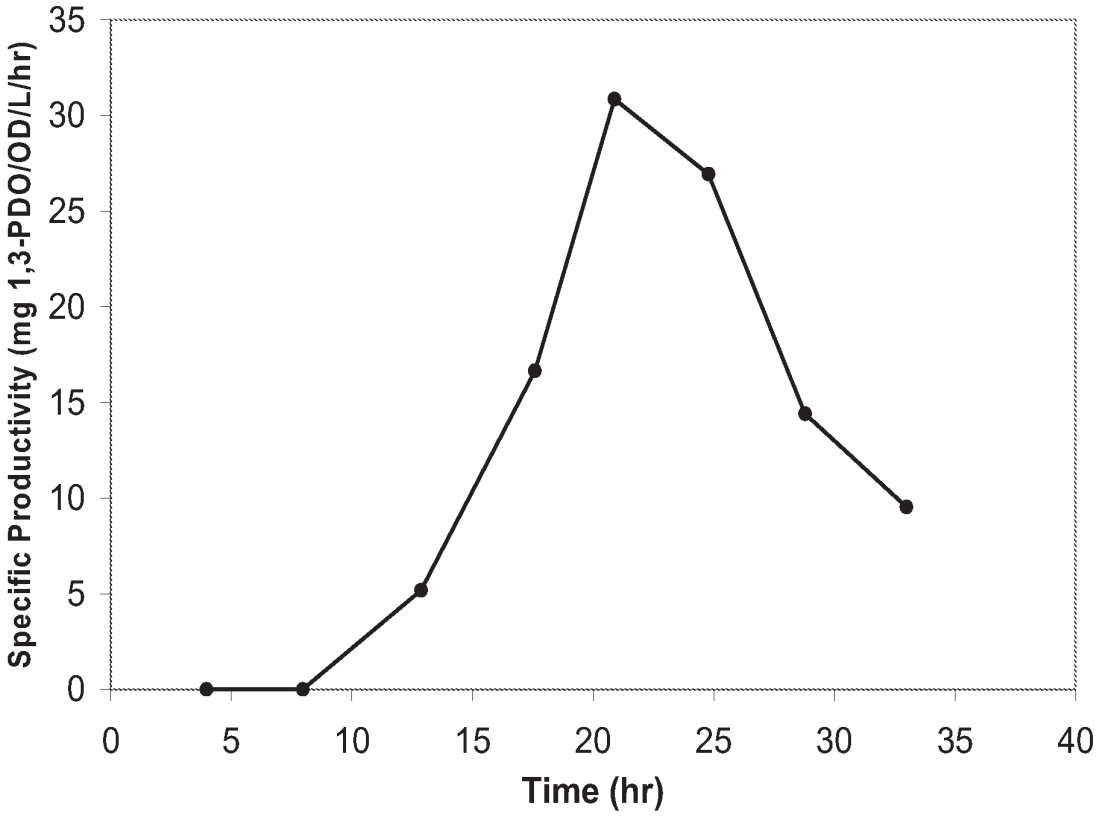

Specific Productivity (mg 1,3-PDO/OD/L/hr)
35
30
25
20
15
10
5
0
0
5
10
15
20
25
30
35
40
Time (hr)

Figure 195

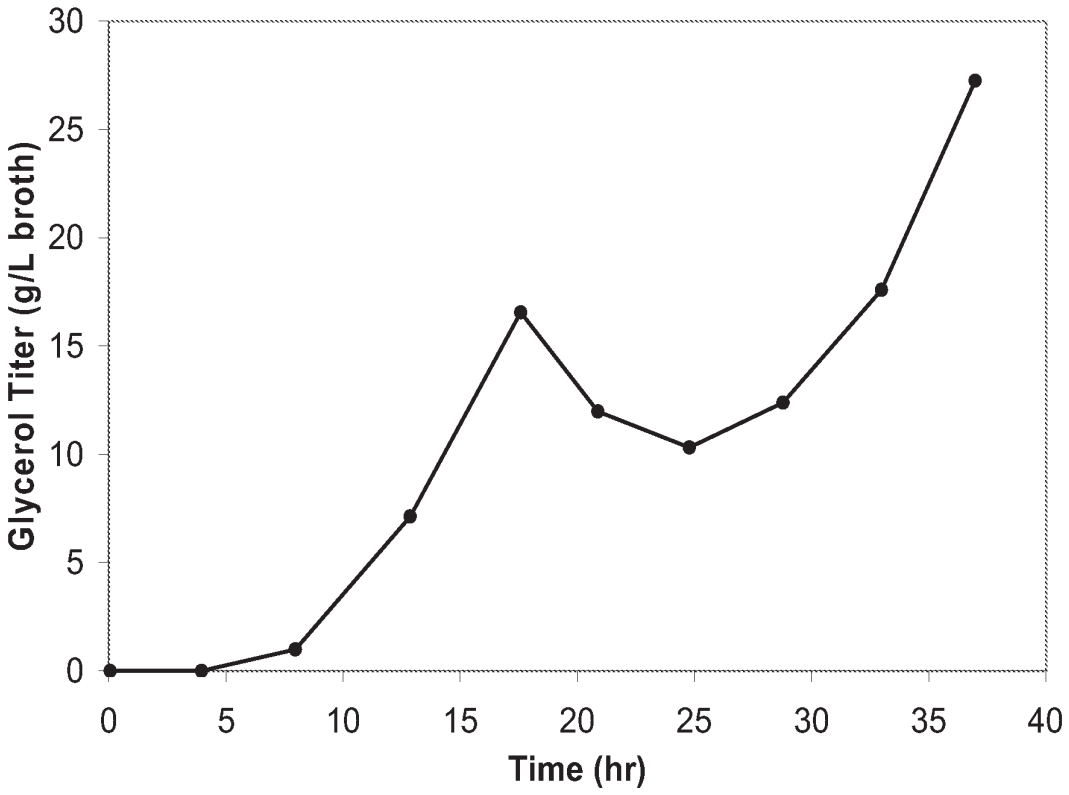

Glycerol Titer (g/L broth)
30
25
20
15
10
5
0
0
5
10
15
20
25
30
35
40
Time (hr)

Figure 196

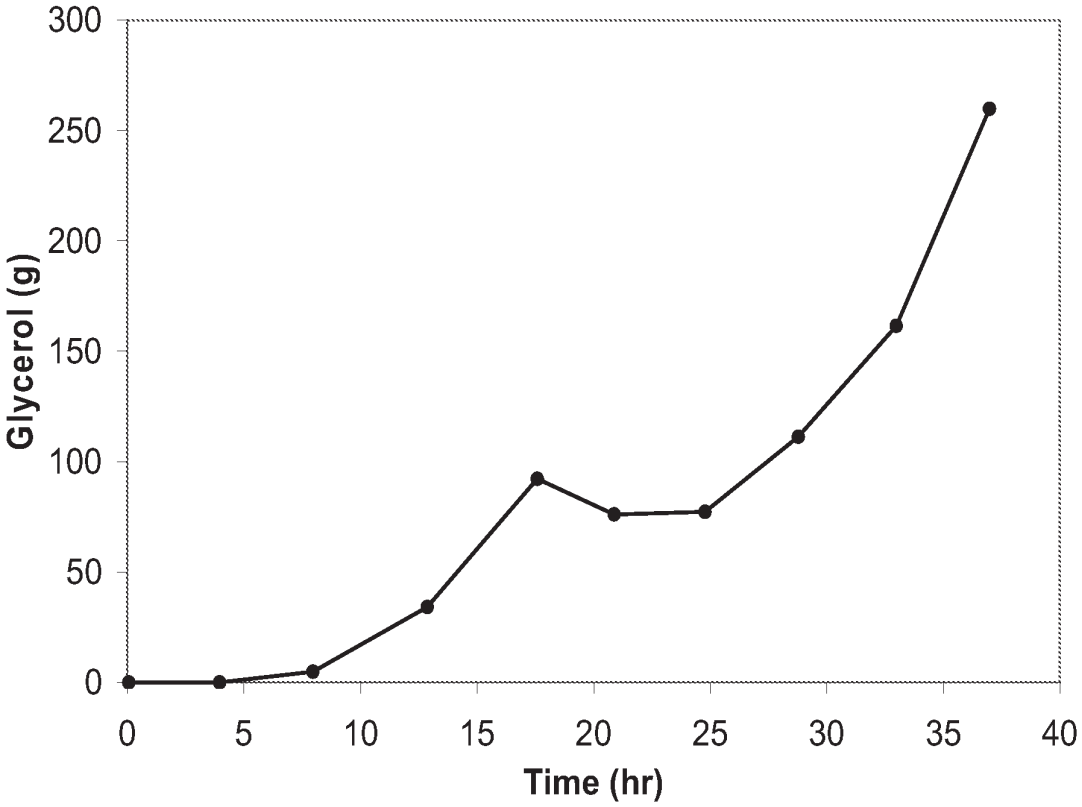
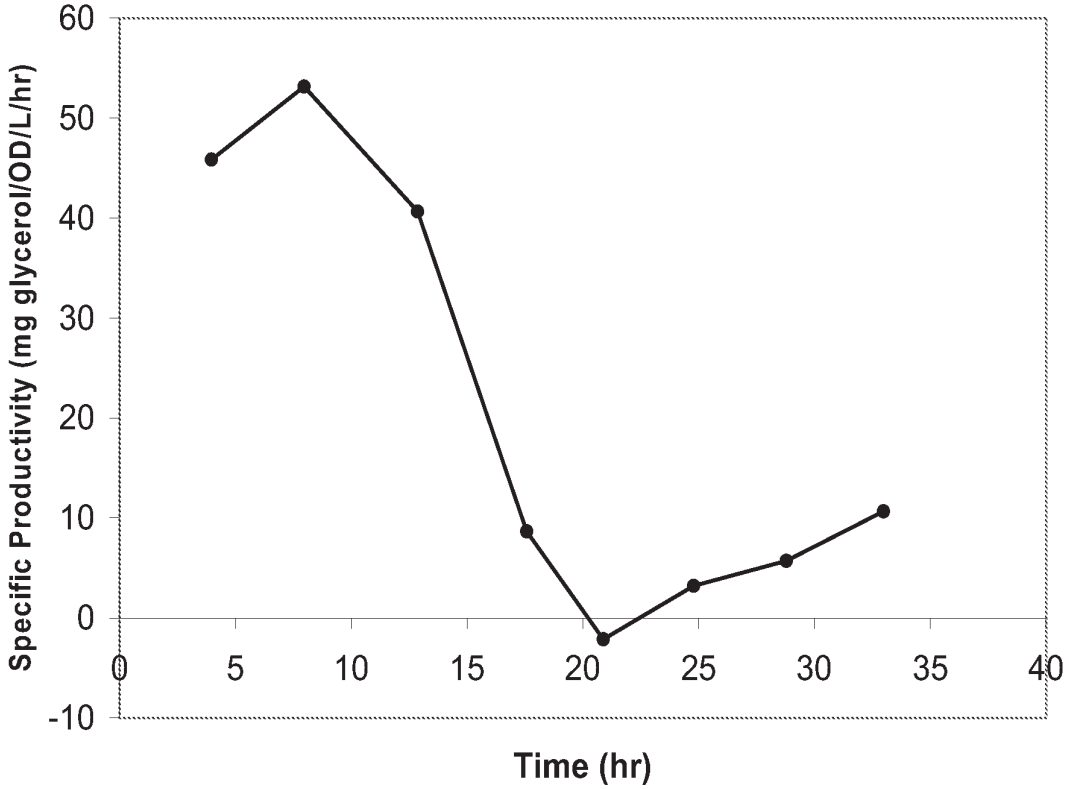


Figure 197


Specific Productivity (mg glycerol/OD/L/hr)
60
50
40
30
20
10
0
-10
0
5
10
15
20
25
30
35
40
Time (hr)