

Supplementary Materials

Engineering 3-Hydroxypropionic Acid Production from Glucose

in *Yarrowia lipolytica* though Malonyl-CoA Pathway

Table S1. Sequences of genes investigated in this study.

| Gene | Sequence |
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| <i>MCR_{Ca}</i> (GenBank: CP000909.1) | ATGAGCGGAACAGGACGACTGGCAGGAAAGATTGCGTTAATTACCGTGGCGCCGGCAATATCGGCAGTGAATTGACACGTCGCTTTCTCGCAGAG GGAGCGACGGTCATTATTAGTGGACGGAATCGGGCGAAGTTGACCGCACTGGCCGAACGGATGACAGGCAGAGGAGGAGTGGCGGCAAGCGCA TCGATCTCGAAGTCATGGATGGGAGTGATCCGGTCGCGGTACGTGCCGGTATCGAAGCGAATTGTGGCCCGTCACGGCCAGATCGACATTCTGGTC AACAAATGCAGGAAGTGGCGGTGCCAGCGTCTGTGGCCGAGATTCCACTACTGAAGCTGAATTAGGCCCTGGCGCCGAAGAGACGCTTCATGC CAGCATCGCCAAATTACTTGGTATGGGATGGCATCTGATGCGTATTGCGGCACCTCATATGCCGGTAGGAAGTGGGTGTCATCAATGTCTCGACCATC TTTTACGGGCTGAGTACTACGGGCGGATTCCGTATGTACCCCTAAAGTGCTCTTAATGCTCTATCTCAACTTGTGCGCGTGAGTTAGGTGCAC GTGGCATCCGCGTTAATACGATCTTCCCGGCCGATTGAAAGTGATCGCATCCGTACAGTGTTCAGCGTATGGATCAGCTCAAGGGGCGGCCCG AAGGCGACACAGCGCACCAATTTTGAACACCATGCGGATGTGTGTCGCCAACGACAGGGCGCGCTTGAACGTGCGTCCCTCCGTCGGTGATG TGGCAGACGCCGTGTCTTTCTGGCCAGTGGCGAATCCGCGCTCTCTCCGGTGAGACGATTGAGGTTACGCACGGAATGGAAGTTGCCGCGCTGC AGTGAGACCAGCTGCTGGCCGTAAGTATGTCGCGACGATTGATGCCAGTGGCCGACGACGCTCATCTGCGCCGGCGACGAGATTGAAGAGGT GATGGCGCTCACCGGTATGTTGCGTACCTGTGGGAGTGAAGTATCATCGGCTTCCGTTCCGCTGCGCGCTGGCCAGTTTCGAGCAGGCAGTCA ATGAGAGTCGGCGGTGGCCGGCGCAGACTTACGCTCCCAATTGCTTCCACTCGATCCACGCGATCCGGCAACAATTGACGCTGTCTCGATT GGGCGCGCGAGAATACCGGCGGGATTATGACGCGGTGATTCTGCTGCTACAGTACGAACCGGCACCGTGGCGTGATTGAGGTTGATGATGAG CGGGTGTGAAATTTCTGGCCGATGAAATACCGGGACAATTGTGATTGCCAGTTCGCTGGCCGTTACTGGCAGTCGAACGGCTTACCCCGGC CGACGTGCGCGTGGCCCGCGTGTATTTTCTCGAACCGGTGCCGATCAAAATGGGAATGTTACGCGACGCAATCAAAAGTCCGCTATCGGTGAC CTCATTCTGTGTGGCGTCACGAGGCTGAACCTTACTATCAGCGTGCAGCGCCGCGGTGATCATGTGCTGCCGCGGTATGGGCCAATCAGATT GTGCGCTTCGCTAACCGCAGCCTTGAAGGGTTAGAATTTGCTGCTGCTGGACAGCTCAATTGCTCCATAGTCAACGCCATATCAATGAGATTACCC TCAACATCCCTGCCAACATTAGCGCCACCAACCGCGCACGCGAGTGATCGGTGCGAATGGCGGAAAGCCTGATCGGGTTGCAATTTGGGGAAGTT GCCTTGATTACCGGTGGCAGCGCCGGTATGTTGGGCGAGATCGGGCGCTCTGGCTTTGAGTGGCGCGCGCGTGATGCTGGCAGCCCGTGATC GGCATAAGCTCGAACAGATGACGCGGATGATCCAATCTGAGCTGGCTGAGGTGGGTATACCGATGTGCAAGATCGCGTCCACATTGACCGGGC TGCATGTGAGTAGCGAAGCGCAGCTTGGGATCTTGTGAACGTACCTGTGACGCTTTTGGCACCGTGATTTATCTGATCAACAAACCGCGGATC GCCGGTGTGCAAGAGATGGTTATCGATATGCCAGTTGAGGGATGGGCCCATACCTCTTCCGCAATCTGATCAGCAACTACTCGTTGATGCGCAAA TGGCGCGGTGATGAAAAACAGGGTAGCGGTACATCCTTAACGTCTCATCATACTTTGGCGGTAAAAAGATGCGGCCATTCCCTACCCCAACCG TGCCGATTACGCCGTCTGAAGGCTGGTACGCGGCAATGGCCGAAGTCTTTGCGCGCTTCTTGGCCCGGAGATACAGATCAATGCCATTGCGC CGGGTCCGGTCAAGGTGATCGCTTGGCGGTACCGGTGAACGTCCCGGCTCTTTGCCCGTGGGCGCGGCTGATTTTGAGAAACAGCGGCT GAATGAGCTTACGCTGCTCTTATCGCGGTGCGCGCACCGATGAGCGATCTATGCAGAACTGGTTGAAGTGTCTTACCAATGATGTGGCCGC ACTAGAGCAGAAATCCCGCAGCACCTACCGCGTTGCGTGAACTGGCAGCAGCGTTTTGCGAGCGAAGCGGATCCGGCGGCAATCAAGCAGTGGCG TGCTGAACCGTTCAATTGCCGTAATTTGCTGGCTCGTTTGCTAATGGTGGCTATGTGTTGCTGCGCGACATCTTTGCAAACTGCCAAACCCGCC CGATCCCTTCTTACCCGAGCCAGATTGATCGCGAGGCTCGCAAGGTTGCTGACGGCATCATGGGATGCTCTACTGCAACGGATGCCGACTGA GTTTGATGTGCAATGGCCACCGTCTATACCTTGGCGACCGCAATGTGAGTGGTGAGACATTCAACCATCAGGTGGTTTGCCTTACGAACGCAAC CCTACCGGTGGCGAACTCTTCGGCTTGCCCTACCGGAACCGGTGGCGGAGTGGTGGGAAGCACGGTCTATCTGATAGGTGAACATCTGACTGA ACACCTTAACCTGCTTGGCGTGGTACTCGAACGTTACGGGGCAGCTCAGGTAGTGATGATTGTTGAGACAGAAACCGGGGAGAGACAATGCG CGCTTGTCTCACGATCAAGCTCGAGGTGGTGGCTGATGACTAATTGTGGCCGGTGATCAGATCAAGCGGCTGCTGAGTCACTATCAGTCTGCTA CGGTGCGCCAGGGCGGTCGTGTATACCCCTTCCGGCCACTGCCGACGGTACCACTGGTGGCGGTAAAGACAGTGAAGTGGAGCAGAGTGTGA GTGAGGTGAATTTGCCGAGTTGTGCGAACACAGCTCACCCACCAATTTCCGGGTAGCGCGCAAGATTGCCCTGAGTGATGGTGCCAGTCTCGCGC TGGTCACTCCGAAACTACGGCTACCTCAACTACCGAGCAATTTGCTTGGCTAACTTATCAAAACGACCCCTTACGCTTTTACGGCTACGATTGCT GTCGAGAGCGAAAGAACTGCTCAGCGCAATTTGATCAATCAAGTCGATCTGACCCGGCGTGGCGGTGCCGAAGAGCGCGGTATCCGCACGAGCG TCAACAAGAACTGGAACGTTTTATCGAGGCACTTGTGTTGCTGACCACTCCCGCTGAAGCGGATACCCGTTACGCCGGGCGGATTATCG CGGACGGGCGATTACCGTGTA |
| Codon-optimized <i>MCR_{Ca}</i> gene sequence | ATGTCTGGCACCGGCGACTGGCCGGCAAGATCGCCCTGATCACCGGCGAGCCGGCAACATCGGCTCTGAGCTGACCCGACGATTCTGGCCG AGGGCGCCACCGTGATCATCTTGGCCGAAACCGAGCCAAAGCTGACCGCTCTGGCTGAGCGAATCGAGCCGAGGCGCGCGTGGCCCAAGCG AATCGACCTGGAAGTGATGGACGGCTCTGACCCCGTGGCCGTGCGAGCCGGCATCGAGGCCATCTGGGCCGACACGGCCAGATCGACATCTG GTGAACACGCGGCTCTGCTGGCGCCAGCGACGACTGGCTGAGATTCCCTGACCGAGGCCGAGCTTGGACCCGGCGCTGAGGAAACCTGCG ACGCCTCTATCGCAACCTGCTCGGCATGGGTGGCACTGATGCGAATCGCCGCTCTCATATGCCCGTGGGCTCTGCGGTGATCAACGTGTCTA CCATCTTCTCGCGAGCCGAGTACTACGGACGAATCCCTACGTGACCCCTAAGGCCGCTCTGAACGCCCTGTCTAGCTGGCCGCTCGAGAGCTG GGAGCCCGAGGCATCCGAGTGAACCACTTTCCCGGACCTATCGAGTCTGACCGAATCCGAACCGTGTTCAGCGAATGGACAGCTGAAGCG AGAACCCGAGGGCGATACCGCTACCACTTCTCAACACCATGGCACTGTGCCGAGCCAAACGACAGGGTGCCCTCGAGCGCAGATTTCCTCTG TGGGCGACGTGGCCGACGCGCCGTGTTCTTGGCTCTGCCGAGTCTGCCGCTGTGTGCGGAGACTATCGAGGTGACCCACGGCATGGAAT GCCCCCTGTCTGAGACTTCCCTGCTGGCCCGAACCGACCTGCGAACCATCGACGCTCTGGACGAACCACTGATCTGTGCGCGGACAGAG TCGAAGAGGTGATGGCCCTGACCGCATGCTGCGAACCCTGTGGCTCTGAGGTGATCATCGGCTTCCGATCTGCGCGCGCTCTGCGCCAGTTGAG CAGGCCGTGAACGAGTCCCGACGACTCGTGGCGCGCACTTACCCCTCTATCGCTCTGCCCCGTGATCTCGAGATCCCGCCACCAATTGACGC TGTTTCTGACTGGGAGCCGGCGAGAACACCGCGGCAATCCAGCCGCTGTGATTCTGCCGCCCACTCTACGAGCCCGCACTTGGTGATCG AGGTGACGACGAGCGAGTGCTGAACCTTCTGGCTGACGAGATCACCGGAACCATCGTGATCGCCCTCTCGACTGGCCGATATGCGCAGTCTCAG |

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| | <p>CGACTGACCCCTGGCGCTCGAGCACGAGGACCCCGAGTGATCTTCTGTCTAACGGCGCCGACCAGAACCGCAACGTGTACGGCCGAATCCAGTC CGCCGCCATCGGACAGCTGATTCGAGTGTGGCGACACGAGGCTGAGCTGGACTACCAGCGAGCCTCCGCCGTGGCGACCACGTGCTGCCTCCA GTGTGGGCCAACAGATCGTGCATTGCGCAACCGATCTCTCGAGGGAAGTCTGAGTTCGCTGCGCTGGACCGCTCAGTGTGCACTCCACGCG ACACATCAACGAGATTACCTGAAACATCCCGCCAACATCTCTGCCACCACCGCGCTCGATCTGCCTCTGTGGCTGGGCGGAGTCTCTGATCGG ACTGCACCTCGGCAAGGTGGCCCTCATTACCGGTGGATCTGCCGGAATCGGAGGACAGATCGGTGCACTGTGGCTCTGTCCGGTGTCTGAGTGA TGCTGGCTGCCGAGATCGACACAAGCTCGAGCAGATGCAAGCCATGATCCAGTCTGAGCTGGCTGAGGTGGGTACACCGACGTGAGGACCGA GTGCACATTGCTCCCGGCTGCGACGTGTCTCTGAGGCCAGCTCGCCGACCTGGTTCGAGCGAAACCTGTCTGCTTCGGCACCCGTGGACTACCT GATCAACAACGCTGGAATCGCCGGCTGGAAGAGATGGTGATTGACATGCTGTGGAAGGTGGCGACACACCTGTTGCTAACCTGATCTCCAA CTACTCTCTCATGCGAAAGCTGGCCCTCTGATGAAGAAGCAAGGCTCTGGCTATATCTGAAAGTGTGCTTACTTCGGCGGCGAGAAGGACGC CGCTATTCCCTATCTAACCGAGCGGACTACGCGGTGTCTAAGGCCGACAGCGAGCCATGGCCGAGGTGTTGCGCCGATTCTTGGGCCCCGAGA TCCAGATCAACGCTATCGCCCTGGACCTGTCTGAGGGCGACCGACTGCGAGGCCACCGGCGAGCGACCCGGCTGTTTGCCCGACGAGCCCGACT GATCTTGGAAAAAAGCGACTGAACGAGCTGCACGCTGCCCTGATCGCTGCCGCTGAAACCGATGAGCGATCTATGACAGAGCTGGTGAAGTGC TGCTGCCCAACGAGCTGGCTGCCCTGGAAACAGAACCCCGCTGCTCCACCGCTCTGCGAGAACTGGCCAGACGATTCCGATCCGAGGGTGACCT GCCGCTTCTTCTTCTGCGCTGTGAACCGATCTATCGCCGCAAGCTCCTGGCTGACTGCACAACGGCGGTACGTGCTCCCGCCGACATT TTTGTAACCTGCTAACCTCTCTGATCCATTCTTACTCGAGCCAGATTGACCGAGAGGCCGAAAGGTGCGAGATGGCATCATGGGCAATGTGT ACCTGCGAGCAATGCCACCGAGTTCGAGCTGCCATGGCCACCGTCTACTACCTGGCCGACCGAAACGTGTCCGGTGAGACTTTTACCCCTTCTG GCGGCTGCGATACGAGCGAACTCCACCGCGGTGAGCTGTTCGGACTGCCCTCGCTGAGCGACTGGCAGAGCTGGTGGCTCTACCGTGTA CTGATCGGCGAGCACCTACCGAGCACCTGAACCTGTTCGCCGAGCCTACTTGAGCGATACGGTGGCCGACAGGTGGTGATGATCGTCGAGA CTGAGACTGGTCCGAGACTATGCGACGACTCTGCAACGACCACTGCGAGGCCGAGCAGACTGATGACCAATTGGGTGCTGGTACCGAGATTGAGCC GCCATTGACAGGCTATACCCGATACGGTTCGACCCGGACCAAGTGGTGTGACCCCTTTCGACCTCTGCTACCGTGCCTCTGGTGGGCGGAAAA GGACTCTGACTGGTCTACCGTGTGTCTGAGGCCGAGTTCGCTGAGCTGTGCGAGCACAGCTGACCCACCACTTTCGAGTCGCCCGAAAGATTGC CCTGTCCGACGGCGCCTCTGTGGCCCTGGTGACCCCTGAGACTACCGCTACCTTACCACCGAGCAGTTCGCCCTGGCCAACTTCATCAAGACCAC TCTGCACGCTTTCACCGCTACCATCGGCGTGCAGTCGGAGCGAACAGCCAGCGAATCTGATTAACAGGTGGACCTGACTCGACGAGCTAGAG CCGAGGAACCCAGAGATCCCAACGAGCGACAGCAAGAGCTGGAACGATTATCGAGGCTGTGCTGCTGGTACCGCTCCTGCACTGCCACTGAGGCT GACACTCGATACGCCGACGAATTACCGAGGACGAGCCATCACCGTGTA</p> |
| Codon-optimized <i>MCR_{Ca-N}</i> gene sequence | <p>ATGTCTGGCACCGCGGCTGGCCGGCAAGATCGCCCTGATCACCGCGGAGCCGGCAACATCGGCTCTGAGCTGACCCGACGATTCTGGCCG AGGGCGCCACCGTGATATCTCTGGCCGAAACCGAGCCAAAGCTGACCGCTCTGGCTGAGCGAATGACAGGCCGAGGCCGGCGTGCCTGCCAAGCG AATCGACCTGGAAGTATGGACGGCTCTGACCCCGTGGCCGTGCGAGCCGCGCATCGAGGCCATCTGGGCCGACACGGCGCAGATCGACATCTCTG GTGAACAACGCCGGCTGTGCTGGCGCCAGCGACGACTGGCTGAGATTCCCTGACCGAGGCCGAGCTTGACCCGGCGCTGAGGAAACCTGTC ACGCTCTATCGCCAACTGCTCGGCATGGGCTGGCACCTGATGCGAATCGCCGCTCCTACATGCCCGTGGGCTCTGCCGTGATCAACGTGTCTA CCATCTTCTCGCGAGCCGAGTACTACGAGCAATCCCTACGTGACCCCTAAGGCCGCTCTGAACCGCCTGTCTCAGCTGGCCGCTCGAGAGCTG GGAGCCCGAGGATCCGAGTGAACCACTCTTCCCGGACCTATCGAGTCTGACCGAATCCGAACCGGTGTTCCAGCGAATGGACAGCTGAAGGG ACGACCCGAGGGCGATACCGCTACCACTTCTCAACCACTGCGACTGTGCCGAGCCAACGACAGGGTGCCTCGAGCGACGATTTCCTCTGT TGGGCGACGTGGCCGACGCGCGCGTGTCTCGGCTCTGCCGAGTCTGCCGCTCTGTCTGGCGAGACTATCGAGGTGACCCAGCGAATGGAAT GCCCGCTGTCTGAGACTTCCCTGTGGCCGAAACCGACCTGCGAACCATCGACGCTCTGGACGAACCACTCTGATCTGTGCCGGCGACAGAGA TCGAAGAGGTGATGGCCCTGACCGGCATGTGCGAACCTGTGGCTCTGAGGTGATCATCGGCTTCGATCTGCCCGCGCTCTCGCCAGTTGAG CAGGCCGTGAACGAGTCCGACGACTCGCTGGCGCCGACTTCACCCCTCTATCGCTCTGCCCTGGAATCTCGAGATCCGCCACCAATTGACGC TGTGTTGACTGGGGAGCCGCGAGAAACCCGCGGCATCCACCGCGCTGTGATTCTGCCCGCCACCTCTACGAGCCCGCACCTTGCGTGATCG AGGTGGACGACGAGCGAGTGTGAACCTTCTGGCTGACGAGATCACCGGAACCATCGTATCGCTCTCGACTGGCCGATACCTGGCAGTCTCAG CGACTGACCCCTGGCGCTCGAGCAGAGGACCCGAGTGTCTTCTGTCTAACGGCGCGACAGAACCGGCAACGTGTACCGCCGAATTCAGTC CGCCGCCATCGGACAGCTGATTGAGTGTGGCGACACGAGGCTGAGCTGGACTACCAGCGAGCCTCCGCCGTGGCGACCACTGTGCTGCTCCA GTGTGGGCCAACAGATCGTGCATTGCGCAACCGATCTCTGAGGGGACTCGAGTTCGCTGCGCTGGACCGCTCAGTGTGCACTCCACGCG ACACATCAACGAGATTACCTGAAACATCCCGCCAACATCTAA</p> |
| Codon-optimized <i>MCR_{Ca-C}</i> gene sequence | <p>ATGTCTGCCACCACCGCGCTCGATCTGCCTCTGTGGCTGGGCGAGTCTCTGATCGGACTGCACCTCGGCAAGGTGGCCCTCATTACCGGTGG ATCTGCCGAATCGGAGGACAGATCGGTGCGATGTGGCTGTGTCGGTGTCTGAGTGTGCTGGCTGCCGAGATCGACACAAGCTCGAGCAGA TGCAGGCCATGATCCAGTCTGAGCTGGCTGAGGTGGGCTACACCGACGCTCGAGGACCGAGTGACATTTGCTCCCGGCTGCGACGTGTCTCTGAG GCCAGCTCGCCGACCTGGTTCGAGCGAAACCTGTCTGCCCTCGGACCGTGGACTACCTGATCAACACGCTGGAATCGCCGGCGTGAAGAGAT GGTGATTGACATGCCTGTGAAGGCTGGCGACACACCTGTTGCTAACTGATCTCCAATACTCTCTATGCGAAAGCTGGCCCTCTGATGAAG AAGCAAGGCTCTGGCTATATCTGAACGTGTCTTACTTCGGCGCGGAGAAGGACGCGCTATTCCTATCTAAACCGAGCCGACTACGCCGTG TCTAAGGCCGACAGCGAGCCATGGCCGAGGTGTTCCGCCGATTTCTGGGCCCGGAGATCCAGATCAACGCTATCGCCCTGGACCTGTGAGGG CGACCGACTGCGAGGCAACCGCGAGCGACCCGGCTGTTTGCCCGACGAGCCGACTGATCTGGAAAAAAGCGACTGAACGAGCTGCACGCT GCCCTGATCGCTGCCGCTCGAACCGATGAGCGATCTATGACAGAGCTGGTGAATGCTGTCGCCAACGACGTGGCTGCCCTGGAACAGAAACC CGCTGTCTCCACCGCTCTGCGAGAACTGGCCAGACGATTCCGATCCGAGGGTGACCTGCCGCTTCTTCTCTTCTGCGCTGTGAACCGATCTAT CGCCGCCAAGCTCTGGCTGCACTGCACAACGGCGGTACGTGCTCCCCCGGACATTTTGTGTAACCTGCTAACCTCTCTGATCCATTCTTACT CGAGCCAGATTGACCGAGAGGCCGAAAGGTGCGAGATGGCATCATGGGCATGTGATCTGACGCGAATGCCACCGAGTTGACGTCGCCAT GGCCACCGTCTACTACCTGGCCGACCGAAACGTGTCCGGTGAGACTTTTACCCCTTCTGGCGGCTGCGATACGAGCGAACTCCACCGCGCGTG AGCTGTTGCGACTGCCCTCGCTGAGCGACTGGCAGAGCTGGTGGCTCTACCGTGTACCTGATCGGCGAGCACCTACCGAGCACCTGAACCTG CTTGCCCGAGCTACCTTGAGCGATACGGTGCCGACAGGTGGTGATGATCGTCGAGACTGAGACTGGTGGCGAGACTATGCGACGACTCTTGCA CGACCAGTCGAGGCCGAGCAGCTGATGACCATTTGGTGTGGTGAACAGATTGAGGCCGCCATTGACCAAGCTATACCCGATACGGTGCACCCG GACCAGTGGTGTGACCCCTTTCGACCTCTGCCTACCGTGCCTCTGGTGGGCGGAAAGGACTCTGACTGGTCTACCGTGTCTGTGAGGCCGAG TTGCTGAGCTGTGCGAGCACAGCTGACCCACCACTTTCGAGTCGCCCGAAAGATTGCCCTGTCCGACGGCGCTCTCTGGCCCTGGTGACCCC TGAGACTACCGCTACTCTACACCGAGAGTTGCGCTGGCCAACTTCATCAAGACCACTCTGACAGCTTTACCGCTACCATCGGCTGCGAGTC GGAGCGAACAGCCAGCGAATCTGATTAACAGGTGGACCTGACTGACGAGCTAGAGCCGAGGAACCCAGAGATCCCAACGAGCGACAGCAAG AGCTGGAACGATTATCGAGGCTGTGCTGCTGGTCAACCGCTCACTGCCACTGAGGCTGACACTCGATACGCCGAGCAATTCACCGAGGACGA GCCATACCGTGTA</p> |

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| <p>Codon-optimized <i>GAPN_{Sm}</i> gene sequence</p> | <p>ATGACCAAGCAGTACAAGAACTACGTCAACGGCGAGTGGAAAGCTGTCCGAGAACGAGATCAAGATCTACGAGCCCGCTCCGGCGCCGAGCTGGG TTCCGTCCCTGCTATGTCCACCGAGGAGGTGCGACTACGTCTACGCCCTCTGCCAAGAAGGCCAGCCCGCTGGCGAGCTCTCTTTACATCGAGCG AGCCGCTACCTCCACAAGGTCGCCGATATCTGTATGCGAGACAAGGAGAAGATTGGCGCCATCTGTCTCAAGGAGGTGCGCAAGGGCTACAAGT CCGCGCTCTCCGAGGTCTGTGCGAACTGCCGAGATCATCAACTACGCCGCTGAGGAGGGCTCGAATGAGGGGAGAGGTCTCTGGAGGGCGGGCTC CTTTGAGGCGCGTTCTAAGAAGAAGATTGCCGTTGTGCGACGAGAGCCCGTGGGACTGGTCTGGGTATCTCTCCCTTTAACTACCCCGTCAACCTG GCCGGTTCCAAGATTGCTCCCGCCCTGATTGCCGCGCAACGTCATCGCTTCAAGCCCCCACCAGGGTCCATCTCCGGTCTGCTCTCGCCGA GGCCTTCGCTGAGGCTGGACTCCCTGCTGGCGTCTTCAACACCATCACCGGCCGAGGCTCCGAGATCGGCGACTACATCTGCGAGCACCAGGCCG TCAACTTCATCAACTTCACCGGCTCCACCGGAATCGGAGAGCGAATCGGAAAAGATGGCCGGCATGCGACCCATTATGCTGGAGCTGGGAGGCAAG GACTCCGCCAATTGTCTCGAGGATGCCGACCTCGAGCTGACCGCTAAGAACATTATCGCTGGTGCCTTCGGTACTCCGGTCAGCGATGCACCGCC GTCAAGCGAGTCTGGTTATGGAGTCCGTGCGCGATGAGCTGGTGGAGAAGATCCGAGAGAAGTCTGGCCCTGACCAATTGGCAACCCCGAGGA CGACGCTGACATTACCCCTCTGATCGACACCAAGTCCGCTGACTACGTCGAGGGTCTGATTAACGATGCCAACGCAAGGGCGCCACCGCCCTGA CTGAGATCAAGCGAGAGGGAACCTGATTGCCCCATCTCTTCGACAAGGTACCACCGACATGCGACTGGCCTGGGAGGAGCCCTTCGGTCTCT GTGCTGCCCATCATCCGAGTTACTCCGTGAGGAGGCCATCGAGATCTCCAACAAGTCCGAGTACGGCCTGCAGGCCCTCCATCTTCAACCAACGAT TTTCCCCGAGCCTTCGGTATCGCTGAGCAGCTGGAGGTGCGCACCGTCCATATTAACAACAAGACCCAGCGAGGACCCGACAATCTCCCTTCCTC GGCGCCAAGAAATCCGGCGCTGGCAATTCAGGGTGTCAAGTACTCATTGAGGCCATGACCACTGTCAAGTCCGTGCTTCGACATCAAGTAA</p> |
| <p>Codon-optimized <i>GAPN_{Bc}</i> gene sequence</p> | <p>ATGACCACCTCCAACACCTACAAGTTCTACCTGAACGGCGAGTGGCGAGAGTCTCTCCGGCGAGACCATCGAGATCCCCCTCCCTTACCTCCAC GAGGTCTCGGCCAGGTTCAGGCCATCACCGAGGCGAGGTTCGACGAGGCTATTGCCTCTGCCAAGGAGGCCAGAAAGTCTGGGCCGAGGCCCT CTCTGCAGGACCGAGCTAAGTACCTGTACAAGTGGGCCGATGAGCTGGTCAACATGCAGGACGAGATCGCCGACATCATGAAAGAGGTGGGT AAGGGCTACAAGGATGCCAAGAAGGAGTCTGCGAACTGCCGATTTTCATCCGATACACCAATTGAGGAGGCTCTGCATGACGAGGAGTCTATG ATGGCGGACTCGTTCCTGGTGGAACTAAGTCCAAGTGGCCATCATCCAGCGAGCCCGCTGGGTGTCGCTCTCGTATCGCTCCCTTAACTAC CCCGTCAACCTGTCCGCGCCCAAGTGGTCCCGCTCTGATTATGGGCAACGCCGTCATCTTCAAGCCCGCCACCAGGGCGCTATCTCCGGTATC AAGATGGTGCAGGCCCTGCACAAGGCCGGCCCTCCTAAGGGTCTGGTCAACGTCGCCACCGGCCGAGGTTCCGTTATTGGCGATTACCTCTGTCGA GCACGAGGGTATCAACATGGTCTCTTACC GGCGGTACCAACCGGTAAGCACTCGCCAAGAAGGCCTCAATGATTCCCTGGTCTCGAGCT GGGCGGCAAGGACCTGGTATTGTCCGAGGAGCGCCGACCTGCAGGACGCTGTCAACCATCTGCTCTGGAGCCTTCTCTACTCCGGTCAGC GATGCACCGCCATTAAGCGAGTCTCGTTTACGAGAACGTCGGCCGATGAGCTCGTGTCCCTGCTCAAGGCCCAAGGTGCGCGAGCTGTCTGTGCGC TCTCCGAGCAGGACTCCACCATCTGTCCTCCCTGATCGACGACAAGTCCGCGCACTTTGTCCAGGGCCTGGTTCGACGATGCCGTGAGAAGGGTGC CACCATTGTTATCGGCAACAAGCGAGAGCGAAACCTGATTATCCCCACCTGATTGACCACGTGACCGAGGAGATGAAGGTGGCTGGGAGGAGC CCTTCGCTCCCATTTCTGCCTATCATCCGAGTTTCTCCGAGGAGCAGGCAATCGAGATCGCCAACAAGTCCGAGTTCGGAATCCAGGCCCTCCGTGT TCACCAAGGATATCAACAAGGCCCTTCGCCATCGCCAACAAGATCGAGACCGGATCTGTCCAGATCAACGGTGAACCGAGCGAGGACCCGACCACT TCCCCTTATCGGTGTCAAGGGCTCCGGCATGGGCGCCAGGGTATCCGAAAGTCCCTCGAGTCCATGACCCGAGAGAAGGTACCGCTCTGAAC CTGGTGTA</p> |
| <p><i>ACC1</i> (KEGG: YALI0C11407p)</p> | <p>ATGCGACTGCAATTGAGGACACTAACACGTGCGTTTTTTCAGTATGGCTTCAGGATCTTCAACGCCAGATGTGGCTCCCTTGGTGGACCCCAACATTC ACAAAGGTCTCGCCTCTCATTCTTTGGACTCAATTCGTCCACACAGCCAAGCCCTCAAAAGTCAAGGAGTTGTGGCTTTCACGAGGGTCATACA GTTATCAACAAGGTCTCTATCGCTAACAACGGTATTGCCGAGTAAAGGAGATCCGTTTCAGTACGAAAAATGGGCTACGAGACCTTTGGCGACGAGC GAGCAATCTCGTTACCGTCTATGGCCACCCCGAAGATCTCGCTGCCAACCGCCGACTACATTAGAATGGCCGATCAGTACGTGAGGTGCCCGGAG GAACCAACAACAACACTACGCCAACGTCGAGCTGATTGTGACGCTGGGTGAGCGGATTCGGCGTCTGATGCCGTGTGGGCGCGGATGGGGCCATGCC AGTGAATAATCCCTGTCTCCCGAGTCTGCTAGCGGCTCTCCCGCAAGATTGTCTTCATCGGCCCTCCCGGAGCTGCCATGAGATCTCTGGGAGAC AAAATTTCTTACCAATTGTGGCCAGCAGCAAGAGTCCCGTGTATCCCGTGGTCTGGAACCGCCGAGGTTCCGTTATGAGGTTGACAAAGCAAC AACCTCGTGTCCGTGTCCGAGGAGGTGTACACCAAGGGCTGCACCAACCGGTCCCAAGCAGGGTCTGGAGAAGGCTAAGCAGATTGGATTCCCGT GATGATCAAGGCTTCGAGGGAGGAGGAGGAAAGGGTATTCGAAAGGTTGAGCGAGAGGAGGACTTCGAGGCTGCTTACCACAGGTCGAGGGA GAGATCCCGGCTCGCCCATCTTATTATGAGCTTGACGGCAATGCCCGGCAATTGGAGGTGCGAGCTTCTGGCTGATCAGTACGGCAACAATATT CACTGTTTGGTCGAGATTGTTCCGTTACGCGACGGCATAAAAGATTATTGAGGAGGCTCCTGTGACTGTGGCTGGCCAGCAGACCTTCACTGCCAT GGAGAAGGCTCCGTCGCACTCGTTAAGCTTGTCCGATATGTCTTCGAGGTACCGTTGAATATCTGTATTCATGAGGACGACAAGTTCTACTTC TTGGAGCTGAATCTCGTCTTCAAGTCTGAACTCTTACCAAGGAGTGTACCGGCTGCAACCTGAGGCTTCCGCTTACGATGCTTCAAGGAGTGTG ATCCCCCTCGATCGAATCAAGGACATTCTGCTCTTTTACGGTGTAAACCTCACACCACCTCCAATTGATTTCGACTTCTCGGGCGAGGATGCTGA TAAGACACAGCGAGTCCCGTCCCGGAGGTACACCACTGCTTGCCGAATCAGATCCGAGGACCTTGAGAGGGGTTCAAGCCCTCCGGAGGTA CTATGCACGAGCTCAACTCCGATCTCGTCCAACGTGTGGGGTAACTTCTCCGTTGGTAAACGAGGAGGATCAATTGCTTCTCGAATTCGAGATT TGGTCACATCTTCGCCTTCGGTGAGAACCGAAGTGCCTCTCGAAAGCAGATGGTGTGTGTTGAAGGAACATATATTTCGAGGTGACTTCGAACC ACCGTCGAGTACCTCATCAAGCTGCTGGAGACACCGGACTTCGAGGACAACACCATCAACCCGGCTGGCTGGATGAGCTTATCTCCAACAAGCTG ACTGCCGAGCGACCCGACTCGTTCTCGCTGTGTTGTGGTGTCTTACCAAGGCCATCGAGCTTCGAGGAGCTTATTGCCACCTACATGGCTT CGCTAGAGAAGGGCCAGGTCCCTGCTCGAGACATTCTCAAGACCTTTTCCCGTTGACTTTCATCTACGAGGGCCAGCGGTACAAGTTCACCGCCA CCCGGCTGCTGAGGACTCTTACACGCTGTTTCATCAACGGTCTTCGATGCGACATGGAGTTAGACCTCTTTTTCGAGGTTGTTATCTGTGCTTGT GGTGGAGATCCCAATGTTCTACTGGAAGGAGGAGGTTGGAGCCACGCGACTGTCTGTGACTCCAAGACCTGCCCTTCGAGGTGGAGAACGA CCCCACTCAGCTTCGATCTCCCTCTCCCGGTAAGTCTGGTTAAGTCTCTGGTTCGAGAACGGCGACCACTGCGAGCCAACGACCCCTATGCCGAGAT TGAGGTATGAAGATGTACATGACTCTCACTGCTCAGGAGGACGGTATTGTCCAGCTGATGAAGCAGCCCGGTTCCACATCGAGGCTGGCGACAT CCTCGGTATCTTGGCCCTTGATGATCTTCAAGGTCAAGCATGCCAAGCCCTTTGAGGGCCAGCTTCCCGAGCTGGAGCCCCCACTCTCAGCGG TAACAAGCCTCATCAGCGATACGAGCACTGCCAGAAGCTGCTCCATAACATTCTGCTTGGTTTCGATAACAGGTTGGTATGAAGTCCACTTTCAG GAGATGGTTGGTCTGCTCCGAAACCTGAGCTTCTTATCTCCAGTGGGCTCATCAGGTGTCTTCTGCGACACCCGAATGAGCGCAAGCTGGAT GCTACTCTTGTGCTCATTGACAAGGCCAAGCAGCGAGGTGGCGAGGTTCTGCGCAAGCAGCTTCTCGAGGCCCTTGAGAAGGAGGCGAGCTCT GGCGAGGTGCGTCTCTCCAGCAAACTCTGCTCTCTGTTTACCTGTCTGAGAGTACCAAGGACGGTCTTGTCTTCCACGAGCTTCAGGTG CTCAGGCTTCTGAGGCTACTACGACTCTGAGGCCCGGTTCTCGGACCCAACGTAAGTACGAGGATGTATTTCTCAAGCTTCGAGAGGAGA ACCGAGATTCTTTCGAAAGGTTGTGATGGCCAGCTGTCTATTCTGAGTGGAGGCCAAGAACAACTTGTGCTGGCCCTTCTCGATGAATACAA GGTGGCCGACAGGCTGGCACCGACTCTCTGCTTCAACGTGACGTTGCAAAAGTACTTGCAGCTGTGCTGCGAAAGATTGTGGAGCTGGAAT CTCGAGCTTCTGCCAAGGTATCTCTGAAAGCCGAGAGATTCTCATCCAGTGGCTCTGCCCCTCTCTAAAGGAGCGAACTGACCACTTGTGACAT TCTGCGATCTTCTGCTGAGTCTCGATACGAGAGGTTGGTCTGGAGCACCAGAACTCCCGAGCGGATATTCTCAAGGAGGTTGTGACTTCAA GTACATTGTCTTGTGATGCTTGGCCAGTCTTGTGCCACGATGATCCCTGGATCGTCTTGTGCTCCGAGCTGTACATCCGACGAGCTTGAAG GCCTACTCCATCTGGACATCAACTACCAACGAGACTCGGACCTGCCTCCCGTCTATCTGTGGCGATTAGACTGCCTACCATTGCTGCTGCTTGT</p> |

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| | <p>ACAACTCAGTAGTGTCTTCTGGCTCCAAAACCCCACTTCCCCCTCGGTGTCTCGAGCTGATTCCGTCTCCGACTTTTCGTACACCGTTGAGCGAGA CTCTGCTCCCGCTCGAACCGGAGCGATTGTTGCCGTGCTCATCTGGATGATCTGGAGGATGCTCTGACTCGTGTCTGGAGAACCTGCCAAACG GGGCGCTGGTCTTGCCATCTCTGTTGGTGTAGCAACAAGAGTCCGCTGCTTCTGCTCGTGACGCTGCTGCTGCTGCCGTTTCATCCGTTGACAC TGGCTGTCCAACTTTGCAACGTTATGATTGGTCCGGTGTATGAGTCTGATGACGACGACACTCTGATTGCCCAATCTCCAGGTCATTGAGGAAC TTAAGGAGGACTTTGAGGCTGTCTCTCGCAGCAATACCTTCTCTCCGCAACTCCCGAGGTACTTATCCCAAGTATTTACGTTCCGAGGGCC CCGCATACGAGGAGGACCCCACTATCCGACACATTGAGCCTGCTCTGGCCTTCCAGCTGGAGCTCGCCCGTCTGTCCAACCTCGACATCAAGCCTG TCCACACCGACAACCGAAACATCCACGTGTACGAGGCTACTGGCAAGAACGCTGCTTCCGACAAGCGGTTCTTACCCCGAGGTATCGTACGACCTG GTCGTCTTCGAGAGAACATCCCCACCTCGGAGTATCTCATTTCGAGGCTGACCGGCTCATGAGCGATATTTGGACGCTCTAGAGGTGATTGGAAC CACCAACTCGGATCTCAACCACATTTTCATCAACTTCTCAGCCGCTTTTGCTCTGAAGCCCGAGGAGGTTGAAGCTGCCCTTGGCGGTTTCTCGGAG CGATTTGGCCGACGCTGTGGCGACTTCGAGTCACCGGTGCCGAGATCCGAATGATGGTATCCGACCCCGAAATGGCTCTGCTTTCCCTCTGCGA GCAATGATCAACAACGCTCTCGGTTACGTTGTGCTGAGCTGTACGCTGAGGCCAAGAAGCAAGGGCCAGTGGATTTCAGTCTCTGGGC AAGCCCGGCTCCATGCACATGCGGTCTATCAACACTCCCTACCCCAAGGAGTGGCTGCAGCCCAAGCGGTACAAGGCCCATCTGATGGGTATG AAGCTCTGCTATGACTTCCCGAGCTGTTCGACAGCTCATGAGTCGGAAGTATGACGCGAAGTATGACGCGAAGGCTCCCGACCATCTCATGACTTG CAACGAGCTGATTCTCGATGAGGACTCTGGCGAGCTGCAGGAGGTGAACCCGAGAGCCCGGCCAAACACGTCGGTATGGTTGCGTGGAAGTTTG AGGCCAAGACCCCGAGTACCTCGAGGCCGATCTTTCATCGTGGTGGCCAAAGATATCACTTCCAGATTGGTTCGTTTGGCCCTGCTGAGGACC AGTTCTTCTCAAGGTGACGGAGCTGGCTCGAAAGCTCGGTATTCCTCGAATCTATCTGTCTGCCAACTCTGGTGTGCAATCGGCATTGCTGACGA GCTCGTTGGCAAGTACAAGTTGCGTGGAACGACGAGACTGACCCCTCAAGGGCTTCAAGTACCTTTACTTACCCCTGAGTCTCTTGCCACCCCTC AAGCCCGACACTGTTGTCAACTGAGATTGAGGAGGAGGTCCAAAGCGCTGGAGAAGCGTCTATGTGATCGACTACATTGTGCGGAGAGAAGGA GGTCTCGGAGTGCAGTGTCTGCGGGGCTCTGGTCTCATTGCAAGGCGCCACTTCTCGAGCCTACAAGGATATCTTCACTCTCACTTGTGACCTGT CGATCCGTTGGTATCGGTGCTTACCTTGTCTTGGTCAACGAGCCATCCAGATTGAGGGCCAGCCCATATTCTCACTGGTGCCCGGCCATCA ACAAGTGTCTGGTCGAGAGGTCTACTTCTCAACTTGCAGCTTGGTGGTACTCAGATCATGTACAACAACGCTGTGTCTCATCTGACTGCCCGAGA TGATCTCAACGGTGTCCACAAGATCATGACGTGGCTGTACATACCTCCCTGCTTCTCGAGGTCTTCAAGTGCCTTCTCCCTCACAAGACCGATGTG TGGGATCGAGACGTGACGTTCCAGCCTGTCCGAGGCGAGCAGTACGATGTAGATGGCTTATTCTGCGCCAACTCTCGAGGATGGTGTCTTCGAG TCTGGTCTCTTGACAAGGACTTCTCCAGGAGACTCTGTCTGGCTGGGCCAAGGGTGTGTGTGGTTCGAGTCTCGTCTTGGCGGCACTTCCCTTCG GTCTATTGGTGTGAGACTGCGACCGTGCACAATACTACCCCTGCGGATCCCGCAACCCGGAATCTTGTGAGATGAGCACTCTGAAGCCGGCC AGGTTTGGTACCCCAACTCGGCCCTTCAAGACCTCTCAGGCCATCAACGACTTCAACCATGGTGAGGCGCTTCTCTCATGATTCTTGCTAACTGGCG AGGCTTTTCTGGTGGTCAGCGAGACATGTACAATGAGGTTCTCAAGTACGGATCTTTCATTGTTGATGCTCTGGTGTGACTACAAGCAGCCCATCATGG TGTACATCCCTCCACCGGTGAGCTGCGAGGTGGTCTTGGGTTGTGGTTGACCCACCATCAACTCGGACATGATGGAGATGTACGCTGACGTGCG AGTCTCGAGGTGGTGTGCTGGAGCCCGAGGGAATGGTCGGTATCAAGTACCGACGAGACAAGCTACTGGACACCATGGCTCGTCTGGATCCCGAG TACTCTCTCTCAAGAAGCAGCTTGAGGAGTCTCCCGATTCTGAGGAGCTCAAGGTCAAGTCAAGCTCAGCGTGCAGAGGATCTCTCATGCCCATCTAC CAGCAGATCTCGTGCAGTTTGGCGACTTGCATGACCGAGCTGGCCGAATGGAGGCCAAGGGTGTTCATTGAGTGGTGTGTTGTTGGAAGGATGTCT CGTCGATTCTTCTTGGCGAATCCGACGACGATTAGTCGAGGAGTACCTCATTACCAAGATCAATAGCACTTCTGCCCTCTTGCACTCGGCTTGAGTG TCTGGCTCGAATCAAGTCGTGGAAGCTGCCACTCTTGATCAGGGCTCTGACCCGGGGTGTGCGCGAGTGGTTGACGAGAATCTGATGCCGTCTC TGCTCGACTCAGCGAGCTCAAGAAGGACGCTTCTGCCAGTCGTTTGTCTCAACTGAGAAAGGACCGACAGGGTACTCTCCAGGGCATGAAGCA GGCTCTCGCTTCTTCTTCTGAGGCTGAGCGGGCTGAGCTGCTCAAGGGTGTGTA</p> |
| Codon-optimized mutant ACS ^{L641P} _{Se} gene sequence | <p>ATGTCCAGACCCACAAGCAGCCATCCCGCCAACATCGCCGACCGATGCTCATCAACCCCGAGCAGTACGAGACCAAGTACAAGCAGTCCATC AACGACCCCGACACCTTCTGGGGCGAGCAGGGAAGATCCTCGACTGGATCACCCCTACCAAGAGTCAAGAACACCTCTTCGCCCCCGGCAA CGTCTCCATCAAGTGGTACGAGGACGGAACCTGAACTGGCCGCTAACTGCTGGACCGACACTGCGAGGAGAACGGCGACCGAACCGCCATCA TCTGGGAGGGCGATGACGCTTCCAGTCCAAGCACATCTCTACCGAGAGCTCCACCGAGACGTTTGTGATTGCGCAACACCTCTGGACCTGG GCATTAGAAGAGGGCGAGTCTGCTGCTATTATCAAGTGGTCCATGGTCCCGAGGGCGCGTCTGCTATGTGGCTGTGCGCCGAATTGGCGCCGTTCACT CCGTCTCTTTCGGCGGTTTTTCCCGGAGGCCGTTGCCGGTCAATTATCGACTCTCTCTCCGACTGGTTATCACTGCCGACGAGGGCGTTTCGAG CCGGCCGATCCATCCCTCTCAAGAAGAACGTTGACGATGCTCTGAAGAACCCCAACGTCATTCGTCGAGCAGCTCATCTCTCAAGCAACCG GTCGACATCGATTGGCAGGAGGGCCGAGACCTGTGGTGGCGAGACCTGATTGAGAAGGCTTCCCGGAGACACAGCCTGAGGCTATGAAGCG CGAGGACCCCTGTTCACTCTGTACACCTCCGGCTCCACCGGCAAGCCCAAGGGAGTCTGCAACACACCGGCGGTTACCTGGTCTACGCCGCCA CCACCTTCAAGTACGCTTTCGACTACACCCCTCCGACATCTACTGGTGACCGTGACGTGGGTCACCGGTCACTTCTACCTCTCTGTACG GCCCTCTGCTGCGGTGCTACTACCTGATGTTGAGGGCGTCCCAACTGGCCTACCCCGCTCGAATGTGCGAGGTGGTGAATAAGCATCAG GTGAACATCTCTACACCGCCCCACCGCCATCCGAGCTCTGATGGCTGAGGGCGACAAGGCTATCGAGGGCACCGACCGATCTCTCTCGGAAT CCTGGGATCTGTTGGCGAGCCCATCAACCCCGAGGCTGGGAGTGGTACTGGAAGAAGATTGGTAAGGAGAAGTGCCCGTCTGTTGACACCTGGT GGCAGACCGAGACCGGAGGCTTCATGATTACTCCCTGCCCGGCGCATCGAGCTGAAGGCTGGTCTGCCACCCGACCCCTTCTCGGAGTGCAG CCCGCCCTGGTGACAACGAGGGTCAACCTCAGGAGGGTGCTACCGAGGGCAACCTCGTCTACTGATTCTCTGGCCCGGCCAGGCCCCGAACCC TGTTTGGTGACACGAGCGATTTCGAGCAGACCTACTTCTCACTTTAAGAATGTAATCTCTCCGCGCAGCGCGCCGACGAGACGAGGACGGGT ACTACTGGATCACCGCGGAGTGCAGATGTGCTCAACGTCTCCGGCCACCGACTGGGCCACCGTGAAGTCCGCTTCTGCTGCTCAACCC AAGATTGCCGAGGGCGCGTGGTGGTATTCCCATGCTATTAAGGGCCAGGCCATCTACGCTACGTTACCTGAACCACGGCGAGGAGCCCTC CCCTGAGCTGTACGCTGAGGTCCGAAATGGGTGCGAAAGGAGATTGGCCCCCTGGCCACCCCGACGTTCTGCACTGGACCGAATCCCTGCCCCA AGACCCGATCCGGTAAGATCATGCGACGAATCTGCGAAAGATCGCCGCGCGGATACCTCGAACCTGGGCGATCTCCACCTCGCCGATCCC GGTGTCTGCGAGAAGCCCTCGAGGAGAAGCAGGCCATCGCCATGCCCTCTCTAA</p> |
| ALD6 (KEGG: YALI0A17875p) | <p>ATGTCTGGGAAACAATCACTCTCTACGCCAATCGATAGTTTGACAGCAACTTGCAACGCTCTCGAGACTCTTTCGAGACCGGCAAGCTCGACTC TGTCGACTACCGTCTCGAGCAGTGCGAACCTGTGGTTCAAGTTCTACGACAACCTCGACAACATCTACGAGGGCGGTACCAAGGATCTCCATCGA CCAGGTTTCGAACCGAGCTACCGAGGTACTGTTGTTGAGAGCAGATTCTCCACCGTATCAAGAACCTGCGAAAGTGGGTCAAGGAAGAAAAG GTGGAGAACCCCGGAGGCCCTTCAGTTTGCCAACCCCGCAATCCGACCCGTTCTCTGGGAGTGGTGTGTTGTCATCTCCCTGGAATACCCC GTCATGCTCAACATCTCACTGTGATTGCCGCCATTGCTGCGGGCTGCCATCGTGCTCAAGATGTCGAGCTGTCTCCACACTTCCGCTGTGTT TTGGCCGAATCTTCAAGGAGGCCCTGGACCCCGGATCATCAGGTTGTTTACGAGGTTGTCTCCCGAGACCAACCGCCCTTCTTACCAGCAATTGGG ACAAGATCATGTACACCGGAACCGAGCCGTTGGTCAATATCGCCAGGCGCGGTCAAGAACCTGACTCTCTAGCTCTTGAAGTGTGGTGGCA AGTACCCCGTGTATCACTTCCAATGCAAGAGCGTTATGACGCGCGCTCGCGGAATCGTGTGGGGCAAGTTTGTCAACGCGGCCAGATCTGTG TCGCTCCAGACTAATTCTGGTGTCTCCGAAAAGGAGGCGAGCTGTCGCTGTATCAAGGAGGTGCTCAAGAACGATACGGCTCCAAGAGAG ACGCCACACCCCGATCTGTCCATATATTCCAAGCCCCATTGGAAGCGTATTCAACATGATCGCCGACCAAGGGAGACATCCAGGTGGG TGGACTCGAGAACGCGACGAAGACCAAAAGTTATCCAGCCCAATCGTCTCCAACGTTCCAGATGACGACATTTCTATGACGAGCAGATTTTC</p> |

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| | | GGACCCATCATCCCCATCATTAAGCCCCGAACCTCGGCCAGCAGGTTGATTACGTCACAAGAAACCATGACACCCCCCTGGCCATGTACATCTTCT CTGACGACCCCAAGGAGGTGGACTGGCTACAGACCCGAATCCGAGCTGGTCTGTAAACATCAACGAGGTCATTGAGCAGGTGCGACTGGCCTCTC TGCTCTCAGTGGAGTTGGAGCTTCGGGAACCGGAGCATACCATGGAATAATTCTCTTCGATGCTTCAACCCAAAGCAGGCCGTTATGGGACAGCC CACTTGCCCCCTTCTTTGAATACCTCATGTATTACCGGTACCCTCTTACTCCGAGTACAAGATGAAGGTGCTCCGAACCTCTTCCACCGGTTCTGTAT TCCTCGAACCGGCCGACCCGACGCTACTGTTCTTCAGCGAGTCTCGGCAACAAGCTGCTTTGGATCATATTATGCCGCCCTTGTTCGTACGCCA AACGAAATGAGCTGCTCATCACCATTGCTCAGATTATGTCGGTGTATTATTAAGTAG |
| | MLS1 (KEGG: YALIOD19140p) | ATGACAGTCAACTCCACTTTTAGATCGGCATCAACTTCCCCGAACTGGGCAAAACAGCCAGGCAGACATCCTGAGCCCCGAGGCCAAAAGTTCC TGTTGAACTCCACAGCAACTTCAACCAGCGACGTCTGGAGCTCCTTGATCTGCGTCAGAAGAACCAGCTCAAGCTCGATGACGGCGAAATCCCCA CGTATCCACGGAAACAGCAGACATCCGAGCAGACAAGTCGTGGACAGGTCCATCTCTGGCTCCCGGTCTCCATGACCGACGGGTGCAATCACTG GCCCCCAGACCGAAAGATGATCATCAACGCCCTCAACACAAACGTCGCCACCTACATGTCCGATTTCGAGGACTCCCAAGCCCCACCTGGGACA ACTGTCTCGATGGGCAAGTCAACCTGTACGATGCCATCCGAAACCAGGTTGATTCGACACAGAGAAGAAACCTTCAAGCTGACTACAAGAAGGTG GACCGAGGGGACCTACTCTAGAGGCTCCACGGACACTCGACCCACTCTTTTGGTGCGCCCTAGAGGCTGGCAGATGCTCGAAAGCCATGTTTCAGAT CGATGGACAGAGCATGTCTGGGTCTCTGTTCGACTTTGGACTCTTCTTCTCAACAACGCCAAGGCTCTGATTGAGGCTGGCCGAGGCCCTTACTTTT ACCTCCCCAAGATGGAGCATTATCTCGAGGCTCGACTCTGGAATGATGCTTTGTTTTCTCTCAAACTACTCGCGAATCCCCCAGGGCACCATTCTGA GCTACTTGTCTGATTGAGACTCTTCTGACGCTCTGCACATGGAGGAGATCATCTACGAGCTGCGAGATCACTCTGCCGCCCTCAACTGTGGTCGAT GGGACTACATGTTCTCAGTTATCAAGCGGTTCGAAACCAGCCGAGAAGCTGCTTCCTGACCGAAAGATGATCACCATGACCGTTCCTTTCATGAAC GCTTACGTGACTCTGCTGTGTTACGTGTGTACAAACGAAAGGTGCATGCCATGGGAGGTATGGCTGCCATCATTCTCTCAAGGATGCTGCGGAGA ACGCCCTTGCCATGGAGAAGGTCAAGGCTGACAAACACAGAGAGGCTCTGACGGCTGTGACGGTACCTGGATCGCTCATCCCGGTTTGGCTGAGA TGCCACCAAGGAGTTTGACGAGTTGATGCCAGGGGAAACCAATTTGATTTCGTGCGGAGAGACGTTCCCTCCGAGCAAGCTTGGATCTACCCAT TGAAGGCTTTGCCATCACCAAGGAGGTTCTCAGGAGAATGTCTACATTGGTCTGCGCTACATGGAGGATGGCTGCGAGGGTTGGGATGTGTGCC CATCAACACCTCATGGAGGATGCTGCTACTGCCAGGTTTCTCGTGCCAGCTGTGGCAGTGGACCAAGCAGCGCAAGTTCACCAAGGAGGAGGT ATTGGAGATGATTTCCAGGAGGCCGAGAAGCTGGGAAACACCGACTCTGTCAAGCGAGCAGGCGAGTTGCTGGGATCTGAGATTGGCGGCATTT TGCAGAGTTCCTCACCGATCTGCTGTATCCTGATCTGGTTGAACAGTAG |
| | MLS1 up homology arm 1000bp | AGGAGGCGCAGGGAGCATCTGAAAGATTAAAGCACACGTTTCGATCTAGCACATGTTGATCTAGCACGTTTCGATCTAGCACGTTTCGATCTAGCAC GTTTCGATCTAGCACCACTTGATCAATAAACGCCCATAAACCATTGTGCTGCTGACTTTGGCCCCCACACATATCTCCGTTCACTGAGTCAATTAC TGAGTCAAGCACTCCCAATTCTGGGTGTATATATGACAGGGTCTCACCGTACGTTAGACGCAGATTTTGTATGATGTTCCGTGCTCCGAGAGAG AGAGACCTAACAGTGCCTCATCTAAGAGATACTGCAATTCTCAAGGAGGGTTGGGTAGCACAGTACATATCTGTATCATGGTCGAGTTGTACTACC GTACCGTAATCTACTAGAGCTACAAGCCCCACCCACGATAAACACTGGGTATTCTTGGCCATATTGGTTGCAAGTGCACTGTTTCGCTTGAGATCC ACCCGACCCCTCTCCGAAACCGGATCATATATCCGTGCGCTGTCTCCCACTGTATCTTTCGCGCCGCGCAGCAATTTAGACGCGGGAGTCTGG AGATGAGCGATAAGTTAATCGGCCGATATTTCGGATGGATGGAAGATGGCTTGTGTGGCGTTTGAGACAACGTAAGGAGGGTGGATTTTGGCTGACA GGGTAAGCGACACGACAGCCGAAATCTGGGTGTCAGAATCGCCCTCACGGGTCCAGATCCCGAGTCGGACACCCCACTGTGCCCACTTTTT CTTTAACTCCCGTCACTCCATGCGGCCAAATAAAAAAATAAACTCAAGGTTGCTGATCTCATGACCCCGGATAACAGGTCGGTTCTCCGTT CATGTACCATGACACACAGATACCAAGATGTATATATAGGTAGCGGGCCGTCTACGTTACGCCCAAAACCTCAACGTCGCTCCATTACACACAC ACACACACACACACACACACAAAC |
| | MLS1 down homology arm 1000bp | GTGGGATGACGAAGAGTATTATTAAAGTAACGCGTTATGATTAGAGAGGACTGCCGGTTGGTGGAGAAAAGGGGATGTAAAATTTAACAAACAGC AGGTACAGTACATACTGTACTTGTAATTGTACTATAGATGTATTCGTAATGTGAGATTAACTCTGTTATCTACCTGCAAGGTCGGGCTTACACATC TTCCTTTTTCTTGAAAGCCCCGTTGACATAGAGTGAATTTCCCGTAGGAACACGACCATGCCTGTAATAGTGCCGCGGTTAGTAGCGACTCCATAG ATGGTAATAGGCGTTATGGAGTTGATGTCCGTCCAGGAGTAAGTGGAATATTTGCTTTCGTCCATTCCGATGTTGGTGTGACGATAACGATGATGAA GGTACATCAAGAGATATCAAGAGGTTCCCTCATCGACACACAGATACCTTTTGTTCGGAATCCTTATCATCAGGCCGTACGGATCTACAGGTA AATACAGTATCTACTCGTGAAACGCTTCCATGGACTGCTTCTTTGTGAAAGGGCGGTGCTAGGGACAAGCAGAATCTCAGATTACAAGATTATACC CAGTGTCTGATTTACCCCTTTTTTTGTACGAGCTTGTGCTTCAGATATATCGGATATTGTCAATTCTGACGTTGCGGTGTTCTATCTCGCAT GGGGATGCACTATCCAAGCACCTGGTTGTGTCGCTGTCTGTAATTTGTGTTTGTATCTGGACCGTATGTAAACCTCAAGTGAGCAITTTCAAGACGC GAACACTTGTCTAACGTGACGGGGAACAGCAGATATATCAGATACTACATTTTTCCAGTCTGTACATCTCTTGGATACGGTAGACATTACAGTG CTTACCAGATATGGAAGTAGAACTCATCAGAACAGAACTGTACTTCTCTGACATCCGTTTGATAGAGTCGTACAGAATCAITTCGTACAAAGTATTGT AACCTCTACTATCGAAGA |
| | CIT2 (KEGG: YALIOE00638p) | ATGATCCCTCTTCGAACCGCCCGTGTGCCCCAACCTCCGTGCTCCATGGTCCAGAAGCGATTGCTTCTGACCTCAAGGGCGCCCTCAAGGAG GCCATCCCCGCCAAGCTGGAGCTCTTCAAGAAGGTCAAGTCCGAGTACTCCAGAAGTCTCTCGGTGATTGCAAGGTGCGAAGCTGCTCGGAGGC ATCGAGGCTCAAGTGCATGCTCTGGGAGGGCTCCGTTCTTGACGCTGATGAGGGTATCCGATTCCACGGCAAGACCATCAAGGAGTGCCAGGA GGTGCTCCCAAGGCCGTTGAGGGCGGCGAGATGCTCCCGAGTCCATGCTGTGGTTCTCTTACCGGCAAGGTTCCCACTGAGGAGCAGGTCC GAGGCTGTCTCGAGAGCTCGCTGAGAAGGGCGAGGTCCCGAGTTGTGTAACAAGATGCTCGACAACCTGCCCTTACCTGACCCCCATGACC CAGTTCTCCATGGCCGTGTCTGCCCTTAACCAAGACTCCAAAGTTCGCCAAGGCTACGAGCGAGGTATCCCAAGTCCGAGTACTGGAGTACACC TTCGATGACTCCATCGACCTCATTGCCAAGCTGCCCCAGATTGCCGCCAAGATCTACCAGAACTTACCTTGGTGGAGGACCTCTCCCCGGCAAGA TTGATCTCAACCGAGACTGGTCTTACAACACGCGCTATGATGGGCAAGGGCGATGAGACCGGCTTCGTTGATCTCTGCGACTCTACTTGTCTCT CCACGGTGACCACGAGGGAGGAAACGTCTCTGCTACGCCACCCACCTGGTTGGATCCGCTCTGTCCGATCTTACCTGCTTACTCTGCTGGTCT CCAGGGTCTTGTGGTCTCTCCACGGCTCGCCGCCAGGAGGTCTCGGATTCATCTCTCGACATGGAGATGGAGAAGCAAGCTGCCAAGGGGTACTCCA ACGAGGACCTCGTCAAGTACCTGTGGTCTGTCTCAAGTCTGGCCGAGTATCCCCGGTTACGGCCACGCCGTTCTCGGAAAGCCTGACCCTCGAT TCGAGGCTCTGATGAATTTGCCAATCTCGACAGGAGATCCGAGACGCCCGTCTTCAGCTCGTTTCCGAAACCTCCGAGGTTGCCATGCGCG TCCTACCGAGCACGGCAAGACCAAGAACCCCAACCGTGCAGTCTCTCTCCGGTGTCTCTTCCACCACTACGGTATCCAGGAGACTCTGT ACTACACCGTCACTTTCGGTGTGTCCGAGCTCTTGGTCTCTGCTCAGCTGGTCTGGGACCGAATTCGGGTCTTCCATTGAGCGACCCAAGT CTCTCTCTCGAGGAGATTATTAAGGTGCGCAAAATA |

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| <p><i>CIT2</i> up homology arm 1000bp</p> | <p>GGTATTATTGTGTTTTGCATCACCAATTGCTGCCATACTGGGTCGCAATAAATATCTCCAAGCCGGAAATATAGGGGTGTCCGGTATATCCGGAGCCG CACATCTCTTCTGATTCCACTCGGTGTTGTGTATGGTCTGTTCAGCTCTGCCCTGGTTACCTTACCGGCCCAACAAGGTGGTCGAGGCATCAAACC TGACCCCCACAAAACGTGGGGAATGGGCCGAGATGACCGATCTAGACTATAGTGTGAATTATATATCAATTGGGTAGGGAAGGAGAGAATCGT TTCTCTGAGGCTGCACAGCCGAGAAAACGTATCTGGTTTAATCCCATTGCTCTCACACACATTCTACAAACAGTCGTCGATCCTAAAAACCTTACCCC CGCGTACACCTCAATTGTATTTCACGTTTTCTCTCTCGAGGTCTAACACTCTCAAAACATCTTAGTGTACTCCATGTGATGGGCTCCGTGAGTACAGG AGACAATCATGGGGAACGCGCCGAATTTCTGTACCGGTCAATAAAAGATCCAATTGCCAGGAATTTGCAGGCAATGAATAATAATGTCAGGCGCG GGGCCCTTTGTTCAGAACCCCTCCGAGAAAGCCGGGTCGGACGTGTCCAAACTCAAACGTACAGAGTTTATGGAGAAACGGATATTGGAGGAGTTGG AGCCCACTGGTTATACTGTAATTGGCTGATCTGAGAGCCCTAAAAAGACACATAAGCAAAATTTCCCATCAATTGCTCTGTGTTCCAGCTTTACTTATC TTTCCATCTGTCCACACACCATCTCTATCTATCCGTCTGTCTCGGCTCACCCTCGGCATTCAATTACGCATACAAAGACAAGGTTAACCGGAGG CCCGTTTGTGCTTTGGCTATTGGGCTGATTGCCACGAGCCAGCTTTATATAAGGAAGTGAGCCTGCCCGCTCTGAACAAGGTCTAGAGTCTTCG TAACTAACCCACACATCAACACA</p> |
| <p><i>CIT2</i> down homology arm 1000bp</p> | <p>GCGAAGTATAGTTGATATGATTACGATGTTTTGAGCAAGCACAGCAGAGATGCTTGAAGATTGTAGATACAGTACCTGCATGAACTAGAATTTGA TTCGTGGCAATAGTATCCACCCGAAAAAGACCCGAAAGACCCGGCACAAATGATCCGGTCTTCTCTGTGCTTATGACCAACCTCACATGTTCTCC CCAACTTTGTGAGACTCGGATGTGGCAATTGTGGCACAAAGTGAGACAGTGAGCCACGGTAAGTTAAGCGCCTTCGGTAGTGGCTGTTTTGAGAGAAAT TGCACTGTGAACAGTAGCTCTGTACATACTGTACAGTACTGTATATAAAATTTAGTAGTTCCTGTGTCAGTACACATGTGCGTTACATTAGCACCG CGGCGGTATGGAGATTGTCTAAGGGGTGATTATCACGCATGAATGATGCTTGTCTCCGGATATATGGCATGCACCCGATATATGGCGTGACCCGTATA TCGTGAGCTCTACGCTCACGATATAGCTCACGATATACGGTATTATTGAAAGCCAGTTTTGTGACTTTCTGGGATATTCCCATATCATGTTACGTA GTCTTCGTGCGTGTAATTTCTGACACTGACTAAAGTAAAGTCCAATTCTACTCTATCAAAAGTTATTCTATAACAACAGGCTATGCTCACATCGATCTT ATTAATTATACAGTAACACACATTTTTATATTTTAGAATCAATACTTTGCTTAAAAAACAGTAAGATATGGATGCTCAACACAGACCCATTAGTCT CTCACAGACTCCATCAAGTAACGACTCTCACTCAATTGCTCTCAATGCTTCCCAACAGGATCACTGGAACGGTGAGAAACAAGGGGATGAGCGTGAA GCATTTCCGAGATATAAACGTTCTGTATGCCTATTTATCTCTGACAGAAGATGATTGCAGTAACCAAGCGTTACGGACCATAATGACCCCAATGA AGGCGTCGGCACCT</p> |
| <p><i>MMSDH</i> (KEGG: YALIO01859p)</p> | <p>ATGCTCAGCAGATCGACCCGACTGGCTCGAGTGGTCCAGACCTCCACCCGGCTCTACTCCACTGCCTACCCCACTACCCATGCGAAAAATCGAGAAC CCCGTGGACACCAAGGCGTTCTCAACCGGCCAAGCAGTCGCCTCCAAGGTACCACTGGTTCGATCTCCATGACCCCGCAACAACAACCTGGTG ACGCGAGTCCCCAGTCCACCGACGAGGAGATGCGACAGGCGCTCGAGGCGGCCAGAAAGCCCTTCTCACTTGGAAAGACACCTCCATCATGCA CAGACAACAGGTGGCTTTCAACTTTGTGCGTCTGATCCGAGACAACCTGGGACCGACTCGCCGCTCCATCACTCCGAGCAGGGCAAGACCTTTGC CGATGCCAAGGGAGACGTGCTCCGTGGCCTTCAGGTGGCCGAGCAGGCTGCTCCATCCCAACACCTCTATGGGCGAGTCCCTGGAGGTGGCC AAGAACATGCAACCGAAATGTACCGTGAGCCTCTCGGTGTGCTGCGGCCCATTTGCTCCCTTCACTTCCCGCAATGGTGCCCTCTGTGTCATCC CCCTGGCTCTCGTGACCGGTAACTCTCATCTCAAGCCCTCCGAGCGAGATCCCGCGCTGCTCTCATCTCGCCGAGCTCATCAGCAGGCGCG GTGCCCCCTCCCGAACCGTCAACATTATCCACGGAGGCGCCCCACCGTCAACTTCTATCTGTGACGCCCCGAGATCAAGGCCATCTCTCTCGTTG GAGGTGATGCTGCCGGCAAGCACATCCATCAGCGAGGCGGAGCCAAACGGTAAGCGAGTTCAGGCCAACCTGGGCGCCAAGAACCACTGCGTTCTG ATGCCCGATGCTGACAAGAACTTTGCTCTCAACTCTATTGTCGGCGTGCCTTTGGCGCTGCGCGGCCAGCGATGCTGCTGCTCACTCCCTGCTG ACCACCGAGGCAACCGGCTCGTGGATGCCCGAGCTTGTGCGAGCTGCCAAGAAGCTACCATTAACGGTGGCTTTGAGGCTGACGCCGATCTGGG ACCTGTCTATCTCCCGCGGCCAAGGCCCGATGTGAGGCTCTGATCCAGTCTGCCATCGACGAGGGAGCCACCGTTCTGCTCGATGGCCGAGGAC AGCACCCCGCAAGTACCCCAACGGTAACCTTATTGCCCCACCATCATCACCGGTGTCAAGCCCGGCATGAAGTGTCTAGCACCAGGAGATTTTCGG CCCCGTTCTTTGTGCTTTGATACCAACCGATCTTGACGACGCCATTGGTCTCATCAACCGAAACAAGTACGGCAACGGTGCTGCCATCTTCAACCGAT CCGGTGTGCAAGCAACAGTTCCAGAAGCAGATCCAGGCCGGCCAGATTGGTATCAACGTGCCATCCCGTCCCTCTCCCATGTTCTCTCTCA CCGGAACAAGGCTCCTTCTGGGCGACCTCAACTCTACGGCAAGGCTGGTGTATGTTCTGACCCAGTACAAGACCGGTGACCAACCGAGTGGC GAGACGAGGATGTACCTCCAGAAAGGTGATGTTATCATGCTTACCCAGAGCTAG</p> |
| <p><i>MMSDH</i> up homology arm 1000bp</p> | <p>CCAGACACAGCAGTTTGGTCCGGCGTAAAGTGCATTGCTGTGTTCTGGAGATACCAAGTATCAATACACCATCTCCACGTGCTAAACGATCG GTAAAGTCCCTATTTGACCCATACTGGGCCATTAAACCTATTAACCTGATATATAAAACCAAAACCGTCTCAACAAAAGTCGATCCGCAATTTTGG CCGACCCGACCCGGGTCCGATGCGGTGCGGGGTGCATACAGAAATACGGTGAAATTTCCGTGCCAAAAAAATTAATAAAATTAATAAAATTA GTCAAGATTCCGAAGAATACAACCTCCACAGTGAAGTGAAGTCCGACGCTAATTACACCTTTTAAACGCCCAATAAATGACCGGCAAGACAGGTATG TAAGAGCAGCAGTAGTTTGGCGGTAAAAACCGTCTCCAGCGCCCAAGAGCCCGATTTCGACAAAACCAAAAGCCTATCATTTTGTGGACAGCT GCCGAGAAATGGCCGGGAGAGACAATTCAGCAGCTCGCAAGCTTTTCGAGGGCCACAAAACGGACCTGTGCCTGACGAGCTCGTTTCAATTGAGTG ATTCAAGACAGAGTTTGAACCGGTGGGGTGTGTTGACGCGAAAAGTGAAGTCTGTTTGGTATTAGTGCCTACCCACAGTCTGTGCGTATCATGTAGA CTATATACTATCTACACGGCTATTGGAGTGGTCCGAAGGGGTGATGTTTAAAGGCGCGGTAGGGGGGATAATGAAATATGAAAAGTGGCTTTTGAT CAGCTCGTCGCCAGAAATCTAATAACGTGTTTATATTTCCACATTATCCCCAAAGCCCTTTTGGTGTGCTTTGCCCCCTCTTATCTCTCTCA TCCTGCATGGTTAAACCTTCGTCTCTCACCCACGTTTACCGCACCCAAAGTATATATATACCCCAAGCTTACCCAAAACTAACATTTTCAACTTTC TCCCTTCACACCTCCGCCCACACA</p> |
| <p><i>MMSDH</i> down homology arm 1000bp</p> | <p>ACCGTGAGTGAGCAGTCTTGCCGGTGACCCAGTGACGATGTTCTACAGTTCAACATGCCGAGAATGGCTGGACTGTGAAAAGTATATAATGATGAT ATGATTGAAATACGAGAAGTGACTGCGCATGCTTGAGGTACGAATCACGTGATTTTATTGTTGCTAGGGTTTACATCACTCCAACACATCTCTCCACAA AAATTGTTAAGTAAATTGGTCACTTTATCAACGGGTGTTCTCGGCTATCGACTGTGCCGTTAACGGGGAAGTATGTTAGCTGTACCCAAAGGAAAGA TTATGTGAGAGTTGCGTGTATTGTGCATCTCCGGTGCAATTTCCGATGCTCTGGCATCGAAAGGAGTCCGTCCAAGTCTCTGAATGACCCGTTAGTT GAATCCGGTGTGGGTGTCTCTCGCGTATCAGITTCGGCGGTGATTAGTCTGTGTGATTAGTCTGCTGCGATTAGTCTGCTGTGATTAGTTGCT GTGATTACAAGAGCTGTTTTGGAGGGGGTAGGTCTTCTGTAGTCTTTCACATCATGTAGGCTACTTGAACCTCCGCTGGCAATCTGTGGACTTCTTTGG GGTAGTGGATCTCGACAGTTCCTTCGAACGCTTGATCTGAAGGATGGGTGACAGCTACTGTAAAGGCGCGAACATGCACCCCTGGTTGGTATACAT GAGCAGTACTGTAAATCGGACTGGAATGTGAGGAGGTGCAAAAGCTGTGACATCTTAGAGATGAGTACAGAGCAGTACACTACAGCACCATACAC TACAGCACCATACACTACAGCACTGTACAATAACAACACTGTACAATAACAACACCGTTTTTTATGTCATGTTACTACAGAAGGAATGGTGGTGGGTGAA CTAATTTTATCTAATAACGAGAGTTGAAGTTGTCTCTAGATGACAATAGATGGATTGGTAATACAATAAATATTTGGTATTATGTAATACAGTAAATATT GACATTATGTAATACAGTA</p> |

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| <p><i>HPDH</i> (KEGG: YALI0F02607p)</p> | <p>ATGCTCTCATCCACTCTCAGAAGCTCCGTCAAGGCCCTGCGACCGCTGCGGGCTCCCGGGACCTGTCTACGGCTTCATTGGTCTGGGTCGAATG GGTCTGCCCATGGCCCTCAATTTGCAGAAGAAGCTGCCCGGTGTCGACGCTGACTCCAAGGTCAACGTGTTGACATGAACAAGGCTGTCTAGAA CAGATTGCCAAGGACAAGGATCCAAGGGCGCCAGCTGGAGGTGCTGGGCTCTGCCGTGGACGTGGCCAGCAAGTCCGATGTCATCTTCAAT GTCCTCTGAGCCCGTCCATGTCCGAGGAGTCTACACCGACCTGGTCAACAACTCGGAGACAAGACCTCCAAGATCTTTGTGACTGTCTCACCAT TGACACTCAGACGTCAATTGAGTGCGGTAAGCTTGTGACCCGACAAGGACGCCTCTGTGCTTGTGGACGCCCCGTCTCCGGAGGTGTCGTGG GAGCCGAGAAGGGCACCCCTACCTTCATGGTGGGTGCAACAAGGACAAGCAGCAGGTGTACAAGCAGGTGGAGGAGTGTCTCAAGCTCATGGGT GGCCGAATCGTCAACTGCGGCACCCAGGGCCAGGGTCTGGGTGCCAAGCTTGCCAACAACCTACCTGTTGGCTGTGACTAACGTTGCCACTGTCTGA GGCTTTCCATCTTGTGAGAAGCTTGGATGCGACCTCAAGCTCTTCTCAGACATTGTCAACTCTCTTCCGGTCGATCTTGGTCTCCGAGGTGAAC AACCCTGCCCAGGTGTCAACCCGCTACTCCTTCTCTCGAGACTACGTTGGAGGGCTTTGGTATCAACCTGATGCGAAAGGACCTGGGTCTGGCC ATCGATGTGGCCAAGCAGTCTGGATCTCCATGCTTGTGGCTGACAAGACTTACGAGGTCTATCAAAAATTGAGAAGGGAGACAACCTACAGGGCA AGGACATGTCTGTTATCTACAAGTTCTCCAGGATCAGGATCAATAA</p> |
| <p><i>HPDH</i> up homology arm 1000bp</p> | <p>TCACGGTGTGAATGAGTAGTCTTGAACCTGGTGACCTTCAGGTGCACCAATAATAGCTGGAGCGTCATCAATTAAGAGGCTTTGACGCACGTTATAA AAGTACAAAAAGTGGTTAAGTACAAGTACGATATTTTCGACACTGGTGCAAGTATGCATGTCCACCAAGAAAGCACTACAAATACTGTAGGATCTCC CACTATTACAGTACATACGTACATGTCTGAGGTATATAATATGCATGCCGATGACTATGTACTGTACTGTGGAGCGCATGAAGGGAATCAATCTCAC TTACGGGGCTAACATGGTGGGTATATAGTAGGATGGTGAACACCCATAATAGTCTGTACTGTACTGTGACCTGGGCAGGACATAATCACTGTGGG TTCATCACTGACAACCCAGTGAAGTTAACTCAGATGTACACACGACGTAATTTGTGACACGACGTAATTTGTGACTACGACCGTCAGTAGAAGTAG AAGGTATATCAATCTATGTGTAATCTAGTTCAATTTGTAACTTCTGCCAACCTCTCGGCCCTCTCTCCAATTAATATACCACAAGCCTGGTCCCT CACCCAACGAAGATGTCCGCTTCGGCGGCAATCGACGAACTCTGTGAGTGTACATAACGCAAGACTAATGCTGGGTGGATAATGTGGGGGGGATC CCTTACCTGTACGACGCGGGTAAATAATGCTTTTGGAGCTAGTCCGAGGAGTTGCGAGGATGAATGCTCCTTTGGAGACAGCTTGAATACGATA TTAGGAAATAAAGTTTCAGTCCACCTCCAAACACCTGCAGTGGGACCCTATTATGCGGTTATTGATGCATCTCCCCACACGCGCCCCGAGACT AGCCCGACAAACCCAAAGTTCAAATCTGGGGTGAGCCGAGGCCAGAGGATAAAGCTAGACCGATCTCTTTCTGGCACTCTTTTCAACACACCAA AACCCACCTAACACATACACAGC</p> |
| <p><i>HPDH</i> down homology arm 1000bp</p> | <p>AACAAATACAAGTTTTAAGCTGACCCAATGAACCTGTGAAACGTATTGCATAAACATTTTCATGGATCATGACTAAATAATGAATGATGATGATGACTTAC ACCACTGGTTAGGCTCACTTGGTAAACATTTATATAACAATGTGGCTGCTGGTTGTAACTGTCTGTGTAATTTGAATGTGTGTTGTCTATTAGGCAT TTTCTACCAACGCTTTTCTATGACGGCATGTACCGTTGCAAGTTATTCGATCTACTGTAGATGTTAGATGTTAGTATGTATACGAAGAAGTCCCCGTC AACCTCCACCTCATTGATGTATTATTATAGTCATACGTTAATGCTTCTATGCTTACAGGTAGAGACCCTCAAGGTTCTCCTCCACCTTGTCTTCAATGA CCCGCTCTTAGCGGTTCCGAAATCTCAGCAGTGACCCGCAATCTCTCTCTCGCAGAGCAAGCAGACCTGCCTCGGTGCACATGGCCTTGATGT CGGCTCCAGAAAGTTATCCTTGGAAAGACACAACTCTCGAGATCAACATCGTTCGTTGAGGTTCACTTTGGAGGTGGATGCCATAATCTTTTCG CTTGGTGGTGGAGTCGGGATTCTCAACAGAATCTTTCCGTCGATTTCGACCAAGTTCAGTGCAGGGTCCAGCGACTCAATCTGTTTGTAGCC ATAATTACCTTGACGCTCTCTCGGTCTCGAATCCATCCAGTCTGGTTCAGAAGCTCCAGCATGGTCCGCTGCACCTCTCGCTCTCCGCGACGCTGC ACTCGTATCGTTTGGTTCCAATAGCGTCAATCTCATCGATGAAAAAATGGACGGTGGTGTCTCGCGCAATCTGGAAAAATCTGTGACACAGTCG GGGACCGTCTCCCAAGTACTTTTGATCAGCTCGGATCCAACGATTCCGCAAAAATGTAGCAGAACTGTGTTGGCGACGGCCTTGGCCAGCAGTGT TTTTCCGGTTCCGGGAGCGCCG</p> |

Table S2. sgRNA used in this study.

| sgRNA | Sequence (5'-3') (sgRNA+ <i>PAM</i>) |
|-------------|--|
| sgRNA-MLS1 | CAACTTCAACCAGCGACGTC <i>TGG</i> (134/fw) |
| sgRNA-CIT2 | GCGATTTGCTTCTGACCTCA <i>AGG</i> (80/fw) |
| sgRNA-HPDH | GTCCTACGGCTTCATTGGTC <i>TGG</i> (86/fw) |
| sgRNA-MMSDH | TGCGAAAATCGAGAACCCCG <i>TGG</i> (101/fw) |

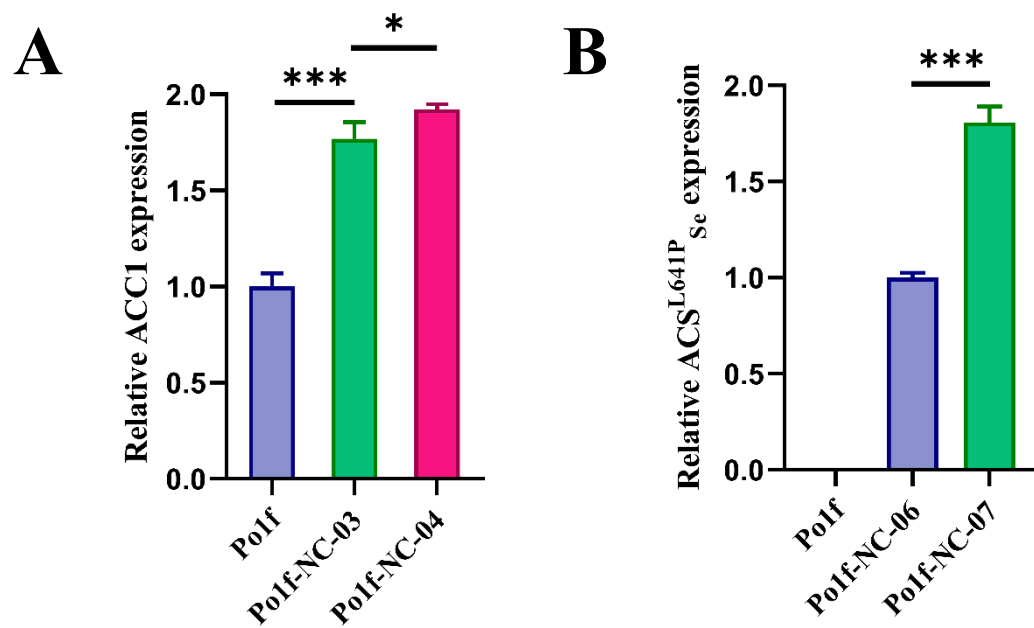


Figure S1. (A) The relative ACC1 expression of strain Po1f, Po1f-NC-03 and Po1f-NC-04. Statistical analysis was conducted as significance indicated by *** $P < 0.001$, * $P < 0.05$. **(B)** The relative ACS^{L641P}_{Se} expression of strain Po1f, Po1f-NC-06 and Po1f-NC-07. Statistical analysis was conducted as significance indicated by *** $P < 0.001$. Data represent the mean ± SD of biological triplicates in **A** and **B**.

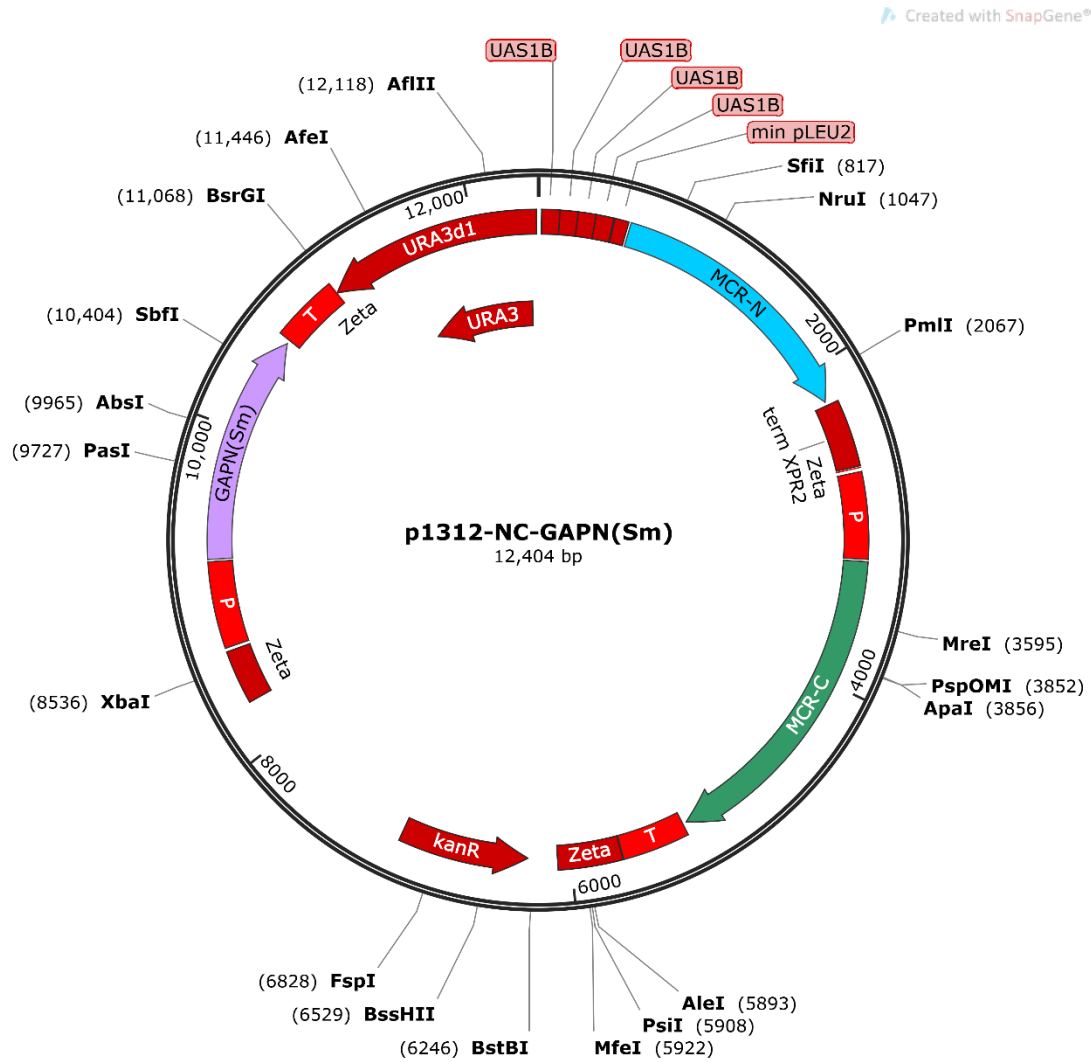


Figure S2. The map of plasmid p1312-NC-GAPN_{Sm}

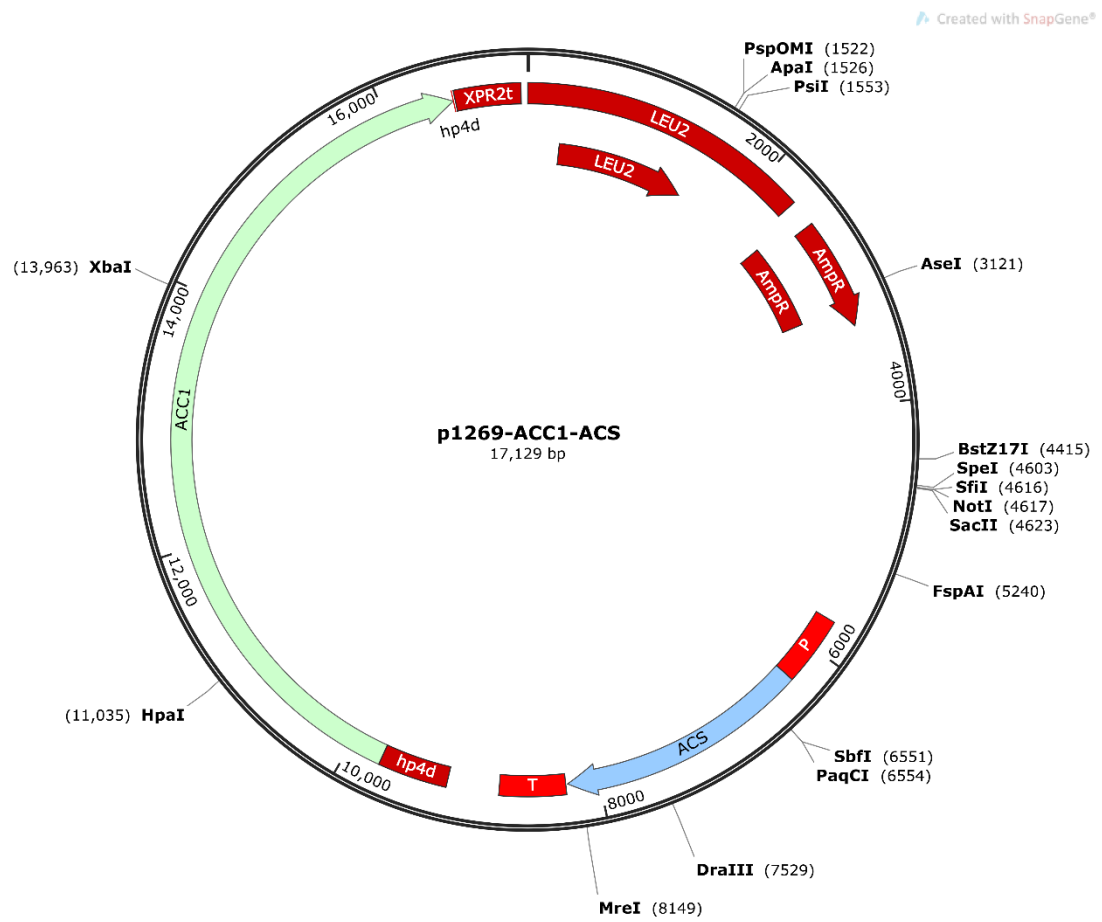


Figure S3. The map of plasmid p1269-ACC1-ACS^{L641P}_{Se}