

## Supplementary information

The synthesized *NheI*-intron-opvhb-*SmaI* sequence

GCTAGC **ATGCCCGTGAGTCCTGCATCCCCATCGTGCACCGTATTCACCTCAT**  
**CGTTTGGCCCCCTTCTCACAGGTCAAGGTC** ATGCTCGACCAGCAGACCATC  
AACATCATCAAGGCCACCGTCCCCGTCTCAAGGAGCACGGCGTCACCATC  
ACCACCACCTTCTACAAGAACCTCTTCGCCAAGCACCCCGAGGTCCGCCCC  
CTCTTCGACATGGGCCGCCAGGAGTCCCTCGAGCAGCCCAAGGCCCTCGC  
CATGACGGTCCTCGCGGCCGCCAGAACATCGAGAACCTCCCCGCCATCCT  
CCCCGCCGTCAAGAAGATCGCCGTCAAGCACTGCCAGGCCGGCGTCGCCG  
CCGCCCATACCCCATCGTCGGCCAGGAGCTCCTCGGCGCCATCAAGGAG  
GTCCTCGGCGACGCCGCCACCGACGACATCCTCGACGCCTGGGGCAAGGC  
CTACGGCGTCATCGCCGACGTCTTTATCCAGGTTCGAGGCCGACCTCTACGC  
CCAGGCCGTCGAGTGACCCGGG

The *gpd* intron sequence was highlighted in red-color font

Sequence alignment of the original and optimized VHb gene.

Sequence alignment		
5' Flanking		
Protein	M L D Q Q T I N I I K A T V P V L K E H G V T I T T T F Y K	
Original 1	ATGTTAGACCAGCAAAACATTAAACATCATCAAGCCACTGTTCCTGTATTGAAGGAGCATGGCGTTACCATTAACACGACTTTTATAAAA	
Optimized	ATGCTCGACCAGCAGACCATCAACATCATCAAGGCCACCGTCCCGTCCTCAAGGAGCACGGCGTCACCATCACCAACCTTCTACAAG	
Protein	N L F A K H P E V R P L F D M G R Q E S L E Q P K A L A M T	
Original 91	AACTTGTTTCCCAAACACCTGAAGTACGTCTTTGTTTGGATATGGGTCGCCAAGAATCTTTGGAGCAGCCTAAGGCTTTGGCGATGACG	
Optimized	AACCTCTTCGCCAAGCACCCGAGGTCCGCCCCCTCTCGACATGGGCCGCCAGGAGTCCCTCGAGCAGCCCAAGGCCCTCGCCATGACG	
Protein	V L A A A Q N I E N L P A I L P A V K K I A V K H C Q A G V	
Original 181	GTATTGGCGGCAGCGCAAAACATTGAAAATTTGCCAGCTATTTTCCTGCGGTCAAAAAATTGCAGTCAAAACATTGTCAAGCAGGCGTG	
Optimized	GTCTTCGCGGCCGCCAGAACATCGAGAACCTCCCCGCCATCCTCCCCGCGTCAAGAAGATCGCCGTCAAGCACTGCCAGGCCGGCGTC	
Protein	A A A H Y P I V G Q E L L G A I K E V L G D A A T D D I L D	
Original 271	GCAGCAGCGCATTATCCGATTGTCGGTCAAGAATTGTTGGGTGCGATTAAAGAAGTATTGGGCGATGCCGCAACCGATGACATTTTGGAC	
Optimized	GCCGCCGCCACTACCCCATCGTCGGCCAGGAGCTCCTCGGCGCCATCAAGGAGGTCTCGGCACGCCGCCACCGACGACATCCTCGAC	
Protein	A W G K A Y G V I A D V F I Q V E A D L Y A Q A V E *	
Original 361	GCGTGGGGCAAGGCTTATGGCGTGATTGCAGATGTGTTTATTCAGTGGAAGCAGATTGTACGCTCAAGCGGTTGAATAA	
Optimized	GCGTGGGGCAAGGCTTACGGCGTCATCGCCGACGTCTTTATCCAGGTTCGAGGCCGACCTCTACGCCAGGCCGTCGAGTGA	
3' Flanking		