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Complete sequence and organization of the human cardiac β-myosin heavy chain gene

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Submitted May 9, 1990

GenBank accession no. X52889

Several investigators, including our group, have isolated and partially characterized the cardiac myosin heavy chain genes (1–4). We screened a human cosmid genomic library using a 1.7 kb cDNA clone of the β-cardiac myosin heavy chain gene as probe (5). We isolated and characterized a genomic clone of 37.5 kb containing the complete human cardiac β-myosin heavy chain gene (4, 6). Like the rat skeletal myosin heavy chain gene, this gene is divided into 41 exons, the first two of which are non-coding. However, exons 37 and 38 are fused together and do not have an intervening intron. This gene extends for 21,828 nucleotides and codes for a putative protein of 1939 residues and a molecular weight of 222,937.

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* To whom correspondence should be addressed

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12076 GCAATGGTGTGCTGGAGGGCATCCGCATCTGCAGGAAAGGCTTCCCCAACCGCATCCTCTACGGGGACTTCCGGCAGAGgtgggtatgagggtgcaccagaagctcatagaacag
C N G V L E G I R I C R K G F P N R I L Y G D F R Q R Exon 19
12191 ggggagccaggctgccctgatgggaatgggatctgcaggtgaccctgaattcctatggggcagagcagactcactgcagagcatgggtgactctggacacttccctcctcagGTA
Y
12306 TCGCATCCTGAACCCAGCGGCCATCCCTGAGGGACAGTTCATTGATAGCAGGAAGGGGGCAGAGAAGCTGCTCAGCTCCCTGGACATTGATCACAACCAGTACAAGTTTGGCCAC
R I L N P A A I P E G Q F I D S R K G A E K L L S S L D I D H N Q Y K F G H
12421 ACCAAGgtgaggaaaggagactaattaattaaaggaaagacatctcttttccattgactcctctgatgcttttcctgttgtaatcatcttagcaaaatctcttacctgtatgcta
T K Exon 20
12536 cccctcccagtggaacatctagcaccactcccctcatcccagctccagctgccattgacctctcctgcaatccttttctaggatgttacccttcctaaggtaatcccacatctct
12651 ttcctcgtaccctccatgtcatgccacaaacttgcctgcagGTGTTCTTCAAGGCCGGGCTGCTGGGGCTGCTGGAGGAAATGAGGGACGAGAGGCTGAGCCGCATCATCACGCG
V F F K A G L L G L L E E M R D E R L S R I I T R
12766 TATCCAGGCCCAGTCCCGAGGTGTGCTCGCCAGAATGGAGTACAAAAAGCTGCTGGAACGTAGgtgagagatctcaagaggaggtttcccgcttctctgaggcccaggctggttc
I Q A Q S R G V L A R M E Y K K L L E R R Exon 21
12881 aggggcagtgtcaggaaaaaaagctcagcagatcttcaaacacagagacctgcaggaggggctcatatgaacacactgcagtcacagggtcagaggcctcaggaagggtgggagg
12996 gatgaaggaaatgggatattcccaaggtttcaggacctcaggtaggaaggaggcaggaggctcagcactcctttcaatgggcccctgcagAGACTCCCTGCTGGTAATCCAGTGG
D S L L V I Q W
13111 AACATTCGGGCCTTCATGGGGGTCAAGAATTGGCCCTGGATGAAGCTCTACTTCAAGATCAAGCCGCTGCTGAAGAGTGCAGAAAGAGAGAAGGAGATGGCCTCCATGAAGGAGG
N I R A F M G V K N W P W M K L Y F K I K P L L K S A E R E K E M A S M K E
13226 AGTTCACAGCCCTCAAAGAGGCGCTAGAGAAGTCCGAGGCTCGCCGCAAGGAGCTGGAGGAGAAGATGGTGTCCCTGCTGCAGGAGAAGAATGACCTGCAGCTCCAAGTGCAGGC
E F T A L K E A L E K S E A R R K E L E E K M V S L L Q E K N D L Q L Q V Q A
13341 Ggtgaggctcctgggctactgttggctcttccaccctgctctgccttcacttcccacagaccctgcacctccctgcacaggggctcactgtcttgttccgttcagtcagaggact
Exon 22
13456 ctgggatcaacacttctaaagacctccaaagaggtccctcaggaggaggaaagggcagaggggaaaaggagctgacttttaaaagcacaggctttctacttgggttcaacctagat
13571 acacagcttaattattttgtgaccttgggcagaccatgcatcatctttgagcctcaagggcctctagacagggaataaagctgtccatttcattaagccatcatacataagtgct
13686 tggcatcagcaaatgcaattcccacccttcgatggaggagaccagaggaagaggtccagatgaagatttctggttcctttcctctctgctcccctccccagtgttcccaagttat
13801 actatcctgaaactcttcccctccccatacttctgaagctcttgccaagtggggatatcctagagttaccctcctatttgagtgatgtgcctctccttccctcctacctgcaaga
13916 atggaggaccttacccccctgaacagcctcccctctgttcctcaccttcaagGAACAAGACAACCTGGCAGATGCTGAGGAGCGCTGTGATCAGCTGATCAAAAACAAGATTCAGC
E Q D N L A D A E E R C D Q L I K N K I Q
14031 TGGAGGCCAAGGTGAAGGAGATGAACGAGAGGCTGGAGGATGAGGAGGAGATGAATGCTGAGCTCACTGCCAAGAAGCGCAACGTGGAAGATGAGTGCTCAGAGCTCAAAAGGGA
L E A K V K E M N E R L E D E E E M N A E L T A K K R N V E D E C S E L K R D
14146 CATCGATGATCTGGAGCTGACACTGGCCAAAGTGGAGAAGGAGAAACACGCAACAGAGAACAAGgtaagggcagcctccctttggctccagcccgggtctcatcaggactctcag
I D D L E L T L A K V E K E K H A T E N K Exon 23
14261 accatactgaccttgacccaggctagccactcggcatccagagagcagcatggaccttgacatggagctccccacagatggcaccaagctggtgacctttgaccctaaaggagat
14376 gggattcttggtcggcagGTGAAAAACCTGACAGAGGAGATGGCTGGGCTGGATGAGATCATTGCCAAGCTGACCAAGGAGAAGAAAGCTCTGCAAGAGGCCCACCAACAGGCTC
V K N L T E E M A G L D E I I A K L T K E K K A L Q E A H Q Q A
14491 TGGATGACCTTCAGGCCGAGGAGGACAAGGTCAACACCCTGACTAAGGCCAAAGTCAAGCTGGAGCAGCAAGTGGATGATgtgagtagattgagagttgtggggcctagatatgc
L D D L Q A E E D K V N T L T K A K V K L E Q Q V D D Exon 24
14606 catgtctatctgtgcccagagctctgtgtgtgtgtgtgtgtgtgtgtgtgtgtgtgtgtgtgtgtgtgtgtgtttgtgtttaatgtttatagggggggtagggttagaggatgttaac
14721 ttttctgatatctttctagaaaggagctggggaatgaaaagtcagaggtggtgatcaattctgaattatgtatctaatctcactggtatgatcaataatagagatgagttttctt
14836 atttaatttaagtgcaatcccatatatctctgcctttgacacaagatttagagggtcatctcataagacatgataaatttctttggaaattttgtgaggctccccaagtagaatt
14951 tttgaaattccaatatttaagggcagaatctgatcattgttccctctgatgcacatatgtctgttgactcacttatcactctgtattttaattatttaagcttctttagatagga
15066 acttagatctattcaatttggggactgcagtgcttagcaagagcctgatgcccagtaggtgtttataggatgctgaaagaatgaatacggcggccagcggtggctcacacctgta
15181 atcccagcactttgggaggccaaggcgggtggatcacgaggtcaagagatcgagaccatcctggccaatatggtgaaaccccatctctactaaaaatacaaaaattagctggatg
15296 tggtggcgtgcgcctgtagtcccagctactcaggaggctgaggcagaataatcccttgaaccagggaggcggaggttcagtgagccgagatcgcgccactgcactccagcctggc

15411 gacaagtgagactccataaaaaaaaaaaaaaaaaaaaggaggaaggaaggaaggaaggagagaaagaaggagagaaagaaagaaagaaagaaagggaaagaaagaaagaatacgg
15526 ctttggggtttcatcccacagtcatttattcctttatctataaaatatgattcagcatcccctatatctaggcaatctcacagtcccctaattaacatttggcccactctgggga
15641 aggtttcccaagtcctgaacacaagatttaccaagtcctgaggtaactgaacaacaaaatcaccaagtcaggatgctttgcctcactgggcctgggctccttctctctaccagCT
L
15756 GGAAGGATCCCTGGAGCAAGAGAAGAAGGTGCGCATGGACCTGGAGCGAGCGAAGCGGAAGCTGGAGGGCGACCTGAAGCTGACCCAGGAGAGCATCATGGACCTGGAGAATGAC
E G S L E Q E K K V R M D L E R A K R K L E G D L K L T Q E S I M D L E N D
15871 AAGCAGCAGCTGGATGAGCGGCTGAAAAAgtactgtgtcccctccctgctgcccttccgcctccccagcccataacagtacaagcagacccaatacagccatcctctgaggcaac
K Q Q L D E R L K K Exon 25
15986 aacctcacgcagcctccacaagtggaggtgcaaaccatgggaaaaggcctcccaggcaagggctttcctcccctagtcccagatatcagggttagttagatggtcctccctggca
16101 aaaagtccattgtatcccatgagtcctttcttcttgttaggcactcagtgggaatgaaaataacagccttcccccttcataacacatctctctttggagaccagttccttgacat
16216 ggaggaaggctccacatgaggagcctcttaggaaagtccctttgtggcttttcacagagagcccacagggcaccaagaaatgccctcacattaaagaagtcaggggtacagggcc
16331 atttctttgtttgcttaacttgtggttccaattcttagtgtagtcttccaaatgtatagacttccagacttggtaaacagtgagcttgcagaacatattttgataattgaaggtc
16446 ttatggtgtttcaggctcaggactttgaaaggctttgagaatcatcataatctacatcctcatcaagtttgtgtttgcacaggaatcttcataccttcccaggcacagaatgtgt
16561 tgaataaatgaataaatacacgatcctatttgattctcaaaacacctttaaggatggtatctttaatttcactttaccaaagaggaaaataagtttcagaaaggttagctgagt
16676 tacccaaagcaatagtgacaaaatttaaagaccatcagagctaaaaaggacctttgaaacaatgtagtccgacccccctcattttacattatgagaaaacaaggaccaaagatggg
16791 aatgtcctgtagagcccaggccccatcaccctgtctacagcactcctcccattacattcttgttggatttcaatctcaccgcaggtgttacacttccagggatcctacatcaccc
16906 ccagaagctgtttttctaatgaaatcctactctttacctgtatcattaccattttcaccactggtggaccctcctggaggccccacgagtctcccttacctcaccatccctcctt
17021 ccccacagAAAAGACTTTGAGCTGAATGCTCTCAACGCAAGGATTGAGGATGAACAGGCCCTCGGCAGCCAGCTGCAGAAGAAGCTCAAGGAGCTTCAGgtgaggtctggacacc
K D F E L N A L N A R I E D E Q A L G S Q L Q K K L K E L Q Exon 26
17136 cacgcgggatgctgagtccctgggctggttctgtttcccctgccccctcctctaggtgtcctgttcacagcattacaggaatgattaatgtgtccatggaggcaggcacgcagct
17251 atcacagtgtgcccatggatacatccaaaaggggtcagtgatccacagagacctgaaaaggtcacaggcctgagggcaagaattcctggcttcctgtctcagctctgccttagtt
17366 gggtgacctctgggagcccactccagatctctgggtctccatgccctcccctgttacatggaggtttttaagagtccttcgactctgatggcatgactttcctccttactctaga
17481 gcagaagctgtgttaggtctttagttgtctggtcaagacaaatacggctctctcattttcaacttttgttattttttatgactaaactgcttaaaatatccccagaacacaggt
17596 ctctttgtccatctttaagagcaagtttcaaccatttccttccaataaagagcatgtagactgtcaggccctcgcctaaaggaaggctcttcaaactatcttccccaaatccttt
17711 aattcccacctctccactggaagagctaaactgacttgctgttccagagaagccgaggagccttttagagccgggggattccagtggaggggtccaggcgtgggtctgagcctt
17826 gtgtctgaccagGCACGCATCGAGGAGCTGGAGGAGGAGCTGGAGGCCGAGCGCACCGCCAGGGCTAAGGTGGAGAAGCTGCGCTCAGACCTGTCTCGGGAGCTGGAGGAGATCA
A R I E E L E E E L E A E R T A R A K V E K L R S D L S R E L E E I
17941 GCGAGCGGCTGGAAGAGGCCGGCGGGGCCACGTCGTGCCAGATCGAGATGAACAAGAAGCGCGAGGCCGAGTTCCAGAAGATGCGGCGGGACCTGGAGGAGGCCACGCTGCAGCA
S E R L E E A G G A T S C Q I E M N K K R E A E F Q K M R R D L E E A T L Q H
18056 CGAGGCCACTGCCGCGGCCCTGCGCAAGAAGCACGCCGACAGCGTGGCCGAGCTGGGCGAGCAGATCGACAACCTGCAGCGGGTGAAGCAGAAGCTGGAGAAGGAGAAGAGCGAG
E A T A A A L R K K H A D S V A E L G E Q I D N L Q R V K Q K L E K E K S E
18171 TTCAAGCTGGAGCTGGATGACGTCACCTCCAACATGGAGCAGATCATCAAGGCCAAGgtaggctctgctcggcctccctcctccaacttcctcctcccacctcccctttctgtcc
F K L E L D D V T S N M E Q I I K A K Exon 27
18286 atgtagtgtctcttccttcatggttcattttcccacttcccttcctctgcctggttctcagatcccctccttcttttcacaccttccctcttcttttctccttcagttgcacctc
18401 ttacacccctcattcccccccgcccccaacatccatcatattaactctccttcccttctcagGCTAACCTGGAGAAGATGTGCCGGACCTTGGAAGACCAGATGAATGAGCACCG
A N L E K M C R T L E D Q M N E H R
18516 GAGCAAGGCGGAGGAGACCCAGCGTTCTGTCAACGACCTCACCAGCCAGCGGGCCAAGTTGCAAACCGAGAATGgtgagcctagagcaggggctccatggttcccaccacagtct
S K A E E T Q R S V N D L T S Q R A K L Q T E N Exon 28
18631 ccccaacctcctgagccactccagcctcgggcacaagccaatacacgcacacacagacacagagtctctccaggaaaatggggcctgagggctagaggaggaggtggggatagag
18746 aggagtgctgatctagaatggtgctccccagGTGAGCTGTCCCGGCAGCTGGATGAGAAGGAGGCACTGATCTCCCAGCTGACCCGAGGCAAGCTCACCTACACCCAGCAGCTGG
G E L S R Q L D E K E A L I S Q L T R G K L T Y T Q Q L
18861 AGGACCTCAAGAGGCAGCTGGAGGAGGAGGTTAAGgtaagggctagactcgcgcacctggcccaagcaaggagcacactgactagccttgcatcaaatcacttcccttcccagca
E D L K R Q L E E E V K Exon 29
18976 ataaggctggctgtggaccaacagttctccaagaattcttgctttatggagaaagctgaacccacctcctggtgcccaccccctccccagGCGAAGAACGCCCTGGCCCACGCACT
A K N A L A H A L
19091 GCAGTCGGCCCGGCATGACTGCGACCTGCTGCGGGAGCAGTACGAGGAGGAGACGGAGGCCAAGGCCGAGCTGCAGCGCGTCCTTTCCAAGGCCAACTCGGAGGTGGCCCAGTGG
Q S A R H D C D L L R E Q Y E E E T E A K A E L Q R V L S K A N S E V A Q W
19206 AGGACCAAGTATGAGACGGACGCCATTCAGCGGACTGAGGAGCTCGAGGAGGCCAAgtgagttctgagcagcctgacttctggctgaggccccttttgcaggcaggactcagccca
R T K Y E T D A I Q R T E E L E E A K Exon 30
19321 gccccagcctcagcagatcccacacaggcgatgcttagctagtgtttgacaacacaggaggactctgccccggccccacctccttctcctctcagggaagctttttgctcgaatt
19436 atgtttctgatccgaatataagacgtacaaaaggtttgtctgagggcagagtgcttccgtctggggcagggcactgtggcagggaaaggcagtggggagggctgcagaagcccat
19551 acctcctcaatgtccatagcgcagaggctgggccagggtcagagggtgcctgggtctccacgccctgctgggatcctctgcctgatgttctcggcccctgggacctgtcctcagg
19666 cttctccagctacacttctgaggtttcaaggattgtctttgagaaggttcatgttgtttacctctttcccccatccacaccctccatcctccccaccctctgccaccctcccctg
19781 ggcagGAAGAAGCTGGCCCAGCGGCTGCAGGAAGCTGAGGAGGCCGTGGAGGCTGTTAATGCCAAGTGCTCCTCGCTGGAGAAGACCAAGCACCGGCTACAGAATGAGATCGAGG
K K L A Q R L Q E A E E A V E A V N A K C S S L E K T K H R L Q N E I E
19896 ACTTGATGGTGGACGTAGAGCGCTCCAATGCTGCTGCTGCAGCCCTGGACAAGAAGCAGAGGAACTTCGACAAGgtgggccctgggtggggcccgcagccagcatgcagggcaag
D L M V D V E R S N A A A A A L D K K Q R N F D K Exon 31
20011 ggggcatgaggggttcagtgagaggccagagccatcctccttggaggtgggggaggaggctgagcccaggcaggtcctgagacagaccctggacatggggctgaggcttgggggc
20126 tgaagagtgagccttctccccgggcagATCCTGGCCGAGTGGAAGCAGAAGTATGAGGAGTCGCAGTCGGAGCTGGAGTCCTCGCAGAAGGAGGCTCGCTCCCTCAGCACAGAGC
I L A E W K Q K Y E E S Q S E L E S S Q K E A R S L S T E
20241 TCTTCAAACTCAAGAACGCCTATGAGGAGTCCCTGGAACATCTGGAGACCTTCAAGCGGGAGAACAAAAACCTGCAGGgtgtgctgggggcccaagaggctggggaggggctgca
L F K L K N A Y E E S L E H L E T F K R E N K N L Q Exon 32
20356 ctgcagtgttcccatatggtgccacccaagggctccaagaggcgtctgggcaaagaggcgtgtccctccaactccactggacctcagcagccctcaaaccgagttaccgtgttcc
20471 ccacacagAGGAGATCTCCGACTTGACTGAGCAGTTGGGTTCCAGCGGAAAGACCATCCATGAGCTGGAGAAGGTCCGAAAGCAGCTGGAGGCCGAGAAGATGGAGCTGCAGTCA
E E I S D L T E Q L G S S G K T I H E L E K V R K Q L E A E K M E L Q S
20586 GCCCTGGAGGAGGCCGAGgtgtgtgtgtgtgcagggcacggggtgcagggagctgagctcaggcttttggtccctgttctcatcccccgctttgtcgttttgttcactgtccatc
A L E E A E Exon 33
20701 cccagagcctaggacagagcctggcacatagtaggcattcagtgaagatttgtggagtgaatgaatgaccagtcactgaactctcttcacataaacattttacccattgcatctt
20816 agctgagcttcccatttccacatacctcccggttcccacctctgcctccctctgttttcttttatactctatacctgattgcctctgtttccttggcaacactttttctcttcat
20931 tttcctccttgtcttcatagctggctctcccctgtgagggcctgaatcactttctcttaggcttattttttatttctcttagattctcttttcctccaccttctgcttctttgaa
21046 ccacttacaccactcttgaagtcacttcgtatccatgattagtgagcaggcccccaccctgccctgtgccctgactgtctgcctgcatcccctcccccaacccctttcccagGCCT
A

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21161 CCCTGGAGCACGAGGAGGGCAAGATCCTCCGGGCCCAGCTGGAGTTCAACCAGATCAAGGCAGAGATCGAGCGGAAGCTGGCAGAGAAGGACGAGGAGATGGAACAGGCCAAGCG
      S  L  E  H  E  E  G  K  I  L  R  A  Q  L  E  F  N  Q  I  K  A  E  I  E  R  K  L  A  E  K  D  E  E  M  E  Q  A  K  R
21276 CAACCACCTGCGGGTGGTGGACTCGCTGCAGACCTCCCTGGACGCAGAGACACGCAGCCGCAACGAGGCCCTGAGGGTGAAGAAGAAGATGGAAGGAGACCTCAATGAGATGGAG
        N  H  L  R  V  V  D  S  L  Q  T  S  L  D  A  E  T  R  S  R  N  E  A  L  R  V  K  K  K  M  E  G  D  L  N  E  M  E
21391 ATCCAGCTCAGCCACGCCAACCGCATGGCCGCCGAGGCCCAGAAGCAAGTCAAGAGCCTCCAGAGCTTGTTGAAGgtactcacccagaggggactggcctccacgtggcctggcg
       I  Q  L  S  H  A  N  R  M  A  A  E  A  Q  K  Q  V  K  S  L  Q  S  L  L  K Exon 34
21506 taagcagtagtgtcttgatacaggcaccagattcctcctgcccctaggttactgcagggacctctgacaggtgcctttagtgaagggaaccgaggctggctccctgctcatgccc
21621 actctcctgatcctcagGACACCCAGATTCAGCTGGACGATGCAGTCCGTGCCAACGACGACCTGAAGGAGAACATCGCAATCGTGGAGCGGCGCAACAACCTGCAGGCTGAGCT
                        D  T  Q  I  Q  L  D  D  A  V  R  A  N  D  D  L  K  E  N  I  A  I  V  E  R  R  N  N  L  Q  A  E  L
21736 GGAGGAGTTGCGTGCCGTGGTGGAGCAGACAGAGCGGTCCCGGAAGCTGGCGGACAGGGAGCTGATTGAGACTAGTGAGCGGGTGCAGCTGCTGCATTCCCAGgtgagcaagctc
        E  E  L  R  A  V  V  E  Q  T  E  R  S  R  K  L  A  D  R  E  L  I  E  T  S  E  R  V  Q  L  L  H  S  Q Exon 35
21851 ccctgctgattcctgaagggagcacaggctggggctcagcaagcaaggcttagagctatgcatagatgctcaatgcttaacctacatctacccaaccctcccccaacccagAACA
                                                                                                                      N
21966 CCAGCCTCATCAACCAGAAGAAGAAGATGGATGCTGACCTGTCCCAGCTCCAGACTGAAGTGGAGGAGGCAGTGCAGGAGTGCAGGAATGCTGAGGAGAAGGCCAAGAAGGCCAT
      T  S  L  I  N  Q  K  K  K  M  D  A  D  L  S  Q  L  Q  T  E  V  E  E  A  V  Q  E  C  R  N  A  E  E  K  A  K  K  A  I
22081 CACGGATgtaagtcccccactccaccgacccgatccagaccagtgtctctccgtgggctgggcagcaagtgtgtgaggacttgaccagaccatgtgccacctctctcctgcacac
        T  D Exon 36
22196 AGGCCGCCATGATGGCAGAGGAGCTGAAGAAGGAGCAGGACACCAGCGCCCACCTGGAGCGCATGAAGAAGAACATGGAACAGACCATTAAGGACCTGCAGCACCGGCTGGACGA
        A  A  M  M  A  E  E  L  K  K  E  Q  D  T  S  A  K  L  E  R  M  K  K  N  M  E  Q  T  I  K  D  L  Q  H  R  L  D  E
22311 AGCCGAGCAGATCGCCCTCAAGGGCGGCAAGAAGCAGCTGCAGAAGCTGGAAGCGCGGGTGCGGGAGCTGGAGAATGAGCTGGAGGCCGAGCAGAAGCGCAACGCAGAGTCGGTG
        A  E  Q  I  A  L  K  G  G  K  K  Q  L  Q  K  L  E  A  R  V  R  E  L  E  N  E  L  E  A  E  Q  K  R  N  A  E  S  V
22426 AAGGGCATGAGGAAGAGCGAGCGGCGCATCAAGGAGCTCACCTACCAGgtgcgacgggcggtgactccaggcagagccctggcaccatagccacagtgacaaccagctgaggaga
       K  G  M  R  K  S  E  R  R  I  K  E  L  T  Y  Q Exon 37/38
22541 atgaagagtttgctcttagcctcttccagggcgaggatgggaatgcagcccccgtttcactttgcctagccctgccccactctgaatgtccctagctcagaggtcagtctctgag
22656 cctcctggcctgggagctccatctcaacacccactcttagcccatcgccaggggacacacacagaattccagacaaagctcacccagtacagctcaccagaaagcaaatatgtag
22771 ccagggtcacccccaaaagacaccaaaaacacacccatcccattcaaacaagcataaaaactttttcattgcccagggcagtgtggactctagctttctgaggtgttttcttaga
22886 atcagactctgaattagaatttgtttcttttccaatccaggatgtcactatctctctaagcacacttgtccttaacttagattaagtcagtgtttctggcctgcattgcagccca
23001 gaaattccatcacactcatagccccaaagtcactcccagcatgtgccgaggtccagagcagggacttcatcccgcatggtccccggaccctgaaaaacctgctccctggagcact
23116 gcacacacacaattttgtgcataatttcagagtcccactagttctttggactctttcctggtacagatcatttaaaatatttacacatatttggtaagaaattataaggagaatt
23231 caagtgtttagtgaggatcagaaagtagaattgggtcaggatatcagatgaagcagggcagggcggaggggatgctaccttctatgactgtgccatcttcacccccctgcctaccc
23346 tctggcccccagACGGAGGAGGACAGGAAAAACCTGCTGCGGCTGCAGGACCTGGTAGACAAGCTGCAGCTAAAGGTCAAGGCCTACAAGCGCCAGGCCGAGGAGGCGgtgagtg
                T  E  E  D  R  K  N  L  L  R  L  Q  D  L  V  D  K  L  Q  L  K  V  K  A  Y  K  R  Q  A  E  E  A Exon 39
23461 accctgctggggactaggcccaggggaggcataggagagctcgtccccaagccaggagtctgagaacccaggcccccctctcacctcatgctcccacctcccgcagGAGGAGCAAG
                                                                                                                E  E  Q
23576 CCAACACCAACCTGTCCAAGTTCCGCAAGGTGCAGCACGAGCTGGATGAGGCAGAGGAGCGGGCGGACATCGCCGAGTCCCAGGTCAACAAGCTGCGGGCCAAGAGCCGTGACAT
      A  N  T  N  L  S  K  F  R  K  V  Q  H  E  L  D  E  A  E  E  R  A  D  I  A  E  S  Q  V  N  K  L  R  A  K  S  R  D  I
23691 TGGCACGAAGgtgggtccctcttttgggctttgctagtcacccccacagcaggcatacccagacagagcaccctcaaacccgggatgcttccttttcatttaattccacacactt
        G  T  K Exon 40
23806 gagccacatggccccagaggcaaggtaatgcagttctctctcatttcaaggattattccagctctaactttttttttttttttttgagacggtgtctcactctgccgcccagg
23921 ctggagtgcagtggcacaatctcagctcactgcaacctctgcctcctgggttctcctgcctcagcctcccaagtagctgggattataggcatgtgctaccatgtcatgctaattt
24036 ttatattttagtagagatgcggtttcaccaatgttggccaggctggtcttgaactcctgaccttgtgatcccactcgcctcagcctcccaaagtacggattacaggcgtgacagc
24151 ccagtccaggctcagctctaaagttcagcctcagaactgccccgaacatgatcctggctttgtttcctttcaaaagGGCTTGAATGAGGAGTAGctttgccacatcttgatctgc
                                                                                                      G  L  N  E  E  * Exon 41
24266 tcagccctggaggtgccagcaaagccccatgctggagcctgtgtaacagctccttgggaggaagcagAATAAAgcaattttccttgaagccgagatcctgactcttcttcactgc
24381 cctgattgaagccgagatcctgactccagactcttcttcactgccctgaggacccggggatggggtctggggaggtggaaatgcaggggagtgggggcaaattcaaaggcctggc
24496 ctaggaggcttcgtggagcagcactgaaaacccctttcacttccccaaaccagccaaatgcagcagaggcgacacctctcctcccagccttctccctggtccagccaggattta
24611 aaggagatttagggagacctcttacgcttcatggtcataagggtctagctctgttggccagaatgtccctttattactggtcgtgtgactggtgaatctgccaatgtaaagtaat
24726 ccattcagcgattgagcgtcaaaatgtaggtatttccatgagcgtttttcctgttgcaatggctggcggtaatattgttctggatattaccagcaaggccagatgtttgagttct
24841 tctactcaggcaagtgatgtattactaatcaaagaagtattgctacaacggttaatttgcgtgatggacaggactcttttactcggtggcctcactgattataaaaacactctca
24956 ggattctggcgtaccgttcctgtctaaaatccctttaatggcctc
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ACKNOWLEDGEMENTS

This work was supported by the Heart and Stroke Foundations of Ontario, the Medical Research Council of Canada and the National Institute of Health (USA).

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