WHO
International Nonproprietary Names Programme

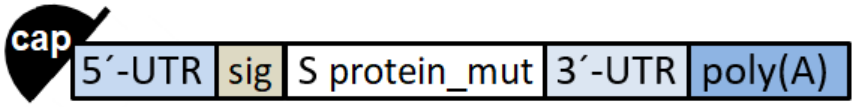
9/2020

11889

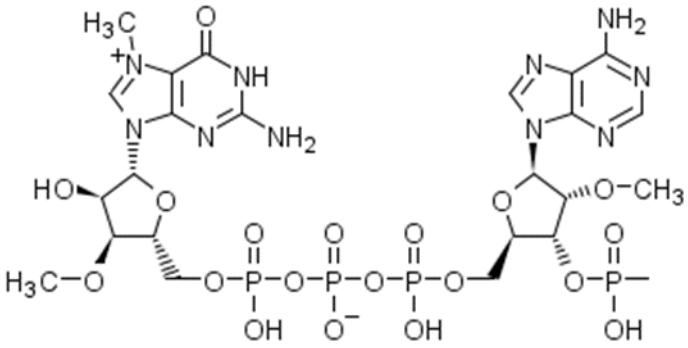
Description

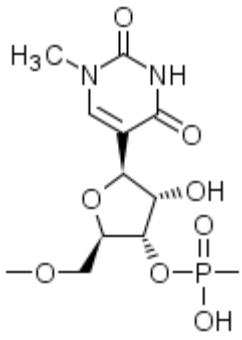
Messenger RNA encoding the full-length SARS-CoV-2 spike glycoprotein.

Schematic



UTR = Untranslated region; sig = extended signal sequence of the S glycoprotein; S protein_mut = S glycoprotein sequence containing mutations K986P and V987P; poly(A) = polyadenylate signal tail.





5‘- capping structure

cap G^1A^2 = $m^7G^+m^{3'}$-5'-ppp-5'-$Am^{2'}$-3'-p-
[m^7 = 7-CH_3; $m^{3'}$ = 3'-*O*-CH_3; $m^{2'}$ = 2'-*O*-CH_3;
-ppp- = -PO_2H-O-PO_2H-O-PO_2H)-; -p- = -PO_2H-]

$m^1\Psi$ = 1-methyl-3'-pseudouridylyl

Table of features

Element	Description	Position
cap	A modified 5’-cap1 structure ($m^7G^+m^{3'}$-5'-ppp-5'-Am)	1-2
5’-UTR	5´-untranslated region derived from human alpha-globin RNA with an optimized Kozak sequence	3-54

sig	S glycoprotein signal peptide (extended leader sequence), which guides translocation of the nascent polypeptide chain into the endoplasmic reticulum.	55-102
S protein_mut	Codon-optimized sequence encoding full-length SARS-CoV-2 spike (S) glycoprotein containing mutations K986P and V987P to ensure the S glycoprotein remains in an antigenically optimal pre-fusion conformation; stop codons: 3874-3879 (underlined)	103-3879
3'-UTR	The 3´ untranslated region comprises two sequence elements derived from the amino-terminal enhancer of split (AES) mRNA and the mitochondrial encoded 12S ribosomal RNA to confer RNA stability and high total protein expression.	3880-4174
poly(A)	A 110-nucleotide poly(A)-tail consisting of a stretch of 30 adenosine residues, followed by a 10-nucleotide linker sequence and another 70 adenosine residues.	4175-4284

Sequence / Séquence / Secuencia

GAGAAΨAAAC ΨAGΨAΨΨCΨΨ CΨGGΨCCCCA CAGACΨCAGA GAGAACCCGC 50
CACC**AΨGΨΨC GΨGΨΨCCΨGG ΨGCΨGCΨGCC ΨCΨGGΨGΨCC AGCCAGΨGΨG** 100
ΨGAACCΨGAC CACCAGAACA CAGCΨGCCΨC CAGCCΨACAC CAACAGCΨΨΨ 150
ACCAGAGGCG ΨGΨACΨACCC CGACAAGGΨG ΨΨCAGAΨCCA GCGΨGCΨGCA 200
CΨCΨACCCAG GACCΨGΨΨCC ΨGCCΨΨΨCΨΨ CAGCAACGΨG ACCΨGGΨΨCC 250
ACGCCAΨCCA CGΨGΨCCGGC ACCAAΨGGCA CCAAGAGAΨΨ CGACAACCCC 300
GΨGCΨGCCCΨ ΨCAACGACGG GGΨGΨACΨΨΨ GCCAGCACCG AGAAGΨCCAA 350
CAΨCAΨCAGA GGCΨGGAΨCΨ ΨCGGCACCAC ACΨGGACAGC AAGACCCAGA 400
GCCΨGCΨGAΨ CGΨGAACAAC GCCACCAACG ΨGGΨCAΨCAA AGΨGΨGCGAG 450
ΨΨCCAGΨΨCΨ GCAACGACCC CΨΨCCΨGGGC GΨCΨACΨACC ACAAGAACAA 500
CAAGAGCΨGG AΨGGAAAGCG AGΨΨCCGGGΨ GΨACAGCAGC GCCAACAACΨ 550
GCACCΨΨCGA GΨACGΨGΨCC CAGCCΨΨΨCC ΨGAΨGGACCΨ GGAAGGCAAG 600
CAGGGCAACΨ ΨCAAGAACCΨ GCGCGAGΨΨC GΨGΨΨΨAAGA ACAΨCGACGG 650
CΨACΨΨCAAG AΨCΨACAGCA AGCACACCCC ΨAΨCAACCΨC GΨGCGGGAΨC 700
ΨGCCΨCAGGG CΨΨCΨCΨGCΨ CΨGGAACCCC ΨGGΨGGAΨCΨ GCCCAΨCGGC 750
AΨCAACAΨCA CCCGGΨΨΨCA GACACΨGCΨG GCCCΨGCACA GAAGCΨACCΨ 800
GACACCΨGGC GAΨAGCAGCA GCGGAΨGGAC AGCΨGGΨGCC GCCGCΨΨACΨ 850
AΨGΨGGGCΨA CCΨGCAGCCΨ AGAACCΨΨCC ΨGCΨGAAGΨA CAACGAGAAC 900
GGCACCAΨCA CCGACGCCGΨ GGAΨΨGΨGCΨ CΨGGAΨCCΨC ΨGAGCGAGAC 950
AAAGΨGCACC CΨGAAGΨCCΨ ΨCACCGΨGGA AAAGGGCAΨC ΨACCAGACCA 1000
GCAACΨΨCCG GGΨGCAGCCC ACCGAAΨCCA ΨCGΨGCGGΨΨ CCCCAAΨAΨC 1050
ACCAAΨCΨGΨ GCCCCΨΨCGG CGAGGΨGΨΨC AAΨGCCACCA GAΨΨCGCCΨC 1100
ΨGΨGΨACGCC ΨGGAACCGGA AGCGGAΨCAG CAAΨΨGCGΨG GCCGACΨACΨ 1150
CCGΨGCΨGΨA CAACΨCCGCC AGCΨΨCAGCA CCΨΨCAAGΨG CΨACGGCGΨG 1200
ΨCCCCΨACCA AGCΨGAACGA CCΨGΨGCΨΨC ACAAACGΨGΨ ACGCCGACAG 1250
CΨΨCGΨGAΨC CGGGGAGAΨG AAGΨGCGGCA GAΨΨGCCCCΨ GGACAGACAG 1300
GCAAGAΨCGC CGACΨACAAC ΨACAAGCΨGC CCGACGACΨΨ CACCGGCΨGΨ 1350

GΨGAΨΨGCCΨ GGAACAGCAA CAACCΨGGAC ΨCCAAAGΨCG GCGGCAACΨA 1400
CAAΨΨACCΨG ΨACCGGCΨGΨ ΨCCGGAAGΨC CAAΨCΨGAAG CCCΨΨCGAGC 1450
GGGACAΨCΨC CACCGAGAΨC ΨAΨCAGGCCG GCAGCACCCC ΨΨGΨAACGGC 1500
GΨGGAAGGCΨ ΨCAACΨGCΨA CΨΨCCCACΨG CAGΨCCΨACG GCΨΨΨCAGCC 1550
CACAAAΨGGC GΨGGGCΨAΨC AGCCCΨACAG AGΨGGΨGGΨG CΨGAGCΨΨCG 1600
AACΨGCΨGCA ΨGCCCCΨGCC ACAGΨGΨGCG GCCCΨAAGAA AAGCACCAAΨ 1650
CΨCGΨGAAGA ACAAAΨGCGΨ GAACΨΨCAAC ΨΨCAACGGCC ΨGACCGGCAC 1700
CGGCGΨGCΨG ACAGAGAGCA ACAAGAAGΨΨ CCΨGCCAΨΨC CAGCAGΨΨΨG 1750
GCCGGGAΨAΨ CGCCGAΨACC ACAGACGCCG ΨΨAGAGAΨCC CCAGACACΨG 1800
GAAAΨCCΨGG ACAΨCACCCC ΨΨGCAGCΨΨC GGCGGAGΨGΨ CΨGΨGAΨCAC 1850
CCCΨGGCACC AACACCAGCA AΨCAGGΨGGC AGΨGCΨGΨAC CAGGACGΨGA 1900
ACΨGΨACCGA AGΨGCCCGΨG GCCAΨΨCACG CCGAΨCAGCΨ GACACCΨACA 1950
ΨGGCGGGΨGΨ ACΨCCACCGG CAGCAAΨGΨG ΨΨΨCAGACCA GAGCCGGCΨG 2000
ΨCΨGAΨCGGA GCCGAGCACG ΨGAACAAΨAG CΨACGAGΨGC GACAΨCCCCA 2050
ΨCGGCGCΨGG AAΨCΨGCGCC AGCΨACCAGA CACAGACAAA CAGCCCΨCGG 2100
AGAGCCAGAA GCGΨGGCCAG CCAGAGCAΨC AΨΨGCCΨACA CAAΨGΨCΨCΨ 2150
GGGCGCCGAG AACAGCGΨGG CCΨACΨCCAA CAACΨCΨAΨC GCΨAΨCCCCA 2200
CCAACΨΨCAC CAΨCAGCGΨG ACCACAGAGA ΨCCΨGCCΨGΨ GΨCCAΨGACC 2250
AAGACCAGCG ΨGGACΨGCAC CAΨGΨACAΨC ΨGCGGCGAΨΨ CCACCGAGΨG 2300
CΨCCAACCΨG CΨGCΨGCAGΨ ACGGCAGCΨΨ CΨGCACCCAG CΨGAAΨAGAG 2350
CCCΨGACAGG GAΨCGCCGΨG GAACAGGACA AGAACACCCA AGAGGΨGΨΨC 2400
GCCCAAGΨGA AGCAGAΨCΨA CAAGACCCCΨ CCΨAΨCAAGG ACΨΨCGGCGG 2450
CΨΨCAAΨΨΨC AGCCAGAΨΨC ΨGCCCGAΨCC ΨAGCAAGCCC AGCAAGCGGA 2500
GCΨΨCAΨCGA GGACCΨGCΨG ΨΨCAACAAAG ΨGACACΨGGC CGACGCCGGC 2550
ΨΨCAΨCAAGC AGΨAΨGGCGA ΨΨGΨCΨGGGC GACAΨΨGCCG CCAGGGAΨCΨ 2600
GAΨΨΨGCGCC CAGAAGΨΨΨA ACGGACΨGAC AGΨGCΨGCCΨ CCΨCΨGCΨGA 2650
CCGAΨGAGAΨ GAΨCGCCCAG ΨACACAΨCΨG CCCΨGCΨGGC CGGCACAAΨC 2700
ACAAGCGGCΨ GGACAΨΨΨGG AGCAGGCGCC GCΨCΨGCAGA ΨCCCCΨΨΨGC 2750
ΨAΨGCAGAΨG GCCΨACCGGΨ ΨCAACGGCAΨ CGGAGΨGACC CAGAAΨGΨGC 2800
ΨGΨACGAGAA CCAGAAGCΨG AΨCGCCAACC AGΨΨCAACAG CGCCAΨCGGC 2850
AAGAΨCCAGG ACAGCCΨGAG CAGCACAGCA AGCGCCCΨGG GAAAGCΨGCA 2900
GGACGΨGGΨC AACCAGAAΨG CCCAGGCACΨ GAACACCCΨG GΨCAAGCAGC 2950
ΨGΨCCΨCCAA CΨΨCGGCGCC AΨCAGCΨCΨG ΨGCΨGAACGA ΨAΨCCΨGAGC 3000
AGACΨGGACC CΨCCΨGAGGC CGAGGΨGCAG AΨCGACAGAC ΨGAΨCACAGG 3050
CAGACΨGCAG AGCCΨCCAGA CAΨACGΨGAC CCAGCAGCΨG AΨCAGAGCCG 3100
CCGAGAΨΨAG AGCCΨCΨGCC AAΨCΨGGCCG CCACCAAGAΨ GΨCΨGAGΨGΨ 3150
GΨGCΨGGGCC AGAGCAAGAG AGΨGGACΨΨΨ ΨGCGGCAAGG GCΨACCACCΨ 3200
GAΨGAGCΨΨC CCΨCAGΨCΨG CCCCΨCACGG CGΨGGΨGΨΨΨ CΨGCACGΨGA 3250
CAΨAΨGΨGCC CGCΨCAAGAG AAGAAΨΨΨCA CCACCGCΨCC AGCCAΨCΨGC 3300
CACGACGGCA AAGCCCACΨΨ ΨCCΨAGAGAA GGCGΨGΨΨCG ΨGΨCCAACGG 3350
CACCCAΨΨGG ΨΨCGΨGACAC AGCGGAACΨΨ CΨACGAGCCC CAGAΨCAΨCA 3400
CCACCGACAA CACCΨΨCGΨG ΨCΨGGCAACΨ GCGACGΨCGΨ GAΨCGGCAΨΨ 3450
GΨGAACAAΨA CCGΨGΨACGA CCCΨCΨGCAG CCCGAGCΨGG ACAGCΨΨCAA 3500
AGAGGAACΨG GACAAGΨACΨ ΨΨAAGAACCA CACAAGCCCC GACGΨGGACC 3550
ΨGGGCGAΨAΨ CAGCGGAAΨC AAΨGCCAGCG ΨCGΨGAACAΨ CCAGAAAGAG 3600
AΨCGACCGGC ΨGAACGAGGΨ GGCCAAGAAΨ CΨGAACGAGA GCCΨGAΨCGA 3650
CCΨGCAAGAA CΨGGGGAAGΨ ACGAGCAGΨA CAΨCAAGΨGG CCCΨGGΨACA 3700
ΨCΨGGCΨGGG CΨΨΨAΨCGCC GGACΨGAΨΨG CCAΨCGΨGAΨ GGΨCACAAΨC 3750
AΨGCΨGΨGΨΨ GCAΨGACCAG CΨGCΨGΨAGC ΨGCCΨGAAGG GCΨGΨΨGΨAG 3800
CΨGΨGGCAGC ΨGCΨGCAAGΨ ΨCGACGAGGA CGAΨΨCΨGAG CCCGΨGCΨGA 3850

AGGGCGΨGAA ACΨGCACΨAC ACAΨGAΨGAC ΨCGAGCΨGGΨ ACΨGCAΨGCA 3900
CGCAAΨGCΨA GCΨGCCCCΨΨ ΨCCCGΨCCΨG GGΨACCCCGA GΨCΨCCCCCG 3950
ACCΨCGGGΨC CCAGGΨAΨGC ΨCCCACCΨCC ACCΨGCCCCA CΨCACCACCΨ 4000
CΨGCΨAGΨΨC CAGACACCΨC CCAAGCACGC AGCAAΨGCAG CΨCAAAACGC 4050
ΨΨAGCCΨAGC CACACCCCCA CGGGAAACAG CAGΨGAΨΨAA CCΨΨΨAGCAA 4100
ΨAAACGAAAG ΨΨΨAACΨAAG CΨAΨACΨAAC CCCAGGGΨΨG GΨCAAΨΨΨCG 4150
ΨGCCAGCCAC ACCCΨGGAGC ΨAGCAAAAAA AAAAAAAAAA AAAAAAAAAA 4200
AAAAGCAΨAΨ GACΨAAAAAA AAAAAAAAAA AAAAAAAAAA AAAAAAAAAA 4250
AAAAAAAAAA AAAAAAAAAA AAAAAAAAAA AAAA 4284

Ψ = 1-methyl-3'-pseudouridylyl