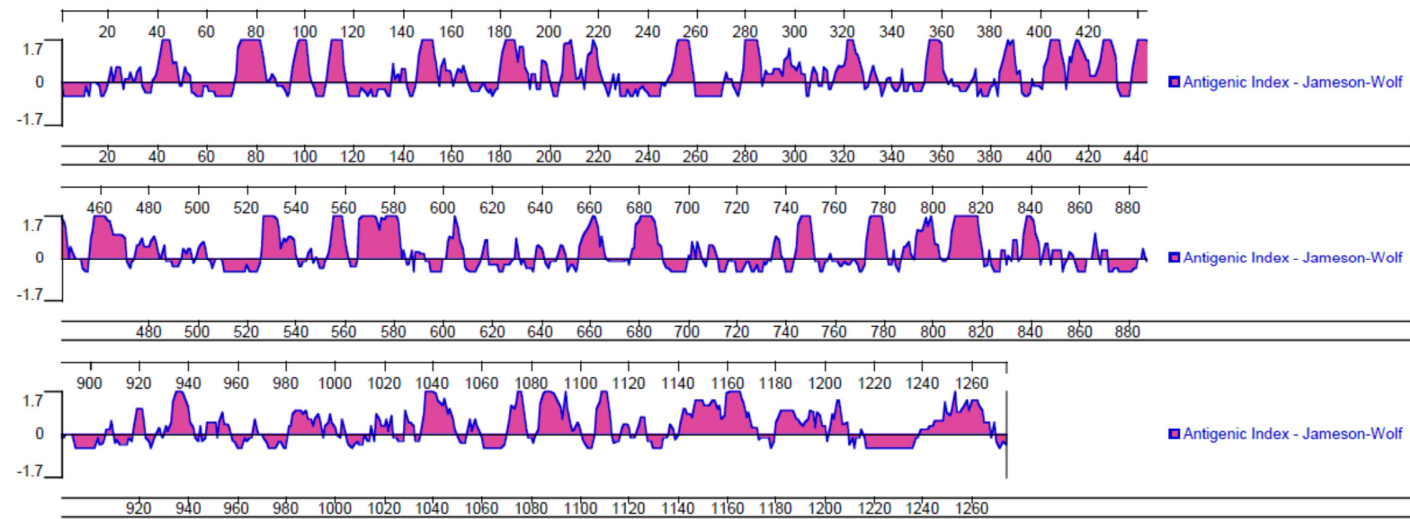


1. Full amino acid sequence of SARS-CoV-2 spike protein (1-1273)

MFVFLVLLPLVSSQCVNLTTRTQLPPAYTNSFTRGVYYPDKVFRSSVLHSTQDLFLPFFSNVTWFHAIHVS GTNGTKRFD
NPVLPFNDGVYFASTEKSNIIRGWIFGTTLD SKTQSL LIVNNATNVVIKVCEFQFCNDPFLGVYYHKNNKSWMESEFRVY
SSANNCTFEYVSQPFLMDLEGKQGNFKNLREFVFKNIDGYFKIYSKHTPINLVRDLPQGFSALEPLVDLPIGINITRFQTLL
ALHRSYLTPGDSSSGWTAGAAAYVGYLQPRTFLLKYNENGTITDAVDCALDPLSETKCTLKSFTVEKGIYQTSNFRVQP
TESIVRFPNITNLCPFGEVFNATRFASVYAWNRRKRISNCVADYSVLVNSASFSTFKCYGVSPTKLNDLCFTNVYADSFVIR
GDEV RQIAPGQTGKIADYNYKLPDDFTGCVIAWNSNNLDSKVGGNYNYLYRLFRKSNLKPFERDISTEIQAGSTPCNG
VEGFNCYFPLQSYGFQPTNGVGYQPYRVVLSFELLHAPATVCGPKKSTNLVKNKCVNFNFNGLTGTGVLTESNKKFLP
FQQFGRDIADTTDAVRDPQTLEILDITPCSFGGVSVITPGTNTSNQVAVLYQDVNCTEVPVAIHADQLTPTWRVYSTGSN
VFQTRAGCLIGA EHVNNSECDIPIGAGICASYQTQTN SPRRARSVASQSIIAYTMSLGAENSVAYSNN SIAIPTNFTISVTT
EILPVSMTKTSVDCTMYICGDSTECSNLLLQYGSFCTQLNRALTGIAVEQDKNTQE VFAQVKQIYKTPPIKDFGGFNFSQI
LPDPSKPSKRSFIEDLLFNKVTLADAGFIKQYGDCLGDIAARDLICAQKFNGLTVLPPLLTD EMI AQYTSALLAGTITSGW
TFGAGAAALQIPFAMQMAYRFNGIGVTQNVLYENQKLIANQFN SAIGKIQDSLSTASALGKLQDVVNQNAQALNTLVK
QLSSNFGAISSVLNDILSRDKVEAEVQIDRLITGRLQSLQTYVTQQLIRAAEIRASANLAATKMSECVLGQSKRVDFCGK
GYHLM SFPQSAPHGVVFLHVTYVPAQEKNFTTAPAICH DGKAHFPREGVFVSNGTHWFVTQRNFYEPQIITTDNTFVSG
NCDVVIGIVNNTVYDPLQPELDSFKEELDKYFKNHTSPD VDLGDISGINASVVNIQKEIDRLNEVAKNLNESLIDLQELGK
YEQYIKWPWYIWLGFIAGLIAIVMVTIMLCCMTSCC SCLKGCCSCGSCCKFDEDDSEPV LKGVKLHYT

2. Antigenic prediction of COVID-19 virus spike protein



3. Supplementary Table S1. Selection of SARS-CoV-2 peptides. Each selected peptide binding to human HLA-I is predicted by using <http://tools.iedb.org/mhci/>, and all alleles are selected and binding of peptide to HLA-II is analyzed using <http://tools.iedb.org/mhcii/>, and peptide length is 15 amino acids against all alleles. Both peptide mixtures with QS21 or Al(OH)₃ induced B and T cell responses in C57BL/6 mice. Furthermore, antibody production against each individual peptide varied with injection time. Using Al(OH)₃ as the adjuvant, the peptide mixtures generated a long-lasting antibody response with an efficacious cellular response. These peptide mixtures, when used as a vaccine, stimulate humoral antibody production, and some peptides could be used to evaluate vaccine effectiveness.

Peptide name and aa sequences	AA position	Binding to MHC-I types	Binding to MHC-II types	Human HLA-II	Human HLA-I
CLPFQQFGRDIADTTDAV RDPQTLEIL	560-585 (A1)	H-2-Dd	N/A	HLA-DRB3*01:01	HLA-A*26:01; HLA-A*30:01; HLA-A*33:01; HLA-A*68:01; HLA-A*68:02; HLA-B*08:01; HLA-B*35:01; HLA-B*51:01; HLA-B*53:01
CYFKIYSKHTPINLVRDLP Q	200-218 (B1)	H-2-Db, H-2-Dd, H-2-Kb, H-2-Kd, H-2-Ld; H-2-Qa1	H2-IEd, H2- IAb	HLA-DPA1*02:01/DPB1*14:01; HLA-DRB1*07:01; HLA-DRB1*08:02; HLA-DRB1*09:01; HLA-DRB1*11:01; HLA-DRB1*13:02; HLA-DRB1*15:01; HLA-DRB3*02:02	HLA-A*02:01; HLA-A*02:03; HLA-A*02:06; HLA-A*23:01; HLA-A*24:02; HLA-A*30:01; HLA-A*32:01; HLA-A*68:02; HLA-B*07:02; HLA-B*08:01; HLA-B*35:01; HLA-B*51:01; HLA-B*53:01; HLA-B*57:01; HLA-B*58:01
CGVYYHKNNKSWMESEF RVY	142-160 (C1)	H-2-Db, H-2-Kb, H-2-Kd	H2-IEd	HLA-DPA1*01:03/DPB1*04:01; HLA-	HLA-A*01:01; HLA-A*03:01; HLA-A*11:01; HLA-A*23:01; HLA-A*24:02; HLA-A*30:01; HLA-A*30:02; HLA-A*31:01; HLA-A*32:01; HLA-B*15:01;

				DRB1*04:01; HLA-DRB3*02:02	HLA-B*35:01; HLA-B*53:01; HLA-B*57:01; HLA-B*58:01
CFHAIHVSGTNGTKRFDN PVLPF	65-84 (D1)	H-2-Kb, H-2-Qa1	H2-IEd	HLA-DRB3*02:02; HLA-DRB1*04:01; HLA-DPA1*01:03/DPB1*04:01	HLA-A*03:01; HLA-A*11:01; HLA-A*23:01; HLA-A*24:02; HLA-A*30:01; HLA-A*30:02; HLA-A*32:01; HLA-A*33:01; HLA-A*68:01
CTRGVYYPDKVFRSSVLHS	33-50 (E1)	H-2-Dd	H2-IEd	HLA-DPA1*02:01/DPB1*05:01; HLA-DRB1*03:01; HLA-DRB1*04:01; LA-DRB1*13:02; HLA-DRB3*01:01; HLA-DRB3*02:02	HLA-A*03:01; HLA-A*11:01; HLA-A*24:02; HLA-A*30:01; HLA-A*30:02; HLA-A*31:01; HLA-A*32:01; HLAA*33:01; HLA-A*68:01; HLA-B*07:02; HLA-B*08:01; HLA-B*15:01; HLA-B*35:01; HLA-B*51:01; HLA-B*53:01
CYQTQTNSPRRARSVAS	674-689 (F1)	H-2-Dd	N/A	HLA-DRB1*04:01	HLA-A*03:01; HLA-A*11:01; HLA-A*30:01; HLA-A*33:01; HLA-A*68:01; HLA-B*07:02; HLA-B*08:01
CVIAWNSNNLDSKVGGN Y	433-449 (G1)	H-2-Db, H-2-Kb	N/A	HLA-DRB3*02:02; HLA-DRB1*13:02	HLA-A*01:01; HLA-A*30:02; HLA-A*68:02
CALDPLSETKCTLKSFTVE KGIYQTSNFRV	291-320 (H1)	H-2-Dd, H-2-Kb, H-2-Kd H-2-Qa1	N/A	N/A	HLA-A*01:01; HLA-A*03:01; HLA-A*11:01; HLA-A*23:01; HLA-A*24:02; HLA-A*30:01; HLA-A*30:02; HLA-A*31:01; HLA-A*32:01; HLA-A*33:01; HLA-A*68:01; HLA-A*68:02; HLA-B*44:01; HLA-B*51:01; HLA-B*53:01; HLA-B*57:01; HLA-B*58:01
CATVCGPKKSTNLVKNK CVNFNFNG	522-545 (I1)	H-2-Db, H-2-Dd, H-2-Kb, H-2-Ld; H-2-Qa1	N/A	LA-DRB1*13:02; HLA-DRB3*02:02	HLA-A*03:01; HLA-A*11:01; HLA-A*30:01; HLA-A*31:01; HLA-B*07:02; HLA-B*08:01; HLA-B*15:01; HLA-B*51:01

CYNYLYRLFRKSNLKPFER DISTEIYQA	452-476 (J1)	H-2-Kk, H-2-Qa2	H2-IEd	HLA-DPA1*01:03/DPB1*02:01; HLA-DPA1*01:03/DPB1*04:01; HLA-DPA1*02:01/DPB1*01:01; HLA-DPA1*02:01/DPB1*05:01; HLA-DRB1*04:01; HLA-DRB1*04:05; HLA-DRB1*07:01; HLA-DRB1*08:02; HLA-DRB1*11:01; HLA-DRB1*12:01; HLA-DRB1*15:01; HLA-DRB3*01:01; HLA-DRB3*02:02; HLA-DRB5*01:01	HLA-A*01:01; HLA-A*03:01; HLA-A*11:01; HLA-A*23:01; HLA-A*24:02; HLA-A*30:01; HLA-A*31:01; HLA-A*33:01; HLA-A*68:02; HLA-B*07:02; HLA-B*08:01; HLA-B*15:01; HLA-B*40:01; HLA-B*44:02; HLA-B*44:03
CIAVEQDKNTQEVFAQV	770-783 (A2)	H-2-Db, H-2-Kb, H-2-Kk, H-2-Qa2	N/A	N/A	HLA-A*02:01; HLA-A*02:03; HLA-A*02:06; HLA-A*26:01; HLA-A*68:02; HLA-B*15:01; HLA-B*40:01; HLA-B*44:02; HLA-B*44:03; HLA-B*51:01
CKQIYKTPPIKDFGGFNFS QILPDPSKPSKRSFIEDLL	786-822 (B2)	H-2-Db, H-2-Dd, H-2-Kb, H-2-Kd, H-2-Qa2	H2-IAb	HLA-DPA1*01:03/DPB1*02:01; HLA-DPA1*01:03/DPB1*04:01; LA-DPA1*02:01/DPB1*01:01; HLA-DQA1*01:01/DQB1*05:01; HLA-DRB1*03:01; HLA-DRB1*04:01; HLA-	HLA-A*02:01; HLA-A*02:03; HLA-A*02:06; HLA-A*03:01; HLA-A*11:01; HLA-A*23:01; HLA-A*24:02; HLA-A*30:01; HLA-A*32:01; HLA-A*68:01; HLA-B*07:02; HLA-B*08:01; HLA-B*35:01; HLA-B*53:01; HLA-B*57:01

				DRB1*04:05; HLA- DRB1*09:01	
CNSAIGKIQDSLSTASAL	927-945 (C2)	H-2-Kd, H-2-Qa1	H2-IAb	HLA-DRB1*04:01; HLA-DRB1*08:02	HLA-A*02:01; HLA-A*02:03; HLA-A*68:02; HLA-B*07:02; HLA-B*08:01
CPLQPELDSFKEELDKYFK NHTSPDVDLGDIS		H-2-Kd	N/A	HLA-DPA1*02:01/DPB1*05:01; HLA-DRB1*04:01; HLA-DRB1*04:05; HLA-DRB1*13:02; HLA-DRB3*02:02	HLA-A*01:01; HLA-A*23:01; HLA-A*24:02; HLA-A*26:01; HLA-A*30:01; HLA-A*30:02; HLA-B*08:01; HLA-B*35:01; HLA-B*44:03; HLA-B*53:01
CVPAQEKNFTTAPAICHD GKAHFPREGVFVSNGTH WF	1068-1103 (E2)	H-2-Db, H-2-Kb, H-2-Kd, H-2-Qa1,	H2-IAb	HLA-DRB1*03:01; HLA-DRB1*13:02; HLA-DRB3*01:01; HLA-DRB3*02:02; HLA-DRB5*01:01	HLA-A*02:06; HLA-A*23:01; HLA-A*24:02; HLA-A*26:01; HLA-A*30:01; HLA-A*30:02; HLA-B*07:01; HLA-B*15:01; HLA-B*35:01; HLA-B*53:01; HLA-B*57:01; HLA-B*58:01
CMTSCCSCLKGCCSCGSC CKFDEDDSEPVLKGV	1236-1267 (F2)	H-2-Kk,H-2-Qa2	N/A	N/A	HLA-A*68:02; HLA-B*40:01; HLA-B*44:02; HLA-B*44:03; HLA-B*51:01