

T cells Take the Lead in COVID-19

Version 3. January 20, 2021

T CELLS ARE IMPORTANT FOR THE RECOVERY OF COVID-19 DISEASE

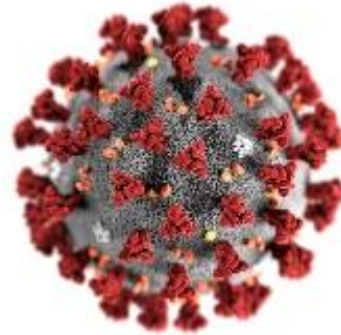
CD4+ and CD8+ T-cell responses to SARS-CoV-2 are crucial for initially resolving acute viral infection and later to assist protection against reinfection through immunological memory (long-lasting immunity) [13,15].

Understanding the specificity, frequency, and durability of the T-cell response is important for defining correlates of protective immunity and helping researchers identify effective vaccine antigens.

SARS-CoV-2-specific memory CD4+ and CD8+ T cells are found in convalescent individuals, including asymptomatic cases [7].

Comprehensive epitope mapping has revealed that functional CD4+ and CD8+ T cells targeting multiple antigens of SARS-CoV-2 are maintained in the resolution phase of both mild and severe COVID-19 [1-12, 14]. Such multi-specific T-cell responses are well suited to provide broad protection, counteracting viral escape mechanisms such as mutation or variable antigen presentation.

Monitoring T-cell responses to numerous epitopes provide a clear picture of the immunity in recovering patients and highlight the potential to pursue epitopes from multiple antigens as targets for immunotherapies and vaccines.



WHAT REMAINS TO BE LEARNED?

Much has been learned about COVID-19 immunity in 2020. However, many open questions crucial for fighting the disease still exist:

- Will the first vaccines provide long-lasting immunity?
- What is the efficacy of a vaccine?
- Do some people have pre-existing immunity to SARS-CoV-2?
- Are some T-cell epitopes immunodominant?
- Are disease severeness reflected in the immunological response?

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PUBLISHED COVID-19 T-CELL EPITOPES

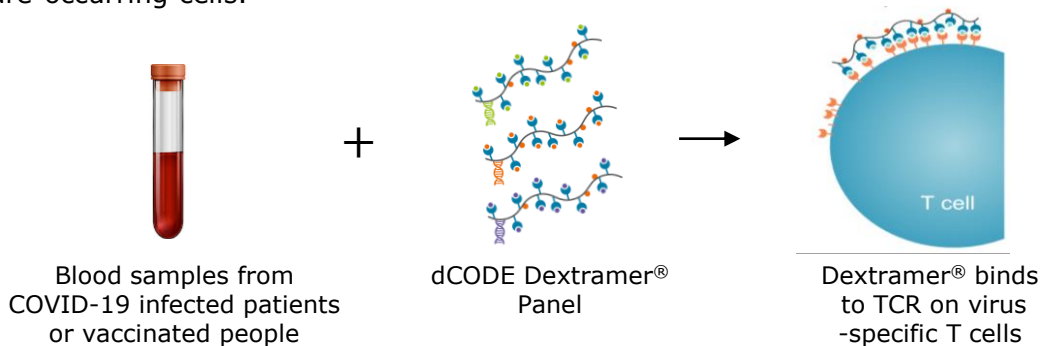
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We want to share a curated list of the published epitopes shown to be recognized by T cells in COVID-19 patients. This list of SARS-CoV-2 specific T-cell epitopes reflects research presented by dedicated scientists worldwide in many recent peer-reviewed and non-peer-reviewed papers.

Thanks to it, you can now choose the most suitable epitopes for your SARS-CoV-2 specific T-cells research and answer some of the questions that remain unanswered about the COVID-19 immunity.

WE CAN HELP YOU STUDY COVID-19 IMMUNITY

Immudex Dextramer® Technology can help you characterize circulating SARS-CoV-2-specific CD4+ and CD8+ T cells in blood from infected individuals without missing rare-occurring cells.



- MHC I and II Dextramer® reagents comprising SARS-CoV-2-epitopes from the list of proven epitopes. Stain blood samples and visualize virus-specific T cells by flow cytometry.
- dCODE Dextramer® (HiT) Technology for epitope discovery or T-cell profiling in bulk solution. The unique DNA barcode enables the detection of antigen-specific T cells by PCR followed by Next Generation Sequencing.
- COVID-19 dCODE Dextramer® Panels allow you to make a full multi-omic profile of the virus-specific immune response by detecting antigen-specific T cells and their T-cell receptor sequencing at the single-cell level. Use a predefined panel or make your own selection from the list of proven T-cell epitopes.

Immudex is your preferred partner in immune monitoring. Our Dextramer® and dCODE® Technologies can help you unravel the specificity of T-cell immunity with high specificity and sensitivity. [Learn more](#) or contact us to discuss your research need at customer@immudex.com

Published COVID-19 T-cell Epitopes

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| HLA Allele | Peptide | Antigen | Reference | T-cell immune monitoring assays | |
|------------|--------------|--------------|-----------------|---------------------------------|-------------|
| | | | | MHC Multimer | Other assay |
| A*0101 | ATSRTLSYY | Membrane | 6 | | X |
| A*0101 | CTDDNALAY | ORF1ab | 8 | X | |
| A*0101 | CTDDNALAYY | ORF1ab | 6, 8, 11 | X | X |
| A*0101 | DTDFVNEFY | ORF1ab | 6, 8, 11, 14 | X | X |
| A*0101 | FTSDYYQLY | ORF3a | 2, 6, 8, 10, 14 | X | X |
| A*0101 | GTDLEGNFY | ORF1ab | 6, 14 | X | X |
| A*0101 | LTDEMIAQY | Spike | 5, 8, 14 | X | X |
| A*0101 | NTCDGTTFTY | ORF1ab | 6 | | X |
| A*0101 | PTDNYITTY | ORF1ab | 6, 11, 14 | X | X |
| A*0101 | RTFKVSIWNLDY | ORF6 | 5 | | X |
| A*0101 | TTDPSFLGRY | ORF1ab | 5, 6, 10, 11 | X | X |
| A*0101 | TVATSRTLSY | Membrane | 11 | X | |
| A*0101 | TTDPSFLGRYM | ORF1ab | 10 | X | |
| A*0101 | CTEIDPKLDNY | ORF1ab | 10 | X | |
| A*0101 | HTTDPDFLGRY | ORF1ab | 14 | X | |
| A*0201 | ALSKGVHFV | ORF3 | 5, 7, 14 | X | X |
| A*0201 | ALWEIQQVV | ORF1ab | 6, 14 | X | X |
| A*0201 | FLHVTYVPA | Spike | 4 | | X |
| A*0201 | FLLPSLATV | ORF1ab | 8 | X | |
| A*0201 | GMSRIGMEV | Nucleocapsid | 8, 16 | X | |
| A*0201 | HLVDFQVTI | ORF6 | 7 | X | |
| A*0201 | ILFTRFFYV | ORF1ab | 8 | X | |
| A*0201 | KIYSKHTPI | Spike | 4 | | X |
| A*0201 | KLLEQWNLV | Membrane | 7 | X | |
| A*0201 | KLPDDFTGCV | Spike | 4 | | X |
| A*0201 | KLWAQCVQL | ORF1ab | 6 | | X |
| A*0201 | LALLLLDRL | Nucleocapsid | 8 | X | |
| A*0201 | LLFNKVTLA | Spike | 4 | | X |
| A*0201 | LLLDRLNQL | Nucleocapsid | 6, 7, 8, 14, 16 | X | X |
| A*0201 | LLLLDRLNQL | Nucleocapsid | 5 | | X |
| A*0201 | LLYDANYFL | ORF3a | 6, 7, 8, 14 | X | X |
| A*0201 | RLDKVEAEV | Spike | 4 | | X |
| A*0201 | RLITGRLQSL | Spike | 4 | | X |
| A*0201 | RLQSLQTYV | Spike | 1, 17 | X | X |

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| HLA Allele | Peptide | Antigen | Reference | T-cell immune monitoring assays | |
|------------|-------------|--------------|----------------------------|---------------------------------|-------------|
| | | | | MHC Multimer | Other assay |
| A*0201 | SLVKPSFYV | Envelope | 7 | X | |
| A*0201 | TLDSKTQSL | Spike | 7 | X | |
| A*0201 | VLNDILSRL | Spike | 7, 16 | X | |
| A*0201 | YLFDESGEFLK | ORF1ab | 6 | X | X |
| A*0201 | YLQPRTFLL | Spike | 1, 6, 7, 9, 11, 14, 17, 18 | X | X |
| A*0201 | YLYALVYFL | ORF3a | 8, 14 | X | |
| A*0201 | RLNEVAKNL | Spike | 11, 16 | X | |
| A*0201 | FLLNKEMYL | ORF1ab | 9 | X | |
| A*0201 | NLLLLFVTV | ORF3 | 10 | X | |
| A*0201 | RTIKVFTTV | ORF1ab | 10 | X | |
| A*0201 | SLDTYPSLETI | ORF1ab | 10 | X | |
| A*0201 | YLATALLTL | ORF1ab | 14 | X | |
| A*0201 | YLDAYNMMI | ORF1ab | 14 | X | |
| A*0201 | NLIDSYFVV | ORF1ab | 14 | X | |
| A*0201 | VVFLHVTVYV | Spike | 14 | X | |
| A*0201 | TLACFVLA AV | Membrane | 16 | X | |
| A*0201 | ILLNKHIDA | Nucleocapsid | 16 | X | |
| A*0201 | NLNESLIDL | Spike | 16 | X | |
| A*0201 | FIAGLIAIV | Spike | 16, 18 | X | |
| A*0301 | KCYGVSP TK | Spike | 6 | | X |
| A*0301 | KLFAAETLK | ORF1ab | 5 | | X |
| A*0301 | KTFPPTEPK | Nucleocapsid | 2, 6, 11, 14 | X | X |
| A*0301 | KTIQPRVEK | ORF1ab | 6, 14 | X | X |
| A*0301 | MVTNNTFTLK | ORF1ab | 6 | | X |
| A*0301 | QLRARSVSPK | ORF7 | 5 | | X |
| A*0301 | RMYIFFASFY | ORF1ab | 8 | X | |
| A*0301 | VVYRGTTTTYK | ORF1ab | 8, 14 | X | |
| A*0301 | VTNNTFTLK | ORF1ab | 14 | X | |
| A*0301 | GVYFASTEK | Spike | 14 | X | |
| A*0301 | KLFD RYFKY | ORF1ab | 14 | X | |
| A*0301 | TSFGPLVRK | ORF1ab | 14 | X | |
| A*0301 | SASKIITLK | ORF3a | 14 | X | |
| A*0301 | TISLAGSYK | ORF1ab | 14 | X | |
| A*1101 | ASAFFGMSR | Nucleocapsid | 6 | | X |

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| HLA Allele | Peptide | Antigen | Reference | T-cell immune monitoring assays | |
|------------|-------------|--------------|------------------|---------------------------------|-------------|
| | | | | MHC Multimer | Other assay |
| A*1101 | ASMPPTIAK | ORF1ab | 5, 8 | X | X |
| A*1101 | ATEGALNTPK | Nucleocapsid | 5, 6 | | X |
| A*1101 | ATSRTLSSYYK | Membrane | 6 | | X |
| A*1101 | KTFPPTEPK | Nucleocapsid | 2, 6, 14 | X | X |
| A*1101 | SAFAMMFVK | ORF1ab | 8, 14 | X | |
| A*1101 | STFNVPMEK | ORF1ab | 8, 14 | X | |
| A*1101 | VTDTPKGP | ORF1ab | 6 | | X |
| A*1101 | VVNARLRAK | ORF1ab | 14 | X | |
| A*1101 | RLFRKSNLK | Spike | 14 | X | |
| A*1101 | VTNNTFTLK | ORF1ab | 14 | X | |
| A*1101 | GTHWFVTQR | Spike | 14 | X | |
| A*1101 | AGFSLWVYK | ORF1ab | 14 | X | |
| A*1101 | AVFDKNLYDK | ORF1ab | 14 | X | |
| A*1101 | TISLAGSYK | ORF1ab | 14 | X | |
| A*1101 | GVYFASTEK | Spike | 14 | X | |
| A*1101 | SASKIITLK | ORF3a | 14 | X | |
| A*1101 | KTIQPRVEK | ORF1ab | 14 | X | |
| A*2402 | KWPWYIWLGF | Spike | 17 | X | |
| A*2402 | DYKHWYQIAQF | Nucleocapsid | 5 | | X |
| A*2402 | FVYYSRVKLN | Envelope | 5 | | X |
| A*2402 | QYIKWPWYI | Spike | 5, 6, 11, 14, 17 | X | X |
| A*2402 | VYFLQSINF | ORF3a | 5, 6, 14 | X | X |
| A*2402 | VYIGDPAQL | ORF1ab | 5, 6, 14 | X | X |
| A*2402 | FYAYLRKHF | ORF1ab | 10 | X | |
| A*2402 | NYNYLYRLF | Spike | 14, 17 | X | |
| A*2402 | NYMPYFFTL | ORF1ab | 14 | X | |
| A*2402 | YYTSNPTTF | ORF1ab | 14 | X | |
| A*2402 | RFDNPVLPF | Spike | 14 | X | |
| A*2402 | TYACWHHSI | ORF1ab | 14 | X | |
| B*0702 | FPRGQGVPI | Nucleocapsid | 5, 7, 8 | X | X |
| B*0702 | IPRRNVATL | ORF1ab | 6, 8, 14 | X | X |
| B*0702 | KPRQKRTAT | Nucleocapsid | 7, 8 | X | |
| B*0702 | NPANNAIIVL | Nucleocapsid | 5 | | X |
| B*0702 | RPDTRYVL | ORF1ab | 6 | | X |
| B*0702 | SPRRARSVA | Spike | 7, 8 | X | |

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| HLA Allele | Peptide | Antigen | Reference | T-cell immune monitoring assays | |
|------------|-------------|--------------|--------------------|---------------------------------|-------------|
| | | | | MHC Multimer | Other assay |
| B*0702 | SPRWYFYYL | Nucleocapsid | 2, 6, 7, 8, 10, 14 | X | X |
| B*0702 | QPGQTFSVL | ORF1ab | 14 | X | |
| B*0702 | RARSVSPKL | ORF7a | 14 | X | |
| B*0702 | APHGVVFL | Spike | 14 | X | |
| B*0702 | RPDTRYVLM | ORF1ab | 14 | X | |
| B*0801 | DLKGKYVQI | ORF1ab | 5 | | X |
| B*0801 | EAFEKMOVSL | ORF1ab | 5 | | X |
| B*0801 | FVKHKHAFI | ORF1ab | 5 | | X |
| B*0801 | TPKYKFVRI | ORF1ab | 5 | | X |
| B*1501 | AQFAPSASAF | Nucleocapsid | 8 | X | |
| B*1501 | KQLIKVTLVF | ORF1ab | 8 | X | |
| B*1501 | LVQMAPISAM | ORF1ab | 8 | X | |
| B*1501 | YLITPVHVM | ORF1ab | 10 | X | |
| B*2705 | QRNAPRITF | Nucleocapsid | 2 | X | |
| B*3501 | QPTESIVRF | Spike | 17 | X | |
| B*3501 | LPFNDGVYF | Spike | 17 | X | |
| B*3501 | IPFAMQMAY | Spike | 17 | X | |
| B*4001 | GETLPTEVL | ORF1ab | 8 | X | |
| B*4001 | GEVITFDNL | ORF1ab | 8 | X | |
| B*4001 | GEEANFCAL | ORF1ab | 8 | X | |
| B*4001 | TEVVGDIIL | ORF1ab | 8 | X | |
| B*4001 | IEYPIIGDEL | ORF1ab | 5 | | X |
| B*4001 | LEYHDVVRVVL | ORF8 | 5 | | X |
| B*4001 | MEVTPSGTWT | Nucleocapsid | 2, 5, 8 | X | X |
| B*4001 | SELVIGAVIL | Membrane | 5 | | X |
| B*4001 | YEGNSPFHPL | ORF7 | 5 | | X |
| B*4403 | EEAIRHVRAW | ORF1ab | 8 | X | |
| B*4403 | EEIAILASF | ORF1ab | 8 | X | |
| B*4403 | MEVTPSGTW | Nucleocapsid | 8 | X | |
| B*4403 | QEILGTVSW | ORF1ab | 8 | X | |
| B*4403 | QEYADVFLY | ORF1ab | 8 | X | |
| B*4403 | SEFSSLPSY | ORF1ab | 8 | X | |
| B*4403 | YEQYIKWPW | Spike | 8 | X | |

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| HLA Allele | Peptide | Antigen | Reference | T-cell immune monitoring assays | |
|--|--------------------|--------------|-----------|---------------------------------|-------------|
| | | | | MHC Multimer | Other assay |
| C*0602 | FYYVWKSIV | ORF1ab | 10 | X | |
| C*0702 | NRFLYIIKL | Membrane | 5 | | X |
| C*0702 | QRNAPRITF | Nucleocapsid | 5 | | X |
| C*0702 | YYQLYSTQL | ORF3a | 5 | | X |
| C*0702 | FYYVWKSIV | ORF1ab | 10 | X | |
| C*0702 | SLRPDTRYVL | ORF1ab | 10 | X | |
| DRB1*0101 DRB1*0401 DRB1*0701 DRB1*1501 | QLIRAAEIRASANLAATK | Spike | 2 | X | |
| DR | KDGIIWVATEGALNT | Nucleocapsid | 5 | | X |
| DR | GTWLTYTGAIKLDDK | Nucleocapsid | 5 | | X |
| DR | RWYFYFLGTGPEAGL | Nucleocapsid | 5 | | X |
| DR | ASWFTALTQHGKEDL | Nucleocapsid | 5 | | X |
| DR | ASAFFGMSRIGMEVT | Nucleocapsid | 5 | | X |
| DR | IGYYRRATRRIRGGD | Nucleocapsid | 5 | | X |
| DRB1*0101 | LLLLDRLNQLESKMS | Nucleocapsid | 5 | | X |
| DR | AADLDDFSKQLQQSM | Nucleocapsid | 5 | | X |
| DR | AIVLQLPQGTTLPKG | Nucleocapsid | 5 | | X |
| DR | YKHWQPQIAQFAPSAS | Nucleocapsid | 5 | | X |
| DR | LDDFVEIIKSQDLSV | ORF1ab | 5 | | X |
| DR | ITRFQTLALHRSYL | Spike | 5 | | X |
| DR | FNGLTVLPPLTDEM | Spike | 5 | | X |
| DR | FMRIFTIGTVTLKQG | ORF3a | 5 | | X |
| DRB1*0101 DRB1*0401 DRB1*0701 | FYVYSRVKNLNSSRV | Envelope | 5 | | X |
| DR | LSYYKLGASQRVAGD | Membrane | 5 | | X |
| DR | IWNLDYIINLIKLN | ORF6 | 5 | | X |
| DR | QEEVQELYSPIFLIV | ORF7 | 5 | | X |
| DR | SKWYIRVGARKSAPL | ORF8 | 5 | | X |
| DR | INVFAFPFTIYSLLL | ORF10 | 5 | | X |

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