

Figure S1

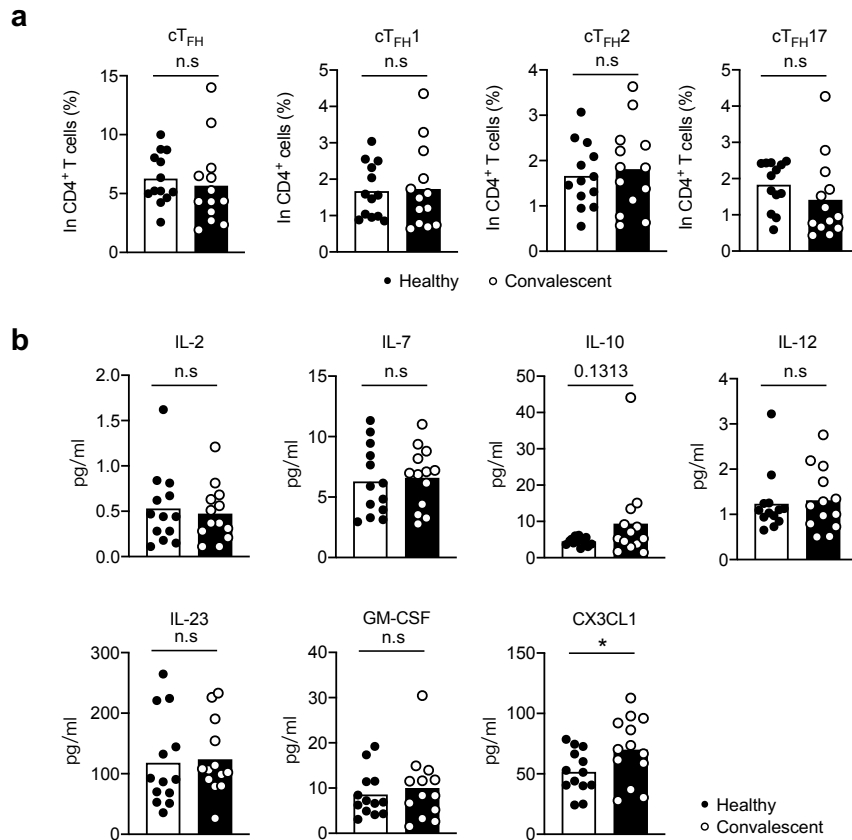


Figure S1. Frequency of cT_{FH} cells in $CD4^+$ T cells and plasma level of cytokines

Blood samples were collected from COVID-19 convalescent patients ($n=13$) and healthy individuals ($n=13$). (a) Frequency of cT_{FH} , cT_{FH1} , cT_{FH2} and cT_{FH17} cells within $CD4^+$ T cells in healthy individuals and COVID-19 convalescent patients (b) Plasma level of IL-2, IL-7, IL-10, IL-12, IL-23, GM-CSF and CX3CL1 were measured and the differences between healthy individuals and COVID-19 convalescent patients were analyzed. Each dot represents an individual subject. Bars represent the mean values. n.s., not significant; * $P<0.05$ and ** $P<0.01$ by unpaired and two-tailed Student's t -test.

Figure S2

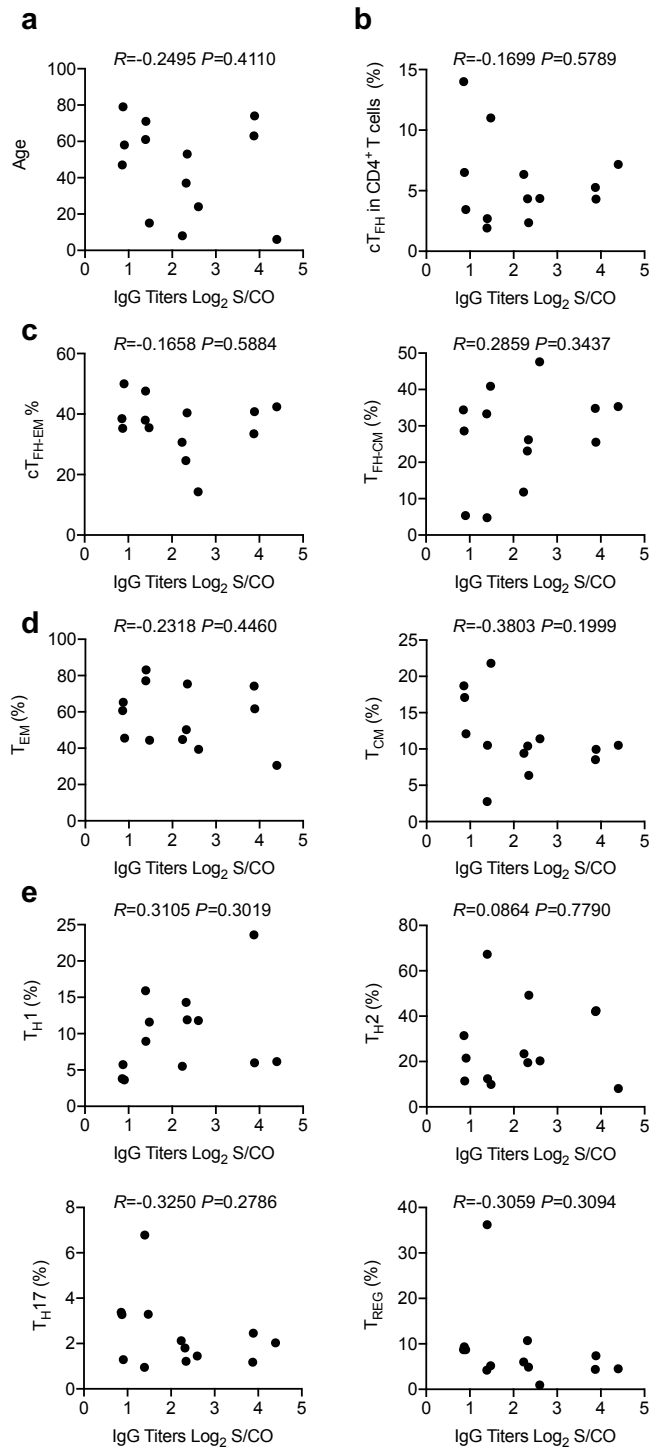


Figure S2. Correlation analysis on SARS-CoV-2 specific IgG antibody titer

Blood samples were collected from COVID-19 convalescent patients (n=13) and healthy individuals (n=13). Plasma were obtained after processing the blood to detect the antibodies specific to SARS-CoV-2 using chemiluminescent immunoassays (CLIA). (a) Correlation between age and SARS-CoV-2 specific IgG antibody titer. (b) Correlation between cT_{FH} cells (%) and SARS-CoV-2 specific IgG antibody titer. (c) Correlation analysis on cT_{FH-EM} cells (%) and cT_{FH-CM} cells (%) with SARS-CoV-2 specific IgG. (d) Correlation analysis on T_{EM} cells (%) and T_{CM} cells (%) with SARS-CoV-2 specific IgG. (e) Correlation analysis on T_{H1}, T_{H2}, T_{H17} and T_{REG} cells (%) with SARS-CoV-2 specific IgG. Each dot represents an individual subject. Measured chemiluminescence values divided by the cutoff (S/CO) were used to present the antibody level. P value was analyzed by two-tailed Pearson correlation coefficient.

Figure S3

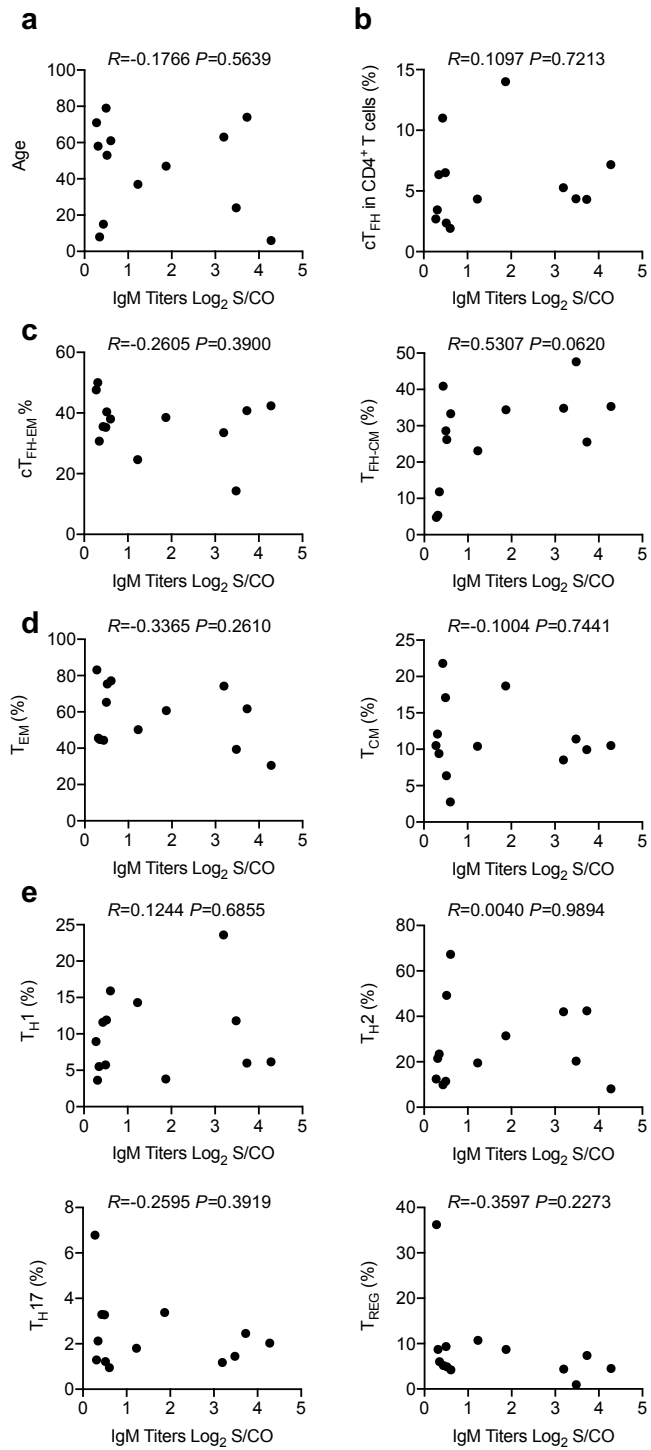


Figure S3. Correlation analysis on SARS-CoV-2 specific IgM antibody titer

Blood samples were collected from COVID-19 convalescent patients (n=13) and healthy individuals (n=13). Plasma were obtained after processing the blood to detect the antibodies specific to SARS-CoV-2 using chemiluminescent immunoassays (CLIA). (a) Correlation between age and SARS-CoV-2 specific IgM antibody titer. (b) Correlation between cT_{FH} cells (%) and SARS-CoV-2 specific IgM antibody titer. (c) Correlation analysis on cT_{FH-EM} cells (%) and cT_{FH-CM} cells (%) with SARS-CoV-2 specific IgM. (d) Correlation analysis on T_{EM} cells (%) and T_{CM} cells (%) with SARS-CoV-2 specific IgM. (e) Correlation analysis on T_{H1}, T_{H2}, T_{H17} and T_{REG} cells (%) with SARS-CoV-2 specific IgM. Each dot represents an individual subject. Measured chemiluminescence values divided by the cutoff (S/CO) were used to present the antibody level. P value was analyzed by two-tailed Pearson correlation coefficient.

Figure S4

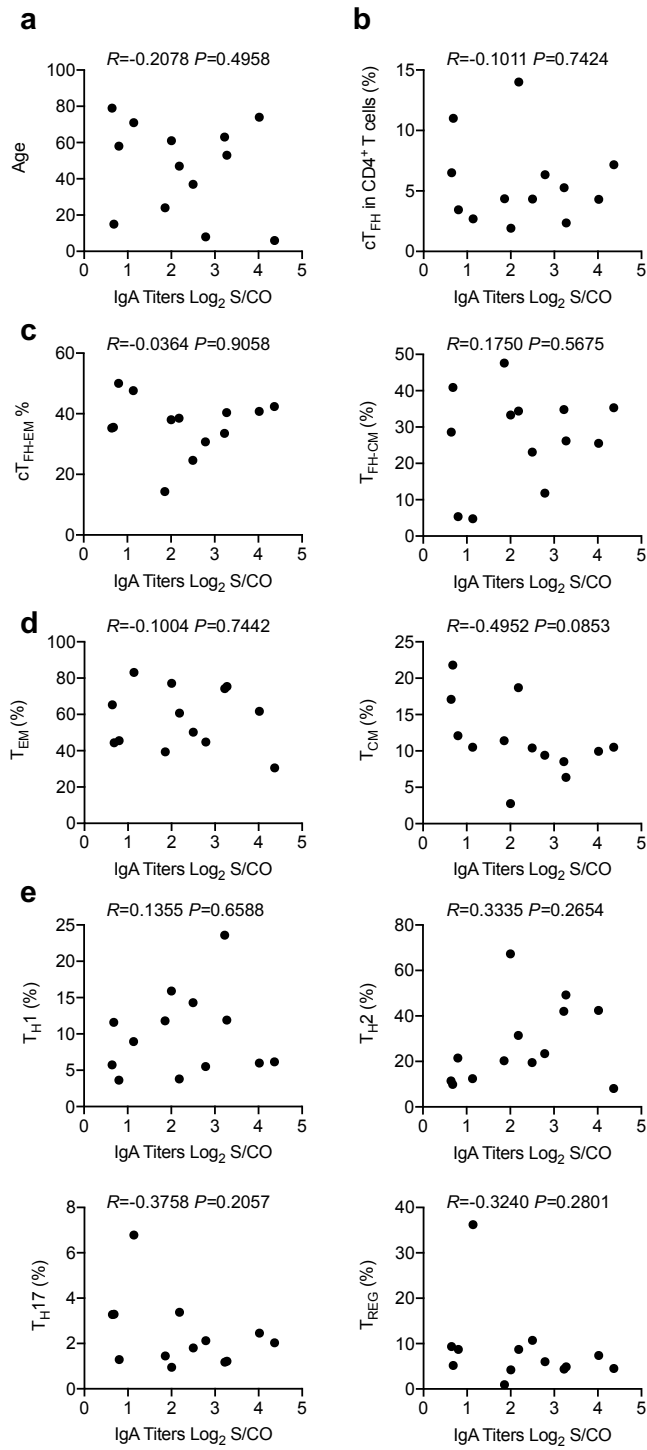


Figure S4. Correlation analysis on SARS-CoV-2 specific IgA antibody titer

Blood samples were collected from COVID-19 convalescent patients (n=13) and healthy individuals (n=13). Plasma were obtained after processing the blood to detect the antibodies specific to SARS-CoV-2 using chemiluminescent immunoassays (CLIA). (a) Correlation between age and SARS-CoV-2 specific IgA antibody titer. (b) Correlation between cT_{FH} cells (%) and SARS-CoV-2 specific IgA antibody titer. (c) Correlation analysis on cT_{FH-EM} cells (%) and cT_{FH-CM} cells (%) with SARS-CoV-2 specific IgA. (d) Correlation analysis on T_{EM} cells (%) and T_{CM} cells (%) with SARS-CoV-2 specific IgA. (e) Correlation analysis on T_{H1}, T_{H2}, T_{H17} and T_{REG} cells (%) with SARS-CoV-2 specific IgA. Each dot represents an individual subject. Measured chemiluminescence values divided by the cutoff (S/CO) were used to present the antibody level. P value was analyzed by two-tailed Pearson correlation coefficient.

Figure S5

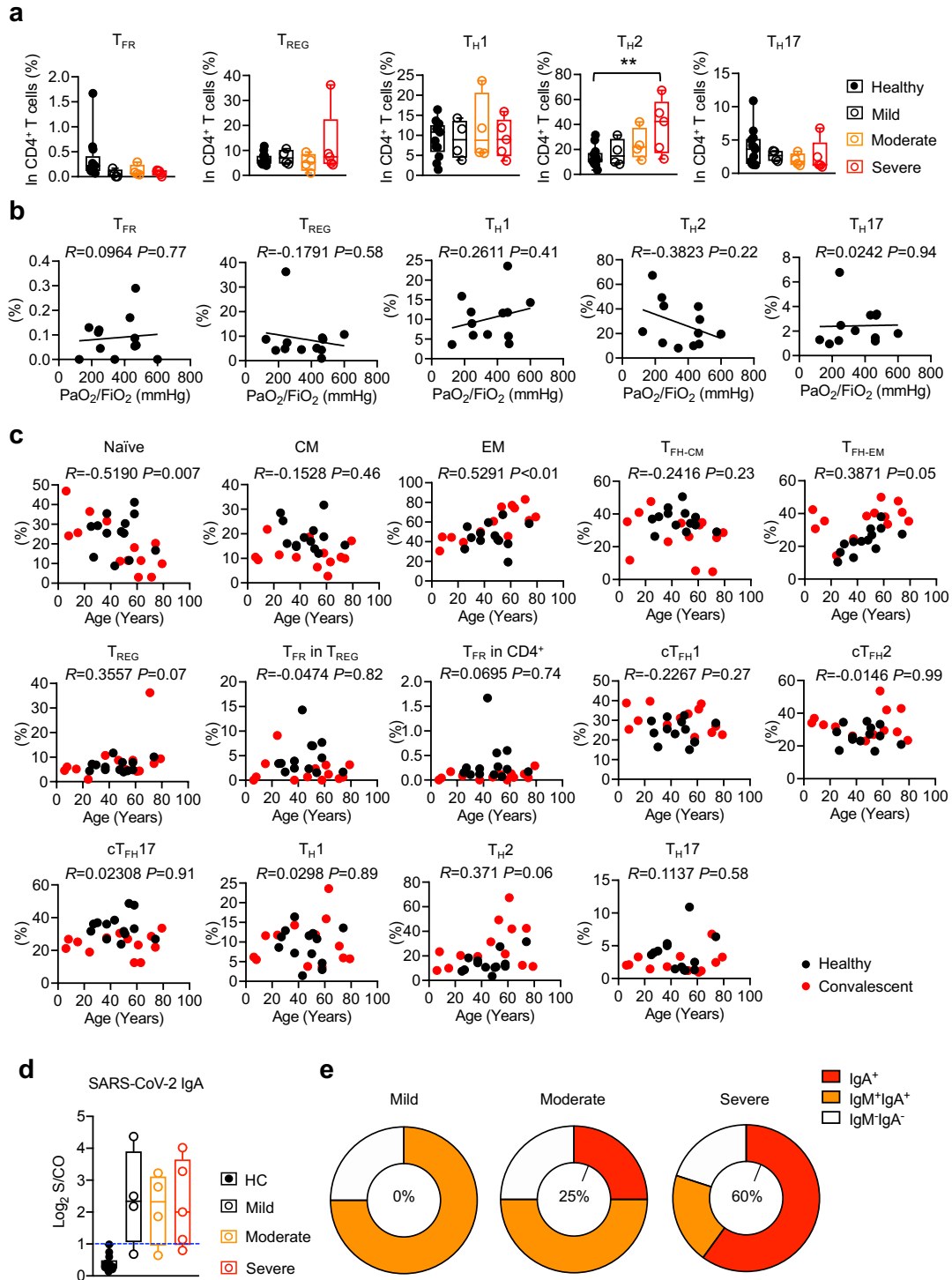


Figure S5. CD4⁺ T cell subsets in different COVID-19 convalescent groups and correlation analysis with age

(a) Statistics showing the frequency of T_{FR}, T_{REG}, T_{H1}, T_{H2} and T_{H17} cells in healthy individuals and different groups of COVID-19 convalescents. Healthy individuals (n=13), mild (N=4), moderate (N=4) and severe (N=5). (b) Correlation of T_{FR}, T_{REG}, T_{H1}, T_{H2} and T_{H17} cells and blood oxygen level (PaO₂/FiO₂) in COVID-19 convalescents. (c) Correlation analysis on age and different CD4⁺ T cell subsets, black dots represent healthy individuals, red dots represent COVID-19 convalescents, overall *R* and *P* values were calculated for each graph. (d) Antibody titer of SARS-CoV-2 specific IgA from convalescent patients in different groups. (e) Ratio of IgM⁺ (no single positive patient in this comparison), IgA⁺ (red), IgM⁺ IgA⁺ (orange) and IgM⁻ IgA⁻ (white) individuals (based on the produced antibody type) in mild, moderate and severe group; percentages in the central circle represent the ratio of IgA⁺ individual in each group. Each dot represents an individual subject. Box plot show min to max. **P*<0.05 and ** *P*<0.01 by One-way ANOVA test or two-tailed Pearson correlation coefficient.

Supplementary Table 1 Clinical and pathological characteristics of each COVID-19 convalescent patient

Pt#	Type	Sex	Age	Travel in Hubei	Signs and symptoms at admission								PaO ₂ /FiO ₂ during hospitalization (mmHg)	Days in hospital	Days since negative PCR for virus
					Fever	Fatigue	Cough	Muscular soreness	Diarrhea	Chest congestion	NA test	CT scan			
#101	Mild	F	47	No	No	No	No	Yes	No	No	P	No abnormal density	471	10	33
#102	Severe	M	71	Yes	Yes	No	Yes	No	No	Yes	P	Bilateral pneumonia	245	30	58
#103	Mild	M	15	Yes	No	No	Yes	No	No	No	P	No abnormal density	433	24	28
#104	Severe	M	53	No	Yes	No	No	No	No	No	P	Bilateral pneumonia	240	8	27
#105	Mild	M	6	No	No	No	No	No	No	No	P	No abnormal density	340	22	26
#106	Severe	M	74	No	No	No	Yes	No	No	No	P	Bilateral pneumonia	252	23	27
#107	Moderate	F	63	No	No	No	No	Yes	No	No	P	Bilateral pneumonia	462	17	29
#108	Moderate	M	79	No	Yes	Yes	Yes	No	No	No	P	Unilateral pneumonia	467	9	69
#109	Moderate	F	24	No	Yes	No	No	No	Yes	No	P	Unilateral pneumonia	462	26	28
#110	Severe	F	61	No	Yes	No	No	No	No	Yes	P	Bilateral pneumonia	183	32	29
#111	Severe	M	58	No	Yes	No	Yes	No	No	No	P	Bilateral pneumonia	124	33	57
#112	Moderate	M	8	No	No	No	Yes	No	No	No	P	No abnormal density	N.T.	9	38
#113	Mild	M	37	No	Yes	No	No	No	No	No	P	No abnormal density	600	26	15

Notes: Pt, patient; F, female; M, male; P, positive; NA, SARS-CoV-2 nucleic acid; PaO₂, arterial oxygen tension; FiO₂, inspired oxygen fraction; N.T., not test; Days in hospital, calculation based on the results of SARS-CoV-2 nucleic acid from positive to negative.

Supplementary Table 2 Antibodies and other key resources

REAGENT or RESOURCE	SOURCE	IDENTIFIER
Antibodies		
FITC Mouse Anti-Human CD8 (Clone:HIT8α)	BD Biosciences	Cat#555634
PerCP-Cy5.5 Mouse Anti-Human CD279 (Clone:EH12.1)	BD Biosciences	Cat#561273
PE Mouse Anti-Human CD196 (Clone:G034E3)	BioLegend	Cat#353410
PE-CF594 Mouse Anti-Human CD25 (Clone:M-A251)	BD Biosciences	Cat#562403
PE-Cy7 Rat Anti-Human CD197 (Clone:3C12)	BD Biosciences	Cat#557648
AF 647 Rat Anti-Human CD185 (Clone:RF8B2)	BD Biosciences	Cat#558113
Alexa Fluor 700 Mouse Anti-Human CD4 (Clone:RPA-T4)	BD Biosciences	Cat#557922
APC/Cyanine7 Mouse Anti-Human CD45RA (Clone:HI100)	BioLegend	Cat#304128
BV421 Mouse Anti-Human CD183 (Clone:G025H7)	BioLegend	Cat#353715
BV510 Mouse Anti-Human CD3 (Clone:UCHT1)	BD Biosciences	Cat#563109
PE Mouse Anti-Human CD366 (Clone:7D3)	BD Biosciences	Cat#563422
PE-CF594 Mouse Anti-Human CD152 (Clone:BNI3)	BD Biosciences	Cat#562742
BV421 Mouse Anti-Human CD127 (Clone:HIL-7R-M21)	BD Biosciences	Cat#562436
Chemicals, Peptides, and Recombinant Proteins		
7AAD Staining Solution	BD Biosciences	Cat#559925
Lysing Solution 10X concentrate	BD Biosciences	Cat#349202
Human BD Fc Block	BD Biosciences	Cat#564219
Ficoll-Paque™ PLUS Media	GE Healthcare Life Sciences	Cat#17144002
FBS	Gibco	Cat#10100147
Critical Commercial Assays		
Anti-SARS-CoV-2 IgG MCLIA kit	Bioscience	Cat#G202004314
Anti-SARS-CoV-2 IgM MCLIA kit	Bioscience	Cat#G202004304
MILLIPLEX _{Map} Human high sensitivity T cell panel (21-plex)-Immunology Multiplex Assay	Merck Millipore	Cat#HSTCMAG-28SK
Kappa light chain reagent	Beckman Coulter life Sciences	Cat#446440
Lambda light chain reagent	Beckman Coulter life Sciences	Cat#446470
Complement 3 reagent	Beckman Coulter life Sciences	Cat#446450
Complement 4 reagent	Beckman Coulter life Sciences	Cat#446490
Anti-streptolysin O reagent	Beckman Coulter life Sciences	Cat#447620
C reactive protein reagent	Beckman Coulter life Sciences	Cat#447280