**Supplementary Information**

**Immune responses in the respiratory tract and blood of COVID-19 patients reveal mechanisms of disease severity**

Wuji Zhang1, Brendon Y. Chua1,2, Kevin J. Selva1, Lukasz Kedzierski1,3, Thomas M. Ashhurst4,5, Ebene R. Haycroft1, Suzanne K. Shoffner6, Luca Hensen1, David F. Boyd7, Fiona James8, Effie Mouhtouris8, Jason C. Kwong1,8, Kyra Y. L. Chua8, George Drewett8, Ana Copaescu8, Julie E. Dobson9, Louise C. Rowntree1, Jennifer R. Habel1, Lilith F. Allen1, Hui-Fern Koay1, Jessica A. Neil1, Matthew Gartner1, Christina Y. Lee6, Patiyan Andersson10, Torsten Seemann10, Norelle L. Sherry8,10, Fatima Amanat11,12, Florian Krammer11, Sarah L. Londrigan1, Linda M. Wakim1, Nicholas J.C. King4,5,13-16,Dale I. Godfrey1, Laura K. Mackay1, Paul G. Thomas7, Suellen Nicholson17, Kelly B. Arnold6, Amy W. Chung1, Natasha E. Holmes8,18-20, Olivia C. Smibert8,21,22,Jason A. Trubiano20-23#,Claire L. Gordon1,8#, Thi H.O. Nguyen1# and Katherine Kedzierska1,2#

**Supplementary Fig. 1 High cytokine levels in non-COVID-19 respiratory samples. a** Distribution of 13 cytokines and chemokines (IL-1β, IFN-⍺2, IFN-γ, TNF, MCP-1, IL-6, IL-8, IL-10, IL-12p70, IL-17A, IL-18, IL-23, and IL-33) in each individual that respiratory and paired blood samples were collected. **b** Comparison of levels of cytokines, chemokines, sIL-6R⍺, and IL-6:sIL-6R⍺ ratio between plasma and respiratory samples for COVID-19 and non-COVID-19 patients. Lines indicate average+SD. Statistical significance was determined with Mann-Whitney test.

**Supplementary Fig. 2 Higher SARS-CoV-2-specific antibodies in COVID-19 than non-COVID-19 respiratory samples.** **a** Heatmaps with unsupervised clustering of antibodies against SARS-CoV-2 and other human coronaviruses including SARS-CoV-1, 229E, NL63, OC43, and HKU1 in COVID-19 plasma and respiratory samples, as measured by multiplex bead array assay. **b** Median fluorescence intensity of IgG1-4 and antibodies with FcγR2aH, FcγR2aR, FcγR2b, FcγR3aV, FcγR3aF, or C1q binding abilities between COVID-19 and non-COVID-19 respiratory samples. Statistical significance was determined with Mann-Whitney test.

**Supplementary Fig. 3 Gating strategies for flow cytometry analyses. a** Respiratory myeloid antibody panel. **b** Whole blood lymphocyte antibody panel. **c** Whole blood innate T cell panel.

**Supplementary Fig. 4 Flow Self-Organizing Map (FlowSOM) analyses of respiratory samples. a**-**b** Cell surface marker expression of **a** respiratory myeloid antibody panel and **b** respiratory lymphocyte antibody panel. **c**-**d** Individual Fit-SNE plots of the **c** myeloid antibody panel and **d** lymphocyte antibody panel. **e** Representative flow cytometry plot of #073 blood neutrophils.

**Supplementary Table 1 DRASTIC cohort demographics**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Patient | Age | Sex | Days post disease onset | Days in hospital | ICU requirement | NIH score | Oxygen supply | Drug therapy |
| V1 | V3 | V5 | V7 | Hospital admission | Hospital discharge |  |
| 009 | 76 | M |  | 19 |  |  | 6 | 36 | 30 | Ward | 2 | NP/HM | D+R |
| 011 | 48 | M |  |  | 8 |  | 4 | 13 | 9 | ICU | 4 | NP | D+R |
| 012 | 48 | M | 7 |  |  |  | 5 | 23 | 18 | ICU | 5 | ETT | D+R |
| 013 | 69 | F | 7 |  |  | 37 | 6 | 37 | 31 | ICU | 5 | ETT | D |
| 014 | 75 | F | 3 |  |  |  | 2 | 8 | 6 | Ward | 4 | NP | D+R |
| 015 | 31 | F | 11 |  |  | 12 | 10 | 12 | 2 | Ward | 3 | N | N |
| 016 | 29 | F | 7 |  |  | 8 | 6 | 8 | 2 | Ward | 2 | N | N |
| 017 | 22 | F | 11 |  |  | 12 | 10 | 12 | 2 | Ward | 3 | N | N |
| 019 | 55 | F | 7 |  |  | 8 | 6 | 8 | 2 | Ward | 3 | N | N |
| 020 | 51 | M | 11 |  |  |  | 10 | 16 | 6 | Ward | 4 | N | D |
| 021 | 47 | F | 7 |  |  |  | 4 | 31 | 27 | ICU | 4 | NP | D+R |
| 022 | 70 | M | 9 |  |  |  | 7 | 20 | 13 | ICU | 4 | NP | D+R |
| 023 | 65 | M | 10 |  |  |  | 7 | 19 | 12 | ICU | 4 | ETT | D+R |
| 024 | 40 | M | 10 |  |  |  | 8 | 14 | 6 | Ward | 5 | N | D |
| 025 | 24 | M | 5 |  |  |  | 4 | 6 | 2 | Ward | 3 | N | N |
| 026 | 65 | M | 12 |  |  |  | 11 | 20 | 9 | Ward | 3 | N | N |
| 027 | 73 | M | 13 |  |  |  | 12 | 16 | 4 | Ward | 4 | N | N |
| 028 | 73 | F | 7 |  |  |  | 6 | 10 | 4 | Ward | 3 | N | N |
| 029 | 28 | M | 5 |  |  | 16 | 4 | 15 | 11 | Ward | 3 | N | D+R |
| 031 | 72 | M | 5 |  |  |  | 4 | 13 | 9 | Ward | 4 | NP  | D+R |
| 032 | 70 | F | 2 |  |  |  | 1 | 20 | 19 | Ward | 4 | NP/HM | D |
| 033 | 60 | M | 7 |  |  | 10 | 6 | 10 | 4 | Ward | 3 | N | N |
| 034 | 59 | M | 8 |  |  | 15 | 7 | 16 | 9 | ICU | 4 | NP/HM | D+R |
| 035 | 69 | F | 12 |  |  |  | 11 | 15 | 4 | Ward | 2 | N | N |
| 036 | 52 | F | 5 |  |  | 26 | 5 | 26 | 21 | ICU | 4 | HFNP | D |
| 037 | 59 | F | 16 |  |  | 36 | 16 | 45 | 29 | ICU | 5 | ETT | D |
| 038 | 53 | F | 6 |  |  |  | 6 | 9 | 3 | Ward | 3 | N | N |
| 039 | 36 | F | 12 |  |  | 17 | 11 | 17 | 6 | Ward | 3 | N | N |
| 042 | 68 | M | 7 |  |  | 28 | 5 | 28 | 23 | Ward | 4 | HFNP | D |
| 043 | 78 | F | 12 |  |  | 15/18# | 3 | 50 | 47 | ICU | 5 | N | N |
| 044 | 90 | M | 2 |  |  | 10 | 0 | 24 | 24 | Ward | 3 | N | N |
| 045 | 35 | M | 11 |  |  |  | 10 | 11 | 1 | Ward | 3 | N | N |
| 046 | 27 | F | 9 |  |  |  | 8 | 9 | 1 | Ward | 2 | N | N |
| 047 | 50 | f | 8 |  |  | 11 | 7 | 11 | 4 | Ward | 4 | NP | D+R |
| 048 | 30 | F | 13 |  |  |  | 12 | 14 | 2 | Ward | 4 | N | D |
| 049 | 67 | M | 9 |  |  |  | 8 | 10 | 2 | Ward | 4 | N | N |
| 050 | 55 | F | 9 |  |  |  | 7 | 14 | 7 | Ward | 3 | N | D |
| 051 | 62 | F | 9 |  |  | 12 | 8 | 12 | 4 | Ward | 2 | NP | D |
| 052 | 85 | M | 9 |  |  | 14 | 9 | 14 | 5 | Ward | 4 | NP | D+R |
| 053 | 75 | M | 4 |  |  | 27 | 3 | 28 | 25 | Ward | 4 | NP | D |
| 054 | 34 | M | 6 |  |  |  | 5 | 6 | 1 | Ward | 3 | N | N |
| 055 | 28 | M | 7 |  |  | 12 | 7 | 11 | 4 | Ward | 4 | NP | D+R |
| 056 | 66 | M |  | 19 |  | 52 | 12 | 56 | 44 | ICU | 3 | ETT | D |
| 057 | 71 | F | 3 |  |  | 10/16# | 2 | 19 | 17 | ICU | 4 | NP | D+R |
| 059 | 52 | M | 7 |  |  |  | 6 | 10 | 4 | ICU | 4 | NP | D+R |
| 060 | 85 | M | 15 |  |  | 24 | 14 | 25 | 11 | Ward | 2 | N | N |
| 061 | 71 | M | 8 |  |  |  | 8 | 14 | 6 | Ward | 3 | NP | D |
| 062 | 58 | M | 10 |  |  | 17 | 10 | 17 | 7 | ICU | 4 | NP | D |
| 063 | 25 | F | 7 |  |  |  | 7 | 13 | 6 | ICU | 5 | ETT | D+R |
| 064 | 58 | F | 7 |  |  |  | 5 | 17 | 12 | Ward | 3 | NP | D+R |
| 065 | 73 | F | 14 |  |  | 17 | 13 | 18 | 5 | Ward | 3 | NP | N |
| 066 | 57 | F | 11 |  |  | 16 | 10 | 16 | 6 | Ward | 4 | N | N |
| 067 | 82 | M | 6 |  |  | 15 | 5 | 18 | 13 | Ward | 4 | N | D |
| 068\* | 41 | F | 3^ |  |  | 53 | 1 | 52 | 51 | ICU | NA | ETT | N |
| 069\* | 73 | F | 0^ |  |  | 19 | 0 | 19 | 19 | ICU | NA | ETT | N |
| 070 | 56 | M | 35 |  |  | 41 | 35 | 43 | 8 | ICU | 4 | NP | D |
| 071 | 31 | F | 10 |  |  | 11 | 9 | 11 | 2 | Ward | 3 | N | N |
| 072 | 59 | M | 12 |  |  | 20 | 12 | 22 | 10 | Ward | 4 | NP | D |
| 073\* | 85 | M | 7 |  |  |  | 6 | 28 | 22 | ICU | NA | ETT | N |
| 074 | 43 | F | 13 |  |  | 16 | 12 | 16 | 4 | Ward | 3 | N | N |
| 075 | 74 | M | 0 |  |  |  | -1 | 6 | 7 | Ward | 4 | NP | D |
| 076\* | 68 | M | 0^ |  |  |  | 0 | 13 | 13 | ICU | NA | ETT | N |
| 077\* | 82 | M | 3 |  |  |  | 2 | 12 | 10 | ICU | NA | ETT | N |
| 078 | 41 | M |  |  |  |  | 48 | 55 | 7 | ICU | 4 | HFNP | D+R |
| 079 | 46 | F | 5 |  |  |  | 4 | 5 | 1 | Ward | 3 | N | N |
| 080\* | 69 | F | 8 |  |  |  | 7 | 10 | 3 | Ward | NA | NP | N |

\*Non-COVID-19 patients with variable disease: 068, decompensated alcoholic hepatitis with encephalopathy; 069, hemangioblastoma intracranial haemorrhage; 073, Klebsiella pneumonia; 076, intracranial haemorrhage; 077, atypical pneumonia; 080, infective exacerbation of chronic obstructive pulmonary disease. ^Date of intubation was used because of no respiratory disease onset. #Patients with delays after anticipated discharge date, data from the later sample were used for analyses if available. V1, hospital admission; V3, ARDS/CRS diagnosis; V5, 24-48 hours post drug therapy; V7, hospital discharge. Abbreviations: N, none; NP, nasal prong; NP/HM, nasal prong/ Hudson mask; HFNP, high flow nasal prong; D, dexamethasone; D+R, dexamethasone and remdesivir.

**Supplementary Table 2 Clinical summary of DRASTIC cohort**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **COVID-19 positive patients** | **Total**(n=60) | **Ward**(n=43) | **ICU**(n=17) | **p value**a | **COVID-19 negative patients**(n=6) | **p value**b |
| **Age** (years), median (range) | 58 (22-90) | 58 (22-90) | 58 (25-78) | 0.9256c | 71 (41-85) | 0.0710c |
| **Female**, n (%) | 28 (46.7%) | 21 (48.8%) | 7 (41.2%) | 0.7749d | 3 (50%) | >0.9999d |
| **Ethnicity**, n (%) |  |  |  | >0.9999d, e |  | 0.6875d, e |
|  African | 3 (5%) | 1 (2.3%) | 2 (11.8%) |  | 0 |  |
|  Arabic | 3 (5%) | 3 (7%) | 0 |  | 0 |  |
|  Asian | 5 (8.3%) | 4 (9.3%) | 1 (5.9%) |  | 2 (33.3%) |  |
|  Aboriginal and Torres Strait Islander | 1 (1.7%) | 1 (2.3%) | 0 |  | 0 |  |
|  European | 33 (55%) | 24 (55.8%) | 9 (52.9%) |  | 4 (66.7%) |  |
|  Indo-Asian | 2 (3.3%) | 2 (4.7%) | 0 |  | 0 |  |
|  Middle Eastern | 7 (11.7%) | 5 (11.6%) | 2 (11.8%) |  | 0 |  |
|  Pacific Islander | 1 (1.7%) | 0 | 1 (5.9%) |  | 0 |  |
|  South Asian | 4 (6.7%) | 2 (4.7%) | 2 (11.8%) |  | 0 |  |
|  Turkish | 1 (1.7%) | 1 (2.3%) | 0 |  | 0 |  |
| **Weight** (kg), median (range) | 77 (44.4-128) | 75.5 (44.6-110) | 88.7 (44.4-128) | 0.0102c | 72 (45-91) | 0.3435c |
| **Height** (cm), median (range) | 167 (152-193) | 165 (152-193) | 170 (157-185) | 0.1202c | 164 (152-175) | 0.4404c |
| **BMI** (kg/m2), median (range) | 26.7 (17.4-41.4) | 26.4 (17.4-41.4) | 30.4 (18-40.3) | 0.0653c | 29 (18-32) | 0.6384c |
| **Days from symptom onset to hospitalization**, median (range) | 7 (-1-48) | 7 (-1-14) | 7 (2-48) | 0.8994c | 2 (0-7) | 0.0064c |
| **Days in hospital**, median (range) | 6 (1-47) | 5 (1-30) | 13 (4-47) | <0.0001c | 16 (3-51) | 0.0753c |
| **Ward/ICU**, n (%) |  |  |  | N/A |  | 0.0136d |
|  Ward | 43 (71.7%) | N/A | N/A |  | 1 (16.7%) |  |
|  ICU | 17 (28.3%) | N/A | N/A |  | 5 (83.3%) |  |
| **NIH score**, n (%) |  |  |  | 0.0001d, f |  | N/A |
|  2 | 6 (10%) | 6 (14%) | 0 |  | N/A |  |
|  3 | 21 (35%) | 20 (46.5%) | 1 (5.9%) |  | N/A |  |
|  4 | 27 (45%) | 16 (5.3%) | 11 (64.7%) |  | N/A |  |
|  5 | 6 (10%) | 1 (2.3%) | 5 (29.4%) |  | N/A |  |
| **Oxygen support**, n (%) |  |  |  | <0.0001d, g |  | 0.0308d, g |
|  **None** | 29 (48.3%) | 28 (65.1%) | 1 (5.9%) |  | 0 |  |
|  **Non-Invasive** | 25 (41.7%) | 15 (34.9%) | 10 (58.8%) |  | 1 (16.7%) |  |
|  Nasal prong | 19 (31.7%) | 12 (27.9%) | 7 (41.2%) |  | 1 (16.7%) |  |
|  Nasal prong / Hudson mask | 3 (5%) | 2 (4.7%) | 1 (5.9%) |  | 0 |  |
|  High flow nasal prong | 3 (5%) | 1 (2.3%) | 2 (11.8%) |  | 0 |  |
|  **Invasive** | 6 (10%) | 0 | 6 (35.3%) |  | 5 (83.3%) |  |
|  Endotracheal tube | 6 (10%) | 0 | 6 (35.3%) |  | 5 (83.3%) |  |
| **Clinical presentation**(ILI/pneumonia/chest x-ray consolidation), n (%) |  | 0.3142d |  | 0.1478d |
|  None | 13 (21.7%) | 11 (25.6%) | 2 (11.8%) |  | 3 (50%) |  |
|  Yes | 47 (78.3%) | 32 (74.4%) | 15 (88.2%) |  | 3 (50%) |  |
| **Drugs**, n (%) |  |  |  | 0.0009d, g |  | 0.0030d, g |
|  None | 24 (40%) | 23 (53.5%) | 1 (5.9%) |  | 6 (100%) |  |
|  Dexamethasone (5-day course) | 18 (30%) | 12 (27.9%) | 6 (35.3%) |  | 0 |  |
|  Dexamethasone (5-day course) + Remdesivir (5-day course) | 18 (30%) | 8 (18.6%) | 10 (58.8%) |  | 0 |  |
| **Immunosuppressants**, n (%) |  |  |  | >0.9999d, g |  | >0.9999d, g |
|  None | 52 (86.7) | 37 (86%) | 15 (88.2%) |  | 6 (100%) |  |
|  Ciclosporin + Mycophenolate mofetil | 1 (1.7%) | 1 (2.3%) | 0 |  | 0 |  |
|  Vinblastine + Prednisolone + Pembrolizumab | 1 (1.7%) | 1 (2.3%) | 0 |  | 0 |  |
|  Methotrexate + Prednisolone | 1 (1.7%) | 0 | 1 (5.9%) |  | 0 |  |
|  Prednisolone | 3 (5%) | 2 (4.7%) | 1 (5.9%) |  | 0 |  |
|  Dexamethasone | 1 (1.7%) | 1 (2.3%) | 0 |  | 0 |  |
|  Tacrolimus | 1 (1.7%) | 1 (2.3%) | 0 |  | 0 |  |
|  Tacrolimus + Mycophenolate mofetil | 0 | 0 | 0 |  | 0 |  |
| **Smoker**, n (%) |  |  |  | 0.6023d, h |  | 0.0347d, h |
|  Non-smoker | 43 (71.7%) | 31 (72.1%) | 12 (70.6%) |  | 0 |  |
|  Ex-smoker | 8 (13.3%) | 7 (16.3%) | 1 (5.9%) |  | 1 (16.7%) |  |
|  Smoker | 5 (8.3%) | 3 (7%) | 2 (11.8%) |  | 2 (33.3%) |  |
|  Unknown | 4 (6.7%) | 2 (4.7%) | 2 (11.8%) |  | 3 (50%) |  |

aComparison between COVID-19 positive ward and ICU patients.

bComparison between COVID-19 positive and COVID-19 negative patients.

cSignificance was determined using the Mann-Whitney test.

dSignificance was determined using the Fisher’s exact test.

eComparison between European and other ethnicities (not including unknown).

fComparison between NIH score 2, 3 and NIH score 4, 5.

gComparison between patients with or without oxygen support, drug treatments, or immunosuppressants.

hComparison between Non-smoker and Ex-smoker, and Smoker (not including unknown).

Abbreviations: ICU, intensive care unit; N/A, not applicable; NIH, National Institutes of Health; ILI, influenza-like-illness.

**Supplementary Table 3 Grading criteria of the National Institutes of Health (NIH) score\***

|  |  |
| --- | --- |
| **NIH score** | **Criteria** |
| Asymptomatic/Presymptomatic (1) | Individuals who:* test positive for SARS-CoV-2 by virologic testing, and
* have no symptoms
 |
| Mild (2) | Individuals who:* have COVID-19 symptoms such as fever, cough, sore throat, malaise, headache, muscle pain, and
* without shortness of breath, dyspnoea, or abnormal chest imaging
 |
| Moderate (3) | Individuals who:* have evidence of lower respiratory disease by clinical assessment or imaging, and
* have a saturation of oxygen (SpO2) ≥94% on room air at sea level
 |
| Severe (4) | Individuals who:* have respiratory frequency >30 breaths per minute, or
* SpO2 <94% on room air at sea level, or
* ratio of arterial partial pressure of oxygen to fraction of inspired oxygen (PaO2/FiO2) <300 mmHg, or
* lung infiltrates >50%
 |
| Critical (5) | Individuals who:* have respiratory failure, septic shock, and/or multiple organ dysfunction
 |

\*https://www.covid19treatmentguidelines.nih.gov/overview/clinical-spectrum/

**Supplementary Table 4 Validation test of the surrogate Virus Neutralization Test**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sample** | **COVID-19 status** | **Dilution**a | **% Inhibition**b |
| COVID-19 positive serum | Positive | Neat | 95.6 |
|  |  | 1:2 | 86.4 |
|  |  | 1:10 | 44.1 |
| DRASTIC 069 ETA | Negative | Neat | 10.5 |
|  |  | 1:2 | 87.3 |
|  |  | 1:10 | 43.1 |
| DRASTIC 080 Sputum | Negative | Neat | 0 |
|  |  | 1:2 | 86.9 |
|  |  | 1:10 | 40.1 |

aCOVID-19 negative ETA and sputum were tested in neat or mixed with the COVID-19 positive serum until the COVID-19 positive serum was in the dilution as stated in the column.

bPositive % inhibition was defined as ≥ 20%.

Abbreviation: ETA, endotracheal aspirate.

**Supplementary Table 5 Panel design of the multiplex bead array assay**

|  |  |  |
| --- | --- | --- |
| **Pathogens** | **Proteins** | **Isotypes and FcɣR/C1q bindings** |
| SARS-CoV-2 | RBD | IgG |
|  | S1 | IgG1 |
|  | S2 | IgG2 |
|  | Trimeric S | IgG3 |
|  | NP | IgG4 |
| SARS-CoV-1 | S1 | IgA1 |
|  | Trimeric S | IgA2 |
|  | NP | IgM |
| HCoV 229E | S1 | FcɣR2aH |
|  | S1+2 | FcɣR2aR |
|  | NP | FcɣR2b |
| HCoV NL63 | S1 | FcɣR3aV |
|  | S1+2 | FcɣR3aF |
|  | Trimeric S | C1qa |
|  | NP |  |
| HCoV OC43 | S1 |  |
|  | S2 |  |
|  | S1+2 |  |
|  | NP |  |
| HCoV HKU1 | S1 |  |
|  | S1+2 |  |
|  | Trimeric S |  |
|  | NP |  |
| C. Tetani | Tetanus Toxin |  |
| Influenza A/Cali/07/2009 (H1N1) | Hemagglutinin |  |

aC1q binding was not tested for NP of SARS-CoV-2, SARS-CoV-1, HCoV 229E, HCoV NL63, HCoV OC43 and HCoV HKU1, and HCoV 229E S1+2. Abbreviations: FcɣR, fragment crystallizable region gamma receptor; C1q, complement component 1q; RBD, receptor binding domain; S, spike; NP, nucleoprotein; HCoV, human coronavirus.

**Supplementary Table 6 Flow cytometry antibody panels**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Colour** | **Fluorochrome** | **Respiratory myeloid panel** | **Respiratory lymphocyte panel** | **Whole blood lymphocyte panel** | **Whole blood innate T cell panel** |
| Violet | BV421 | CD66b | CXCR5 | CD71 |  |
| BV510 | CD64 |   | CD19 | Live/Dead |
| BV605 | HLA-DR | HLA-DR | HLA-DR | CD161 |
| BV650 | CD4 | CD4 | CD4 |  |
| BV711 | CD32 | CD27 | CD27 | TRAV1-2 |
| BV786 | CD11b | CD38 | CD38 |  |
| Red | APC | CD62L | CD56 | CD56 |  |
| AF700 | CD16 | CD16 | CD16 | CD27 |
| APC-H7 | Live/Dead | Live/Dead | CD14 | CD19 |
| Blue | FITC |   | CD45RA | CD45RA | TCRgd |
| PerCP-Cy5.5 | CD45 | CD45 | CD8 |  |
| Yellow-Green | PE | CD38 | TCRgd | TCRgd | MR1-5-OP-RU tetramer |
| ECD | CD19 | CD19 | CD3 |  |
| PE-Cy7 | CD1c | PD-1 |  |  |
| UV | BUV395 | CD3 | CD3 |  | CD3 |
| BUV496 |  |  |  | CD4 |
| BUV737 | CD14 | CD14 |  |  |
| BUV805 | CD8 | CD8 |  | CD8 |