

Gene Set Names	Defining Genes
Interferon Gamma Response Signature	<i>CCL5, CD3D, CXCL10, IL2RB, LAG3, IDO1, IL2RG, STAT1, PRF1, PDCD1, GZMA, GZMB, CD8A, CXCL9, TBX21, CD27, CD4, CD74, IFNG, CCR5, CXCL11, CXCL13, CXCR6, PTPRC</i>
B Cell Markers	<i>CD79A, BLNK, CD79B, CCR9, CD19, PNOC, BLK, CD22, HLA-DOB, TCL1A, CR2, SPIB, CD72, TNFRSF17, HLA-DQA1, PAX5, MS4A1, MEF2C, FCRL2</i>
Cytotoxic CD8 T-Cells	<i>GZMK, FLT3LG, KLRK1, KLRD1, PRF1, GZMA, CD3G, CD8B, SIGIRR, GZMB, KLRB1, CD8A, GZMH, PF4, TBX21, CD3E, NKG7, CD27, IFNG, GNLY, EOMES, GZMM, KLRF1, KLRC1, RUNX3</i>
Cytotoxic Receptors and Function	<i>ZNF683, SLAMF6, KLRK1, KLRD1, SLAMF7, NCR1, SH2D1B, GZMA, TYROBP, SH2D1A, GZMB, KLRB1, KIR3DL3, CLEC4C, CLEC4D, KLRC1, GZMH, NKG7, NCR3, GNLY, GZMM, KLRF1</i>
T-Cell Checkpoint Modulation	<i>HLA-DQA2, CD274, TNFRSF14, CD86, CARD11, CD40, AKT1, CD3D, TNFRSF9, KLRK1, LAG3, CSK, TNFRSF13C, CD276, CD80, PDCD1, CD40LG, CD3G, PDCD1LG2, PTPN6, HLA-DQB2, ADORA2A, HLA-DPB1, TNFSF4, TIGIT, HLA-DRB1, CCL19, HAVCR2, CD3E, CD27, CD5, CCL21, CD4, HLA-DQA1, VAV1, CD70, CD24, GRB2, SRC, HLA-DRA, CD28, TNFSF13B, HLA-DPA1, TNFRSF4, CTLA4, ICOS, LYN, BTLA</i>
Tumor Inflammation	<i>PRF1, GZMA, GZMK, CCL5, CXCL10, IFNG, CXCL9, STAT1</i>
Th1 Polarization and Response	<i>NFKB1, RELA, IL12B, TBX21, IL2, IFNGR1, IL12RB1, RBPJ, JAK2, TYK2, JAK1, DLL1, IFNG, STAT1, STAT4, IL12A</i>
Lymphocyte Trafficking	<i>CD274, FAM129C, CDH2, CXCR4, CD68, PDCD1, PDCD1LG2, PLCG2, CD40LG, HLA-DOB, MAPK11, ITGAL, CD52, HLA-DPB1, HLA-DRB1, PVR, CD4, ITGA5, HLA-DQA1, VAV1, NCAM1, HLA-C, LILRB3, CTLA4, CD83, CD86, LILRB1, HLA-DOA, LILRA3, CXCL12, ROCK2, LILRA5, ITGAX, CD84, PLCG1, TIGIT, HLA-DMB, ITGA4, MMP9, CD28, CYBB, SELE, ICOS, CLEC4E, ICAM1, HLA-DQA2, SDC1, CEACAM3, CD96, CD80, CD22, CD84, SELL, CD209, PDPN, SIGLEC5, HLA-DRA, SIGLEC1, ITGB2, S1PR4, CD7, CD177, ITGAM, HLA-A, ITK, CD40, ITGB7, CD34, MSN, HLA-F, CD276, PTK2B, RASSF5, CD6, S1PR1, MAPK14, VCAM1, HLA-E, TREM1, HLA-DMA, HLA-DPA1</i>
General T Cell Markers	<i>LCK, CD247, CD2, CD3E, CD3G, CD5, SH2D1A, TNFRSF25, TRAT1, CD96, CD6, LAMP1, CD3D, IL2RB, CD14, ZAP70</i>
Receptor	<i>PDCD1, HAVCR2, TNFRSF14, CD27, CD40, TLR4, KIR2DL1, ICOS, BTLA, TNFRSF9, ADORA2A, LAG3, TNFRSF4, CTLA4, TIGIT, IL2RA, TNFRSF18</i>
Stress Toxicity	<i>RAD17, DDIT3, TLR4, ATR, ADM, BID, CHEK2, HSP90B1, IL1B, RIPK1, CCL2, IL6, HSPA5, CD40LG, CRP, GADD45A, VEGFA, DDB2, HSP90AA1, CASP1, TNFRSF10A, PARP1, PVR, CDKN1A, TP53, TNFRSF10B, NBN, EDN1, FAS, SERPINE1, RAD51, NFAT5, ATG7, CA9, IFNG, ATG5, ATG12, XPC, CALR, GRB2, RAD9A, HMOX1, MMP9, HUS1, EPO, IL1A, CHEK1, ATM, TNF</i>
DNA Repair (Hallmark)	<i>TYMS, POLR1D, GTF2H1, ITPA, TAF6, TK2, SDCBP, GPX4, SMAD5, SAC3D1, UMP5, NUDT9, NME3, RPA3, NFX1, DGUOK, GTF2H3, DGCR8, DCTN4, ERCC2, TAF9, POLR2H, NME4, XPC, BOLA2_2B, DAD1, VPS37D, TMED2, NCBP2, RAE1, NUDT21, CCNO, GTF3C5, ERCC4, SUPT5H, ARL6IP1, EIF1B, ZNF707, AK3, VPS28, RAD52, TAF10, ERCC3, FEN1, SUPT4H1, PCNA, POLR2A, POLH, BCAP31, POLB, NTS5, HCLSI, SRSF6, POLR2J, REV3L, USP11, VPS37B, POLR2K, GTF2H5, ADCY6, HPRT1, TP53, PRIM1, RALA, BCAM, POLD1, CLP1, SURF1, POLD4, GMPR2, MPG, PNP, DDB1, POLR2D, RBX1, SF3A3, RFC4, ZWINT, IMPDH2, POLR2C, ADRM1, PDE6G, POLR2G, POLR1C, POLR2F, LIG1, DUT, CMPK2, SEC61A1, RFC3, GUK1, PDE4B, RAD51, GTF2F1, POLA2, STX3, TARBP2, CDA, APRT, ELL, RFC5, POM121, RPA2, POLR3C, NME1, POLR2E, AK1, NPR2, ERCC1, GSDME, TAF12, POLR2I, POLA1, CETN2, POLL, ZNRD1, POLD3, RNMT, TSG101, ELOA, DDB2, UPF3B, SNAPC5, CANT1, ADA, POLR3GL, TAF13, COX17, ERCC8, AAAS, BRF2, POLE4, SSRP1, TAF1C, RFC2, SNAPC4, EDF1, ERCC5, CSTF3, GTF2B, GTF2A2, NELFCD, MRPL40, RRM2B</i>
P53 Pathway (Hallmark)	<i>LRMP, IRAK1, DDIT3, AK1, BAK1, ACVR1B, RGS16, ITGB4, IFI30, HBEGF, SDC1, APAF1, MXD1, SOCS1, TXNIP, VWA5A, TRAFD1, BTG2, RAD51C, CEBPA, SPHK1, DGKA, HRAS, BAX, DDB2, GADD45A, CD82, TGFBI, RRAD, ELP1, FBXW7, CYFIP2, TCHH, PTPRE, ADA, PCNA, CDH13, CD81, CASP1, POLH, AEN, SLC3A2, SEC61A1, CDKN1A, LIF, TP53, PHLDA3, FAS, NINJ1, DEF6, FOS, TSPYL2, XPC, PROCR, HDAC3, RAD9A, HMOX1, ERCC5, CCND2, POM121, FOXO3, IL1A, CCND3, TNFSF9, TRAF4, TAP1, APP, HIST1H1C, PPP1R15A, NOTCH1, BTG1</i>
Oxidative Phosphorylation	<i>VDAC1, ALAS1, HSD17B10, SDHA, ALDH6A1, ATP5F1, PHB2, BAX, TCIRG1, GPX4, CASP7, NDUFA5, POLR2F, COX17, HTRA2, SURF1, OAT, SLC25A3, DLAT, GPI</i>
(Hallmark) Peroxisome (Hallmark)	<i>HSD11B2, ABCD2, ABCB1, ERCC1, ERCC3, HRAS, CDK7, CADM1, FDPS, BCL10, ACSL1, MSH2</i>
Hypoxia	<i>NFKB1, VDAC1, ADORA2B, ATR, NAMPT, ADM, TXNIP, MAP3K1, F3, VEGFA, EGRI, RBPJ, MIF, IGFBP3, NCOA1, HIF1A, PLAU, TP53, EDN1, SERPINE1, FOS, CA9, PER1, NOS3, MMP9, HMOX1, LGALS3, MET, EPO, APEX1, BLM, GPI, PIMI</i>
TGF Beta Signaling	<i>CBL, CREBBP, LTBP1, ID1, TGFBI, SMAD5, MYC, PARP1, TGFB3, EP300, IFNG, TGFBRI, SMAD2, TGFB2, THBS1, SMAD3, TGFB3, MAPK3, TNF</i>

Extended data Table S1: Genes defining gene-set enrichment pathways

Channel	Marker	Clone
1	DAPI	NA
2	CD45RO	T200/797
3	HLA-A	EP1395Y
4	CD4	EPR6855
5	Podoplanin	18H5
6	CD20	SP32
7	CD68	RM1031
8	CD8	EPR26538-16
9	SMA	EPR5368
10	CD11c	FK24
11	HLA-E	MEM-E/02
12	CD31	WM59
13	HLA-DR	EPR6148
14	Granzyme B	EPR20129-217
15	Vimentin	LN-6
16	CD3e	EPR5361(2)
17	CD56	EP2567Y
18	CD34	4H11
19	PD-L1	28-8
20	ICOS	HK53
21	CD57	HNK1
22	FOXP3	2A11G9
23	NKG2D	polyclonal
24	Pan-Cytokeratin	AE1+AE3
25	CD163	RM1114
26	PAX-5	EPR3730(2)
27	ASCT2	CAL33
28	PD-1	CAL20
29	CD21	EP3093
30	GLUT1	EPR3915
31	CD11b	M1/70
32	Ki67	EPR3610
33	S100A4	1F12-1G7
34	Collagen IV	HL1351
35	CD14	1H5D8
36	LC3B	EPR21234
37	CD45	EPR27167-58
38	IFNG	IFNG/466
39	CD79a	EP3618
40	IDO1	EPR20374
41	CD44	IM7.8.1
42	NKG2A	ab96319
43	GATA3	EPR16651
44	CD66b	polyclonal
45	CD138	polyclonal
46	HIF1A	EPR16897
47	MPO	EPR20257
48	DNAM-1	EPR23641-137
49	NKp46	Innate Pharma
50	CXCR3	ab71864
51	CD38	EPR22691-219
52	CD16	EPR22409-124
53	ATPA5	polyclonal
54	CTST	polyclonal
55	LDHA	EP1563Y
56	HK1	EPR10134(B)
57	MMP9	EP1254
58	PHHH3	polyclonal
59	BAX	ab53154

Extended data Table S2: Antibody panel for CODEX multiplexed immunofluorescence staining

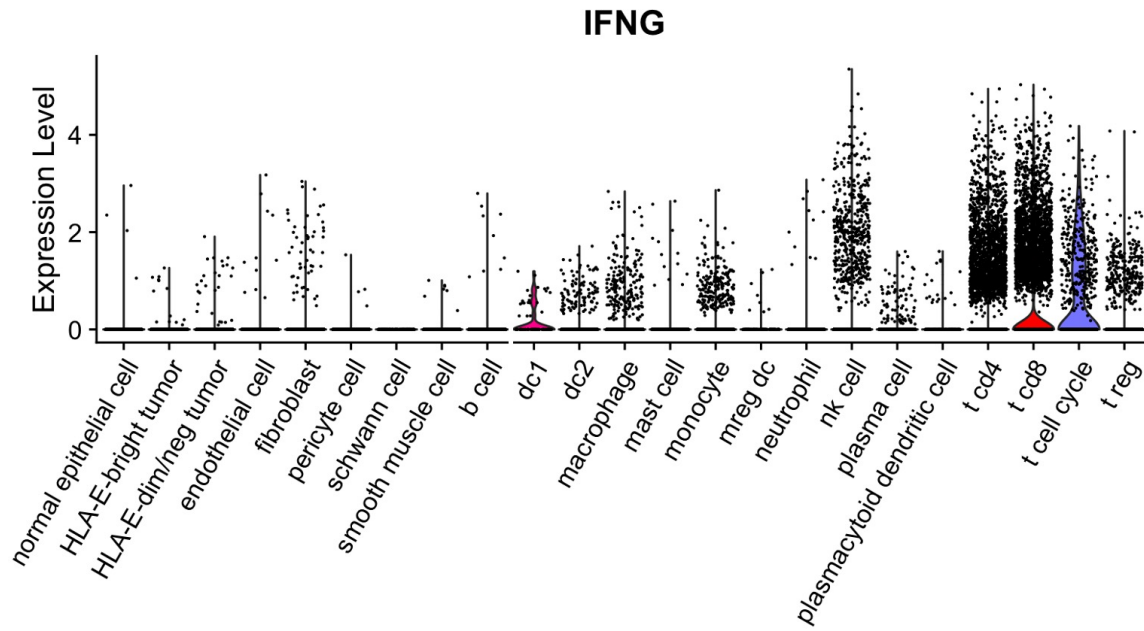
cell cluster	signature genes
normal epithelial cell	C19orf33, SNCG, MIR205HG, KRT19, KRT17, FXYD3, SYT8, SMIM22, ELF3, KRT18, CLDN4 KRT8, CD24, KRT18, TACSTD2, MGST1, FXYD3, ELF3, CLDN4, SMIM22, KLF5, KRT7, KRT19, DHRS2, S100P, GDF15, PSCA, AGR2, SERINC2, S100A14, SDC1, GATA3, KRT20, CLDN7, FOXQ1, CYB5A, AKR1C3, C19orf33, TMEM54, MDK, RARRES1, RAB25, NQO1, TMEM97, SDC4, VSI2, RALBP1, EFNA1, CDH1, EHF, JUP, CAPS, IDH1, SPTSSB, HEBP2, SPINT2, CAMK2N1, AL158206.1, MGST2, TSTD1, MAL2, S100A13, ADIRF, HES1, b1ca PTPRF, ERBB2, TBX3, PHLDA2, RAB11FIP1, SFN, ID1, ATP1B1, GNL3, CYP4B1, TXNDC17, MARCKSL1, LSR, NR2F6, ABHD11, PLPPP2, TNFRSF21, S100A16, SLP1, TSPAN13, TNFAIP2, SPINT1, NEDD4L, STAP2, KRTCAP3, CD9, BEX3, AKR1C2, EPCAM, RAB11A, PPARG, FOXA1, CTTN, GIPC1, ALAS1, AHR, SH3YL1, EMP2, TCEAL4, GGCT, PAFAH1B3, FBP1, NDUFS6, IGFBP3, SNHG18, GPRC5A, AP1S1, CISD3, ECHS1, TIMM13, RBM47, UQC22, POLR21, TSPAN6, OCIAD2, GRHL3, ARPC1A, KRT10, CENPX, CRABP2, MRPL14, DCXR, PRDX2 PCAT19, SPARCL1, RAMP2, VWF, EGFL7, ECSCR, PLVAP, AQP1, TM4SF1, CLDN5, ADGRL4, CLEC14A, CAV1, CRIP2, IGFBP7, EPAS1, RAMP3, EMP1, IFI27, KLF2, SPRY1, EMCN, A2M, ENG, NPDC1, STC1, HYAL2, CAVIN1, TCF4, BCAM, IFITM2, STOM, MMRN2, ESAM, CALCRL, IFITM3, C19orf33, CAVIN2, TGFBR2, IGFBP4, CD34, S1PR1, SOCS3, PECAM1, ACKR1, GJA1, CD59, SLC9A3R2, ITGA6, NNMT, PDLIM1, APP, MTUS1, TSPAN7, ADAMTS9, C2CD4B, CDH5, ADAMTS1, APOLD1, MEF2C, LMO2, YBX3, ELK3, TIMP3, CYR1, CD93, TFPI, THBD, RNASE1, SPTBN1, HLA-DRB5, ITGA5, SOX18, GRASP, CLU, ID3 DCN, CCDC80, IGFBP6, COL1A2, MGP, COL6A2, C1R, PLAC9, FBLN1, CFD, PCOLCE2, SERPING1, LUM, SERPINF1, C1S, MFAP5, MFAP4, SOD3, COL6A1, P16, OGN, GSN, CLU, SPARCL1, LTBP4, COL6A3, MMP2, EFEMP1, C3, SFRP2, SCARA5, ADH1B, GPX3, SLIT2, CALD1, TIMP2, COL3A1, SPARC, CTSK, FBN1, SPON2, PMP22, PCOLCE, CCN1, PLPP3, OLFML3, EGR1, TFPI, FBLN5, ACKR3, CD34, FBLN2, DPT, RARRES2, APOD, IGFBP5, LRP1, CCN2, ABI3BP, FGFR1, ISLR, GPNMB, AEBP1, CCN5, TIMP1, MXRA8, SOCS3, MFG8, NNMT, IGFBP7, CEBPD, EMP1, CD248, MYC, C11orf96, AC080038.1, NFIA, FSTL1, TIMP3 RGS5, PPP1R14A, BGN, TPM2, MYL9, IGFBP7, CALD1, MFG8, COL4A1, NDUFA4L2, COL4A2, C11orf96, ACTA2, MGP, CAV1, PDGFRB, COX7A1, SOD3, COL18A1, CPE, SPARC, COL3A1, COL6A2, CAVIN3, CSRP2, CRIP2, LHFPL6, COX4I2, WFDC1, COL1A2, A2M, TPM1, PDGFA, TGFB11, COL6A1, SPARCL1, MEF2C, FAM162B, HIGD1B, HES4, SELENOM, IGFBP2, CNN3, FN1, FILIP1L, MAP1B, LBH, EHD2, CRYAB, TPPP3, EPS8, IFITM3, PCOLCE, GJA4, CCDC102B, PTP4A3, MYO1B, NR2F2, TINAGL1, PLAC9, RRAS, CYGB, NREP, MYH11, RAMP1, AP002956.1, PLXDC1, RBPMS, SERPING1, ITGA1, LAMA4, PTMS, ACTN1, DSTN NRXN1, CRYAB, GPM6B, S100B, CDH19, SCN7A, MAL, ANGPTL7, LGI4, CHL1, MPZ, GFRA3, PLP1, CADM1, MATN2, SEMA3B, ZEB2-AS1, ANK3, schwann cell PMP22, AC005747.1, TMEM176B, SPARC, VWA1, PDGFA, CD9, IGFBP7, CLU, SPARCL1, FGL2, RHOB, PRNP, EPB41L2, NDRG2, CNN3, SAMHD1, PDK4, ZEB2 CNN1, ACTG2, PCP4, DES, MYH11, PPP1R14A, TPM2, ACTA2, MYL9, SMTN, FHL1, CSRP1, MYLK, CKB, ECRG4, RAMP1, ACTC1, SORBS1, TPM1, TGFB11, SPARCL1, PALLD, TAGLN, PDLIM3, CRYAB, CAV1, SYNPO2, SYNM, SORBS2, TNS1, HSPB6, SLMAP, RBPMS, FERMT2, SELENOM, PSD, NEXN, COX7A1, LIMS2, PTGS1, PDLIM7, CARMN, ACTN1, FN1, AC022868.1, VWA1, CALD1, AF001548.1, MAP1B, COL6A1, LPP, LMOD1, SVIL, FLNA, PGM5, NIBAN1, PKIG, DSTN, FXYD6, CFL2, PITX1, CAVIN1, DMD, PGM5-AS1, FLNC, SLC25A4, ALDH1B1, FBXO32, RBPMS2, HSPB8, LMO3, TNNT2, RBFOX3, DIXDC1, KANK2, TGM2, RRAS, RARRES2, COL4A2, ILK, VCL, CLU, IGFBP7, NFIA, PPP1R12A, COL6A2, NME4, NUPR1, TCEAL4, PLEKHO1, AD000090.1 b cell IGHM, CD79A, CXCR4, IGKC, CCR7, CD37, VPREB3, ARHGAP24 LGALS2, CLEC9A, DNASE1L3, WDFY4, IDO1, XCR1, HLA-DOB, RAB7B, SERPINF2, S100B, NAPS, BATF3, P2RY6, WFDC21P, C1orf54, SLAMF8, CPVL, CADM1, ASB2, IRF8, SHTN1, PADI2, LYZ, C1orf162, NAAA, HCK, SPI1, SLAMF7, LY86, VMO1, HLA-DQB1, PLEK, ANPEP, FGD2, HLA-DQA1, MPEG1, AIF1, MND4, CLEC7A, HLA-DRB6, HLA-DPB1, PTPRE, HLA-DPA1, LGALS9, RGS10, HLA-DMB, HLA-DRA, FGL2, HLA-DRB1, HLA-DMA, CD86, CPNE3, SMCO4, SNX3, RAB32, CXCL16, BCL2A1, PPT1, BASP1, LST1, GCA, ITGAX, RNASE6, AP1S2, ADA2, TAP1, RGCC, TGFB1, ITGB2, PARVG, AC004687.1, SELPLG, LSP1, COTL1, SERPINB9, CD40, CD83, CTSZ, BID, SEMA4A, GNA15, ASAP1, C20orf27, SAMHD1, UNC119, dc1 CCDC88A, PLEKHO1, RGS19, PYCARD, PDLIM7, SERPINB1, ATG3, LIMD2, LCP1, EVI2B, SEPTIN6, TYMP, HLA-DRB5, LSM6, FNBP1, CCND1, PAK1, FAM49B, TNFAIP8, WAS, HCLS1, CD48, NFKBID, TMEM14A, PRCP, PSMB9, SNX10, PPA1, UCP2, DUSP4, DNAJC4, ICAM3, CST7, RNH1, ANXA6, PSME2, NET1, SERPINF1, AC010618.1, GLIPR1, NME4, RNASET2, SGK1, DBNL, MRPL23, VASP, TPP1, FMNL1, ACTN1, CKLF, CFL1, CYB5R3, RHOG, CORO1A, SYNGR2, GPR183, LTB, MZT2A, CAP1, CDK2AP2, GNG5, SERPINB6, GMFG, GPM3, CRIP1, GABARAP, PLAUR, AP2S1, DUSP2, CTSS, HLA-F, FCGRT, NR4A2, LAPTM5, CD53, RGS2, GTF3C6, BUD23, CD37, MSN, CD52 LST1, AIF1, HLA-DQB1, TYROBP, FCER1A, HLA-DQA1, CD1C, FCER1G, HLA-DMB, MS4A6A, C1orf162, SPI1, CLEC10A, GPR183, CD86, NAPS, JAML, HLA-DPB1, HLA-DMA, HLA-DRB6, LYZ, CD1E, PKIB, LY86, HLA-DRB1, HLA-DPA1, CPVL, RNASE6, MND4, LGALS2, IGSF6, HCK, HLA-DRA, dc2 HLA-DQA2, HLA-DQB2, PLD4, FCGR2B, CALHM6, CXCL16, COTL1, NR4A3, OLR1, CLEC7A, ITGB2, AXL, RGS10, BCL2A1, LGALS9, PAK1, PLAUR, AP1S2, TYMP, CD83, LSP1, ALOX5AP, YWHAH, EVI2B, FAM49B, RGS1, PLSCR1, RGS2, PYCARD, CST7, GPM3, MACROH2A1, RNASET2, HCLS1, BASP1, CD53, SAMS1, CORO1A, LAPTM5, CXCR4, GMFG AIF1, C1QC, C1QA, C1QB, TYROBP, FCER1G, FCGR2A, MS4A7, MS4A6A, CD14, APOE, SPI1, APOC1, MSR1, FCGR3A, MS4A4A, TGFB1, CSF1R, macrophage LST1, CTSZ, HLA-DQA1, SPP1, CD163, CTSS, DAB2, HLA-DPB1, ADAP2, HLA-DMB, TREM2, ITGB2, LAPTM5, LGMN, CD4, CCL3, RNFI30, HLA-DQB1, C1orf162, OLR1, mast cell TPSB2, TPSAB1, CPA3, IL1RL1, RHEX, LTC4S, GATA2, FCER1G, CTSG, HDC, VWA5A, KIT, MS4A2, CLU, ALOX5AP monocyte AIF1, TYROBP, FCER1G, LST1, LYZ, S100A8, S100A9, SERPINA1, BCL2A1, PLAUR, IL1B, C5AR1, CTSS, G0S2, FCN2, MND4, SPI1, OLR1, SOD2, TYMP, COTL1, MS4A6A, CSTA, SAMS1, MS4A7, EREG, CD14, C1orf162, CLEC7A, ITGB2, SRGN, LAPTM5 LAMP3, CCL22, CCL19, NCCRP1, EB13, CCL17, TVP23A, AOC1, IDO1, CD200, FSCN1, CFP, CCR7, WFDC21P, RASSF4, TMEM176A, CD86, POGU17, BIRC3, CD40, IL4I1, TMEM176B, BCL2A1, TBC1D4, RAMP1, NR2P, CD83, MIR155HG, GPR183, LSP1, HLA-DQA1, SAMS1, IRF4, BASP1, mreg dc TYROBP, HLA-DQB1, LAD1, IL7R, TXN, KDM2B, HLA-DPB1, MARCKSL1, HLA-DQA2, KYNU, HLA-DRA, NUB1, RFTN1, DUSP5, SYNGR2, ANXA6, RELB, MTHFD2, MGLL, RGS1, LGALS9, HLA-DPA1, TYMP, ERICH1, CSTA, ID2, GRSF1, SPI1, NABP1, CRIP1, KIF2A, HLA-DRB1, PPA1, VOPPI1, CFLAR, SOCS1, NFKB1, HMGN3, TNFAIP8, COTL1, CTSH, STK4 neutrophil G0S2, CSF3R, TREM1, LUCAT1, S100A8, IL1R2, SLC11A1, NAMPT, CXCL8, BCL2A1, S100A9, IVNS1ABP, TPI1, ZFAS1 nk cell NKG7, DNLY, CCL5, CTSS, CST7, GZMB, TYROBP, PRF1, CD7, GZMA, HCST, KLRD1, CD247, TRDC, PTPRC, KLRC1, CCL4 MZB1, DERL3, CD79A, FKBP11, JCHAIN, IGHG3, TNFRSF17, ID2, ITM2C, CD27, PIM2, IGH1, SEC11C, ANKRD28, SLAMF7, PRDX4, IGHG1, plasma cell JSRP1, XBP1, IGLC3, IGKC, POU2AF1, CD38, IGHG2, ST6GAL1, TPD52, SPCS3, SDF2L1, ANKRD36BP2, DNAJB9, SPAG4, EAF2, ERLEC1, IGH2, CRELD2, RNU2-63P, TXNDC15, DTNB, TXNDC5, HERPUD1, KLF13, IGHG, PRDM1, IGHG4, IGLV3-1, PDE4B, PLPP5, ISG20, GLRX, SSR3, RN7SL2, RN7SL1, NUCB2, MANF, CYTOR, ICAM3, CFLAR, SELENOS PLAC8, PLD4, SCT, LILRA4, LRRC26, PTCRA, SPIB, TCL1A, SMPD3, IRF4, NAPS, LILRB4, DERL3, GZMB, MZB1, IRF7, BCL11A, JCHAIN, MYBL2, IRF8, C12orf75, GPR183, CLIC3, LDLRAD4, SELL, EGLN3, ITM2C, NR4A3, ALOX5AP, THEMIS2, CXCR3, RNASE6, TSPAN13, OPN3, CCDC50, plasmacytoid dendritic cell SLC15A4, PPP1R14B, SEC61B, AC004687.1, AREG, FCER1G, DUSP5, SLC7A5, TYROBP, CXCR4, HERPUD1, NR3C1, GNA15, CREM, SERPINF1, ZC3HAV1, N4BP2L1, RGS1, RGS2, TCF4, MS4A6A, HLA-DRB1, PIM2, HLA-DRA, NPC2, LTB, RPL2, HLA-DPB1, ZNF331, CD83, RNASET2, HLA-DMA, SRGN, YPEL5, CTSS, HLA-DPA1, CD37, RPL7, UCP2, NR4A2, HLA-DQB1, LSP1 t cd4 CD2, CD3D, LTB, IL7R, IL32, CD52, TRAC, TRBC2, CD3E t cd8 NKG7, CD3D, CCL5, GZMA, TRBC2, CD2, TRAC, CD3G, CD8A, CTSS, LINC01871, HCST, CD3E, CST7, CD52, CD7, IL32, GZMB, PTPRC, CCL4, CORO1A, TRGC2, IL2RG, ALOX5AP, LCK, RGS1, TRBV28, RAC2, KLRD1 PCLAF, TYMS, CD2, TRBC2, LINC01871, CD3G, NUSAP1, STMN1, CD3D, SMC4, CD7, PTTG1, HMGB2, TOP2A, APOBEC3G, TMPO, CENPM, CENPK, ZWINT, UBE2C, CKS1B, MAD2L1, TIGIT, TK1, LMNB1, SMC2, MKI67, CENPF, SIT1, CDKN3, CLEC2D, CD8A, CDK1, PHF19, PRC1, AURKB, TRGC2, TACC3, KLRC1, CENPU, HELLS, CXCL13, UBE2T, RRM2, ASF1B, H2AC12, LAG3, CTLA4, BIRC5, LINC02195, TUBB, HMGN2, TRAC, RAB27A, PTPN7, GZMB, CORO1A, CENPW, RAC2, CD3E, NKG7, IFNG, AL035456.1, EZH2, GZMA, H2AX, LCK, IL2RB, PCNA, DTYMK, TUBA1B, H2AZ2, CD96, C12orf75, CTSS, PSMB9, CD247, CRIP1, MCM7, HMGB1P5, NUDT1, DUT, ANP32E, TNFRSF18, TBC1D10C, SKA2, DEK, PTPN22, DDX39A, PCED1B-AS1, IL2RG, GNG2, CKLF, CALM3, CBX5, SLA, CCL5, LCP1, BUB3, PSMB8, OXNAD1, DNMT1, CCDC167, ANP32B, TUBBP1, PSIP1, IL32, RPA3, HCST, CYTOR, PTPRC, LSP1, GMFG, SEPTIN1, CD52, ANXA6, RANBP1, HOPX, PAXX, CST7, LBH, ICAM3, ITM2A, IFI16, HLA-F, EVL, ACAP1, ALOX5AP, CKS2, LIMD2, FYN, CBX3, NAP1L4, MZT2A, MT2A, IFI27L2, COTL1, CD53, HCLS1, STK17B, ID2, RGS1, SAMS1, FXYD5, LAPTM5 t reg LTB, CD3D, TIGIT, IL32, TNFRSF4, TRAC, CD2, TNFRSF18, TRBC2, SPOCK2, CTLA4, CD27, CD3E, FOXP3, CD7, BATF, IL2RG, TRBC1, IL2RA, CARD16, TBC1D4, CORO1A, LCK, RGS1, IL7R, PTPRC, CD3G, ICOS, RAC2, PCED1B-AS1, CYTOR, CD52

Extended data Table S3: Annotated clusters with list of significantly defining genes for major clusters defined by scRNAseq

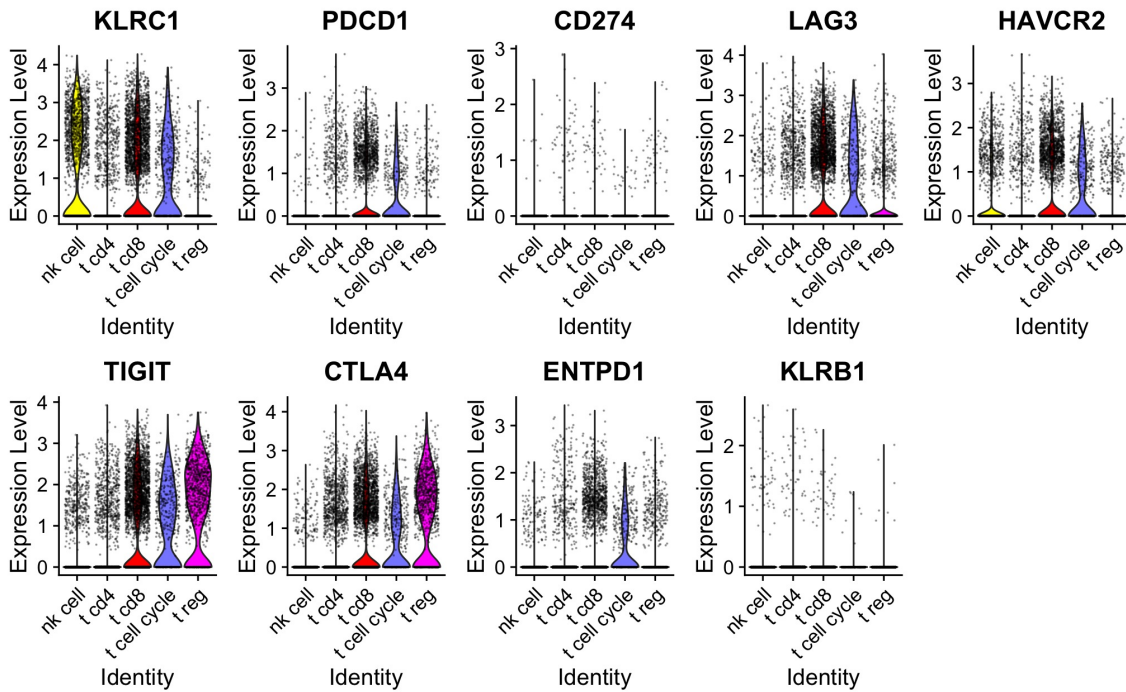
Cluster ID	Cell count:
normal epithelial	3458
HLA-E-bright tumor	5461
HLA-E-dim/neg tumor	9256
endothelial cell	3135
fibroblast	7630
pericyte cell	1963
schwann cell	186
smooth muscle cell	660
b cell	3675
dc1	80
dc2	599
macrophage	5271
mast cell	1015
monocyte	1871
mreg dc	150
neutrophil	519
nk cell	2580
plasma cell	1301
plasmacytoid dendritic cell	171
t cd4	8548
t cd8	5491
t cell cycle	629
t reg	1675
	65,324

Extended data Table S4: Annotated scRNAseq clusters with numbers of cells

A

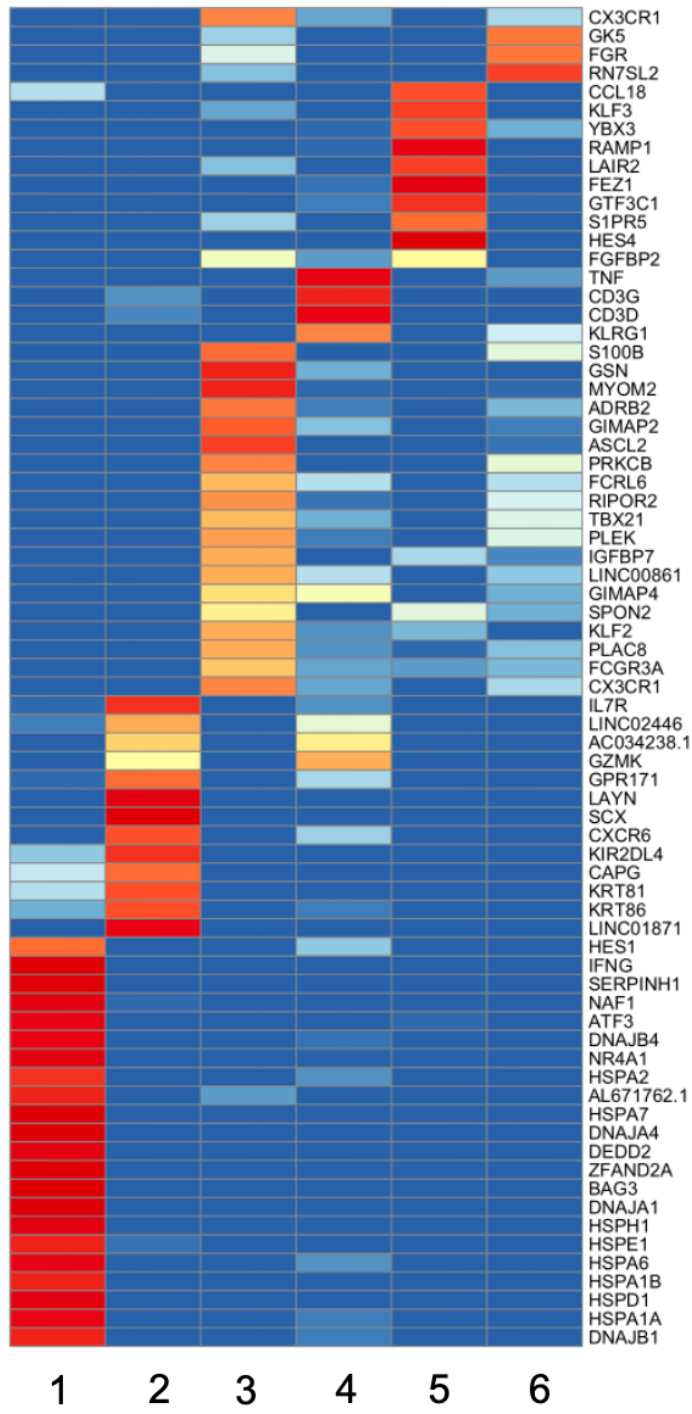


B

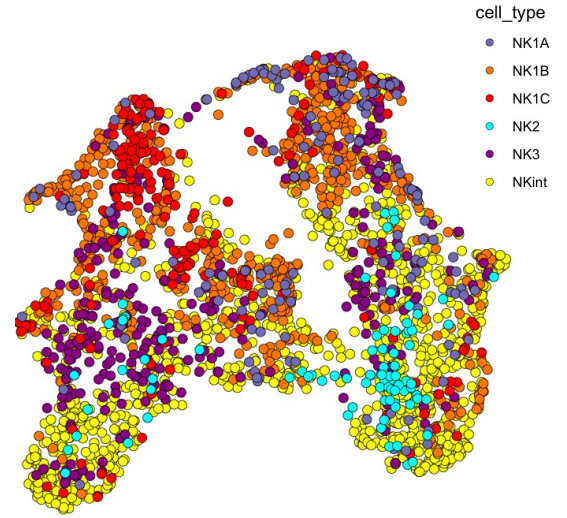


Extended data Figure S1: Cellular sources of IFN- γ in NMIBC by scRNAseq

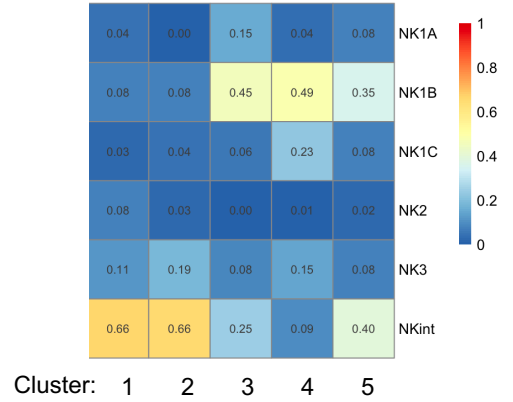
A



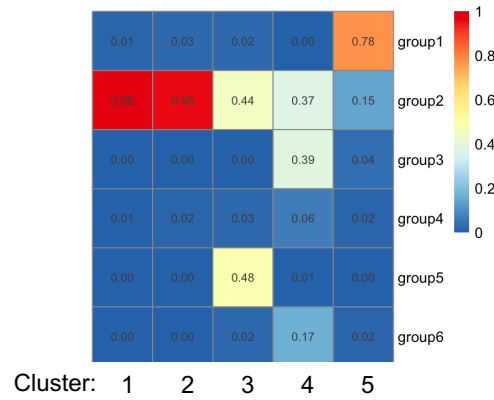
B

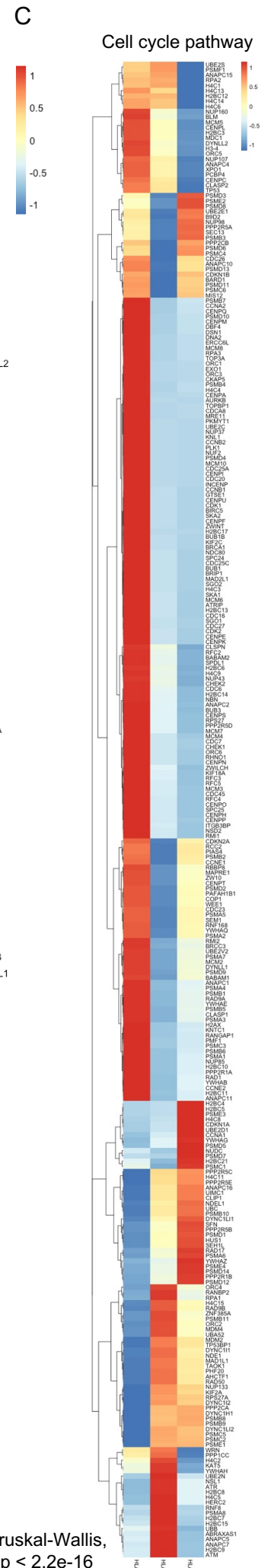
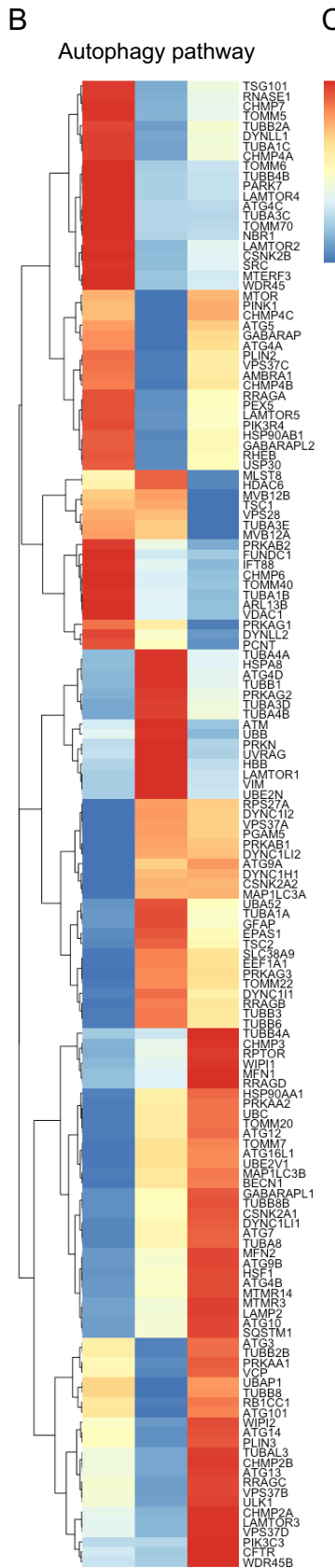
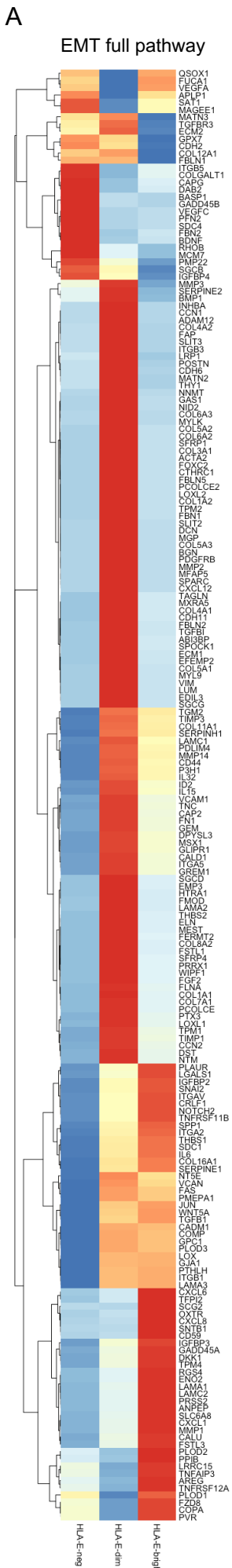


C



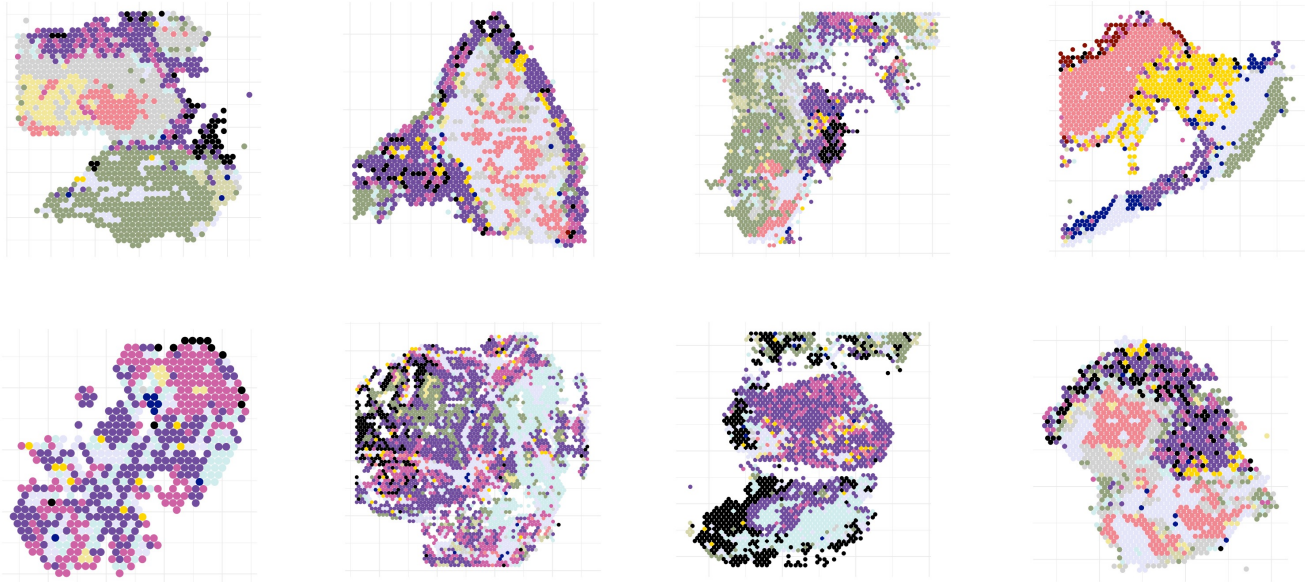
D



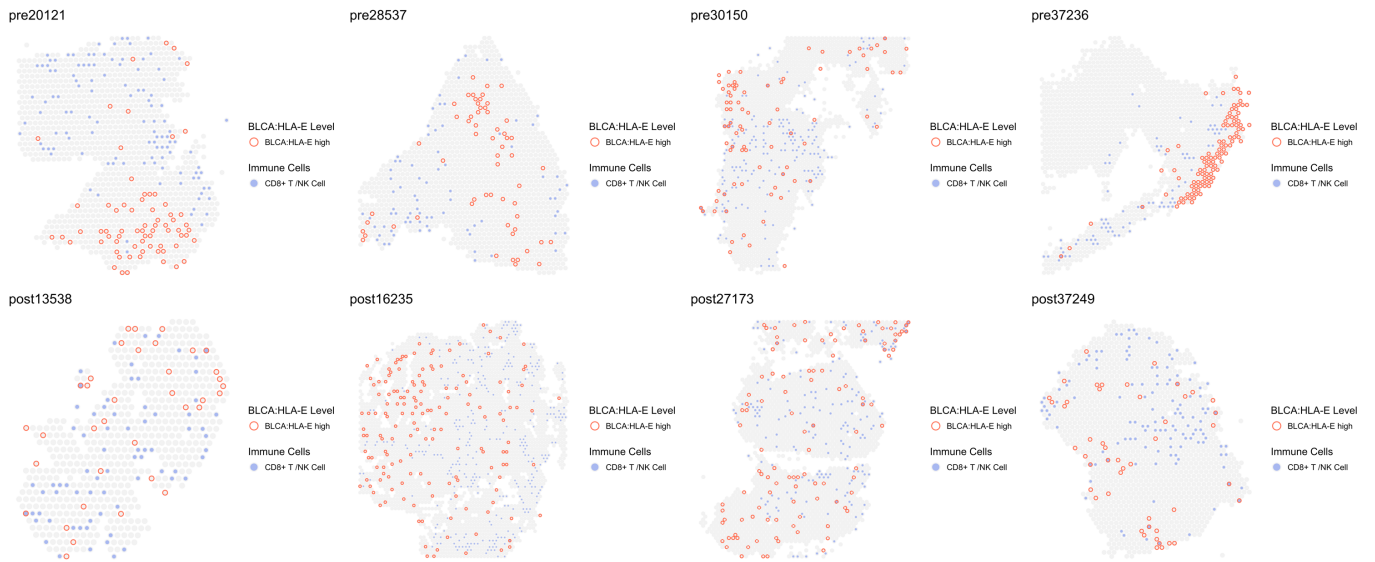


Extended
Data Fig. S3

A



B



C



