Supplementary

Table S1 Canonical marker genes

Cell	Marker
Epithelial cells	EPCAM
	KRT19
	KRT18
Fibroblasts	COL1A1
	COL1A2
	THY1
Pericytes	PDGFRB
	ACTA2
	FN1
T lymphocytes	CD3D
	CD3E
	CD3G
B lymphocytes	CD19
	CD79B
	MS4A1
NK cells	NKG7
	KLRD1
	NCAM1
Neutrophils	RGS2
	S100A8
	S100A9
Macrophages	CD68
	CD163
	FCN1
Microglia	P2RY12
	SELPLG
	TMEM119
Oligodendrocytes	MBP
	PLP1
	OLIG1
Endothelial cells	PECAM1
	CLDN5
	FLT1
Plasma cells	IGHG1
	MZB1
	CD79A
Mast cells	TPSB2
	TPSAB1
	CPA3
Astrocyte	GFAP
	S100B
	ALDOC
DC	CD1C
	FCER1A
	CCR7

DC, dendritic cell; NK, natural killer.

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Table S2 Key phagocytosis-related genes

Pathway names	Genes
KEGG_Phagosome	*MARCO*
KEGG_Phagosome	*HLA-DRB5*
KEGG_Phagosome	*HLA-DRA*
KEGG_Phagosome	*NCF2*
KEGG_Phagosome	*CTSS*
KEGG_Phagosome	*HLA-B*
KEGG_Phagosome	*MSR1*
KEGG_Phagosome	*ACTB*
KEGG_Phagosome	*CYBA*
KEGG_Phagosome	*ACTG1*
KEGG_Phagosome	*ATP6V0D1*
KEGG_Phagosome	*SFTPA2*
KEGG_Phagosome	*TUBB6*
KEGG_Phagosome	*MRC1*
KEGG_Phagosome	*TFRC*
KEGG_Phagosome	*CYBB*
KEGG_Phagosome	*HLA-DQB2*
KEGG_Phagosome	*TUBA1B*
KEGG_Phagosome	*COLEC12*
KEGG_Phagosome	*ATP6V1D*
KEGG_Phagosome	*LAMP1*
KEGG_Phagosome	*OLR1*

KEGG, Kyoto Encyclopedia of Genes and Genomes.

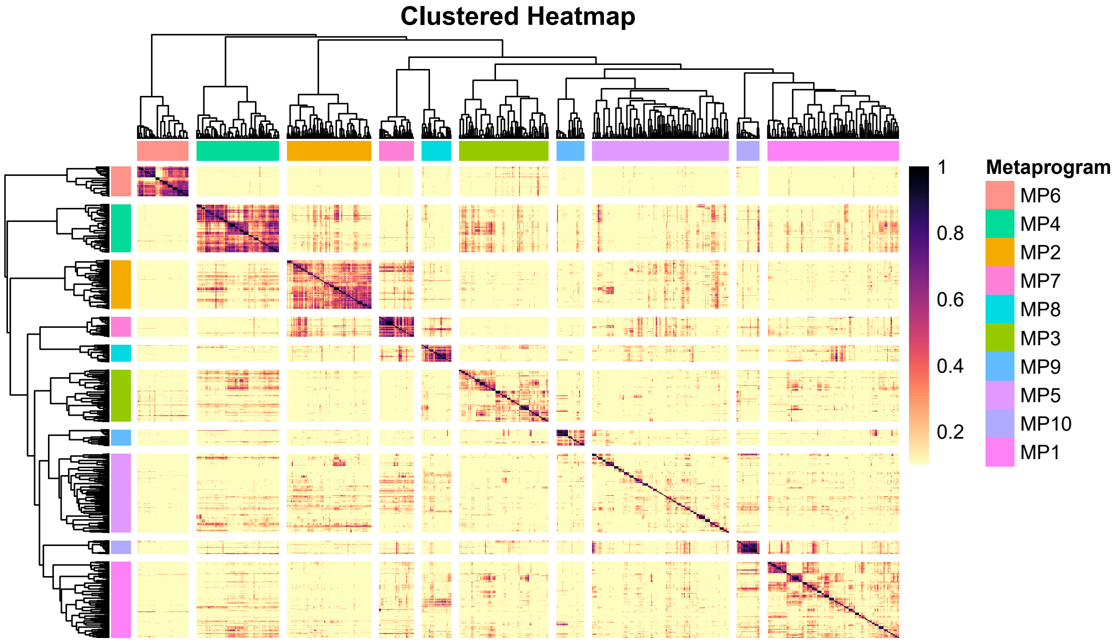

Figure S1 Heatmap of MPs before filtering. MP, meta program.

Table S3 Metaprogram metrics

MPs	Sample coverage	Silhouette	Mean similarity	Number genes	Number programs
MP1	1	–0.02	0.16	92	156
MP2	0.9	0.17	0.34	86	100
MP3	0.9	0.33	0.19	109	100
MP4	0.85	0.31	0.42	40	98
MP5	0.85	–0.08	0.1	36	162
MP6	0.61	0.44	0.48	37	61
MP7	0.52	0.4	0.55	85	41
MP8	0.47	0.37	0.48	91	35
MP9	0.42	0.31	0.38	40	33
MP10	0.33	0.54	0.62	49	27

MP, meta program.

Table S4 MPs-driven genes

MPs	Genes
MP4	*CCL3L3, CCL4, CCL4L2, IL1B, IER3, CXCL8, CCL3, CXCL2, DUSP2, EGR1, TNFAIP3, EGR2, TNF, NR4A2, CCL20, NFKBIZ, CXCL3, EREG, FOSB, NFKBIA, CD83, PTGS2, IER2, GPR183, G0S2, PPP1R15A, LINC00936, ABL2, NR4A3, NR4A1, KDM6B, CSRNP1, OTUD1, MAFF, ZFP36, SOCS3, TCOF1, KLF6, GADD45B, FOS*
MP6	*KIAA0101, TRAC, TK1, CD3D, CD2, ZWINT, HIST1H4C, CKS1B, STMN1, IL32, CD7, CDK1, PCNA, TRBC2, MCM7, PTTG1, SMC4, GGH, SMC2, DNAJC9, TBC1D10C, DHFR, TMEM106C, CD69, TACC3, NKG7, CCL5, CENPW, HMGB2, RUNX3, DTYMK, YEATS4, TMPO, ISG20, TUBA4A, GMNN, H2AFX*
MP7	*CCL18, NUPR1, IFI27, HS3ST2, FABP4, SCD, PPIC, SEPP1, PLA2G7, ACP5, KCNMA1, CCL13, FN1, RBP1, CES1, FUCA1, TMEM37, FABP3, CXCL3, CD59, GCHFR, LGMN, SLC40A1, MARCO, SDC2, CCL2, CYP27A1, CXCL2, GPNMB, GPX3, EGR1, OTOA, LIPA, RMDN3, FOLR2, CHCHD6, CRIP1, AC079767.4, MGLL, PLTP, NR1H3, CCL23, PLPP3, RAB42, CFD, ALDH1A1, PLD3, VAT1, TDP2, IFI6, NGFRAP1, SEMA3C, TCN2, HMOX1, RNASE1, S100A9, RP11-598F7.3, CSTB, HLA-DQA1, TFRC, RND3, LGALS3, C1QC, PCOLCE2, TSPAN4, SLC38A6, EPHX1, CCL3, LILRB5, CTSL, LYZ, KLHDC8B, STMN1, NPL, LINC01272, AGRP, AKR1C3, S100A8, CCL8, MARCKS, CD36, DNAJC5B, SERPING1, EPAS1, DNAJB1*
MP8	*FABP4, PCOLCE2, RP11-598F7.3, CES1, MCEMP1, IFI27, PLAC8, PPIC, AKR1C3, SERPING1, NUPR1, MARCO, CD52, GCHFR, CCL4L2, CCL18, TCF7L2, GLDN, VMO1, S100A8, MGST1, RND3, TREM1, ACOT7, PLA2G16, CYP27A1, HCAR2, LPL, SCD, RETN, CCL20, JAML, MDH1, VSIG4, TK1, FN1, HLA-DQA1, CCND3, CFD, TIMP1, LTA4H, FABP5, ALOX5AP, LGALS3BP, S100A9, STMN1, FBP1, CARD16, CRIP1, LYZ, KAT8, ABHD5, SPARC, CXCL3, FFAR4, HLA-DOA, S1PR4, ACP5, ALOX5, IFI6, S100A13, ZBTB8OS, GCA, RP11-1008C21.1, DECR1, IFIT3, C1QC, TNNI2, NMB, ALDH1A1, LIPA, CLDN7, PLIN2, FUCA1, GPNMB, TUBA1B, AKR1B1, SPN, IFIT1, PPARG, MMP19, GYPC, HDDC2, STXBP2, RMDN3, TBC1D10C, CA2, TGM2, TXNIP, CKS1B, CD9*
MP10	*SPP1, CCL7, G0S2, CCL2, CLEC5A, SLC2A1, ADAM8, HAMP, SLC2A5, IL4I1, CCL4, CCND1, CCL3, SDC2, ERO1A, NUPR1, MT1G, IL1B, CCL3L3, IER3, BNIP3, GPR183, PDPN, S100A8, TNS1, CXCL8, GALM, AREG, NFKBIA, PHLDA1, DUSP2, MEF2C, LGMN, SCD, CSTB, FBP1, ARL4C, NR4A2, LIPA, RNASE1, FN1, C15orf48, CORO1A, GPNMB, MARCO, NKG7, ENO1, EREG, LSP1*

MP, metaprogram.

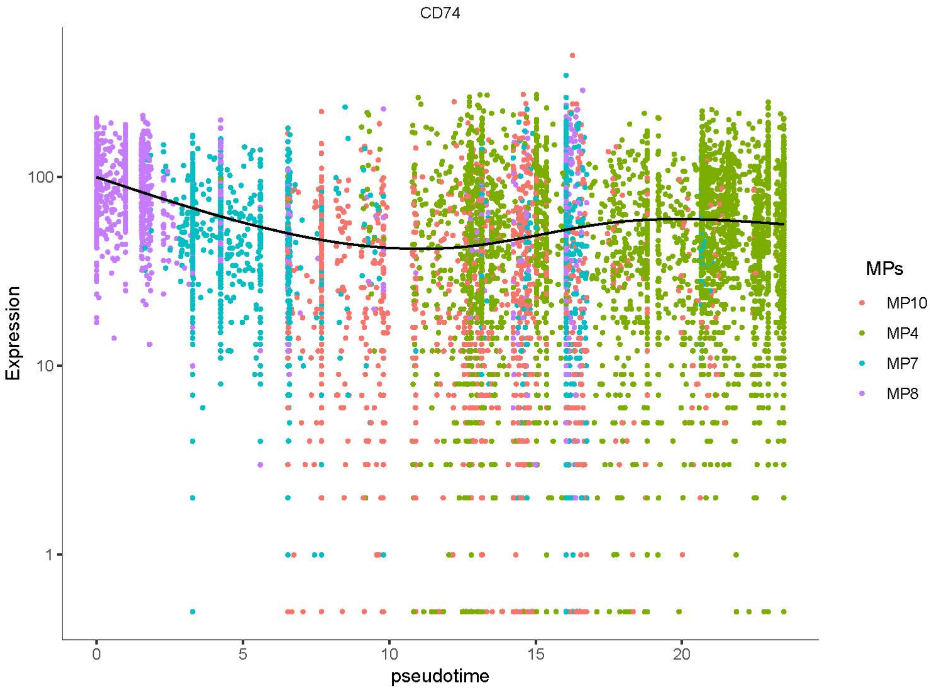

Figure S2 Dynamics of *CD74* expression in total TAMs. MP, meta program; TAM, tumor-associated macrophage.

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Table S5 TAM lineage-specific gene signatures

	Genes
Microglia genes	*P2RY12, TMEM119, CX3CR1, BIN1, NAV3*
BMDM genes	*ITGA4, MRC1, TGFBI, THBD*

BMDM, bone marrow-derived macrophage; TAM, tumor-associated macrophage.

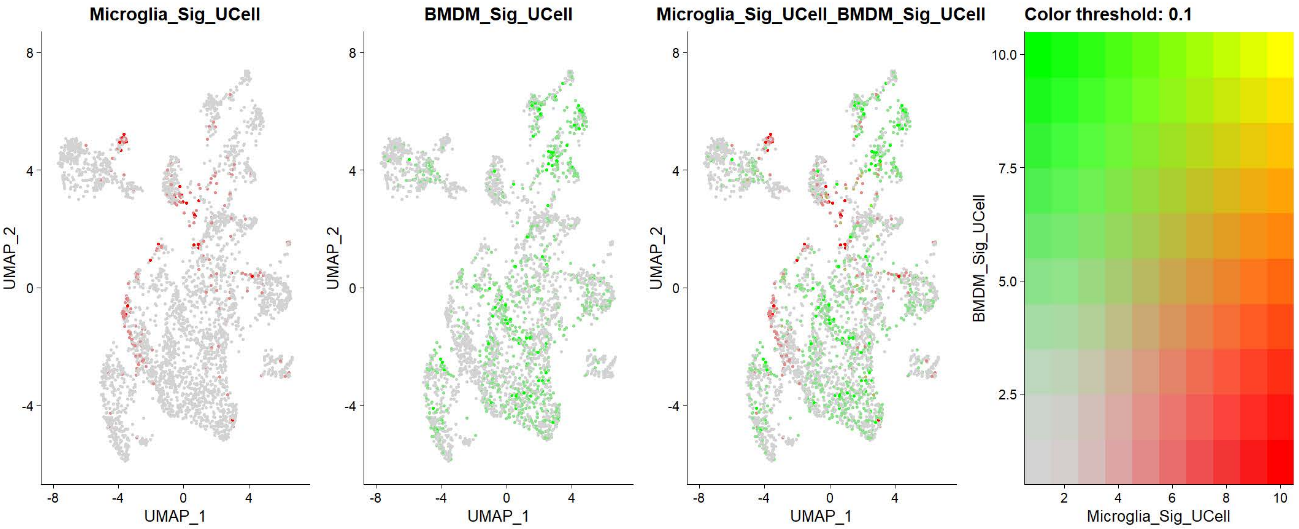

Figure S3 UMAP of the TAM lineage-specific genes. TAM, tumor-associated macrophage; UMAP, Uniform Manifold Approximation and Projection.

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