

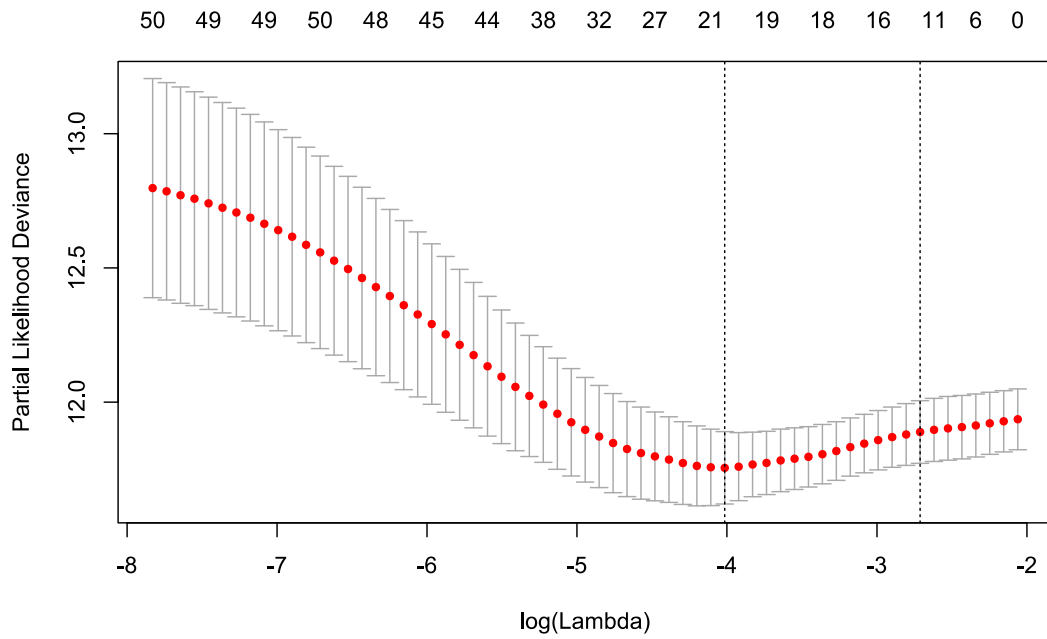
Supplementary material

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Supplementary Figure 1 Five-fold cross-validation for tuning parameter selection in the LASSO model. Solid vertical lines represent partial likelihood deviance \pm standard error (SE). The dotted vertical lines are drawn at the optimal values by minimum criteria and 1-SE criteria. Herein, a value $\lambda = 0.066$ with $\log(\lambda) = -2.72$ was chosen by 5-time cross-validation via 1-SE criteria.

Supplementary Table 1 Clinical features for the HCC patients from TCGA database.

Characteristics	Immune score			Stromal score		
	High score (n=258)	Low score (n=86)	P value	High score (n=258)	Low score (n=86)	P value
TNM stage (%)			0.045			0.308
Stage I	127 (52.9)	35 (42.2)		126 (52.7)	36 (42.9)	
Stage II	60 (25.0)	18 (21.7)		54 (22.6)	24 (28.6)	
Stage III	50 (20.8)	30 (36.1)		56 (23.4)	24 (28.6)	
Stage IV	3 (1.2)	0 (0.0)		3 (1.3)	0 (0.0)	
Age (median [IQR])	61.50 [52.00, 69.00]	59.00 [50.25, 67.75]	0.12	61.00 [52.00, 69.00]	61.00 [51.00, 68.00]	0.657
Gender (%)			0.16			1
Female	76 (29.5)	33 (38.4)		82 (31.8)	27 (31.4)	
Male	182 (70.5)	53 (61.6)		176 (68.2)	59 (68.6)	
Race list (%)			0.493			0.005
American Indian or Alaska native	1 (0.4)	0 (0.0)		1 (0.4)	0 (0.0)	
Asian	105 (42.2)	44 (51.8)		100 (39.8)	49 (59.0)	
Black or African American	12 (4.8)	3 (3.5)		10 (4.0)	5 (6.0)	
White	131 (52.6)	38 (44.7)		140 (55.8)	29 (34.9)	
Child-pugh Score (%)			0.418			0.858
A	151 (92.1)	54 (87.1)		146 (90.1)	59 (92.2)	
B	12 (7.3)	8 (12.9)		15 (9.3)	5 (7.8)	
C	1 (0.6)	0 (0.0)		1 (0.6)	0 (0.0)	
ECGO (%)			0.067			0.362
0	111 (55.5)	47 (62.7)		117 (58.5)	41 (54.7)	
1	65 (32.5)	14 (18.7)		60 (30.0)	19 (25.3)	
2	16 (8.0)	8 (10.7)		15 (7.5)	9 (12.0)	
3	6 (3.0)	6 (8.0)		7 (3.5)	5 (6.7)	
4	2 (1.0)	0 (0.0)		1 (0.5)	1 (1.3)	
AFP (median [IQR])	14.50 [4.00, 243.00]	16.00 [4.00, 618.00]	0.65	11.50 [4.00, 150.75]	36.00 [6.00, 1808.00]	0.024
Fibrosis ishak score (%)			0.025			0.346
0 (No Fibrosis)	51 (34.0)	22 (43.1)		55 (35.3)	18 (40.0)	
1-2 (Portal Fibrosis)	28 (18.7)	2 (3.9)		25 (16.0)	5 (11.1)	
3-4 (Fibrous Speta)	17 (11.3)	7 (13.7)		16 (10.3)	8 (17.8)	
5 (Nodular)	8 (5.3)	0 (0.0)		8 (5.1)	0 (0.0)	

Formation and Incomplete Cirrhosis)					
6 (Established Cirrhosis)	46 (30.7)	20 (39.2)	52 (33.3)	14 (31.1)	
Histologic grade (%)			0.367		0.005
G1	42 (16.6)	11 (12.8)	43 (16.9)	10 (11.8)	
G2	125 (49.4)	37 (43.0)	131 (51.6)	31 (36.5)	
G3	78 (30.8)	34 (39.5)	74 (29.1)	38 (44.7)	
G4	8 (3.2)	4 (4.7)	6 (2.4)	6 (7.1)	
Vascular invasion (%)			0.485		0.048
Macro	12 (5.5)	4 (5.6)	10 (4.5)	6 (8.6)	
Micro	61 (27.9)	25 (35.2)	59 (26.8)	27 (38.6)	
None	146 (66.7)	42 (59.2)	151 (68.6)	37 (52.9)	
Hepatitis (%)			0.172		0.694
N	130 (53.7)	53 (63.1)	139 (57.0)	44 (53.7)	
Y	112 (46.3)	31 (36.9)	105 (43.0)	38 (46.3)	
Alcohol (%)			0.173		0.217
N	154 (63.6)	61 (72.6)	166 (68.0)	49 (59.8)	
Y	88 (36.4)	23 (27.4)	78 (32.0)	33 (40.2)	

Supplementary Table 2 Information for all the genes identified by the univariate Cox regression analysis.

gene	HR	z	P value
CFHR3	0.889179428	-4.009786817	6.08E-05
CLEC5A	1.204955509	3.890189187	1.00E-04
ADH1C	0.909902608	-3.67096597	2.42E-04
CD5L	0.90059314	-3.55013328	3.85E-04
MMP7	1.091061308	3.511051263	4.46E-04
PFKP	1.175632661	3.501515945	4.63E-04
CTSL2	1.127409768	3.485593716	4.91E-04
SELP	0.846033368	-3.480300945	5.01E-04
INPP4B	0.792564818	-3.475263202	5.10E-04
TBX21	0.776063785	-3.472174458	5.16E-04
MSC	1.130736563	3.470847795	5.19E-04
CTHRC1	1.149471408	3.411532172	6.46E-04
UGT2B15	0.90743716	-3.406924504	6.57E-04
NLRC3	0.721081977	-3.368130997	7.57E-04
KLRB1	0.840139712	-3.357669559	7.86E-04
ADAM12	1.136117441	3.336272561	8.49E-04
GP1BA	0.828796115	-3.266092268	0.001090427
DARC	0.884855748	-3.230578285	0.001235401
IL8	1.111134688	3.216627922	0.001297067
GPR18	0.796408983	-3.216616825	0.001297117
RASGRP2	0.815636812	-3.153961929	0.001610701
CRHBP	0.876541825	-3.141743134	0.001679453
GFRA2	0.818813023	-3.126945906	0.001766324
ZNF831	0.832933084	-3.105443222	0.001899941
GIMAP1	0.74014872	-3.091106704	0.00199412
UCHL1	1.09292059	3.089880669	0.002002369
GZMH	0.82831695	-3.048661761	0.002298631
FAM65B	0.809850604	-3.033969716	0.002413587
C20orf103	1.125239484	3.031463703	0.002433712
C16orf54	0.813687558	-3.026035078	0.002477836
COLEC10	0.888871374	-2.989826579	0.002791359
MYH11	0.876022457	-2.983057091	0.002853848
KLRK1	0.836191206	-2.954750546	0.00312922
DOK5	0.843517254	-2.868972654	0.004118074
P2RY6	1.179733964	2.847706281	0.004403555
FLT3	0.843230245	-2.841524752	0.004489837
ZAP70	0.84437096	-2.801927046	0.005079836
INMT	0.88224616	-2.801593581	0.005085089

PLAUR	1.191370436	2.800305333	0.005105429
C11orf21	0.822528219	-2.775258055	0.005515792
SLAMF6	0.846322634	-2.748846078	0.005980546
TNFRSF11B	1.115877519	2.747384287	0.00600727
GVIN1	0.828304552	-2.744499455	0.006060326
LILRB5	0.835042767	-2.707088445	0.006787617
FBLN2	0.904026715	-2.675063299	0.007471514
TRAF3IP3	0.82590919	-2.671560797	0.007549939
C7	0.928143283	-2.670655802	0.007570323
ITK	0.862680716	-2.663687597	0.00772893
SELL	0.837240817	-2.654440007	0.007944016
ELN	0.903479518	-2.64325708	0.008211266
PDZD4	0.865866125	-2.62348347	0.008703567
CXCL1	1.081637004	2.62166019	0.008750263
FCN3	0.894649926	-2.611153606	0.009023735
FBLN5	0.880785078	-2.610477302	0.009041597
CD8A	0.874250078	-2.586881818	0.00968488
HTRA3	1.114705835	2.583923955	0.009768333
CLEC9A	0.848041102	-2.565502442	0.01030265
PNMA2	1.139905854	2.545186033	0.010921953
OGN	0.91741814	-2.509483977	0.01209077
MIAT	0.849114186	-2.505440497	0.012229897
CCR7	0.876179164	-2.477134613	0.013244194
ZG16B	1.09024913	2.475884973	0.013290639
EOMES	0.873195953	-2.472668004	0.013410866
PTGS1	1.151745259	2.470539947	0.013490925
HTR2B	0.894439525	-2.466944172	0.01362716
KCNA3	0.856435685	-2.461835151	0.013822818
NCF2	1.164919664	2.459761214	0.013902948
THEMIS	0.863410681	-2.454240937	0.014118235
GZMK	0.892901967	-2.433714678	0.01494477
SIDT1	0.833983947	-2.428875959	0.015145713
MMP9	1.096737517	2.428537532	0.015159856
P2RX1	0.857087143	-2.423103891	0.015388525
PRF1	0.839527313	-2.385156012	0.01707188
CAMK4	0.845502469	-2.382387959	0.017200765
C6orf223	1.063959499	2.375715929	0.017514941
ITM2A	0.874948629	-2.373956927	0.017598603
PRKCQ	0.863278547	-2.365073522	0.018026492
S1PR4	0.848590473	-2.356527106	0.018446721
ITPR3	1.09810663	2.355478646	0.01849886
CST7	0.864144186	-2.343846676	0.019086016
CXCR6	0.886516346	-2.340230514	0.019271841

PYHIN1	0.880127857	-2.335017625	0.0195425
CHST4	1.067535523	2.331752944	0.019713692
CXCL6	1.059771634	2.31833777	0.020430971
LGI2	1.134108858	2.315621128	0.020578964
CD69	0.888577353	-2.314900382	0.020618384
PTGES	1.076021483	2.294569775	0.021757792
GPR171	0.887736193	-2.292561442	0.021873266
EGFL6	1.121349415	2.291011517	0.021962748
TNXB	0.868192536	-2.285339694	0.022292917
SLA2	0.860411889	-2.283395518	0.022407081
CD28	0.851811736	-2.281007533	0.022548001
GZMA	0.876284091	-2.279259257	0.022651658
SLC7A8	1.162895099	2.265698593	0.023469844
GLT8D2	0.864892851	-2.263060513	0.023631959
FLI1	0.791530179	-2.25533395	0.024112375
RASA3	1.166394259	2.252019538	0.024321037
GPR84	1.132855089	2.245915706	0.024709408
COL11A1	1.074382608	2.238138453	0.025212028
TMC5	1.060744823	2.233714864	0.02550184
MFAP2	1.090738477	2.232824984	0.025560488
IL7R	0.916851044	-2.232680205	0.025570041
CD40LG	0.880332607	-2.231899312	0.025621618
PTPRO	1.15287418	2.216651385	0.026646923
MS4A1	0.909278915	-2.208359689	0.027219209
CFP	0.882596171	-2.196170972	0.028079708
SLC7A7	1.161570329	2.190663633	0.028476143
SRPX2	1.115531502	2.184097064	0.028955116
SAMD3	0.870760204	-2.180877138	0.029192505
LOC100233209	0.871467381	-2.164474502	0.030427951
CREB3L1	1.093934052	2.161073925	0.030689629
CPXM1	1.106303444	2.152268317	0.031376228
UBASH3A	0.888232846	-2.145167951	0.031939421
CD5	0.896373054	-2.143095324	0.032105445
BCL11B	0.882129857	-2.141452944	0.032237529
TNFAIP6	1.094659302	2.139674743	0.032381062
CCL21	0.940076979	-2.136453303	0.032642483
SLC6A6	1.109923554	2.132999715	0.03292475
LOC100131726	0.944308216	-2.105867285	0.035215882
PLTP	1.11349633	2.103934622	0.03538415
TRAT1	0.895681915	-2.100178696	0.035713125
IL16	0.820688725	-2.089723126	0.036642678
PHLDA3	0.908768817	-2.082919263	0.037258583
SLFN12L	0.86437128	-2.079845985	0.037539662

SH2D1A	0.897496041	-2.072283712	0.038238991
STRA6	1.084456021	2.072072218	0.038258707
BACE2	1.088730971	2.063038108	0.039109008
SLC34A2	1.054033686	2.055702623	0.039811189
HPSE	1.129232434	2.054801631	0.039898169
GBGT1	1.162891147	2.054615546	0.039916153
ACAP1	0.901539294	-2.05246546	0.040124449
FOXL1	1.11614711	2.050245919	0.040340439
IPCEF1	0.862434995	-2.049563849	0.040407011
APLNR	0.902455747	-2.045433883	0.040812101
SPN	0.86924681	-2.038997103	0.041450317
CD79A	0.923585339	-2.036761892	0.041673909
IGJ	0.937123602	-2.023729097	0.042998033
ATP2A3	0.884906832	-2.006679934	0.044783754
CD247	0.870187646	-1.999599323	0.045543547
CRYAB	1.076596932	1.999138004	0.045593424
RERGL	0.909928735	-1.992551751	0.046310553
ACAN	1.080137125	1.986922981	0.046930932
ZNF469	1.121014561	1.98219647	0.047457256
ADAP2	1.21265895	1.979957484	0.047708306
TMEM71	0.859866397	-1.979387351	0.047772412
C6orf105	1.078901288	1.967278783	0.04915108
LAX1	0.886979947	-1.964552993	0.049465997
