|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Gene | OR | 2.50% | 97.50% | *p-value* |
| *IDH1* | 0.95 | 0.94 | 0.97 | 0 |
| *TP53* | 0.95 | 0.93 | 0.96 | 0 |
| *ATRX* | 0.95 | 0.93 | 0.96 | 0 |
| *CIC* | 1.01 | 1 | 1.03 | 0.103 |
| *TTN* | 1.03 | 1.01 | 1.05 | 0.01 |
| *FUBP1* | 1.03 | 1 | 1.05 | 0.017 |
| *PIK3CA* | 1.02 | 0.99 | 1.04 | 0.136 |
| *NOTCH1* | 1.02 | 1 | 1.05 | 0.099 |
| *MUC16* | 1 | 0.97 | 1.02 | 0.82 |
| *EGFR* | 1.1 | 1.07 | 1.13 | 0 |
| *NF1* | 1.03 | 1.01 | 1.06 | 0.019 |

Table S1. The results of logistic regression with gene mutations of which frequency is over 5 percent and age in the lower grade glioma. OR is odds ratio. 2.50% and 97.50% is boundary value of 95 percent confidence interval.

Table S2. The results of logistic regression with gene mutations of which frequency is over 5 percent and age in the glioblastoma. OR is odds ratio. 2.50% and 97.50% is boundary value of 95 percent confidence interval.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Gene | OR | 2.50% | 97.50% | *p-value* |
| *TP53* | 0.98 | 0.96 | 1.01 | 0.165 |
| *PTEN* | 1.02 | 0.99 | 1.05 | 0.14 |
| *EGFR* | 1 | 0.97 | 1.03 | 0.929 |
| *TTN* | 0.99 | 0.96 | 1.01 | 0.305 |
| *MUC16* | 0.98 | 0.95 | 1.02 | 0.368 |
| *SPTA1* | 1.01 | 0.98 | 1.06 | 0.472 |
| *NF1* | 1 | 0.96 | 1.04 | 0.855 |
| *RYR2* | 0.98 | 0.95 | 1.02 | 0.397 |
| *OBSCN* | 0.95 | 0.91 | 0.99 | 0.013 |
| *PIK3CA* | 0.99 | 0.95 | 1.03 | 0.633 |
| *RB1* | 0.99 | 0.95 | 1.03 | 0.509 |
| *FLG* | 0.98 | 0.94 | 1.02 | 0.253 |
| *AHNAK2* | 0.98 | 0.94 | 1.02 | 0.262 |
| *PIK3R1* | 0.99 | 0.95 | 1.03 | 0.558 |
| *PCLO* | 0.98 | 0.94 | 1.02 | 0.288 |
| *MUC17* | 1 | 0.96 | 1.05 | 0.907 |
| *HYDIN* | 0.98 | 0.94 | 1.03 | 0.458 |
| *KEL* | 1.01 | 0.97 | 1.07 | 0.635 |
| *ATRX* | 0.88 | 0.82 | 0.93 | 0 |
| *DNAH17* | 0.97 | 0.93 | 1.02 | 0.277 |
| *DNAH5* | 0.99 | 0.95 | 1.04 | 0.788 |
| *PKHD1* | 1.01 | 0.96 | 1.07 | 0.649 |
| *DOCK5* | 0.97 | 0.93 | 1.02 | 0.258 |
| *COL6A3* | 1.01 | 0.96 | 1.07 | 0.625 |
| *SYNE1* | 1 | 0.95 | 1.06 | 0.987 |
| *GPR98* | 0.95 | 0.91 | 1 | 0.051 |
| *APOB* | 0.99 | 0.94 | 1.04 | 0.648 |
| *CALN1* | 0.99 | 0.94 | 1.05 | 0.745 |
| *SEMA3C* | 1.01 | 0.96 | 1.07 | 0.589 |
| *VWF* | 0.97 | 0.92 | 1.02 | 0.259 |
| *COL1A2* | 0.97 | 0.92 | 1.02 | 0.17 |
| *GRM3* | 0.97 | 0.92 | 1.02 | 0.27 |
| *USH2A* | 0.96 | 0.92 | 1.02 | 0.154 |
| *MROH2B* | 1 | 0.95 | 1.06 | 0.956 |
| *SLIT3* | 0.97 | 0.92 | 1.02 | 0.179 |
| *TCHH* | 0.98 | 0.93 | 1.03 | 0.348 |
| *ARHGEF5* | 0.95 | 0.91 | 1 | 0.07 |
| *RYR3* | 0.97 | 0.93 | 1.03 | 0.321 |

Table S4. The log-rank *p-value* in Grade and IDH1 mutation. Grade compares groups of IDH1 mutation and IDH1 wild-type in each grade. Mutation compares groups of grades in IDH1 mutation and IDH1 wild-type

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | Grade |  | Mutation | |
|  | G2 | G3 | G4 | *IDH1* wild-type | *IDH1* mutation |
| Log-rank *p-value* | 0.0023443 | 9.50E-12 | 0.015408 | 3.30E-13 | 1.95E-08 |

Table S5. The results of multi-label feature selection information gain of IDH1 and grade

|  |  |  |
| --- | --- | --- |
| Gene | Clusters | |
| *ACAA2* | 1 |  |
| *ADAM12* | 1 |  |
| *ALG3* | 1 |  |
| *ANKRD53* | 1 |  |
| *ANXA1* | 1 |  |
| *ANXA2* | 1 |  |
| *ANXA2P1* | 1 |  |
| *ANXA2P2* | 1 |  |
| *ANXA5* | 1 |  |
| *AQP5* | 1 |  |
| *ARAP3* | 1 |  |
| *ARL9* | 1 |  |
| *ARSD* | 1 |  |
| *ASF1B* | 1 |  |
| *ATP5EP2* | 1 |  |
| *ATP6V1C2* | 1 |  |
| *AURKA* | 1 |  |
| *B3GNT5* | 1 |  |
| *B3GNT7* | 1 |  |
| *BCL2L12* | 1 |  |
| *BGN* | 1 |  |
| *BOLA3* | 1 |  |
| *BUB1* | 1 |  |
| *BZW1* | 1 |  |
| *C11orf63* | 1 |  |
| *C12orf48* | 1 |  |
| *C1orf85* | 1 |  |
| *C2orf28* | 1 |  |
| *C5orf35* | 1 |  |
| *C5orf62* | 1 |  |
| *C6orf115* | 1 |  |
| *C9orf64* | 1 |  |
| *CA3* | 1 |  |
| *CALU* | 1 |  |
| *CAPZA1* | 1 |  |
| *CASP3* | 1 |  |
| *CASP4* | 1 |  |
| *CASP6* | 1 |  |
| *CCDC109B* | 1 |  |
| *CCDC8* | 1 |  |
| *CCNA2* | 1 |  |
| *CCNB1* | 1 |  |
| *CCNB2* | 1 |  |
| *CCNYL1* | 1 |  |
| *CD101* | 1 |  |
| *CD151* | 1 |  |
| *CD248* | 1 |  |
| *CD276* | 1 |  |
| *CD58* | 1 |  |
| *CD63* | 1 |  |
| *CD97* | 1 |  |
| *CDC20* | 1 |  |
| *CDCA8* | 1 |  |
| *CDK2* | 1 |  |
| *CDKN3* | 1 |  |
| *CENPA* | 1 |  |
| *CENPK* | 1 |  |
| *CENPL* | 1 |  |
| *CEP55* | 1 |  |
| *CHI3L1* | 1 |  |
| *CKLF* | 1 |  |
| *CKS1B* | 1 |  |
| *CKS2* | 1 |  |
| *CLIC1* | 1 |  |
| *CNIH4* | 1 |  |
| *COL4A1* | 1 |  |
| *COL5A2* | 1 |  |
| *DAP* | 1 |  |
| *DCTD* | 1 |  |
| *DDB2* | 1 |  |
| *DDOST* | 1 |  |
| *DEDD2* | 1 |  |
| *DEPDC1* | 1 |  |
| *DMRTA2* | 1 |  |
| *DPYD* | 1 |  |
| *E2F7* | 1 |  |
| *ECT2* | 1 |  |
| *EDARADD* | 1 |  |
| *EDEM2* | 1 |  |
| *EFEMP2* | 1 |  |
| *EMP3* | 1 |  |
| *EPR1* | 1 |  |
| *EVC2* | 1 |  |
| *F11R* | 1 |  |
| *FAM109B* | 1 |  |
| *FAM176B* | 1 |  |
| *FBXO17* | 1 |  |
| *FBXO39* | 1 |  |
| *FKBP9* | 1 |  |
| *FMOD* | 1 |  |
| *FSTL1* | 1 |  |
| *FUCA2* | 1 |  |
| *G0S2* | 1 |  |
| *GDF15* | 1 |  |
| *GGH* | 1 |  |
| *GJC1* | 1 |  |
| *GLA* | 1 |  |
| *GLB1* | 1 |  |
| *GNG12* | 1 |  |
| *GPN1* | 1 |  |
| *GPR1* | 1 |  |
| *GPX7* | 1 |  |
| *GPX8* | 1 |  |
| *GSTK1* | 1 |  |
| *GUSB* | 1 |  |
| *HAUS1* | 1 |  |
| *HDAC3* | 1 |  |
| *HDHD3* | 1 |  |
| *HEBP2* | 1 |  |
| *HEXB* | 1 |  |
| *HFE* | 1 |  |
| *HIST1H2BH* | 1 |  |
| *HJURP* | 1 |  |
| *HOTAIR* | 1 |  |
| *HOXA1* | 1 |  |
| *HOXA2* | 1 |  |
| *HOXA3* | 1 |  |
| *HOXA5* | 1 |  |
| *HOXB3* | 1 |  |
| *HOXC10* | 1 |  |
| *IFNGR2* | 1 |  |
| *IGF2BP3* | 1 |  |
| *IGFBP2* | 1 |  |
| *IKBIP* | 1 |  |
| *ITGA5* | 1 |  |
| *KDELC2* | 1 |  |
| *KDELR1* | 1 |  |
| *KDELR2* | 1 |  |
| *KDELR3* | 1 |  |
| *KIAA0101* | 1 |  |
| *KIAA0495* | 1 |  |
| *KIF20A* | 1 |  |
| *KIF23* | 1 |  |
| *KIF4A* | 1 |  |
| *KPNA2* | 1 |  |
| *LAMC1* | 1 |  |
| *LATS2* | 1 |  |
| *LDHA* | 1 |  |
| *LEPRE1* | 1 |  |
| *LGALS1* | 1 |  |
| *LGALS3* | 1 |  |
| *LOC100130776* | 1 |  |
| *LOC284276* | 1 |  |
| *LOC407835* | 1 |  |
| *LOC493754* | 1 |  |
| *LOC541471* | 1 |  |
| *LOC647946* | 1 |  |
| *LOX* | 1 |  |
| *LOXL1* | 1 |  |
| *LSP1* | 1 |  |
| *LYPLA1* | 1 |  |
| *MAP1LC3C* | 1 |  |
| *MARVELD1* | 1 |  |
| *MDK* | 1 |  |
| *MED8* | 1 |  |
| *MELK* | 1 |  |
| *MEOX2* | 1 |  |
| *METTL7B* | 1 |  |
| *MIR155HG* | 1 |  |
| *MLX* | 1 |  |
| *MMP11* | 1 |  |
| *MSN* | 1 |  |
| *MYD88* | 1 |  |
| *MYL12A* | 1 |  |
| *NANP* | 1 |  |
| *NCRNA00152* | 1 |  |
| *NNMT* | 1 |  |
| *NOX4* | 1 |  |
| *NSUN7* | 1 |  |
| *NTAN1* | 1 |  |
| *NUP37* | 1 |  |
| *OCIAD2* | 1 |  |
| *OSTC* | 1 |  |
| *OTP* | 1 |  |
| *PA2G4P4* | 1 |  |
| *PCNA* | 1 |  |
| *PCOLCE* | 1 |  |
| *PDIA3P* | 1 |  |
| *PDIA4* | 1 |  |
| *PDIA6* | 1 |  |
| *PDLIM1* | 1 |  |
| *PDLIM4* | 1 |  |
| *PDPN* | 1 |  |
| *PGCP* | 1 |  |
| *PION* | 1 |  |
| *PLA2G2A* | 1 |  |
| *PLAT* | 1 |  |
| *PLAUR* | 1 |  |
| *PLEK2* | 1 |  |
| *PLP2* | 1 |  |
| *PMM2* | 1 |  |
| *PMS2L2* | 1 |  |
| *POC1A* | 1 |  |
| *POLR1D* | 1 |  |
| *POSTN* | 1 |  |
| *PPCS* | 1 |  |
| *PPIA* | 1 |  |
| *PPIC* | 1 |  |
| *PPIL5* | 1 |  |
| *PPPDE1* | 1 |  |
| *PRDX4* | 1 |  |
| *PRICKLE3* | 1 |  |
| *PRPS2* | 1 |  |
| *PSMC2* | 1 |  |
| *PSRC1* | 1 |  |
| *PTGFRN* | 1 |  |
| *PTTG1* | 1 |  |
| *PTX3* | 1 |  |
| *PVT1* | 1 |  |
| *PYGL* | 1 |  |
| *RAB32* | 1 |  |
| *RAB34* | 1 |  |
| *RAB36* | 1 |  |
| *RAB42* | 1 |  |
| *RABL5* | 1 |  |
| *RAD54B* | 1 |  |
| *RAET1K* | 1 |  |
| *RAP1B* | 1 |  |
| *RARRES2* | 1 |  |
| *RARS* | 1 |  |
| *RBP1* | 1 |  |
| *RFC2* | 1 |  |
| *RINL* | 1 |  |
| *RPA3* | 1 |  |
| *RPS2P32* | 1 |  |
| *RRM2* | 1 |  |
| *S100A4* | 1 |  |
| *SAA1* | 1 |  |
| *SDF4* | 1 |  |
| *SEC24D* | 1 |  |
| *SEC61G* | 1 |  |
| *SERPINH1* | 1 |  |
| *SH2D4A* | 1 |  |
| *SHOX2* | 1 |  |
| *SHQ1* | 1 |  |
| *SKA1* | 1 |  |
| *SLC25A24* | 1 |  |
| *SLC27A3* | 1 |  |
| *SLC2A10* | 1 |  |
| *SLC35A2* | 1 |  |
| *SLC43A3* | 1 |  |
| *SMC4* | 1 |  |
| *SPAG4* | 1 |  |
| *SPON2* | 1 |  |
| *SPRY1* | 1 |  |
| *STAC* | 1 |  |
| *STEAP3* | 1 |  |
| *SUMO1P3* | 1 |  |
| *TAGLN2* | 1 |  |
| *TBL2* | 1 |  |
| *TCEA3* | 1 |  |
| *TEAD3* | 1 |  |
| *TGIF1* | 1 |  |
| *TICAM2* | 1 |  |
| *TIMP1* | 1 |  |
| *TMBIM1* | 1 |  |
| *TMEM106C* | 1 |  |
| *TMEM159* | 1 |  |
| *TMEM165* | 1 |  |
| *TMEM214* | 1 |  |
| *TMEM60* | 1 |  |
| *TMEM71* | 1 |  |
| *TMSB10* | 1 |  |
| *TMSL3* | 1 |  |
| *TNFAIP6* | 1 |  |
| *TNFRSF11B* | 1 |  |
| *TNFRSF12A* | 1 |  |
| *TOM1L1* | 1 |  |
| *TPM4* | 1 |  |
| *TTC26* | 1 |  |
| *TTYH3* | 1 |  |
| *TUBA1C* | 1 |  |
| *TXNDC5* | 1 |  |
| *TYMS* | 1 |  |
| *UBE2A* | 1 |  |
| *UBE2MP1* | 1 |  |
| *ULBP3* | 1 |  |
| *VASN* | 1 |  |
| *VAV3* | 1 |  |
| *WEE1* | 1 |  |
| *XKR8* | 1 |  |
| *YIPF1* | 1 |  |
| *ZCCHC9* | 1 |  |
| *ZNF90* | 1 |  |
| *AARS* | 2 |  |
| *ABI1* | 2 |  |
| *ABLIM1* | 2 |  |
| *ACBD5* | 2 |  |
| *ACVR2B* | 2 |  |
| *AKAP6* | 2 |  |
| *ALCAM* | 2 |  |
| *ALDH2* | 2 |  |
| *ALDH5A1* | 2 |  |
| *ANKRD16* | 2 |  |
| *ANKRD26* | 2 |  |
| *ARPP21* | 2 |  |
| *ASB13* | 2 |  |
| *ATP6V1G2* | 2 |  |
| *ATP9A* | 2 |  |
| *BEND7* | 2 |  |
| *BMP2* | 2 |  |
| *BRD7* | 2 |  |
| *C10orf4* | 2 |  |
| *C5orf53* | 2 |  |
| *CBARA1* | 2 |  |
| *CDC26* | 2 |  |
| *CDH20* | 2 |  |
| *CDHR1* | 2 |  |
| *CPEB3* | 2 |  |
| *CRTAC1* | 2 |  |
| *CSDC2* | 2 |  |
| *CSMD3* | 2 |  |
| *CYTH1* | 2 |  |
| *DDX42* | 2 |  |
| *DGCR2* | 2 |  |
| *DHTKD1* | 2 |  |
| *DIP2C* | 2 |  |
| *DNAJB12* | 2 |  |
| *DNAJC12* | 2 |  |
| *DNM3* | 2 |  |
| *DSCAML1* | 2 |  |
| *DST* | 2 |  |
| *DUSP26* | 2 |  |
| *DYNC1H1* | 2 |  |
| *EEF1A1P9* | 2 |  |
| *FAM133A* | 2 |  |
| *FAM171A1* | 2 |  |
| *FAM190B* | 2 |  |
| *FAM192A* | 2 |  |
| *FAM21C* | 2 |  |
| *FAM71D* | 2 |  |
| *FBXO18* | 2 |  |
| *FCHSD2* | 2 |  |
| *FLRT1* | 2 |  |
| *FOXO3B* | 2 |  |
| *FOXO4* | 2 |  |
| *FRY* | 2 |  |
| *FTHL3* | 2 |  |
| *GALNT13* | 2 |  |
| *GCSH* | 2 |  |
| *GLUD1* | 2 |  |
| *GUSBL1* | 2 |  |
| *H2AFY2* | 2 |  |
| *H3F3C* | 2 |  |
| *HDAC4* | 2 |  |
| *HDAC5* | 2 |  |
| *HERC1* | 2 |  |
| *HIPK2* | 2 |  |
| *HMX1* | 2 |  |
| *HNRNPA3P1* | 2 |  |
| *HNRNPH3* | 2 |  |
| *HNRNPUL2* | 2 |  |
| *JMY* | 2 |  |
| *JPH3* | 2 |  |
| *JPH4* | 2 |  |
| *KCNB1* | 2 |  |
| *KCNIP3* | 2 |  |
| *KIAA0427* | 2 |  |
| *KIAA0430* | 2 |  |
| *KIAA1279* | 2 |  |
| *LARP4B* | 2 |  |
| *LOC254559* | 2 |  |
| *LOC339674* | 2 |  |
| *LOC341056* | 2 |  |
| *LOC399744* | 2 |  |
| *LOC442454* | 2 |  |
| *LOC643387* | 2 |  |
| *LOC644936* | 2 |  |
| *LOC728643* | 2 |  |
| *LRIT2* | 2 |  |
| *LRRC37A4* | 2 |  |
| *MAPT* | 2 |  |
| *MCF2L2* | 2 |  |
| *MGEA5* | 2 |  |
| *MIPOL1* | 2 |  |
| *MLL* | 2 |  |
| *MLLT6* | 2 |  |
| *MTPAP* | 2 |  |
| *MXI1* | 2 |  |
| *MYO18A* | 2 |  |
| *MYST4* | 2 |  |
| *NACA2* | 2 |  |
| *NACAP1* | 2 |  |
| *NALCN* | 2 |  |
| *NAP1L3* | 2 |  |
| *NCAM1* | 2 |  |
| *NCRNA00093* | 2 |  |
| *NET1* | 2 |  |
| *NLGN2* | 2 |  |
| *NOG* | 2 |  |
| *NRG3* | 2 |  |
| *NSUN6* | 2 |  |
| *NTNG2* | 2 |  |
| *NUMA1* | 2 |  |
| *OPHN1* | 2 |  |
| *PABPC5* | 2 |  |
| *PCDH15* | 2 |  |
| *PDCD4* | 2 |  |
| *PHLPP1* | 2 |  |
| *PHYHIPL* | 2 |  |
| *PIP4K2B* | 2 |  |
| *PLCB1* | 2 |  |
| *PPIAL4C* | 2 |  |
| *PRLHR* | 2 |  |
| *RABGAP1* | 2 |  |
| *RANBP17* | 2 |  |
| *RASL10A* | 2 |  |
| *RBM17* | 2 |  |
| *REPS2* | 2 |  |
| *RICTOR* | 2 |  |
| *RPL12* | 2 |  |
| *RPL13AP3* | 2 |  |
| *RPL17* | 2 |  |
| *RPL23P8* | 2 |  |
| *RPL7* | 2 |  |
| *RPS27A* | 2 |  |
| *SCAPER* | 2 |  |
| *SH3GL2* | 2 |  |
| *SIRT1* | 2 |  |
| *SLC25A21* | 2 |  |
| *SLC6A10P* | 2 |  |
| *SMC3* | 2 |  |
| *SMOC1* | 2 |  |
| *SOX8* | 2 |  |
| *SPIRE1* | 2 |  |
| *SPTAN1* | 2 |  |
| *SSTR1* | 2 |  |
| *SUFU* | 2 |  |
| *SYT15* | 2 |  |
| *TAPT1* | 2 |  |
| *TARSL2* | 2 |  |
| *TCEAL2* | 2 |  |
| *TEF* | 2 |  |
| *TMOD2* | 2 |  |
| *TNK2* | 2 |  |
| *TNRC6C* | 2 |  |
| *TOM1L2* | 2 |  |
| *TOP1P2* | 2 |  |
| *TRIM8* | 2 |  |
| *TTC3* | 2 |  |
| *TUB* | 2 |  |
| *UPF2* | 2 |  |
| *USP34* | 2 |  |
| *WAC* | 2 |  |
| *WBP11P1* | 2 |  |
| *WDR37* | 2 |  |
| *X..10357* | 2 |  |
| *X..653553* | 2 |  |
| *ZCCHC24* | 2 |  |
| *ZDHHC22* | 2 |  |
| *ZMYND11* | 2 |  |
| *ZNF248* | 2 |  |
| *ZNF25* | 2 |  |
| *ZNF33A* | 2 |  |
| *ZNF638* | 2 |  |
| *ZRANB1* | 2 |  |

Table S6. The proportion of patients divided by mutation status. The mutation status information is suggested as *IDH1-TP53-ATRX-EGFR*. WT is wild-type. MT is mutation.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| WT-WT-WT-WT | MT-WT-WT-WT | MT-MT-WT-WT | MT-MT-MT-WT | WT-WT-WT-MT |
| 64 | 154 | 58 | 171 | 29 |
| 0.13 | 0.32 | 0.12 | 0.36 | 0.06 |

Table S7. The log-rank p-value in each four age-related mutation. OS is overall survival. PFI is progression free interval

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | *IDH1* | *TP53* | *ATRX* | *EGFR* |
| OS | 2.82E-18 | 0.05141 | 0.066567 | 2.12E-14 |
| PFI | 1.10E-17 | 0.5545189 | 0.5479266 | 1.63E-19 |

Table S8. The results of multi-label feature selection information gain of *ATRX*, *TP53,* and grade

|  |  |  |
| --- | --- | --- |
| Gene | Clusters | |
| *AKIRIN1* | 1 |  |
| *ARHGEF10L* | 1 |  |
| *ASAP3* | 1 |  |
| *BSDC1* | 1 |  |
| *BTF3L4* | 1 |  |
| *C19orf2* | 1 |  |
| *C1orf109* | 1 |  |
| *C1orf144* | 1 |  |
| *C1orf174* | 1 |  |
| *C2orf67* | 1 |  |
| *CAPZB* | 1 |  |
| *CCDC123* | 1 |  |
| *CCDC146* | 1 |  |
| *CDC42* | 1 |  |
| *CMPK1* | 1 |  |
| *CNN3* | 1 |  |
| *CSDE1* | 1 |  |
| *CYB561D1* | 1 |  |
| *DDOST* | 1 |  |
| *DDX20* | 1 |  |
| *DNAJC8* | 1 |  |
| *DNALI1* | 1 |  |
| *DOCK7* | 1 |  |
| *DR1* | 1 |  |
| *EIF3I* | 1 |  |
| *EVI5* | 1 |  |
| *EXOSC10* | 1 |  |
| *FAM54B* | 1 |  |
| *FBXO42* | 1 |  |
| *FOXJ3* | 1 |  |
| *GDAP2* | 1 |  |
| *GNAI3* | 1 |  |
| *GNL2* | 1 |  |
| *GPATCH1* | 1 |  |
| *GPBP1L1* | 1 |  |
| *GTF2B* | 1 |  |
| *H6PD* | 1 |  |
| *HDAC1* | 1 |  |
| *HP1BP3* | 1 |  |
| *HS3ST1* | 1 |  |
| *INPP5B* | 1 |  |
| *KDM1A* | 1 |  |
| *KDM4A* | 1 |  |
| *KIAA0467* | 1 |  |
| *KIAA2013* | 1 |  |
| *KPNA6* | 1 |  |
| *LEFTY2* | 1 |  |
| *LOC148189* | 1 |  |
| *LRRC41* | 1 |  |
| *LRRC42* | 1 |  |
| *LSM14A* | 1 |  |
| *MFN2* | 1 |  |
| *MIER1* | 1 |  |
| *MIIP* | 1 |  |
| *MTF2* | 1 |  |
| *NADK* | 1 |  |
| *NFIA* | 1 |  |
| *NFYC* | 1 |  |
| *NRAS* | 1 |  |
| *NRD1* | 1 |  |
| *NSUN4* | 1 |  |
| *OR4N2* | 1 |  |
| *PABPC4* | 1 |  |
| *PARS2* | 1 |  |
| *PGD* | 1 |  |
| *PHACTR4* | 1 |  |
| *PHC2* | 1 |  |
| *PHF13* | 1 |  |
| *PKN2* | 1 |  |
| *PNRC2* | 1 |  |
| *PPP1R8* | 1 |  |
| *PRPF38A* | 1 |  |
| *psiTPTE22* | 1 |  |
| *PSMA5* | 1 |  |
| *PSMB2* | 1 |  |
| *RBBP4* | 1 |  |
| *RLF* | 1 |  |
| *RPAP2* | 1 |  |
| *RPF1* | 1 |  |
| *S100PBP* | 1 |  |
| *SCP2* | 1 |  |
| *SERBP1* | 1 |  |
| *SF3A3* | 1 |  |
| *SFRS4* | 1 |  |
| *SNIP1* | 1 |  |
| *SNRNP40* | 1 |  |
| *SNX7* | 1 |  |
| *SRRM1* | 1 |  |
| *ST7L* | 1 |  |
| *STX12* | 1 |  |
| *TCEB3* | 1 |  |
| *THRAP3* | 1 |  |
| *TMEM167B* | 1 |  |
| *TMEM69* | 1 |  |
| *TRNAU1AP* | 1 |  |
| *TTC4* | 1 |  |
| *TXLNA* | 1 |  |
| *TXNDC12* | 1 |  |
| *UBA2* | 1 |  |
| *UBIAD1* | 1 |  |
| *UROD* | 1 |  |
| *USP48* | 1 |  |
| *UTP11L* | 1 |  |
| *VCAM1* | 1 |  |
| *WASF2* | 1 |  |
| *WDR77* | 1 |  |
| *WDR78* | 1 |  |
| *X15.Sep* | 1 |  |
| *YTHDF2* | 1 |  |
| *ZNF362* | 1 |  |
| *ZZZ3* | 1 |  |
| *C1orf230* | 2 |  |
| *C6orf138* | 2 |  |
| *CHGB* | 2 |  |
| *DRAM1* | 2 |  |
| *DRG2* | 2 |  |
| *EDA2R* | 2 |  |
| *GRPEL2* | 2 |  |
| *TERT* | 2 |  |
| *TRIM67* | 2 |  |

Table S9. The results of multi-label feature selection information gain of *EGFR* and grade

|  |  |  |
| --- | --- | --- |
| Gene | Clusters | |
| *ABLIM1* | 1 |  |
| *C10orf4* | 1 |  |
| *C5orf53* | 1 |  |
| *CDC26* | 1 |  |
| *CPEB3* | 1 |  |
| *DYNC1H1* | 1 |  |
| *EEF1A1P9* | 1 |  |
| *FAM171A1* | 1 |  |
| *FAM190B* | 1 |  |
| *FAM71D* | 1 |  |
| *FRY* | 1 |  |
| *FTHL3* | 1 |  |
| *GCSH* | 1 |  |
| *GUSBL1* | 1 |  |
| *H3F3C* | 1 |  |
| *HERC1* | 1 |  |
| *HNRNPA3P1* | 1 |  |
| *HNRNPUL2* | 1 |  |
| *KIAA0427* | 1 |  |
| *KIAA0430* | 1 |  |
| *KIAA1279* | 1 |  |
| *LARP4B* | 1 |  |
| *LOC341056* | 1 |  |
| *LOC442454* | 1 |  |
| *LOC643387* | 1 |  |
| *LOC644936* | 1 |  |
| *LOC728643* | 1 |  |
| *LRRC37A4* | 1 |  |
| *MLLT6* | 1 |  |
| *MYO18A* | 1 |  |
| *NACA2* | 1 |  |
| *NACAP1* | 1 |  |
| *NALCN* | 1 |  |
| *NUMA1* | 1 |  |
| *PPIAL4C* | 1 |  |
| *RICTOR* | 1 |  |
| *RPL13AP3* | 1 |  |
| *RPL17* | 1 |  |
| *RPL23P8* | 1 |  |
| *SCAPER* | 1 |  |
| *SLC6A10P* | 1 |  |
| *SPTAN1* | 1 |  |
| *TARSL2* | 1 |  |
| *TEF* | 1 |  |
| *TMOD2* | 1 |  |
| *TNRC6C* | 1 |  |
| *TOM1L2* | 1 |  |
| *TOP1P2* | 1 |  |
| *TTC3* | 1 |  |
| *UPF2* | 1 |  |
| *WBP11P1* | 1 |  |
| *X..10357* | 1 |  |
| *X..653553* | 1 |  |
| *ZMYND11* | 1 |  |
| *ZNF33A* | 1 |  |
| *ZNF638* | 1 |  |
| *ZRANB1* | 1 |  |
| *ADAM12* | 2 |  |
| *ALG3* | 2 |  |
| *ANXA2P1* | 2 |  |
| *ARAP3* | 2 |  |
| *ASF1B* | 2 |  |
| *ATP5EP2* | 2 |  |
| *ATP6V1C2* | 2 |  |
| *AURKA* | 2 |  |
| *C12orf48* | 2 |  |
| *C2orf28* | 2 |  |
| *CALU* | 2 |  |
| *CAPZA1* | 2 |  |
| *CASP4* | 2 |  |
| *CCDC109B* | 2 |  |
| *CCNB1* | 2 |  |
| *CCNB2* | 2 |  |
| *CCNYL1* | 2 |  |
| *CD58* | 2 |  |
| *CDCA8* | 2 |  |
| *CDK2* | 2 |  |
| *CDKN3* | 2 |  |
| *CENPA* | 2 |  |
| *CENPK* | 2 |  |
| *CENPL* | 2 |  |
| *CEP55* | 2 |  |
| *CHI3L1* | 2 |  |
| *CKLF* | 2 |  |
| *CLIC1* | 2 |  |
| *CNIH4* | 2 |  |
| *COL5A2* | 2 |  |
| *DDOST* | 2 |  |
| *DEPDC1* | 2 |  |
| *EDARADD* | 2 |  |
| *EDEM2* | 2 |  |
| *EMP3* | 2 |  |
| *FKBP9* | 2 |  |
| *FSTL1* | 2 |  |
| *GGH* | 2 |  |
| *GLA* | 2 |  |
| *GLB1* | 2 |  |
| *GPN1* | 2 |  |
| *GPX7* | 2 |  |
| *GPX8* | 2 |  |
| *GUSB* | 2 |  |
| *IFNGR2* | 2 |  |
| *IGFBP2* | 2 |  |
| *IKBIP* | 2 |  |
| *KDELR2* | 2 |  |
| *KPNA2* | 2 |  |
| *LDHA* | 2 |  |
| *LOC100130776* | 2 |  |
| *LOC407835* | 2 |  |
| *LOC541471* | 2 |  |
| *LOX* | 2 |  |
| *LYPLA1* | 2 |  |
| *MED8* | 2 |  |
| *MLX* | 2 |  |
| *NCRNA00152* | 2 |  |
| *NNMT* | 2 |  |
| *NOX4* | 2 |  |
| *NUP37* | 2 |  |
| *OSTC* | 2 |  |
| *PA2G4P4* | 2 |  |
| *PCNA* | 2 |  |
| *PDPN* | 2 |  |
| *PLA2G2A* | 2 |  |
| *PLEK2* | 2 |  |
| *PMS2L2* | 2 |  |
| *PPIA* | 2 |  |
| *PPIL5* | 2 |  |
| *PRDX4* | 2 |  |
| *PSMC2* | 2 |  |
| *PTTG1* | 2 |  |
| *RAB32* | 2 |  |
| *RAB42* | 2 |  |
| *RAP1B* | 2 |  |
| *RPA3* | 2 |  |
| *SEC61G* | 2 |  |
| *SERPINH1* | 2 |  |
| *SHOX2* | 2 |  |
| *SHQ1* | 2 |  |
| *SLC43A3* | 2 |  |
| *SMC4* | 2 |  |
| *SUMO1P3* | 2 |  |
| *TAGLN2* | 2 |  |
| *TBL2* | 2 |  |
| *TGIF1* | 2 |  |
| *TIMP1* | 2 |  |
| *TMEM106C* | 2 |  |
| *TMSL3* | 2 |  |
| *TNFAIP6* | 2 |  |
| *TPM4* | 2 |  |
| *TUBA1C* | 2 |  |
| *UBE2A* | 2 |  |
| *UBE2MP1* | 2 |  |
| *WEE1* | 2 |  |
| *ZCCHC9* | 2 |  |
| *ZNF90* | 2 |  |