

# A genome-wide CRISPR screen identifies regulators of MAPK and MTOR pathways that mediate resistance to sorafenib in acute myeloid leukemia

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**Supplementary Table 1:** Normalized gene-level CRISPR results with RRA p-values  $\leq 0.05$ , tiers are shown

| Gene ID  | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers     |
|----------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|-----------|
| LZTR1    | 5   | 1.00      | 1.00        | 17994    | 3.01    | 9.2E-07   | 4.1E-06     | 1        | 5             | 3.01    | Tier1     |
| BIRC6    | 5   | 1.00      | 1.00        | 17992    | 1.99    | 1.2E-05   | 5.1E-05     | 5        | 5             | 1.99    | Tier3     |
| TSC2     | 4   | 0.97      | 0.97        | 17330    | 3.39    | 1.2E-05   | 4.9E-05     | 4        | 3             | 3.39    | Tier1     |
| TXNDC9   | 5   | 0.51      | 0.60        | 10419    | 3.17    | 1.1E-05   | 4.9E-05     | 3        | 4             | 3.17    | Tier2     |
| ZNHIT3   | 6   | 1.00      | 1.00        | 17993    | 1.96    | 7.2E-06   | 4.2E-05     | 2        | 6             | 1.96    | Tier3     |
| ABCB1    | 5   | 0.00      | 0.02        | 324      | 2.75    | 1.2E-04   | 5.4E-04     | 29       | 3             | 2.75    | Tier1     |
| ACTL6A   | 5   | 0.57      | 0.63        | 10949    | 0.98    | 1.2E-04   | 5.4E-04     | 31       | 3             | 0.98    | Tier2     |
| AP2S1    | 7   | 1.00      | 1.00        | 17922    | 1.76    | 3.3E-05   | 2.1E-04     | 7        | 6             | 1.76    | Tier3     |
| ATP8A2   | 5   | 0.15      | 0.29        | 5013     | 1.61    | 8.7E-05   | 4.0E-04     | 21       | 3             | 1.61    | Tier2     |
| C1orf52  | 5   | 0.95      | 0.95        | 17030    | 2.70    | 1.0E-04   | 4.7E-04     | 24       | 3             | 2.70    | Tier2     |
| CADM2    | 5   | 0.98      | 0.98        | 17499    | 2.81    | 6.7E-05   | 3.1E-04     | 17       | 4             | 2.81    | Tier2     |
| CDK1     | 5   | 1.00      | 1.00        | 17982    | 2.02    | 1.2E-04   | 5.3E-04     | 28       | 5             | 2.02    | Tier2     |
| CEP63    | 5   | 0.68      | 0.70        | 12239    | 2.86    | 7.0E-05   | 3.2E-04     | 18       | 4             | 2.86    | Tier2     |
| DHX15    | 5   | 1.00      | 1.00        | 17989    | 2.63    | 4.2E-05   | 2.0E-04     | 10       | 5             | 2.63    | Tier1     |
| EBNA1BP2 | 5   | 0.95      | 0.95        | 16936    | 2.15    | 5.7E-05   | 2.7E-04     | 11       | 4             | 2.15    | Tier1     |
| EXOSC8   | 5   | 1.00      | 1.00        | 17981    | 1.94    | 9.8E-05   | 4.5E-04     | 23       | 5             | 1.94    | Tier3     |
| HADH     | 5   | 0.22      | 0.36        | 6274     | -0.34   | 2.9E-05   | 1.4E-04     | 6        | 2             | -0.34   | Singleton |
| HRC      | 5   | 1.00      | 1.00        | 17984    | 1.77    | 1.1E-04   | 4.8E-04     | 25       | 5             | 1.77    | Tier3     |
| LSM5     | 2   | 1.00      | 1.00        | 17988    | 3.55    | 6.7E-05   | 1.2E-04     | 16       | 2             | 3.55    | Tier1     |
| MAK      | 3   | 1.00      | 1.00        | 17987    | 2.33    | 7.6E-05   | 2.3E-04     | 19       | 3             | 2.33    | Tier3     |
| MAT2A    | 4   | 1.00      | 1.00        | 17991    | 2.64    | 5.8E-05   | 2.3E-04     | 12       | 4             | 2.64    | Tier3     |
| NPRL2    | 5   | 1.00      | 1.00        | 17874    | 1.96    | 4.2E-05   | 2.0E-04     | 9        | 4             | 1.96    | Tier3     |
| PIP5K1A  | 8   | 1.00      | 1.00        | 17986    | 1.27    | 7.9E-05   | 5.5E-04     | 20       | 8             | 1.27    | Singleton |
| PPP1R8   | 13  | 0.83      | 0.92        | 14798    | 1.82    | 3.7E-05   | 3.3E-04     | 8        | 7             | 1.82    | Tier3     |
| PUS7     | 5   | 0.08      | 0.18        | 3207     | 2.03    | 1.1E-04   | 5.0E-04     | 27       | 4             | 2.03    | Tier1     |
| RSL1D1   | 4   | 1.00      | 1.00        | 17990    | 2.47    | 6.2E-05   | 2.5E-04     | 14       | 4             | 2.47    | Tier3     |
| SMARCB1  | 4   | 0.98      | 0.98        | 17470    | 2.61    | 1.3E-04   | 4.9E-04     | 32       | 3             | 2.61    | Tier1     |
| TMEM62   | 5   | 0.94      | 0.94        | 16783    | 2.89    | 5.9E-05   | 2.7E-04     | 13       | 4             | 2.89    | Tier2     |
| TNK2     | 5   | 1.00      | 1.00        | 17888    | 2.23    | 6.7E-05   | 3.1E-04     | 15       | 5             | 2.23    | Tier1     |
| TSC1     | 5   | 1.00      | 1.00        | 17985    | 2.12    | 9.3E-05   | 4.3E-04     | 22       | 5             | 2.12    | Tier3     |
| TTF2     | 5   | 1.00      | 1.00        | 17983    | 1.64    | 1.1E-04   | 5.0E-04     | 26       | 5             | 1.64    | Tier3     |
| ZNF816   | 3   | 0.47      | 0.48        | 10037    | 3.65    | 1.2E-04   | 3.8E-04     | 30       | 2             | 3.65    | Tier2     |
| NDST4    | 5   | 0.05      | 0.12        | 2278     | -1.04   | 1.4E-04   | 6.6E-04     | 35       | 2             | -1.04   | Singleton |
| PIWIL2   | 5   | 0.98      | 0.98        | 17588    | 2.01    | 1.3E-04   | 6.2E-04     | 33       | 4             | 2.01    | Tier3     |
| SEPSECS  | 5   | 0.44      | 0.57        | 9813     | 1.01    | 1.4E-04   | 6.2E-04     | 34       | 3             | 1.01    | Tier2     |
| TAF7     | 5   | 0.94      | 0.94        | 16713    | 2.61    | 1.5E-04   | 6.7E-04     | 36       | 3             | 2.61    | Tier2     |

| Gene ID        | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|----------------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| TPK1           | 4   | 1.00      | 1.00        | 17979    | 1.99    | 1.8E-04   | 6.6E-04     | 40       | 4             | 1.99    | Tier3      |
| PNPO           | 5   | 0.61      | 0.65        | 11384    | 0.70    | 1.5E-04   | 6.9E-04     | 37       | 3             | 0.70    | Tier2      |
| GMNN           | 4   | 0.00      | 0.01        | 138      | -0.32   | 2.1E-04   | 7.7E-04     | 44       | 1             | -0.32   | Unassigned |
| DUSP18         | 5   | 1.00      | 1.00        | 17980    | 2.02    | 1.7E-04   | 8.1E-04     | 38       | 5             | 2.02    | Tier2      |
| SCAF4          | 5   | 0.56      | 0.62        | 10865    | 2.66    | 1.7E-04   | 8.1E-04     | 39       | 4             | 2.66    | Tier2      |
| TUBE1          | 5   | 1.00      | 1.00        | 17978    | 2.23    | 1.8E-04   | 8.4E-04     | 41       | 5             | 2.23    | Tier2      |
| RPLP0          | 5   | 0.93      | 0.93        | 16592    | 0.60    | 2.0E-04   | 9.3E-04     | 42       | 2             | 0.60    | Singleton  |
| TRIP13         | 5   | 0.54      | 0.62        | 10741    | 2.08    | 2.1E-04   | 9.4E-04     | 43       | 4             | 2.08    | Tier3      |
| GOT1           | 5   | 0.18      | 0.31        | 5529     | 2.58    | 2.2E-04   | 1.0E-03     | 46       | 4             | 2.58    | Tier2      |
| RPL27A         | 4   | 1.00      | 1.00        | 17976    | 1.85    | 2.8E-04   | 1.0E-03     | 50       | 4             | 1.85    | Tier3      |
| ZDHHC24        | 5   | 1.00      | 1.00        | 17977    | 1.79    | 2.1E-04   | 9.8E-04     | 45       | 5             | 1.79    | Tier3      |
| UBTF           | 4   | 1.00      | 1.00        | 17975    | 1.78    | 2.9E-04   | 1.1E-03     | 52       | 4             | 1.78    | Tier3      |
| MANBAL         | 4   | 0.49      | 0.54        | 10280    | 1.19    | 3.0E-04   | 1.1E-03     | 53       | 2             | 1.19    | Tier3      |
| STAM           | 4   | 0.99      | 0.99        | 17681    | 2.59    | 3.1E-04   | 1.1E-03     | 54       | 3             | 2.59    | Tier1      |
| LTA4H          | 5   | 0.54      | 0.62        | 10716    | 1.06    | 2.6E-04   | 1.2E-03     | 47       | 3             | 1.06    | Tier2      |
| TP53BP1        | 5   | 0.30      | 0.44        | 7767     | 0.40    | 2.7E-04   | 1.2E-03     | 48       | 2             | 0.40    | Tier2      |
| TMTC4          | 5   | 0.99      | 0.99        | 17816    | 1.88    | 2.8E-04   | 1.3E-03     | 49       | 4             | 1.88    | Tier3      |
| IMPAD1         | 4   | 0.04      | 0.09        | 1810     | 1.77    | 3.6E-04   | 1.3E-03     | 59       | 2             | 1.77    | Tier2      |
| FAM92A1        | 5   | 0.05      | 0.12        | 2250     | -0.49   | 3.1E-04   | 1.4E-03     | 55       | 2             | -0.49   | Tier2      |
| KRT76          | 5   | 0.64      | 0.68        | 11838    | 1.95    | 3.2E-04   | 1.5E-03     | 56       | 3             | 1.95    | Tier3      |
| C6             | 3   | 1.00      | 1.00        | 17971    | 2.10    | 5.1E-04   | 1.5E-03     | 68       | 3             | 2.10    | Tier3      |
| MSL2           | 5   | 0.98      | 0.98        | 17442    | 1.83    | 3.3E-04   | 1.5E-03     | 57       | 4             | 1.83    | Tier3      |
| PNMA6C         | 1   | 1.00      | 1.00        | 17940    | 4.57    | 1.6E-03   | 1.6E-03     | 167      | 1             | 4.57    | Singleton  |
| PRUNE          | 5   | 0.94      | 0.94        | 16844    | 1.84    | 3.4E-04   | 1.6E-03     | 58       | 4             | 1.84    | Tier3      |
| DEFB114        | 1   | 1.00      | 1.00        | 17938    | 4.10    | 1.7E-03   | 1.6E-03     | 173      | 1             | 4.10    | Singleton  |
| UBE2Q2         | 5   | 0.44      | 0.57        | 9822     | 1.50    | 3.8E-04   | 1.7E-03     | 62       | 3             | 1.50    | Tier2      |
| UNK            | 5   | 0.98      | 0.98        | 17509    | 2.29    | 3.8E-04   | 1.7E-03     | 61       | 4             | 2.29    | Tier3      |
| UXS1           | 5   | 1.00      | 1.00        | 17974    | 1.57    | 3.7E-04   | 1.7E-03     | 60       | 5             | 1.57    | Singleton  |
| IMPDH2         | 4   | 0.99      | 0.99        | 17752    | 2.44    | 5.2E-04   | 1.9E-03     | 69       | 4             | 2.44    | Tier1      |
| TEX10          | 5   | 0.92      | 0.92        | 16375    | 2.38    | 4.1E-04   | 1.9E-03     | 63       | 4             | 2.38    | Tier2      |
| C15orf38-AP3S2 | 1   | 1.00      | 1.00        | 17929    | 4.55    | 2.0E-03   | 1.9E-03     | 200      | 1             | 4.55    | Singleton  |
| TMEM150A       | 5   | 0.97      | 0.98        | 17425    | 1.32    | 4.3E-04   | 2.0E-03     | 64       | 3             | 1.32    | Tier3      |
| CETN3          | 3   | 1.00      | 1.00        | 17969    | 2.26    | 7.1E-04   | 2.1E-03     | 81       | 3             | 2.26    | Tier3      |
| FAM127B        | 2   | 1.00      | 1.00        | 17955    | 3.07    | 1.1E-03   | 2.1E-03     | 121      | 2             | 3.07    | Tier1      |
| NDOR1          | 4   | 0.98      | 0.98        | 17533    | 2.17    | 5.8E-04   | 2.1E-03     | 73       | 3             | 2.17    | Tier1      |
| CCDC130        | 5   | 1.00      | 1.00        | 17972    | 1.53    | 4.9E-04   | 2.2E-03     | 67       | 5             | 1.53    | Unassigned |
| FAM134C        | 5   | 1.00      | 1.00        | 17973    | 1.34    | 4.9E-04   | 2.2E-03     | 65       | 5             | 1.34    | Tier3      |
| TRAPPC3L       | 3   | 1.00      | 1.00        | 17968    | 1.90    | 7.7E-04   | 2.2E-03     | 85       | 3             | 1.90    | Tier3      |
| ZNF37A         | 5   | 0.14      | 0.27        | 4744     | -0.41   | 4.9E-04   | 2.2E-03     | 66       | 1             | -0.41   | Singleton  |

| Gene ID  | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|----------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| GRAMD3   | 3   | 1.00      | 1.00        | 17965    | 2.79    | 8.1E-04   | 2.4E-03     | 92       | 3             | 2.79    | Tier3      |
| COCH     | 5   | 0.37      | 0.51        | 8918     | 1.40    | 5.5E-04   | 2.5E-03     | 71       | 3             | 1.40    | Tier3      |
| PLAGL2   | 5   | 0.99      | 0.99        | 17829    | 2.39    | 5.4E-04   | 2.5E-03     | 70       | 4             | 2.39    | Tier2      |
| RCN1     | 3   | 1.00      | 1.00        | 17960    | 2.00    | 8.5E-04   | 2.5E-03     | 101      | 3             | 2.00    | Tier3      |
| RDX      | 16  | 0.20      | 0.47        | 5917     | 0.35    | 2.9E-04   | 2.4E-03     | 51       | 6             | 0.35    | Tier3      |
| GP5      | 5   | 0.83      | 0.83        | 14875    | 0.19    | 5.7E-04   | 2.6E-03     | 72       | 2             | 0.19    | Tier2      |
| AK6      | 3   | 0.92      | 0.92        | 16382    | 1.74    | 9.9E-04   | 2.9E-03     | 108      | 2             | 1.74    | Tier3      |
| CCL2     | 5   | 1.00      | 1.00        | 17901    | 1.78    | 6.1E-04   | 2.8E-03     | 76       | 5             | 1.78    | Tier3      |
| CLN3     | 4   | 1.00      | 1.00        | 17966    | 1.49    | 8.0E-04   | 2.9E-03     | 89       | 4             | 1.49    | Unassigned |
| DCX      | 5   | 1.00      | 1.00        | 17970    | 1.81    | 6.3E-04   | 2.8E-03     | 78       | 5             | 1.81    | Tier3      |
| HSPB6    | 4   | 1.00      | 1.00        | 17967    | 1.48    | 7.9E-04   | 2.8E-03     | 88       | 4             | 1.48    | Unassigned |
| PPIL4    | 5   | 0.96      | 0.96        | 17044    | 2.28    | 6.2E-04   | 2.8E-03     | 77       | 3             | 2.28    | Tier2      |
| PRH2     | 5   | 0.97      | 0.97        | 17287    | 2.03    | 5.8E-04   | 2.6E-03     | 74       | 4             | 2.03    | Tier2      |
| TBC1D7   | 4   | 0.26      | 0.38        | 6947     | 2.35    | 8.0E-04   | 2.9E-03     | 90       | 3             | 2.35    | Tier1      |
| XAB2     | 5   | 0.15      | 0.28        | 4995     | 1.70    | 6.1E-04   | 2.7E-03     | 75       | 4             | 1.70    | Tier2      |
| MAPK12   | 4   | 1.00      | 1.00        | 17963    | 1.50    | 8.4E-04   | 3.0E-03     | 96       | 4             | 1.50    | Unassigned |
| RPSA     | 2   | 1.00      | 1.00        | 17942    | 2.62    | 1.5E-03   | 3.0E-03     | 158      | 2             | 2.62    | Tier1      |
| SUN2     | 5   | 0.81      | 0.81        | 14439    | 2.35    | 6.6E-04   | 3.0E-03     | 79       | 4             | 2.35    | Tier2      |
| WFDC1    | 5   | 0.67      | 0.69        | 12143    | 0.17    | 6.7E-04   | 3.0E-03     | 80       | 2             | 0.17    | Tier2      |
| AMBRA1   | 5   | 0.99      | 0.99        | 17813    | 1.68    | 8.6E-04   | 3.8E-03     | 103      | 4             | 1.68    | Tier3      |
| AVPR1A   | 5   | 1.00      | 1.00        | 17964    | 1.48    | 8.4E-04   | 3.8E-03     | 95       | 5             | 1.48    | Tier2      |
| C11orf65 | 4   | 0.80      | 0.80        | 14204    | 2.13    | 1.0E-03   | 3.7E-03     | 115      | 3             | 2.13    | Tier1      |
| C19orf40 | 4   | 0.42      | 0.49        | 9613     | 1.78    | 1.0E-03   | 3.7E-03     | 114      | 2             | 1.78    | Tier2      |
| CNOT6    | 5   | 0.75      | 0.76        | 13405    | 1.80    | 7.4E-04   | 3.3E-03     | 83       | 3             | 1.80    | Tier3      |
| COPS8    | 5   | 1.00      | 1.00        | 17902    | 1.68    | 8.4E-04   | 3.8E-03     | 97       | 5             | 1.68    | Tier3      |
| CYFIP1   | 5   | 0.83      | 0.83        | 14807    | 1.35    | 8.6E-04   | 3.8E-03     | 104      | 3             | 1.35    | Tier2      |
| DCBLD1   | 5   | 0.90      | 0.90        | 16006    | 1.26    | 7.2E-04   | 3.2E-03     | 82       | 3             | 1.26    | Singleton  |
| DNAH6    | 5   | 1.00      | 1.00        | 17961    | 1.47    | 8.5E-04   | 3.8E-03     | 100      | 5             | 1.47    | Unassigned |
| ELMOD2   | 4   | 1.00      | 1.00        | 17956    | 1.78    | 1.1E-03   | 3.8E-03     | 120      | 4             | 1.78    | Tier3      |
| GABRR1   | 5   | 0.38      | 0.52        | 8942     | 2.24    | 8.0E-04   | 3.6E-03     | 91       | 4             | 2.24    | Tier2      |
| LMTK2    | 5   | 1.00      | 1.00        | 17962    | 1.46    | 8.5E-04   | 3.8E-03     | 99       | 5             | 1.46    | Unassigned |
| NDNL2    | 5   | 0.41      | 0.55        | 9572     | -0.05   | 8.3E-04   | 3.7E-03     | 94       | 2             | -0.05   | Tier2      |
| PHKG1    | 5   | 0.78      | 0.78        | 13931    | 1.64    | 8.2E-04   | 3.7E-03     | 93       | 4             | 1.64    | Tier3      |
| TNFRSF14 | 5   | 1.00      | 1.00        | 17913    | 2.24    | 7.6E-04   | 3.4E-03     | 84       | 5             | 2.24    | Tier2      |
| UBQLN4   | 5   | 1.00      | 1.00        | 17897    | 1.63    | 8.5E-04   | 3.8E-03     | 98       | 5             | 1.63    | Tier2      |
| ZNF330   | 5   | 0.94      | 0.94        | 16798    | 2.06    | 8.6E-04   | 3.8E-03     | 102      | 4             | 2.06    | Tier2      |
| ZNF407   | 5   | 0.05      | 0.12        | 2147     | 0.49    | 7.8E-04   | 3.5E-03     | 87       | 2             | 0.49    | Singleton  |
| ZNF572   | 4   | 0.91      | 0.91        | 16178    | 1.86    | 9.3E-04   | 3.3E-03     | 105      | 2             | 1.86    | Tier2      |
| EFR3A    | 4   | 1.00      | 1.00        | 17954    | 1.37    | 1.1E-03   | 4.0E-03     | 124      | 4             | 1.37    | Singleton  |

| Gene ID  | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|----------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| ZNF596   | 3   | 0.19      | 0.29        | 5745     | 0.57    | 1.4E-03   | 4.1E-03     | 148      | 1             | 0.57    | Singleton  |
| BCLAF1   | 3   | 1.00      | 1.00        | 17944    | 1.64    | 1.5E-03   | 4.2E-03     | 154      | 3             | 1.64    | Singleton  |
| MMD      | 5   | 0.98      | 0.98        | 17552    | 1.87    | 9.4E-04   | 4.2E-03     | 106      | 4             | 1.87    | Tier3      |
| NLGN4X   | 5   | 0.71      | 0.72        | 12747    | 0.78    | 9.5E-04   | 4.2E-03     | 107      | 3             | 0.78    | Singleton  |
| BRDT     | 5   | 0.47      | 0.58        | 10052    | 2.00    | 1.0E-03   | 4.6E-03     | 113      | 4             | 2.00    | Tier2      |
| CARS     | 5   | 1.00      | 1.00        | 17957    | 1.18    | 1.1E-03   | 4.7E-03     | 119      | 5             | 1.18    | Tier2      |
| CCDC136  | 5   | 0.83      | 0.83        | 14741    | 0.75    | 1.0E-03   | 4.5E-03     | 112      | 3             | 0.75    | Singleton  |
| CNGA1    | 4   | 1.00      | 1.00        | 17949    | 1.77    | 1.3E-03   | 4.6E-03     | 137      | 4             | 1.77    | Tier3      |
| CNOT3    | 5   | 0.99      | 0.99        | 17835    | 1.71    | 1.1E-03   | 4.7E-03     | 118      | 4             | 1.71    | Tier2      |
| CNST     | 5   | 0.96      | 0.96        | 17161    | 0.88    | 9.9E-04   | 4.4E-03     | 109      | 3             | 0.88    | Tier2      |
| FAM122A  | 5   | 1.00      | 1.00        | 17959    | 1.73    | 1.0E-03   | 4.6E-03     | 116      | 5             | 1.73    | Tier3      |
| GNPNAT1  | 2   | 0.96      | 0.96        | 17174    | 2.81    | 2.2E-03   | 4.4E-03     | 217      | 2             | 2.81    | Singleton  |
| MOXD1    | 5   | 0.88      | 0.88        | 15601    | 1.46    | 1.0E-03   | 4.4E-03     | 110      | 4             | 1.46    | Tier2      |
| NEURL1   | 5   | 1.00      | 1.00        | 17904    | 1.54    | 1.0E-03   | 4.5E-03     | 111      | 5             | 1.54    | Tier3      |
| PITRM1   | 4   | 0.98      | 0.98        | 17623    | 2.27    | 1.3E-03   | 4.5E-03     | 134      | 3             | 2.27    | Tier3      |
| SMC2     | 5   | 1.00      | 1.00        | 17958    | 1.72    | 1.0E-03   | 4.7E-03     | 117      | 5             | 1.72    | Tier2      |
| EXOSC10  | 5   | 0.84      | 0.84        | 14891    | 2.14    | 1.1E-03   | 4.8E-03     | 122      | 4             | 2.14    | Tier2      |
| SCN4B    | 10  | 0.13      | 0.31        | 4498     | 0.32    | 7.7E-04   | 4.9E-03     | 86       | 4             | 0.32    | Tier2      |
| SRPK1    | 5   | 0.92      | 0.92        | 16300    | 2.19    | 1.1E-03   | 4.9E-03     | 123      | 3             | 2.19    | Tier2      |
| TSTD2    | 5   | 0.59      | 0.64        | 11243    | -0.13   | 1.1E-03   | 5.0E-03     | 125      | 2             | -0.13   | Tier2      |
| AIFM1    | 5   | 1.00      | 1.00        | 17952    | 1.26    | 1.2E-03   | 5.4E-03     | 129      | 5             | 1.26    | Singleton  |
| ARHGEF38 | 5   | 0.99      | 0.99        | 17710    | 1.45    | 1.2E-03   | 5.3E-03     | 126      | 4             | 1.45    | Tier3      |
| DHODH    | 5   | 0.16      | 0.30        | 5209     | 0.55    | 1.2E-03   | 5.5E-03     | 130      | 2             | 0.55    | Tier2      |
| DNAJC16  | 4   | 0.81      | 0.81        | 14508    | 0.37    | 1.6E-03   | 5.7E-03     | 165      | 1             | 0.37    | Singleton  |
| KLF11    | 5   | 1.00      | 1.00        | 17951    | 1.14    | 1.3E-03   | 5.6E-03     | 132      | 5             | 1.14    | Unassigned |
| MTIF2    | 4   | 0.38      | 0.47        | 9054     | 1.95    | 1.6E-03   | 5.6E-03     | 161      | 3             | 1.95    | Tier3      |
| PDE4D    | 4   | 0.05      | 0.11        | 2102     | 1.14    | 1.6E-03   | 5.6E-03     | 160      | 2             | 1.14    | Tier2      |
| PICALM   | 4   | 1.00      | 1.00        | 17941    | 1.33    | 1.6E-03   | 5.6E-03     | 162      | 4             | 1.33    | Singleton  |
| PPAN     | 5   | 1.00      | 1.00        | 17953    | 1.17    | 1.2E-03   | 5.3E-03     | 127      | 5             | 1.17    | Tier3      |
| STAG2    | 5   | 0.83      | 0.84        | 14877    | 2.23    | 1.2E-03   | 5.3E-03     | 128      | 3             | 2.23    | Tier2      |
| TARDBP   | 3   | 0.89      | 0.89        | 15773    | 2.68    | 2.0E-03   | 5.7E-03     | 202      | 2             | 2.68    | Tier2      |
| TMC4     | 5   | 1.00      | 1.00        | 17896    | 1.91    | 1.3E-03   | 5.6E-03     | 131      | 5             | 1.91    | Tier3      |
| TMEM168  | 3   | 0.14      | 0.22        | 4626     | 2.10    | 2.0E-03   | 5.6E-03     | 199      | 2             | 2.10    | Tier2      |
| ZNF589   | 5   | 0.94      | 0.94        | 16778    | 1.67    | 1.3E-03   | 5.6E-03     | 133      | 4             | 1.67    | Tier3      |
| AQP3     | 5   | 0.81      | 0.81        | 14489    | 0.44    | 1.3E-03   | 5.8E-03     | 135      | 2             | 0.44    | Singleton  |
| RPS4X    | 3   | 0.99      | 0.99        | 17790    | 1.26    | 2.0E-03   | 5.8E-03     | 205      | 3             | 1.26    | Singleton  |
| TMED8    | 5   | 1.00      | 1.00        | 17950    | 1.01    | 1.3E-03   | 5.8E-03     | 136      | 5             | 1.01    | Tier3      |
| CLC      | 5   | 0.13      | 0.26        | 4483     | 0.97    | 1.4E-03   | 6.0E-03     | 142      | 3             | 0.97    | Tier2      |
| DRAP1    | 5   | 1.00      | 1.00        | 17948    | 1.60    | 1.3E-03   | 6.0E-03     | 140      | 5             | 1.60    | Tier3      |

| Gene ID  | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|----------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| KANSL2   | 5   | 0.15      | 0.28        | 4950     | 0.53    | 1.4E-03   | 6.0E-03     | 143      | 2             | 0.53    | Singleton  |
| NANOGNB  | 4   | 0.90      | 0.90        | 15957    | 0.88    | 1.6E-03   | 5.8E-03     | 170      | 2             | 0.88    | Singleton  |
| SLC25A21 | 5   | 1.00      | 1.00        | 17947    | 1.05    | 1.3E-03   | 6.0E-03     | 141      | 5             | 1.05    | Tier3      |
| TRAPPC8  | 5   | 0.89      | 0.89        | 15794    | 2.21    | 1.3E-03   | 5.9E-03     | 138      | 3             | 2.21    | Tier2      |
| PIK3C2G  | 5   | 0.16      | 0.29        | 5132     | 0.72    | 1.4E-03   | 6.1E-03     | 144      | 3             | 0.72    | Tier2      |
| PGBD1    | 4   | 0.26      | 0.38        | 6916     | 0.07    | 1.7E-03   | 6.2E-03     | 178      | 2             | 0.07    | Singleton  |
| ATCAY    | 5   | 1.00      | 1.00        | 17946    | 1.12    | 1.4E-03   | 6.2E-03     | 146      | 5             | 1.12    | Unassigned |
| MYRF     | 5   | 0.72      | 0.73        | 12818    | 1.65    | 1.5E-03   | 6.5E-03     | 153      | 4             | 1.65    | Tier3      |
| SMARCC1  | 5   | 1.00      | 1.00        | 17945    | 1.19    | 1.5E-03   | 6.5E-03     | 152      | 5             | 1.19    | Unassigned |
| SNRPD3   | 5   | 0.99      | 0.99        | 17782    | 1.79    | 1.5E-03   | 6.4E-03     | 150      | 3             | 1.79    | Tier3      |
| TMEM246  | 5   | 0.81      | 0.81        | 14332    | 1.52    | 1.5E-03   | 6.4E-03     | 151      | 4             | 1.52    | Tier3      |
| AARS2    | 5   | 1.00      | 1.00        | 17943    | 1.37    | 1.5E-03   | 6.7E-03     | 155      | 5             | 1.37    | Tier3      |
| DEFB123  | 3   | 0.37      | 0.41        | 8924     | 2.61    | 2.4E-03   | 6.8E-03     | 230      | 2             | 2.61    | Tier2      |
| EIF4E    | 3   | 1.00      | 1.00        | 17924    | 2.11    | 2.3E-03   | 6.6E-03     | 227      | 3             | 2.11    | Tier2      |
| GRB2     | 5   | 0.09      | 0.20        | 3588     | 0.75    | 1.5E-03   | 6.7E-03     | 157      | 4             | 0.75    | Singleton  |
| RIOK1    | 4   | 0.25      | 0.38        | 6858     | 0.55    | 1.9E-03   | 6.7E-03     | 191      | 2             | 0.55    | Tier3      |
| ZNF675   | 4   | 0.81      | 0.81        | 14326    | 1.92    | 1.9E-03   | 6.7E-03     | 193      | 3             | 1.92    | Tier3      |
| CLRN1    | 7   | 0.92      | 0.92        | 16378    | 1.76    | 1.3E-03   | 6.9E-03     | 139      | 6             | 1.76    | Tier3      |
| CXorf56  | 7   | 0.98      | 0.98        | 17615    | 0.59    | 1.4E-03   | 7.3E-03     | 147      | 3             | 0.59    | Tier2      |
| FASTKD2  | 5   | 1.00      | 1.00        | 17939    | 1.65    | 1.6E-03   | 7.2E-03     | 171      | 5             | 1.65    | Tier3      |
| MRPL32   | 5   | 0.96      | 0.96        | 17055    | 1.69    | 1.6E-03   | 7.2E-03     | 169      | 4             | 1.69    | Tier2      |
| MRPL51   | 5   | 0.77      | 0.77        | 13659    | 2.13    | 1.6E-03   | 7.0E-03     | 163      | 4             | 2.13    | Tier2      |
| MRPS10   | 5   | 0.11      | 0.23        | 4032     | 2.15    | 1.7E-03   | 7.3E-03     | 172      | 3             | 2.15    | Tier2      |
| NR2C1    | 4   | 1.00      | 1.00        | 17930    | 2.31    | 2.0E-03   | 7.0E-03     | 197      | 4             | 2.31    | Tier3      |
| RAB20    | 5   | 0.92      | 0.93        | 16466    | 1.32    | 1.7E-03   | 7.3E-03     | 174      | 3             | 1.32    | Tier2      |
| SF3B14   | 5   | 1.00      | 1.00        | 17937    | 1.49    | 1.7E-03   | 7.3E-03     | 175      | 5             | 1.49    | Tier2      |
| TMEM11   | 5   | 0.73      | 0.74        | 13000    | 1.48    | 1.6E-03   | 7.0E-03     | 164      | 4             | 1.48    | Tier2      |
| U2AF1L4  | 5   | 0.95      | 0.95        | 17016    | 0.48    | 1.6E-03   | 7.1E-03     | 168      | 2             | 0.48    | Tier2      |
| ZNF345   | 3   | 0.32      | 0.37        | 8084     | 0.12    | 2.5E-03   | 7.1E-03     | 236      | 1             | 0.12    | Singleton  |
| ZNF552   | 4   | 0.41      | 0.49        | 9543     | 1.25    | 2.0E-03   | 7.3E-03     | 207      | 2             | 1.25    | Tier2      |
| ABHD13   | 4   | 0.01      | 0.02        | 584      | -0.22   | 2.2E-03   | 7.8E-03     | 215      | 2             | -0.22   | Tier2      |
| C1orf131 | 5   | 0.96      | 0.96        | 17096    | 2.10    | 1.9E-03   | 8.1E-03     | 188      | 3             | 2.10    | Tier2      |
| C5orf15  | 3   | 0.50      | 0.51        | 10327    | -0.19   | 2.9E-03   | 8.1E-03     | 264      | 1             | -0.19   | Singleton  |
| CCDC90B  | 7   | 0.94      | 0.94        | 16790    | 1.52    | 1.4E-03   | 7.4E-03     | 149      | 6             | 1.52    | Tier3      |
| CDC42EP4 | 5   | 0.68      | 0.70        | 12351    | 2.05    | 1.7E-03   | 7.5E-03     | 177      | 4             | 2.05    | Tier2      |
| CFHR4    | 6   | 0.72      | 0.75        | 12812    | 1.48    | 1.6E-03   | 8.0E-03     | 166      | 4             | 1.48    | Tier3      |
| COPS7A   | 5   | 1.00      | 1.00        | 17934    | 1.48    | 1.8E-03   | 7.9E-03     | 183      | 5             | 1.48    | Unassigned |
| CREB5    | 5   | 1.00      | 1.00        | 17933    | 1.20    | 1.8E-03   | 7.9E-03     | 184      | 5             | 1.20    | Singleton  |
| DENND1A  | 5   | 0.17      | 0.31        | 5405     | 1.05    | 1.9E-03   | 8.1E-03     | 190      | 4             | 1.05    | Tier2      |

| Gene ID  | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|----------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| DZIP3    | 5   | 0.06      | 0.14        | 2576     | 1.15    | 1.9E-03   | 8.1E-03     | 189      | 3             | 1.15    | Tier2      |
| ERCC8    | 5   | 1.00      | 1.00        | 17932    | 1.15    | 1.8E-03   | 8.0E-03     | 186      | 5             | 1.15    | Unassigned |
| MYL3     | 5   | 1.00      | 1.00        | 17931    | 1.06    | 1.8E-03   | 8.1E-03     | 187      | 5             | 1.06    | Singleton  |
| NT5M     | 5   | 1.00      | 1.00        | 17935    | 1.04    | 1.8E-03   | 7.8E-03     | 182      | 5             | 1.04    | Unassigned |
| PFN1     | 5   | 0.48      | 0.58        | 10122    | 1.99    | 1.8E-03   | 8.0E-03     | 185      | 3             | 1.99    | Tier3      |
| RAB4A    | 5   | 1.00      | 1.00        | 17936    | 0.98    | 1.7E-03   | 7.5E-03     | 176      | 5             | 0.98    | Unassigned |
| RPUSD4   | 5   | 0.86      | 0.86        | 15260    | 2.04    | 1.8E-03   | 7.6E-03     | 179      | 3             | 2.04    | Tier2      |
| SKAP2    | 1   | 0.99      | 0.99        | 17796    | 3.55    | 7.9E-03   | 7.9E-03     | 583      | 1             | 3.55    | Singleton  |
| SLC7A5   | 5   | 0.49      | 0.59        | 10211    | 1.80    | 1.8E-03   | 7.7E-03     | 181      | 4             | 1.80    | Tier3      |
| VPS36    | 5   | 0.36      | 0.50        | 8693     | 1.42    | 1.8E-03   | 7.7E-03     | 180      | 4             | 1.42    | Singleton  |
| WDR70    | 4   | 0.54      | 0.57        | 10725    | 0.83    | 2.3E-03   | 8.1E-03     | 221      | 3             | 0.83    | Singleton  |
| MYB      | 5   | 0.27      | 0.41        | 7179     | 1.79    | 1.9E-03   | 8.2E-03     | 192      | 3             | 1.79    | Tier3      |
| CDH23    | 10  | 0.94      | 0.94        | 16725    | 1.13    | 1.4E-03   | 8.4E-03     | 145      | 8             | 1.13    | Unassigned |
| TMEM64   | 5   | 0.90      | 0.90        | 15929    | 0.31    | 1.9E-03   | 8.4E-03     | 196      | 2             | 0.31    | Singleton  |
| BRCA2    | 5   | 0.99      | 0.99        | 17777    | 2.05    | 2.1E-03   | 9.0E-03     | 211      | 4             | 2.05    | Tier2      |
| C4BPB    | 4   | 0.81      | 0.81        | 14356    | 2.18    | 2.4E-03   | 8.5E-03     | 229      | 3             | 2.18    | Tier2      |
| CDCA7    | 5   | 1.00      | 1.00        | 17928    | 1.20    | 2.0E-03   | 8.8E-03     | 203      | 5             | 1.20    | Unassigned |
| GEMIN5   | 5   | 1.00      | 1.00        | 17919    | 1.80    | 2.1E-03   | 8.9E-03     | 209      | 5             | 1.80    | Tier3      |
| IFNGR2   | 5   | 0.77      | 0.77        | 13758    | 1.77    | 2.1E-03   | 8.9E-03     | 208      | 4             | 1.77    | Tier2      |
| KLHL41   | 5   | 0.14      | 0.27        | 4782     | 2.08    | 2.1E-03   | 9.0E-03     | 210      | 3             | 2.08    | Tier2      |
| RGPD2    | 1   | 0.99      | 0.99        | 17779    | 3.43    | 8.8E-03   | 8.8E-03     | 631      | 1             | 3.43    | Singleton  |
| TAF2     | 4   | 0.74      | 0.74        | 13115    | 1.88    | 2.4E-03   | 8.6E-03     | 231      | 3             | 1.88    | Tier2      |
| TFIP11   | 5   | 1.00      | 1.00        | 17915    | 2.07    | 2.0E-03   | 8.6E-03     | 201      | 5             | 2.07    | Tier2      |
| TMEM198  | 5   | 0.81      | 0.81        | 14324    | 2.04    | 2.0E-03   | 8.8E-03     | 204      | 3             | 2.04    | Tier2      |
| TUBD1    | 9   | 0.23      | 0.44        | 6387     | 0.28    | 1.5E-03   | 8.9E-03     | 156      | 4             | 0.28    | Tier2      |
| WDR89    | 5   | 0.68      | 0.70        | 12275    | 2.01    | 2.0E-03   | 8.9E-03     | 206      | 3             | 2.01    | Tier2      |
| YARS     | 4   | 0.50      | 0.55        | 10398    | 2.25    | 2.5E-03   | 8.7E-03     | 233      | 3             | 2.25    | Tier3      |
| ATP6AP2  | 4   | 0.94      | 0.94        | 16801    | 1.21    | 2.6E-03   | 9.1E-03     | 239      | 2             | 1.21    | Tier3      |
| RAB14    | 4   | 1.00      | 1.00        | 17878    | 1.72    | 2.6E-03   | 9.2E-03     | 243      | 4             | 1.72    | Tier2      |
| RBFOX1   | 5   | 1.00      | 1.00        | 17927    | 1.34    | 2.1E-03   | 9.3E-03     | 212      | 5             | 1.34    | Tier3      |
| ESAM     | 5   | 0.89      | 0.89        | 15901    | 1.57    | 2.2E-03   | 9.4E-03     | 213      | 4             | 1.57    | Singleton  |
| FBXW8    | 5   | 0.83      | 0.83        | 14709    | 2.04    | 2.2E-03   | 9.4E-03     | 214      | 3             | 2.04    | Tier2      |
| GTPBP4   | 4   | 0.71      | 0.71        | 12718    | 1.97    | 2.7E-03   | 9.5E-03     | 248      | 3             | 1.97    | Tier2      |
| PRAMEF11 | 1   | 0.99      | 0.99        | 17761    | 3.43    | 9.6E-03   | 9.5E-03     | 669      | 1             | 3.43    | Singleton  |
| HMGA2    | 4   | 0.18      | 0.29        | 5545     | 0.49    | 2.8E-03   | 9.7E-03     | 251      | 2             | 0.49    | Singleton  |
| RXRB     | 5   | 0.24      | 0.38        | 6620     | -0.04   | 2.2E-03   | 9.7E-03     | 216      | 2             | -0.04   | Tier2      |
| TRA2B    | 7   | 0.16      | 0.32        | 5083     | 1.03    | 1.9E-03   | 9.6E-03     | 195      | 4             | 1.03    | Tier2      |
| EXOSC6   | 5   | 0.57      | 0.63        | 10978    | 1.51    | 2.3E-03   | 9.8E-03     | 219      | 4             | 1.51    | Unassigned |
| PSMB2    | 5   | 0.98      | 0.98        | 17579    | 2.08    | 2.2E-03   | 9.8E-03     | 218      | 4             | 2.08    | Tier2      |

| Gene ID | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|---------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| ECSIT   | 12  | 0.72      | 0.86        | 12942    | 0.92    | 1.5E-03   | 1.0E-02     | 159      | 9             | 0.92    | Tier3      |
| KAL1    | 4   | 1.00      | 1.00        | 17916    | 1.17    | 2.8E-03   | 9.9E-03     | 261      | 4             | 1.17    | Unassigned |
| LATS1   | 5   | 0.27      | 0.40        | 7099     | -0.38   | 2.3E-03   | 9.9E-03     | 220      | 1             | -0.38   | Singleton  |
| NOP16   | 5   | 0.58      | 0.64        | 11108    | 2.04    | 2.3E-03   | 1.0E-02     | 223      | 4             | 2.04    | Tier2      |
| SNRNP25 | 5   | 0.63      | 0.67        | 11695    | 1.47    | 2.3E-03   | 1.0E-02     | 222      | 4             | 1.47    | Tier2      |
| DNASE1  | 5   | 0.69      | 0.71        | 12417    | 0.33    | 2.3E-03   | 1.0E-02     | 226      | 2             | 0.33    | Tier2      |
| GNB1L   | 5   | 1.00      | 1.00        | 17926    | 1.49    | 2.3E-03   | 1.0E-02     | 224      | 5             | 1.49    | Unassigned |
| TMEM160 | 5   | 1.00      | 1.00        | 17925    | 1.20    | 2.3E-03   | 1.0E-02     | 225      | 5             | 1.20    | Unassigned |
| HMHA1   | 5   | 0.99      | 0.99        | 17747    | 1.62    | 2.4E-03   | 1.0E-02     | 228      | 4             | 1.62    | Tier2      |
| AFAP1L1 | 4   | 0.69      | 0.69        | 12387    | 1.79    | 3.0E-03   | 1.0E-02     | 269      | 3             | 1.79    | Tier3      |
| ARL2BP  | 4   | 1.00      | 1.00        | 17911    | 1.63    | 3.0E-03   | 1.1E-02     | 270      | 4             | 1.63    | Tier2      |
| EXOC6   | 5   | 1.00      | 1.00        | 17923    | 1.10    | 2.4E-03   | 1.1E-02     | 232      | 5             | 1.10    | Unassigned |
| INTS6   | 8   | 0.00      | 0.00        | 27       | -1.75   | 1.9E-03   | 1.1E-02     | 194      | 3             | -1.75   | Tier3      |
| EIF3F   | 4   | 1.00      | 1.00        | 17909    | 1.55    | 3.1E-03   | 1.1E-02     | 274      | 4             | 1.55    | Tier3      |
| GPI     | 5   | 0.97      | 0.98        | 17426    | 1.96    | 2.5E-03   | 1.1E-02     | 234      | 3             | 1.96    | Tier3      |
| CCDC84  | 4   | 0.11      | 0.21        | 4089     | -0.88   | 3.1E-03   | 1.1E-02     | 275      | 1             | -0.88   | Singleton  |
| TAZ     | 5   | 0.31      | 0.45        | 7898     | 1.35    | 2.5E-03   | 1.1E-02     | 235      | 3             | 1.35    | Tier2      |
| VPS33A  | 5   | 1.00      | 1.00        | 17921    | 1.72    | 2.5E-03   | 1.1E-02     | 237      | 5             | 1.72    | Tier3      |
| ALDH1L1 | 5   | 0.92      | 0.92        | 16359    | 0.67    | 2.6E-03   | 1.1E-02     | 240      | 2             | 0.67    | Singleton  |
| MED30   | 5   | 0.28      | 0.41        | 7235     | 1.44    | 2.6E-03   | 1.1E-02     | 241      | 4             | 1.44    | Tier3      |
| STX4    | 4   | 0.08      | 0.16        | 3126     | 0.58    | 3.1E-03   | 1.1E-02     | 281      | 2             | 0.58    | Tier2      |
| ACOT9   | 3   | 0.98      | 0.98        | 17624    | 2.39    | 4.3E-03   | 1.2E-02     | 353      | 3             | 2.39    | Tier2      |
| C5orf51 | 4   | 0.13      | 0.23        | 4568     | 0.57    | 3.4E-03   | 1.2E-02     | 300      | 2             | 0.57    | Singleton  |
| CDX4    | 5   | 0.99      | 0.99        | 17853    | 1.99    | 2.7E-03   | 1.2E-02     | 247      | 4             | 1.99    | Tier3      |
| CNIH3   | 5   | 0.60      | 0.65        | 11274    | 0.10    | 2.6E-03   | 1.1E-02     | 244      | 2             | 0.10    | Singleton  |
| COPG1   | 5   | 0.99      | 0.99        | 17792    | 1.74    | 2.8E-03   | 1.2E-02     | 257      | 4             | 1.74    | Tier3      |
| CXCR3   | 5   | 0.77      | 0.77        | 13630    | 1.96    | 2.8E-03   | 1.2E-02     | 252      | 4             | 1.96    | Tier3      |
| DROSHA  | 5   | 0.98      | 0.98        | 17459    | 1.60    | 2.6E-03   | 1.1E-02     | 242      | 4             | 1.60    | Tier3      |
| GNB5    | 5   | 0.98      | 0.98        | 17441    | 1.52    | 2.8E-03   | 1.2E-02     | 260      | 4             | 1.52    | Tier2      |
| METTL23 | 6   | 0.03      | 0.10        | 1725     | -0.76   | 2.5E-03   | 1.2E-02     | 238      | 1             | -0.76   | Singleton  |
| MORC1   | 5   | 1.00      | 1.00        | 17917    | 1.40    | 2.8E-03   | 1.2E-02     | 259      | 5             | 1.40    | Tier2      |
| NPHP3   | 4   | 0.92      | 0.92        | 16402    | 1.31    | 3.2E-03   | 1.1E-02     | 290      | 3             | 1.31    | Singleton  |
| NUDCD3  | 5   | 1.00      | 1.00        | 17918    | 1.42    | 2.8E-03   | 1.2E-02     | 258      | 5             | 1.42    | Tier2      |
| PDCD4   | 5   | 0.48      | 0.58        | 10144    | -0.13   | 2.7E-03   | 1.2E-02     | 246      | 2             | -0.13   | Tier2      |
| RHOD    | 5   | 1.00      | 1.00        | 17920    | 1.34    | 2.7E-03   | 1.2E-02     | 245      | 5             | 1.34    | Singleton  |
| SET     | 2   | 0.99      | 0.99        | 17839    | 1.99    | 6.2E-03   | 1.2E-02     | 473      | 2             | 1.99    | Tier3      |
| SNX18   | 5   | 0.96      | 0.96        | 17158    | 0.86    | 2.8E-03   | 1.2E-02     | 256      | 3             | 0.86    | Singleton  |
| SURF2   | 5   | 0.61      | 0.65        | 11408    | 0.63    | 2.7E-03   | 1.2E-02     | 250      | 2             | 0.63    | Tier2      |
| UBOX5   | 5   | 0.91      | 0.92        | 16292    | 1.42    | 2.8E-03   | 1.2E-02     | 255      | 4             | 1.42    | Tier3      |

| Gene ID   | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|-----------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| VAV2      | 5   | 0.97      | 0.97        | 17329    | 1.62    | 2.8E-03   | 1.2E-02     | 253      | 4             | 1.62    | Tier3      |
| VPS18     | 5   | 0.88      | 0.88        | 15600    | 1.82    | 2.7E-03   | 1.2E-02     | 249      | 4             | 1.82    | Tier3      |
| CLEC2D    | 11  | 0.05      | 0.15        | 2080     | 0.69    | 2.0E-03   | 1.2E-02     | 198      | 5             | 0.69    | Tier2      |
| ARHGAP39  | 5   | 1.00      | 1.00        | 17912    | 1.21    | 2.9E-03   | 1.3E-02     | 268      | 5             | 1.21    | Unassigned |
| CDKL3     | 5   | 0.85      | 0.85        | 15213    | 0.58    | 2.9E-03   | 1.2E-02     | 263      | 2             | 0.58    | Tier2      |
| DBI       | 6   | 0.93      | 0.93        | 16622    | 1.52    | 2.8E-03   | 1.3E-02     | 254      | 5             | 1.52    | Tier2      |
| LACRT     | 5   | 1.00      | 1.00        | 17914    | 1.17    | 2.9E-03   | 1.3E-02     | 267      | 5             | 1.17    | Unassigned |
| PDSS2     | 4   | 0.56      | 0.59        | 10895    | 1.48    | 3.6E-03   | 1.3E-02     | 307      | 2             | 1.48    | Tier2      |
| PRKCE     | 5   | 0.94      | 0.94        | 16770    | 1.69    | 2.9E-03   | 1.3E-02     | 266      | 3             | 1.69    | Tier3      |
| SEC61B    | 5   | 0.59      | 0.64        | 11231    | 1.94    | 2.9E-03   | 1.2E-02     | 262      | 4             | 1.94    | Tier3      |
| WDR25     | 5   | 0.89      | 0.89        | 15789    | 1.54    | 2.9E-03   | 1.2E-02     | 265      | 4             | 1.54    | Tier2      |
| C16orf13  | 5   | 1.00      | 1.00        | 17906    | 1.14    | 3.2E-03   | 1.4E-02     | 289      | 5             | 1.14    | Unassigned |
| CALY      | 5   | 0.92      | 0.92        | 16462    | 1.39    | 3.2E-03   | 1.4E-02     | 286      | 4             | 1.39    | Unassigned |
| CDADC1    | 4   | 0.43      | 0.50        | 9728     | 1.72    | 3.8E-03   | 1.3E-02     | 317      | 2             | 1.72    | Tier2      |
| CTC1      | 5   | 1.00      | 1.00        | 17910    | 1.24    | 3.1E-03   | 1.3E-02     | 273      | 5             | 1.24    | Unassigned |
| DNASE1L3  | 5   | 0.37      | 0.51        | 8884     | 1.90    | 3.2E-03   | 1.4E-02     | 288      | 3             | 1.90    | Tier3      |
| ETV1      | 5   | 1.00      | 1.00        | 17908    | 1.26    | 3.1E-03   | 1.3E-02     | 279      | 5             | 1.26    | Singleton  |
| FAM213B   | 5   | 1.00      | 1.00        | 17907    | 1.05    | 3.2E-03   | 1.4E-02     | 285      | 5             | 1.05    | Unassigned |
| HIGD1C    | 5   | 0.09      | 0.20        | 3508     | -0.74   | 3.1E-03   | 1.3E-02     | 282      | 2             | -0.74   | Singleton  |
| HIST1H2BG | 5   | 0.78      | 0.78        | 13838    | 1.97    | 3.2E-03   | 1.4E-02     | 291      | 3             | 1.97    | Tier3      |
| KPNA3     | 4   | 1.00      | 1.00        | 17894    | 1.38    | 3.9E-03   | 1.4E-02     | 322      | 4             | 1.38    | Tier3      |
| MAGEA8    | 5   | 0.28      | 0.41        | 7252     | 0.77    | 3.2E-03   | 1.4E-02     | 283      | 3             | 0.77    | Tier2      |
| MAPK8IP3  | 5   | 0.46      | 0.58        | 9976     | 1.82    | 3.1E-03   | 1.3E-02     | 280      | 4             | 1.82    | Tier3      |
| MBD3L3    | 1   | 0.99      | 0.99        | 17659    | 3.13    | 1.4E-02   | 1.4E-02     | 894      | 1             | 3.13    | Singleton  |
| PPIPSK2   | 5   | 0.54      | 0.62        | 10713    | 0.09    | 3.3E-03   | 1.4E-02     | 293      | 2             | 0.09    | Tier2      |
| PSMA7     | 5   | 0.96      | 0.96        | 17182    | 1.41    | 3.2E-03   | 1.4E-02     | 292      | 4             | 1.41    | Singleton  |
| RAB33B    | 5   | 0.72      | 0.73        | 12894    | 0.52    | 3.3E-03   | 1.4E-02     | 295      | 2             | 0.52    | Tier2      |
| RABGGTB   | 5   | 0.20      | 0.34        | 5939     | 2.00    | 3.0E-03   | 1.3E-02     | 272      | 4             | 2.00    | Tier3      |
| SENP1     | 4   | 1.00      | 1.00        | 17895    | 1.48    | 3.9E-03   | 1.3E-02     | 320      | 4             | 1.48    | Unassigned |
| SHFM1     | 2   | 0.95      | 0.95        | 16889    | 2.65    | 6.8E-03   | 1.3E-02     | 510      | 2             | 2.65    | Singleton  |
| SPIC      | 4   | 0.28      | 0.41        | 7357     | 1.84    | 4.0E-03   | 1.4E-02     | 331      | 3             | 1.84    | Tier3      |
| SPICE1    | 5   | 0.15      | 0.28        | 4916     | 0.37    | 3.0E-03   | 1.3E-02     | 271      | 2             | 0.37    | Singleton  |
| STOML2    | 5   | 1.00      | 1.00        | 17905    | 1.35    | 3.3E-03   | 1.4E-02     | 294      | 5             | 1.35    | Tier3      |
| TARS      | 4   | 0.95      | 0.95        | 16906    | 1.63    | 3.7E-03   | 1.3E-02     | 314      | 2             | 1.63    | Tier2      |
| TM4SF20   | 5   | 0.99      | 0.99        | 17687    | 1.35    | 3.1E-03   | 1.3E-02     | 276      | 4             | 1.35    | Singleton  |
| TMEM121   | 5   | 0.88      | 0.88        | 15604    | 1.36    | 3.1E-03   | 1.3E-02     | 278      | 4             | 1.36    | Tier3      |
| TMEM82    | 4   | 0.48      | 0.53        | 10169    | 1.83    | 4.0E-03   | 1.4E-02     | 329      | 3             | 1.83    | Tier2      |
| RPS16     | 4   | 1.00      | 1.00        | 17890    | 1.26    | 4.0E-03   | 1.4E-02     | 333      | 4             | 1.26    | Unassigned |
| RALBP1    | 4   | 0.07      | 0.15        | 2795     | 1.81    | 4.0E-03   | 1.4E-02     | 334      | 3             | 1.81    | Tier3      |

| Gene ID   | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|-----------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| CENPU     | 4   | 0.03      | 0.07        | 1456     | 0.26    | 4.0E-03   | 1.4E-02     | 336      | 2             | 0.26    | Tier2      |
| COX4I1    | 5   | 1.00      | 1.00        | 17898    | 1.53    | 3.4E-03   | 1.4E-02     | 296      | 5             | 1.53    | Singleton  |
| CRIPAK    | 3   | 0.99      | 0.99        | 17864    | 1.36    | 5.2E-03   | 1.4E-02     | 412      | 3             | 1.36    | Unassigned |
| NNMT      | 5   | 0.76      | 0.76        | 13507    | -0.10   | 3.4E-03   | 1.4E-02     | 298      | 2             | -0.10   | Tier2      |
| AUTS2     | 5   | 1.00      | 1.00        | 17900    | 0.81    | 3.5E-03   | 1.5E-02     | 304      | 5             | 0.81    | Unassigned |
| C10orf11  | 4   | 1.00      | 1.00        | 17884    | 1.42    | 4.2E-03   | 1.5E-02     | 349      | 4             | 1.42    | Tier3      |
| C14orf166 | 4   | 1.00      | 1.00        | 17883    | 1.59    | 4.3E-03   | 1.5E-02     | 350      | 4             | 1.59    | Tier2      |
| CCDC178   | 5   | 0.21      | 0.35        | 6107     | 1.99    | 3.5E-03   | 1.5E-02     | 302      | 3             | 1.99    | Tier3      |
| CCDC62    | 4   | 0.32      | 0.44        | 8064     | 0.77    | 4.3E-03   | 1.5E-02     | 351      | 2             | 0.77    | Singleton  |
| DYNC1LI2  | 4   | 0.52      | 0.55        | 10488    | 1.30    | 4.3E-03   | 1.5E-02     | 358      | 2             | 1.30    | Tier2      |
| GEMIN7    | 5   | 0.88      | 0.88        | 15683    | 0.68    | 3.5E-03   | 1.5E-02     | 303      | 2             | 0.68    | Tier2      |
| GPR75     | 5   | 0.10      | 0.22        | 3835     | 1.46    | 3.6E-03   | 1.5E-02     | 306      | 4             | 1.46    | Tier3      |
| MCSR      | 4   | 1.00      | 1.00        | 17886    | 1.31    | 4.2E-03   | 1.5E-02     | 345      | 4             | 1.31    | Unassigned |
| MRPS24    | 5   | 0.94      | 0.94        | 16789    | 1.71    | 3.5E-03   | 1.5E-02     | 301      | 4             | 1.71    | Tier2      |
| PPCS      | 7   | 0.88      | 0.88        | 15589    | 0.99    | 3.1E-03   | 1.5E-02     | 277      | 5             | 0.99    | Tier2      |
| SDSL      | 5   | 0.79      | 0.79        | 13990    | 0.92    | 3.6E-03   | 1.5E-02     | 305      | 4             | 0.92    | Tier2      |
| SPRED1    | 5   | 1.00      | 1.00        | 17903    | 1.33    | 3.4E-03   | 1.5E-02     | 299      | 5             | 1.33    | Unassigned |
| THOC2     | 4   | 0.92      | 0.92        | 16438    | 1.50    | 4.2E-03   | 1.5E-02     | 346      | 3             | 1.50    | Tier3      |
| ZNF83     | 3   | 0.99      | 0.99        | 17750    | 2.26    | 5.4E-03   | 1.5E-02     | 423      | 3             | 2.26    | Tier2      |
| TMPO      | 4   | 1.00      | 1.00        | 17880    | 1.18    | 4.4E-03   | 1.5E-02     | 362      | 4             | 1.18    | Unassigned |
| HTR7      | 5   | 1.00      | 1.00        | 17899    | 1.17    | 3.6E-03   | 1.5E-02     | 309      | 5             | 1.17    | Unassigned |
| PLEKHM1   | 5   | 0.52      | 0.60        | 10509    | 0.46    | 3.6E-03   | 1.5E-02     | 310      | 2             | 0.46    | Tier2      |
| NOL9      | 4   | 0.98      | 0.98        | 17618    | 1.67    | 4.5E-03   | 1.5E-02     | 366      | 3             | 1.67    | Tier2      |
| CRYGC     | 5   | 0.99      | 0.99        | 17837    | 1.03    | 3.7E-03   | 1.6E-02     | 313      | 3             | 1.03    | Tier2      |
| FZD10     | 4   | 0.27      | 0.40        | 7183     | 1.74    | 4.5E-03   | 1.6E-02     | 372      | 3             | 1.74    | Tier3      |
| GABARAPL2 | 5   | 0.87      | 0.87        | 15479    | 1.98    | 3.7E-03   | 1.6E-02     | 311      | 4             | 1.98    | Tier3      |
| GTF2H4    | 4   | 0.96      | 0.96        | 17230    | 2.07    | 4.5E-03   | 1.6E-02     | 368      | 3             | 2.07    | Tier2      |
| PSMB3     | 5   | 0.23      | 0.37        | 6505     | 1.23    | 3.7E-03   | 1.6E-02     | 312      | 3             | 1.23    | Tier2      |
| ZNF207    | 5   | 0.99      | 0.99        | 17669    | 1.33    | 3.7E-03   | 1.6E-02     | 315      | 4             | 1.33    | Singleton  |
| ZNF813    | 4   | 0.98      | 0.98        | 17617    | 1.48    | 4.6E-03   | 1.6E-02     | 373      | 3             | 1.48    | Singleton  |
| ABCC9     | 5   | 1.00      | 1.00        | 17892    | 1.33    | 3.9E-03   | 1.7E-02     | 325      | 5             | 1.33    | Tier3      |
| CACNA1S   | 5   | 1.00      | 1.00        | 17881    | 1.40    | 4.0E-03   | 1.7E-02     | 332      | 4             | 1.40    | Tier3      |
| CDK16     | 5   | 0.06      | 0.14        | 2594     | 1.93    | 3.9E-03   | 1.6E-02     | 321      | 3             | 1.93    | Tier3      |
| CENPE     | 4   | 0.06      | 0.15        | 2693     | 1.73    | 4.7E-03   | 1.6E-02     | 381      | 3             | 1.73    | Tier3      |
| CFHR3     | 4   | 0.99      | 0.99        | 17821    | 2.01    | 4.8E-03   | 1.7E-02     | 386      | 4             | 2.01    | Tier2      |
| CLINT1    | 5   | 0.12      | 0.25        | 4300     | -0.13   | 3.8E-03   | 1.6E-02     | 318      | 2             | -0.13   | Singleton  |
| DCLRE1B   | 5   | 0.85      | 0.85        | 15061    | 1.39    | 3.9E-03   | 1.7E-02     | 326      | 4             | 1.39    | Tier2      |
| HOOK2     | 4   | 1.00      | 1.00        | 17873    | 1.01    | 4.8E-03   | 1.7E-02     | 388      | 4             | 1.01    | Unassigned |
| HYOU1     | 5   | 1.00      | 1.00        | 17891    | 1.40    | 4.0E-03   | 1.7E-02     | 327      | 5             | 1.40    | Unassigned |

| Gene ID   | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|-----------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| KRTAP19-6 | 3   | 0.99      | 0.99        | 17843    | 1.88    | 6.0E-03   | 1.7E-02     | 457      | 3             | 1.88    | Tier3      |
| MOCS2     | 8   | 0.33      | 0.54        | 8241     | 0.51    | 3.2E-03   | 1.6E-02     | 287      | 3             | 0.51    | Tier2      |
| NF1       | 4   | 0.99      | 0.99        | 17741    | 1.98    | 4.6E-03   | 1.6E-02     | 379      | 4             | 1.98    | Tier2      |
| NUP43     | 4   | 0.96      | 0.96        | 17108    | 1.78    | 4.8E-03   | 1.7E-02     | 389      | 3             | 1.78    | Tier3      |
| RAD23B    | 5   | 1.00      | 1.00        | 17893    | 1.00    | 3.9E-03   | 1.6E-02     | 324      | 5             | 1.00    | Singleton  |
| RBM34     | 5   | 0.79      | 0.79        | 14110    | 1.60    | 4.0E-03   | 1.7E-02     | 328      | 3             | 1.60    | Tier3      |
| SEC14L1   | 5   | 0.00      | 0.01        | 196      | -2.53   | 3.9E-03   | 1.6E-02     | 323      | 1             | -2.53   | Singleton  |
| SF3B5     | 5   | 0.98      | 0.99        | 17635    | 1.70    | 3.8E-03   | 1.6E-02     | 319      | 4             | 1.70    | Tier3      |
| TADA2B    | 3   | 0.81      | 0.81        | 14410    | 0.54    | 6.0E-03   | 1.6E-02     | 454      | 1             | 0.54    | Singleton  |
| TPI1      | 9   | 0.98      | 0.98        | 17437    | 1.07    | 3.2E-03   | 1.7E-02     | 284      | 5             | 1.07    | Tier2      |
| VPS45     | 3   | 0.98      | 0.98        | 17589    | 2.23    | 6.1E-03   | 1.7E-02     | 462      | 3             | 2.23    | Tier2      |
| AKR1C1    | 4   | 0.96      | 0.96        | 17143    | 1.47    | 5.5E-03   | 1.9E-02     | 428      | 2             | 1.47    | Tier2      |
| ARPP19    | 5   | 0.68      | 0.70        | 12355    | 1.28    | 4.6E-03   | 1.9E-02     | 378      | 4             | 1.28    | Tier2      |
| C5orf22   | 5   | 0.19      | 0.32        | 5656     | 0.58    | 4.4E-03   | 1.8E-02     | 363      | 2             | 0.58    | Singleton  |
| C9orf43   | 5   | 0.83      | 0.83        | 14716    | 1.69    | 4.6E-03   | 1.9E-02     | 377      | 4             | 1.69    | Tier3      |
| C9orf64   | 5   | 0.97      | 0.97        | 17326    | 0.57    | 4.4E-03   | 1.8E-02     | 360      | 1             | 0.57    | Singleton  |
| CCDC110   | 3   | 0.57      | 0.57        | 10980    | 1.58    | 6.4E-03   | 1.7E-02     | 483      | 2             | 1.58    | Singleton  |
| CCNI      | 5   | 0.00      | 0.01        | 174      | 1.41    | 4.2E-03   | 1.7E-02     | 342      | 4             | 1.41    | Unassigned |
| CHMP4C    | 4   | 0.12      | 0.21        | 4296     | -0.27   | 5.4E-03   | 1.9E-02     | 418      | 2             | -0.27   | Singleton  |
| CPNE4     | 4   | 0.47      | 0.52        | 10016    | 1.67    | 5.5E-03   | 1.9E-02     | 429      | 3             | 1.67    | Tier3      |
| CPSF7     | 5   | 0.82      | 0.82        | 14534    | 1.65    | 4.7E-03   | 1.9E-02     | 382      | 3             | 1.65    | Tier3      |
| DNMT3A    | 10  | 0.13      | 0.31        | 4494     | 1.27    | 3.4E-03   | 1.9E-02     | 297      | 6             | 1.27    | Tier3      |
| ENTPD8    | 5   | 0.26      | 0.40        | 7043     | 1.36    | 4.3E-03   | 1.8E-02     | 359      | 4             | 1.36    | Unassigned |
| ERCC1     | 5   | 0.89      | 0.89        | 15786    | 1.15    | 4.2E-03   | 1.8E-02     | 348      | 4             | 1.15    | Singleton  |
| FKBPL     | 5   | 0.85      | 0.85        | 15066    | 1.14    | 4.6E-03   | 1.9E-02     | 375      | 4             | 1.14    | Tier2      |
| GPR65     | 5   | 0.72      | 0.73        | 12932    | 1.84    | 4.3E-03   | 1.8E-02     | 357      | 3             | 1.84    | Tier3      |
| IBA57     | 5   | 0.90      | 0.90        | 15972    | 1.86    | 4.4E-03   | 1.8E-02     | 364      | 4             | 1.86    | Tier3      |
| ITGAM     | 5   | 0.24      | 0.37        | 6563     | 0.21    | 4.6E-03   | 1.9E-02     | 374      | 2             | 0.21    | Tier2      |
| KIF16B    | 5   | 1.00      | 1.00        | 17889    | 1.23    | 4.0E-03   | 1.7E-02     | 335      | 5             | 1.23    | Singleton  |
| NAA25     | 4   | 0.99      | 0.99        | 17691    | 1.62    | 5.1E-03   | 1.8E-02     | 409      | 4             | 1.62    | Singleton  |
| NDUFA1    | 4   | 0.23      | 0.35        | 6517     | 0.92    | 5.0E-03   | 1.7E-02     | 396      | 2             | 0.92    | Tier2      |
| PAGE4     | 4   | 0.38      | 0.47        | 8947     | 0.40    | 5.5E-03   | 1.9E-02     | 430      | 2             | 0.40    | Singleton  |
| PARD6B    | 3   | 0.21      | 0.30        | 6030     | 1.24    | 6.8E-03   | 1.9E-02     | 512      | 2             | 1.24    | Singleton  |
| PEX11A    | 5   | 0.38      | 0.52        | 8987     | 1.91    | 4.3E-03   | 1.8E-02     | 354      | 3             | 1.91    | Tier3      |
| PGK2      | 5   | 0.02      | 0.06        | 1108     | -0.67   | 4.1E-03   | 1.7E-02     | 340      | 1             | -0.67   | Singleton  |
| PIGC      | 4   | 0.27      | 0.39        | 7105     | 0.94    | 5.4E-03   | 1.9E-02     | 425      | 2             | 0.94    | Tier2      |
| PIM1      | 5   | 0.99      | 0.99        | 17767    | 1.85    | 4.6E-03   | 1.9E-02     | 380      | 4             | 1.85    | Tier3      |
| PLG       | 8   | 0.66      | 0.78        | 12012    | 1.31    | 3.7E-03   | 1.9E-02     | 316      | 5             | 1.31    | Tier3      |
| POLE2     | 3   | 0.99      | 0.99        | 17831    | 1.98    | 6.4E-03   | 1.8E-02     | 489      | 3             | 1.98    | Tier3      |

| Gene ID  | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|----------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| POLR3A   | 5   | 0.87      | 0.87        | 15501    | 1.87    | 4.5E-03   | 1.9E-02     | 371      | 4             | 1.87    | Tier3      |
| PRKRIP1  | 5   | 1.00      | 1.00        | 17885    | 1.42    | 4.2E-03   | 1.8E-02     | 347      | 5             | 1.42    | Tier3      |
| PSMA2    | 5   | 0.11      | 0.23        | 3992     | 0.01    | 4.5E-03   | 1.9E-02     | 367      | 2             | 0.01    | Singleton  |
| PUS3     | 4   | 0.99      | 0.99        | 17868    | 1.46    | 5.1E-03   | 1.8E-02     | 404      | 4             | 1.46    | Unassigned |
| RAB2B    | 5   | 0.45      | 0.57        | 9898     | 1.32    | 4.1E-03   | 1.7E-02     | 341      | 4             | 1.32    | Tier2      |
| RASSF3   | 5   | 0.08      | 0.18        | 3206     | -0.20   | 4.4E-03   | 1.8E-02     | 365      | 2             | -0.20   | Tier2      |
| RBM17    | 4   | 0.81      | 0.81        | 14449    | 1.56    | 5.6E-03   | 1.9E-02     | 433      | 3             | 1.56    | Tier2      |
| RD3      | 5   | 0.91      | 0.91        | 16264    | 1.35    | 4.4E-03   | 1.8E-02     | 361      | 4             | 1.35    | Tier2      |
| RHOG     | 5   | 0.19      | 0.32        | 5701     | 0.95    | 4.5E-03   | 1.9E-02     | 369      | 3             | 0.95    | Tier3      |
| RIOK2    | 4   | 0.90      | 0.90        | 15944    | 2.00    | 5.6E-03   | 1.9E-02     | 437      | 3             | 2.00    | Tier2      |
| ROBO2    | 5   | 1.00      | 1.00        | 17887    | 1.22    | 4.1E-03   | 1.7E-02     | 339      | 5             | 1.22    | Singleton  |
| SLC41A1  | 5   | 0.22      | 0.36        | 6314     | 1.30    | 4.3E-03   | 1.8E-02     | 355      | 4             | 1.30    | Unassigned |
| SPCS2    | 4   | 0.38      | 0.47        | 9006     | 1.26    | 5.2E-03   | 1.8E-02     | 411      | 2             | 1.26    | Tier2      |
| SPRTN    | 5   | 0.90      | 0.90        | 15964    | 1.89    | 4.1E-03   | 1.7E-02     | 338      | 4             | 1.89    | Tier3      |
| TBCD     | 5   | 0.96      | 0.96        | 17224    | 1.83    | 4.5E-03   | 1.9E-02     | 370      | 3             | 1.83    | Tier3      |
| TCTN3    | 4   | 0.97      | 0.97        | 17294    | 1.60    | 5.1E-03   | 1.8E-02     | 408      | 3             | 1.60    | Tier2      |
| TGM1     | 4   | 1.00      | 1.00        | 17871    | 1.50    | 4.9E-03   | 1.7E-02     | 393      | 4             | 1.50    | Singleton  |
| THAP11   | 5   | 0.92      | 0.92        | 16338    | 1.53    | 4.6E-03   | 1.9E-02     | 376      | 4             | 1.53    | Unassigned |
| TM6SF1   | 5   | 0.68      | 0.70        | 12341    | -0.04   | 4.1E-03   | 1.7E-02     | 337      | 2             | -0.04   | Singleton  |
| TMPRSS15 | 4   | 0.12      | 0.22        | 4307     | 1.92    | 5.3E-03   | 1.8E-02     | 416      | 3             | 1.92    | Tier2      |
| UBFD1    | 5   | 0.83      | 0.84        | 14878    | 0.93    | 4.2E-03   | 1.8E-02     | 344      | 3             | 0.93    | Tier2      |
| USP9Y    | 4   | 0.99      | 0.99        | 17859    | 1.07    | 5.5E-03   | 1.9E-02     | 426      | 4             | 1.07    | Unassigned |
| ARID2    | 5   | 0.28      | 0.41        | 7228     | 1.47    | 4.7E-03   | 1.9E-02     | 384      | 3             | 1.47    | Tier2      |
| DEPDC5   | 5   | 0.99      | 0.99        | 17783    | 1.34    | 4.7E-03   | 1.9E-02     | 383      | 4             | 1.34    | Tier2      |
| PACRGL   | 7   | 0.07      | 0.19        | 2962     | -0.58   | 4.2E-03   | 1.9E-02     | 343      | 1             | -0.58   | Singleton  |
| SMURF2   | 4   | 0.99      | 0.99        | 17851    | 1.16    | 5.7E-03   | 1.9E-02     | 442      | 4             | 1.16    | Singleton  |
| CHRM3    | 5   | 0.84      | 0.84        | 15013    | 0.49    | 4.8E-03   | 1.9E-02     | 385      | 2             | 0.49    | Singleton  |
| NCAPD3   | 5   | 0.13      | 0.26        | 4563     | 1.83    | 4.8E-03   | 2.0E-02     | 387      | 3             | 1.83    | Tier3      |
| SLK      | 5   | 0.97      | 0.97        | 17311    | 1.32    | 4.8E-03   | 2.0E-02     | 390      | 4             | 1.32    | Unassigned |
| TEN1     | 5   | 0.99      | 0.99        | 17744    | 1.82    | 4.9E-03   | 2.0E-02     | 391      | 4             | 1.82    | Tier3      |
| MMP16    | 5   | 0.00      | 0.01        | 261      | -1.42   | 4.9E-03   | 2.0E-02     | 392      | 1             | -1.42   | Singleton  |
| C10orf12 | 4   | 0.93      | 0.93        | 16579    | 1.72    | 6.0E-03   | 2.0E-02     | 452      | 3             | 1.72    | Tier3      |
| CDKAL1   | 5   | 0.71      | 0.72        | 12759    | 0.79    | 4.9E-03   | 2.0E-02     | 394      | 3             | 0.79    | Singleton  |
| GLB1L3   | 5   | 0.37      | 0.51        | 8805     | 0.66    | 5.0E-03   | 2.0E-02     | 399      | 2             | 0.66    | Singleton  |
| GZMB     | 5   | 0.14      | 0.27        | 4771     | 1.82    | 5.1E-03   | 2.0E-02     | 402      | 3             | 1.82    | Tier3      |
| IQCH     | 9   | 0.27      | 0.49        | 7191     | 0.87    | 4.0E-03   | 2.1E-02     | 330      | 7             | 0.87    | Tier3      |
| LRRRC49  | 5   | 0.24      | 0.38        | 6661     | 1.40    | 5.1E-03   | 2.1E-02     | 405      | 4             | 1.40    | Singleton  |
| MBL2     | 5   | 0.02      | 0.06        | 1156     | -0.91   | 5.1E-03   | 2.0E-02     | 401      | 1             | -0.91   | Unassigned |
| MCM6     | 5   | 0.98      | 0.98        | 17614    | 1.67    | 4.9E-03   | 2.0E-02     | 395      | 4             | 1.67    | Tier3      |

| Gene ID  | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|----------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| PSMD2    | 5   | 0.08      | 0.18        | 3282     | 1.42    | 5.0E-03   | 2.0E-02     | 398      | 4             | 1.42    | Unassigned |
| PTPN6    | 5   | 0.35      | 0.49        | 8590     | 1.34    | 5.1E-03   | 2.0E-02     | 403      | 4             | 1.34    | Tier3      |
| PUSL1    | 5   | 0.22      | 0.35        | 6227     | 0.25    | 5.1E-03   | 2.1E-02     | 407      | 2             | 0.25    | Singleton  |
| RBM6     | 5   | 0.01      | 0.02        | 399      | 1.17    | 5.0E-03   | 2.0E-02     | 397      | 3             | 1.17    | Unassigned |
| RPS6KA6  | 3   | 0.74      | 0.74        | 13111    | 2.22    | 7.5E-03   | 2.0E-02     | 552      | 2             | 2.22    | Tier2      |
| ABL1     | 5   | 0.64      | 0.68        | 11823    | 0.29    | 6.1E-03   | 2.4E-02     | 464      | 2             | 0.29    | Singleton  |
| AICDA    | 5   | 0.77      | 0.77        | 13669    | 0.62    | 7.1E-03   | 2.7E-02     | 527      | 2             | 0.62    | Tier2      |
| ALDH1A2  | 5   | 0.98      | 0.98        | 17522    | 0.71    | 7.2E-03   | 2.7E-02     | 531      | 3             | 0.71    | Tier2      |
| ANAPC11  | 9   | 0.40      | 0.62        | 9407     | 0.92    | 4.3E-03   | 2.2E-02     | 352      | 5             | 0.92    | Tier2      |
| ATP6AP1  | 5   | 0.89      | 0.89        | 15874    | 1.50    | 6.3E-03   | 2.4E-02     | 481      | 3             | 1.50    | Singleton  |
| BOLA3    | 6   | 0.05      | 0.14        | 2295     | 0.01    | 5.6E-03   | 2.3E-02     | 435      | 2             | 0.01    | Singleton  |
| C11orf52 | 4   | 0.72      | 0.72        | 12817    | 0.06    | 7.7E-03   | 2.6E-02     | 570      | 1             | 0.06    | Singleton  |
| C12orf5  | 5   | 0.67      | 0.69        | 12161    | 1.76    | 5.8E-03   | 2.3E-02     | 448      | 3             | 1.76    | Tier3      |
| C16orf59 | 5   | 0.27      | 0.40        | 7107     | 0.31    | 5.2E-03   | 2.1E-02     | 414      | 2             | 0.31    | Singleton  |
| C1QTNF6  | 5   | 0.99      | 0.99        | 17771    | 1.32    | 6.2E-03   | 2.4E-02     | 469      | 4             | 1.32    | Unassigned |
| C4orf26  | 4   | 0.61      | 0.62        | 11447    | 1.66    | 6.5E-03   | 2.2E-02     | 491      | 3             | 1.66    | Singleton  |
| C5orf63  | 5   | 0.29      | 0.43        | 7580     | 0.18    | 5.6E-03   | 2.2E-02     | 440      | 2             | 0.18    | Singleton  |
| C6orf163 | 4   | 0.55      | 0.58        | 10797    | 0.96    | 7.2E-03   | 2.5E-02     | 535      | 2             | 0.96    | Tier3      |
| C6orf201 | 5   | 0.13      | 0.26        | 4519     | 0.30    | 5.7E-03   | 2.3E-02     | 445      | 2             | 0.30    | Tier2      |
| C6orf62  | 5   | 0.01      | 0.04        | 769      | -1.48   | 7.2E-03   | 2.7E-02     | 530      | 2             | -1.48   | Tier2      |
| CAPG     | 5   | 0.99      | 0.99        | 17763    | 1.52    | 5.6E-03   | 2.2E-02     | 439      | 4             | 1.52    | Singleton  |
| CBFA2T2  | 5   | 0.99      | 0.99        | 17705    | 1.68    | 6.0E-03   | 2.3E-02     | 458      | 4             | 1.68    | Tier3      |
| CCT8     | 5   | 0.99      | 0.99        | 17671    | 0.52    | 6.9E-03   | 2.6E-02     | 514      | 2             | 0.52    | Tier2      |
| CD164    | 5   | 0.89      | 0.89        | 15747    | 1.40    | 5.4E-03   | 2.1E-02     | 421      | 4             | 1.40    | Unassigned |
| CDH15    | 4   | 0.99      | 0.99        | 17826    | 1.52    | 6.6E-03   | 2.2E-02     | 497      | 4             | 1.52    | Singleton  |
| CDS2     | 5   | 0.17      | 0.30        | 5356     | 0.00    | 6.5E-03   | 2.5E-02     | 492      | 2             | 0.00    | Tier2      |
| CEACAM19 | 5   | 0.99      | 0.99        | 17820    | 1.34    | 6.9E-03   | 2.6E-02     | 516      | 4             | 1.34    | Tier3      |
| CIRH1A   | 5   | 0.04      | 0.11        | 2044     | 1.45    | 5.8E-03   | 2.3E-02     | 446      | 4             | 1.45    | Tier2      |
| COG2     | 4   | 0.20      | 0.32        | 5946     | 1.94    | 7.1E-03   | 2.4E-02     | 528      | 3             | 1.94    | Tier2      |
| CYP4A11  | 3   | 0.91      | 0.91        | 16285    | 2.14    | 9.5E-03   | 2.5E-02     | 662      | 2             | 2.14    | Tier2      |
| DCDC1    | 4   | 0.99      | 0.99        | 17824    | 1.37    | 6.7E-03   | 2.3E-02     | 501      | 4             | 1.37    | Unassigned |
| DCLRE1C  | 5   | 0.08      | 0.18        | 3185     | 0.04    | 6.8E-03   | 2.6E-02     | 509      | 2             | 0.04    | Tier2      |
| DDX23    | 5   | 0.31      | 0.44        | 7778     | 1.80    | 6.7E-03   | 2.5E-02     | 503      | 3             | 1.80    | Tier3      |
| DHRS12   | 5   | 0.99      | 0.99        | 17686    | 1.39    | 6.4E-03   | 2.4E-02     | 487      | 4             | 1.39    | Tier2      |
| DPH6     | 6   | 0.58      | 0.68        | 11113    | 1.60    | 6.0E-03   | 2.5E-02     | 455      | 4             | 1.60    | Tier3      |
| DYNC1H1  | 5   | 0.66      | 0.68        | 11997    | 1.13    | 6.8E-03   | 2.6E-02     | 506      | 3             | 1.13    | Tier2      |
| ECHDC1   | 13  | 0.15      | 0.38        | 5017     | 1.30    | 3.6E-03   | 2.2E-02     | 308      | 8             | 1.30    | Tier2      |
| EEF1E1   | 4   | 0.99      | 0.99        | 17788    | 1.66    | 7.7E-03   | 2.6E-02     | 571      | 4             | 1.66    | Tier3      |
| EMC2     | 4   | 0.99      | 0.99        | 17808    | 1.50    | 7.4E-03   | 2.5E-02     | 547      | 4             | 1.50    | Unassigned |

| Gene ID   | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|-----------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| ENTPD7    | 5   | 0.98      | 0.98        | 17583    | 1.82    | 7.0E-03   | 2.6E-02     | 521      | 4             | 1.82    | Tier3      |
| EXOC5     | 5   | 0.19      | 0.32        | 5720     | 0.83    | 7.1E-03   | 2.7E-02     | 526      | 4             | 0.83    | Singleton  |
| FABP4     | 5   | 0.96      | 0.96        | 17212    | 1.76    | 5.5E-03   | 2.2E-02     | 431      | 4             | 1.76    | Tier2      |
| FANCC     | 4   | 0.96      | 0.96        | 17099    | 1.93    | 7.6E-03   | 2.6E-02     | 560      | 3             | 1.93    | Tier2      |
| GAPDH     | 5   | 0.99      | 0.99        | 17685    | 0.69    | 6.9E-03   | 2.6E-02     | 515      | 2             | 0.69    | Tier2      |
| GPR116    | 5   | 0.19      | 0.33        | 5778     | 0.81    | 6.2E-03   | 2.4E-02     | 468      | 3             | 0.81    | Tier2      |
| GPX2      | 5   | 0.99      | 0.99        | 17799    | 1.51    | 5.6E-03   | 2.2E-02     | 436      | 4             | 1.51    | Unassigned |
| JOSD1     | 5   | 0.98      | 0.98        | 17516    | 1.79    | 6.6E-03   | 2.5E-02     | 500      | 4             | 1.79    | Tier3      |
| KEAP1     | 5   | 0.99      | 0.99        | 17828    | 1.46    | 6.4E-03   | 2.4E-02     | 486      | 4             | 1.46    | Tier3      |
| KLC4      | 5   | 0.65      | 0.68        | 11955    | 0.99    | 5.9E-03   | 2.3E-02     | 449      | 3             | 0.99    | Tier2      |
| KLRF2     | 3   | 0.06      | 0.11        | 2416     | -1.37   | 9.4E-03   | 2.5E-02     | 659      | 1             | -1.37   | Singleton  |
| KRTAP19-8 | 3   | 0.80      | 0.80        | 14284    | 0.57    | 8.7E-03   | 2.4E-02     | 625      | 1             | 0.57    | Singleton  |
| KRTAP9-6  | 2   | 0.10      | 0.15        | 3763     | 0.48    | 1.4E-02   | 2.7E-02     | 901      | 1             | 0.48    | Singleton  |
| LMNB1     | 5   | 0.87      | 0.87        | 15470    | 1.15    | 7.1E-03   | 2.6E-02     | 524      | 4             | 1.15    | Tier2      |
| LONP2     | 5   | 0.90      | 0.90        | 15962    | 0.83    | 5.7E-03   | 2.2E-02     | 441      | 3             | 0.83    | Tier2      |
| LRSAM1    | 5   | 0.74      | 0.74        | 13169    | 1.61    | 6.0E-03   | 2.3E-02     | 453      | 4             | 1.61    | Tier3      |
| LYRM4     | 4   | 0.99      | 0.99        | 17801    | 1.61    | 7.7E-03   | 2.6E-02     | 572      | 4             | 1.61    | Tier3      |
| MATN3     | 5   | 0.72      | 0.73        | 12832    | 0.72    | 7.2E-03   | 2.7E-02     | 532      | 3             | 0.72    | Tier2      |
| MMP9      | 5   | 0.93      | 0.93        | 16485    | 1.75    | 6.8E-03   | 2.6E-02     | 505      | 3             | 1.75    | Tier3      |
| MRAS      | 8   | 0.21      | 0.40        | 6025     | 1.33    | 4.3E-03   | 2.1E-02     | 356      | 6             | 1.33    | Tier2      |
| MRPS31    | 4   | 0.06      | 0.13        | 2447     | 1.65    | 6.8E-03   | 2.3E-02     | 511      | 3             | 1.65    | Tier3      |
| MTMR11    | 5   | 0.36      | 0.50        | 8637     | 1.69    | 7.0E-03   | 2.6E-02     | 518      | 3             | 1.69    | Tier3      |
| MTPN      | 5   | 0.65      | 0.68        | 11849    | 1.78    | 5.6E-03   | 2.2E-02     | 438      | 4             | 1.78    | Tier3      |
| NDRG3     | 4   | 0.92      | 0.92        | 16403    | 1.64    | 8.0E-03   | 2.7E-02     | 584      | 3             | 1.64    | Tier2      |
| NFKB2     | 5   | 0.52      | 0.60        | 10532    | 1.28    | 5.4E-03   | 2.1E-02     | 420      | 4             | 1.28    | Unassigned |
| NIPA2     | 4   | 0.11      | 0.21        | 4104     | -0.57   | 6.5E-03   | 2.2E-02     | 495      | 1             | -0.57   | Singleton  |
| NIPAL4    | 5   | 0.96      | 0.96        | 17190    | 1.57    | 5.5E-03   | 2.2E-02     | 427      | 3             | 1.57    | Tier2      |
| NOP56     | 5   | 0.17      | 0.30        | 5354     | 1.84    | 5.6E-03   | 2.2E-02     | 434      | 4             | 1.84    | Tier3      |
| NRSN2     | 5   | 0.99      | 0.99        | 17651    | 1.73    | 6.8E-03   | 2.6E-02     | 513      | 3             | 1.73    | Tier3      |
| OSBPL10   | 5   | 0.48      | 0.58        | 10124    | 1.22    | 5.9E-03   | 2.3E-02     | 450      | 3             | 1.22    | Singleton  |
| PLCXD2    | 4   | 0.76      | 0.76        | 13490    | 1.68    | 6.2E-03   | 2.1E-02     | 472      | 3             | 1.68    | Tier3      |
| PPAT      | 5   | 0.84      | 0.84        | 14984    | 0.97    | 6.0E-03   | 2.3E-02     | 456      | 3             | 0.97    | Tier2      |
| PPIA      | 1   | 0.98      | 0.98        | 17514    | 2.83    | 2.1E-02   | 2.1E-02     | 1252     | 1             | 2.83    | Singleton  |
| PPP1R12A  | 4   | 0.99      | 0.99        | 17809    | 1.57    | 7.4E-03   | 2.5E-02     | 546      | 4             | 1.57    | Tier2      |
| PSMA6     | 4   | 0.96      | 0.96        | 17125    | 1.75    | 7.9E-03   | 2.7E-02     | 579      | 3             | 1.75    | Tier2      |
| PTGES2    | 5   | 0.62      | 0.66        | 11567    | 1.26    | 5.8E-03   | 2.3E-02     | 447      | 3             | 1.26    | Singleton  |
| RACGAP1   | 5   | 0.37      | 0.51        | 8846     | 1.69    | 6.2E-03   | 2.4E-02     | 470      | 3             | 1.69    | Singleton  |
| RAD51     | 5   | 0.37      | 0.51        | 8903     | 1.35    | 5.4E-03   | 2.1E-02     | 422      | 3             | 1.35    | Tier2      |
| RAD51B    | 4   | 0.97      | 0.97        | 17352    | 1.56    | 7.4E-03   | 2.5E-02     | 545      | 3             | 1.56    | Unassigned |

| Gene ID  | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|----------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| RASSF6   | 4   | 0.98      | 0.98        | 17463    | 1.52    | 6.5E-03   | 2.2E-02     | 496      | 2             | 1.52    | Tier2      |
| RNASEH2B | 4   | 0.89      | 0.89        | 15828    | 1.49    | 7.9E-03   | 2.7E-02     | 581      | 2             | 1.49    | Tier2      |
| RNF111   | 5   | 0.94      | 0.94        | 16759    | 1.42    | 5.4E-03   | 2.1E-02     | 417      | 4             | 1.42    | Tier2      |
| RNF4     | 5   | 0.95      | 0.95        | 16930    | 1.28    | 6.3E-03   | 2.4E-02     | 478      | 4             | 1.28    | Tier2      |
| RNF8     | 5   | 0.88      | 0.88        | 15716    | 0.80    | 6.3E-03   | 2.4E-02     | 479      | 3             | 0.80    | Tier2      |
| RPL14    | 5   | 0.87      | 0.87        | 15496    | 1.25    | 7.0E-03   | 2.6E-02     | 520      | 4             | 1.25    | Singleton  |
| RPL3L    | 5   | 0.95      | 0.95        | 17035    | 0.51    | 6.4E-03   | 2.4E-02     | 485      | 2             | 0.51    | Singleton  |
| RPL4     | 2   | 0.99      | 0.99        | 17704    | 1.78    | 1.2E-02   | 2.3E-02     | 795      | 2             | 1.78    | Unassigned |
| RPS27L   | 4   | 0.40      | 0.48        | 9349     | 1.98    | 6.4E-03   | 2.2E-02     | 488      | 3             | 1.98    | Tier2      |
| RRP1     | 4   | 0.86      | 0.86        | 15272    | 1.39    | 7.0E-03   | 2.4E-02     | 519      | 2             | 1.39    | Tier2      |
| SCYL1    | 5   | 0.24      | 0.38        | 6684     | 1.27    | 5.7E-03   | 2.2E-02     | 443      | 4             | 1.27    | Unassigned |
| SERP2    | 4   | 0.05      | 0.12        | 2266     | -0.09   | 6.2E-03   | 2.1E-02     | 466      | 2             | -0.09   | Singleton  |
| SESTD1   | 5   | 0.70      | 0.71        | 12502    | 0.36    | 6.3E-03   | 2.4E-02     | 477      | 2             | 0.36    | Tier2      |
| SETD2    | 5   | 0.06      | 0.14        | 2557     | -0.43   | 7.1E-03   | 2.6E-02     | 525      | 1             | -0.43   | Singleton  |
| SH3BGRL  | 5   | 0.97      | 0.97        | 17416    | 1.89    | 5.2E-03   | 2.1E-02     | 413      | 3             | 1.89    | Tier3      |
| SH3GL1   | 6   | 0.99      | 0.99        | 17641    | 1.27    | 5.0E-03   | 2.1E-02     | 400      | 5             | 1.27    | Singleton  |
| SHOX     | 5   | 0.08      | 0.18        | 3196     | -0.80   | 6.3E-03   | 2.4E-02     | 476      | 2             | -0.80   | Singleton  |
| SLC25A29 | 5   | 0.99      | 0.99        | 17785    | 1.32    | 6.3E-03   | 2.4E-02     | 475      | 4             | 1.32    | Singleton  |
| SLC35G2  | 4   | 0.99      | 0.99        | 17814    | 1.29    | 7.0E-03   | 2.4E-02     | 522      | 4             | 1.29    | Singleton  |
| SLC52A3  | 5   | 0.19      | 0.32        | 5627     | 0.48    | 6.1E-03   | 2.4E-02     | 461      | 2             | 0.48    | Tier2      |
| SLMO2    | 4   | 0.99      | 0.99        | 17728    | 1.05    | 7.5E-03   | 2.5E-02     | 558      | 4             | 1.05    | Singleton  |
| SNRPA    | 5   | 0.94      | 0.94        | 16760    | 1.20    | 7.1E-03   | 2.6E-02     | 523      | 4             | 1.20    | Singleton  |
| SNX31    | 4   | 0.99      | 0.99        | 17797    | 1.06    | 7.9E-03   | 2.7E-02     | 577      | 4             | 1.06    | Singleton  |
| SRRM1    | 5   | 0.05      | 0.11        | 2117     | 1.30    | 7.2E-03   | 2.7E-02     | 534      | 4             | 1.30    | Singleton  |
| SSR4     | 5   | 0.40      | 0.54        | 9293     | 1.21    | 6.4E-03   | 2.4E-02     | 484      | 4             | 1.21    | Unassigned |
| ST3GAL4  | 5   | 0.65      | 0.68        | 11948    | 1.60    | 6.5E-03   | 2.5E-02     | 494      | 4             | 1.60    | Singleton  |
| SULT1C4  | 5   | 0.10      | 0.22        | 3817     | 1.78    | 6.2E-03   | 2.4E-02     | 465      | 3             | 1.78    | Tier3      |
| TAAR6    | 5   | 0.14      | 0.27        | 4725     | 0.96    | 6.1E-03   | 2.3E-02     | 460      | 3             | 0.96    | Tier3      |
| TAF3     | 4   | 0.82      | 0.82        | 14548    | 1.56    | 6.7E-03   | 2.3E-02     | 504      | 3             | 1.56    | Singleton  |
| TIA1     | 5   | 0.80      | 0.80        | 14254    | 1.41    | 5.4E-03   | 2.1E-02     | 419      | 4             | 1.41    | Singleton  |
| TIPIN    | 5   | 0.07      | 0.16        | 2946     | 1.62    | 6.1E-03   | 2.4E-02     | 463      | 4             | 1.62    | Tier2      |
| TMEM249  | 4   | 0.96      | 0.96        | 17235    | 1.83    | 6.3E-03   | 2.2E-02     | 480      | 3             | 1.83    | Tier2      |
| TMIGD2   | 5   | 0.84      | 0.84        | 14917    | 1.47    | 5.9E-03   | 2.3E-02     | 451      | 4             | 1.47    | Tier3      |
| TMOD2    | 5   | 0.74      | 0.75        | 13259    | 1.33    | 5.5E-03   | 2.2E-02     | 432      | 4             | 1.33    | Tier2      |
| TMX1     | 4   | 0.99      | 0.99        | 17838    | 1.11    | 6.2E-03   | 2.1E-02     | 474      | 4             | 1.11    | Unassigned |
| TOP1     | 4   | 0.79      | 0.79        | 14050    | 0.65    | 7.3E-03   | 2.5E-02     | 537      | 2             | 0.65    | Singleton  |
| TPP2     | 4   | 0.29      | 0.42        | 7551     | 1.45    | 7.8E-03   | 2.6E-02     | 576      | 2             | 1.45    | Tier2      |
| TRDMT1   | 5   | 0.88      | 0.88        | 15628    | 1.09    | 6.2E-03   | 2.4E-02     | 467      | 3             | 1.09    | Tier2      |
| TRPV3    | 5   | 0.88      | 0.88        | 15717    | 1.28    | 6.5E-03   | 2.5E-02     | 493      | 4             | 1.28    | Unassigned |

| Gene ID   | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|-----------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| TTC27     | 5   | 0.96      | 0.96        | 17242    | 1.80    | 5.4E-03   | 2.2E-02     | 424      | 4             | 1.80    | Tier3      |
| TWISTNB   | 5   | 0.82      | 0.82        | 14641    | 0.47    | 6.8E-03   | 2.6E-02     | 508      | 2             | 0.47    | Singleton  |
| UBE2E2    | 5   | 0.85      | 0.86        | 15223    | 1.13    | 6.7E-03   | 2.5E-02     | 502      | 3             | 1.13    | Tier3      |
| UBE2I     | 5   | 0.99      | 0.99        | 17860    | 1.79    | 7.2E-03   | 2.7E-02     | 533      | 4             | 1.79    | Tier3      |
| UBE2L3    | 6   | 0.99      | 0.99        | 17806    | 1.06    | 5.1E-03   | 2.1E-02     | 406      | 5             | 1.06    | Singleton  |
| USP27X    | 4   | 0.99      | 0.99        | 17803    | 0.95    | 7.7E-03   | 2.6E-02     | 564      | 4             | 0.95    | Singleton  |
| VPS13A    | 3   | 0.99      | 0.99        | 17753    | 1.37    | 9.8E-03   | 2.6E-02     | 677      | 3             | 1.37    | Unassigned |
| VPS37B    | 5   | 0.95      | 0.95        | 17007    | 1.21    | 6.1E-03   | 2.3E-02     | 459      | 4             | 1.21    | Tier3      |
| WNT5A     | 5   | 0.13      | 0.26        | 4428     | -0.63   | 6.6E-03   | 2.5E-02     | 499      | 1             | -0.63   | Singleton  |
| ZBTB21    | 5   | 0.48      | 0.58        | 10166    | 0.40    | 5.7E-03   | 2.3E-02     | 444      | 2             | 0.40    | Tier2      |
| ZMYND11   | 5   | 0.96      | 0.96        | 17213    | 1.80    | 6.6E-03   | 2.5E-02     | 498      | 3             | 1.80    | Tier3      |
| ZNF217    | 5   | 0.99      | 0.99        | 17768    | 1.83    | 6.8E-03   | 2.6E-02     | 507      | 4             | 1.83    | Tier3      |
| ZNF440    | 5   | 0.89      | 0.89        | 15783    | 0.61    | 5.2E-03   | 2.1E-02     | 410      | 2             | 0.61    | Singleton  |
| ZNF492    | 5   | 0.12      | 0.24        | 4206     | 0.90    | 6.4E-03   | 2.5E-02     | 490      | 4             | 0.90    | Singleton  |
| ZNF563    | 3   | 0.99      | 0.99        | 17764    | 1.72    | 9.6E-03   | 2.6E-02     | 665      | 3             | 1.72    | Tier3      |
| ZNF581    | 4   | 0.93      | 0.93        | 16569    | 1.80    | 7.7E-03   | 2.6E-02     | 567      | 3             | 1.80    | Tier2      |
| ZNF701    | 6   | 0.99      | 0.99        | 17657    | 1.49    | 6.4E-03   | 2.6E-02     | 482      | 5             | 1.49    | Tier3      |
| ZNF770    | 4   | 0.49      | 0.54        | 10288    | 0.46    | 7.2E-03   | 2.4E-02     | 529      | 2             | 0.46    | Singleton  |
| HDAC3     | 5   | 0.99      | 0.99        | 17780    | 1.38    | 7.2E-03   | 2.7E-02     | 536      | 3             | 1.38    | Singleton  |
| ABCA6     | 5   | 0.32      | 0.45        | 7949     | 1.28    | 7.5E-03   | 2.8E-02     | 553      | 3             | 1.28    | Singleton  |
| ACTR8     | 5   | 0.20      | 0.34        | 5952     | 1.29    | 7.4E-03   | 2.7E-02     | 542      | 4             | 1.29    | Tier3      |
| ARL8B     | 5   | 0.06      | 0.13        | 2450     | -0.98   | 7.5E-03   | 2.8E-02     | 557      | 2             | -0.98   | Tier2      |
| CLTC      | 5   | 0.27      | 0.41        | 7170     | 1.26    | 7.5E-03   | 2.8E-02     | 554      | 3             | 1.26    | Tier2      |
| CPSF3L    | 5   | 0.46      | 0.58        | 9999     | 1.27    | 7.5E-03   | 2.8E-02     | 549      | 4             | 1.27    | Tier3      |
| CRTAC1    | 5   | 0.93      | 0.93        | 16657    | 1.20    | 7.5E-03   | 2.8E-02     | 550      | 4             | 1.20    | Unassigned |
| EIF2B3    | 5   | 0.39      | 0.53        | 9172     | 0.24    | 7.4E-03   | 2.7E-02     | 544      | 2             | 0.24    | Singleton  |
| FAM19A4   | 5   | 0.12      | 0.24        | 4193     | -0.33   | 7.3E-03   | 2.7E-02     | 539      | 2             | -0.33   | Singleton  |
| GABARAPL1 | 5   | 0.99      | 0.99        | 17683    | 1.71    | 7.5E-03   | 2.8E-02     | 555      | 3             | 1.71    | Tier3      |
| GADD45G   | 5   | 0.99      | 0.99        | 17863    | 1.34    | 7.5E-03   | 2.8E-02     | 551      | 4             | 1.34    | Tier3      |
| KIAA0895  | 5   | 0.94      | 0.94        | 16847    | 1.42    | 7.4E-03   | 2.7E-02     | 540      | 3             | 1.42    | Tier2      |
| NPBWR1    | 5   | 0.99      | 0.99        | 17846    | 1.29    | 7.4E-03   | 2.8E-02     | 548      | 4             | 1.29    | Tier2      |
| POT1      | 5   | 0.02      | 0.07        | 1213     | -0.39   | 7.5E-03   | 2.8E-02     | 556      | 2             | -0.39   | Tier2      |
| PRMT3     | 5   | 0.04      | 0.11        | 1985     | 1.81    | 7.4E-03   | 2.7E-02     | 543      | 3             | 1.81    | Tier3      |
| SLC35A1   | 4   | 0.99      | 0.99        | 17789    | 1.10    | 8.3E-03   | 2.8E-02     | 594      | 4             | 1.10    | Unassigned |
| TLCD1     | 5   | 0.97      | 0.97        | 17375    | 0.83    | 7.5E-03   | 2.8E-02     | 559      | 4             | 0.83    | Tier2      |
| ZNHIT6    | 5   | 0.08      | 0.18        | 3138     | 0.91    | 7.4E-03   | 2.7E-02     | 541      | 4             | 0.91    | Tier2      |
| PPP1CB    | 4   | 0.72      | 0.72        | 12862    | 0.66    | 8.3E-03   | 2.8E-02     | 595      | 2             | 0.66    | Singleton  |
| INPPL1    | 5   | 0.94      | 0.94        | 16746    | 0.51    | 7.6E-03   | 2.8E-02     | 561      | 2             | 0.51    | Tier2      |
| KCNIP2    | 5   | 0.97      | 0.97        | 17413    | 1.20    | 7.6E-03   | 2.8E-02     | 563      | 4             | 1.20    | Singleton  |

| Gene ID  | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|----------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| KIAA1429 | 5   | 0.33      | 0.46        | 8132     | -0.38   | 7.6E-03   | 2.8E-02     | 562      | 2             | -0.38   | Singleton  |
| CCDC74B  | 3   | 0.99      | 0.99        | 17721    | 1.34    | 1.1E-02   | 2.9E-02     | 724      | 3             | 1.34    | Unassigned |
| CLTB     | 5   | 0.96      | 0.96        | 17245    | 1.18    | 7.7E-03   | 2.8E-02     | 568      | 4             | 1.18    | Unassigned |
| ELP5     | 5   | 0.96      | 0.96        | 17234    | 1.71    | 7.8E-03   | 2.9E-02     | 575      | 4             | 1.71    | Tier3      |
| FAM105A  | 4   | 0.16      | 0.26        | 5043     | 1.40    | 8.5E-03   | 2.8E-02     | 604      | 3             | 1.40    | Singleton  |
| MDN1     | 5   | 0.25      | 0.38        | 6724     | 1.24    | 7.8E-03   | 2.8E-02     | 573      | 4             | 1.24    | Singleton  |
| MTRF1    | 3   | 0.23      | 0.31        | 6414     | 1.18    | 1.1E-02   | 2.8E-02     | 717      | 2             | 1.18    | Singleton  |
| OTX1     | 5   | 0.96      | 0.96        | 17239    | 1.20    | 7.7E-03   | 2.8E-02     | 569      | 4             | 1.20    | Unassigned |
| PLGLB2   | 1   | 0.97      | 0.97        | 17373    | 2.64    | 2.8E-02   | 2.8E-02     | 1579     | 1             | 2.64    | Singleton  |
| PRAMEF22 | 2   | 0.79      | 0.79        | 14078    | 1.89    | 1.5E-02   | 2.9E-02     | 960      | 1             | 1.89    | Singleton  |
| SLC6A6   | 5   | 0.19      | 0.32        | 5743     | 1.08    | 7.8E-03   | 2.9E-02     | 574      | 3             | 1.08    | Singleton  |
| TDP1     | 4   | 0.89      | 0.89        | 15880    | 1.53    | 8.6E-03   | 2.9E-02     | 612      | 2             | 1.53    | Tier2      |
| TMEM207  | 5   | 0.99      | 0.99        | 17656    | 0.53    | 7.9E-03   | 2.9E-02     | 578      | 1             | 0.53    | Singleton  |
| TMPRSS13 | 5   | 0.06      | 0.14        | 2553     | 1.73    | 7.7E-03   | 2.8E-02     | 566      | 3             | 1.73    | Tier3      |
| FFAR3    | 5   | 0.99      | 0.99        | 17649    | 1.57    | 7.9E-03   | 2.9E-02     | 580      | 4             | 1.57    | Unassigned |
| ILF2     | 5   | 0.03      | 0.09        | 1665     | 0.44    | 7.9E-03   | 2.9E-02     | 582      | 2             | 0.44    | Singleton  |
| CAMSAP3  | 5   | 0.76      | 0.76        | 13570    | 1.73    | 8.0E-03   | 2.9E-02     | 585      | 4             | 1.73    | Tier3      |
| NCBP2    | 6   | 0.75      | 0.77        | 13427    | 1.38    | 7.3E-03   | 2.9E-02     | 538      | 4             | 1.38    | Tier3      |
| PDILT    | 5   | 0.65      | 0.68        | 11880    | 0.23    | 8.0E-03   | 2.9E-02     | 586      | 2             | 0.23    | Singleton  |
| RAB27A   | 4   | 0.99      | 0.99        | 17748    | 1.65    | 8.7E-03   | 2.9E-02     | 620      | 4             | 1.65    | Tier3      |
| RSRC1    | 5   | 0.76      | 0.76        | 13547    | 1.69    | 8.0E-03   | 2.9E-02     | 587      | 3             | 1.69    | Tier3      |
| GOLGA7   | 5   | 0.55      | 0.62        | 10770    | 0.70    | 8.2E-03   | 3.0E-02     | 591      | 3             | 0.70    | Tier2      |
| POLR3D   | 5   | 0.89      | 0.89        | 15740    | 1.70    | 8.2E-03   | 3.0E-02     | 589      | 3             | 1.70    | Tier3      |
| TMEM50B  | 5   | 0.84      | 0.84        | 15008    | 0.72    | 8.2E-03   | 3.0E-02     | 590      | 3             | 0.72    | Tier2      |
| ZP2      | 5   | 0.84      | 0.84        | 15046    | 1.74    | 8.1E-03   | 3.0E-02     | 588      | 3             | 1.74    | Tier3      |
| NLRC4    | 5   | 0.94      | 0.94        | 16846    | 1.64    | 8.2E-03   | 3.0E-02     | 592      | 4             | 1.64    | Tier3      |
| ABLIM3   | 5   | 0.22      | 0.35        | 6222     | 0.73    | 8.7E-03   | 3.1E-02     | 622      | 3             | 0.73    | Tier2      |
| ABRA     | 5   | 0.09      | 0.19        | 3454     | -0.76   | 8.3E-03   | 3.0E-02     | 600      | 2             | -0.76   | Tier3      |
| ABT1     | 5   | 0.99      | 0.99        | 17866    | 1.06    | 8.4E-03   | 3.0E-02     | 603      | 4             | 1.06    | Tier2      |
| ARHGEF9  | 5   | 0.08      | 0.17        | 3123     | -0.11   | 8.7E-03   | 3.1E-02     | 624      | 2             | -0.11   | Singleton  |
| ASPHD2   | 5   | 0.88      | 0.88        | 15665    | 1.20    | 8.9E-03   | 3.2E-02     | 633      | 3             | 1.20    | Singleton  |
| ATPAF1   | 13  | 0.34      | 0.60        | 8348     | 0.56    | 5.3E-03   | 3.0E-02     | 415      | 5             | 0.56    | Tier2      |
| C19orf24 | 5   | 0.60      | 0.65        | 11341    | 1.15    | 8.5E-03   | 3.1E-02     | 605      | 4             | 1.15    | Singleton  |
| CCNA2    | 5   | 0.75      | 0.75        | 13344    | 1.77    | 8.9E-03   | 3.2E-02     | 635      | 3             | 1.77    | Tier3      |
| CIAO1    | 5   | 0.99      | 0.99        | 17867    | 1.52    | 8.7E-03   | 3.1E-02     | 623      | 4             | 1.52    | Tier2      |
| DCAKD    | 5   | 0.29      | 0.43        | 7534     | 1.73    | 8.3E-03   | 3.0E-02     | 593      | 4             | 1.73    | Tier3      |
| DCTN2    | 5   | 0.61      | 0.66        | 11463    | 0.38    | 8.7E-03   | 3.1E-02     | 618      | 2             | 0.38    | Singleton  |
| DLGAP2   | 5   | 0.76      | 0.77        | 13605    | 1.18    | 8.6E-03   | 3.1E-02     | 614      | 3             | 1.18    | Tier2      |
| DYNC1I2  | 5   | 0.35      | 0.49        | 8567     | 1.61    | 8.9E-03   | 3.2E-02     | 636      | 3             | 1.61    | Tier2      |

| Gene ID  | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|----------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| FAM208A  | 5   | 0.45      | 0.57        | 9895     | 1.20    | 8.6E-03   | 3.1E-02     | 610      | 4             | 1.20    | Singleton  |
| GPHA2    | 5   | 0.96      | 0.96        | 17087    | 1.19    | 8.3E-03   | 3.0E-02     | 597      | 4             | 1.19    | Tier2      |
| KAZALD1  | 5   | 0.65      | 0.68        | 11896    | 1.32    | 8.8E-03   | 3.2E-02     | 630      | 3             | 1.32    | Tier2      |
| KCTD21   | 5   | 0.33      | 0.47        | 8224     | 0.66    | 8.5E-03   | 3.1E-02     | 607      | 2             | 0.66    | Singleton  |
| LEPROTL1 | 5   | 0.99      | 0.99        | 17769    | 1.43    | 8.6E-03   | 3.1E-02     | 615      | 4             | 1.43    | Tier3      |
| MLLT10   | 7   | 0.34      | 0.52        | 8365     | 0.16    | 6.9E-03   | 3.1E-02     | 517      | 2             | 0.16    | Tier2      |
| NAGA     | 5   | 0.99      | 0.99        | 17653    | 1.21    | 8.9E-03   | 3.2E-02     | 637      | 4             | 1.21    | Tier2      |
| NUAK1    | 5   | 0.54      | 0.61        | 10699    | 1.69    | 8.6E-03   | 3.1E-02     | 613      | 3             | 1.69    | Tier3      |
| PRKRIR   | 5   | 0.14      | 0.27        | 4748     | -0.43   | 8.6E-03   | 3.1E-02     | 617      | 1             | -0.43   | Singleton  |
| PSG11    | 2   | 0.98      | 0.98        | 17595    | 1.57    | 1.7E-02   | 3.2E-02     | 1052     | 2             | 1.57    | Unassigned |
| PTPLB    | 5   | 0.91      | 0.91        | 16234    | 1.28    | 8.4E-03   | 3.0E-02     | 601      | 4             | 1.28    | Tier3      |
| RASGEF1B | 5   | 0.34      | 0.48        | 8333     | 1.74    | 8.9E-03   | 3.2E-02     | 634      | 3             | 1.74    | Tier3      |
| RBM25    | 5   | 0.26      | 0.39        | 6955     | 0.46    | 8.3E-03   | 3.0E-02     | 598      | 2             | 0.46    | Tier2      |
| RNASE3   | 5   | 0.34      | 0.48        | 8395     | -0.09   | 8.3E-03   | 3.0E-02     | 596      | 2             | -0.09   | Tier2      |
| RPGRIP1  | 4   | 0.99      | 0.99        | 17773    | 1.25    | 9.0E-03   | 3.0E-02     | 640      | 4             | 1.25    | Unassigned |
| SLC13A4  | 5   | 0.87      | 0.87        | 15519    | 1.68    | 8.8E-03   | 3.2E-02     | 628      | 3             | 1.68    | Tier3      |
| SLC22A13 | 5   | 0.71      | 0.72        | 12754    | 1.73    | 8.8E-03   | 3.1E-02     | 626      | 3             | 1.73    | Tier3      |
| SNF8     | 5   | 0.83      | 0.83        | 14767    | 1.24    | 8.7E-03   | 3.1E-02     | 621      | 4             | 1.24    | Tier2      |
| SYNDIG1L | 5   | 0.83      | 0.83        | 14833    | 0.66    | 8.6E-03   | 3.1E-02     | 611      | 2             | 0.66    | Singleton  |
| TCERG1   | 4   | 0.89      | 0.89        | 15883    | 1.49    | 9.4E-03   | 3.1E-02     | 655      | 3             | 1.49    | Tier2      |
| TIPARP   | 5   | 0.79      | 0.79        | 14024    | 1.32    | 8.7E-03   | 3.1E-02     | 619      | 3             | 1.32    | Tier2      |
| TIPRL    | 2   | 0.98      | 0.98        | 17593    | 2.38    | 1.7E-02   | 3.2E-02     | 1053     | 2             | 2.38    | Singleton  |
| TSPAN8   | 5   | 0.63      | 0.66        | 11612    | 1.51    | 8.6E-03   | 3.1E-02     | 616      | 4             | 1.51    | Tier3      |
| UQCRB    | 5   | 0.01      | 0.03        | 676      | 1.76    | 8.4E-03   | 3.0E-02     | 602      | 3             | 1.76    | Tier3      |
| VPS8     | 5   | 0.28      | 0.42        | 7395     | 1.72    | 8.8E-03   | 3.1E-02     | 627      | 3             | 1.72    | Tier3      |
| VWA9     | 5   | 0.83      | 0.83        | 14846    | 0.28    | 8.5E-03   | 3.1E-02     | 609      | 2             | 0.28    | Tier2      |
| XRCC2    | 5   | 0.01      | 0.02        | 441      | -0.38   | 8.5E-03   | 3.1E-02     | 606      | 2             | -0.38   | Singleton  |
| ZNF335   | 5   | 0.93      | 0.93        | 16571    | 0.88    | 8.5E-03   | 3.1E-02     | 608      | 3             | 0.88    | Tier2      |
| ZNF653   | 5   | 0.92      | 0.92        | 16356    | 1.41    | 8.8E-03   | 3.2E-02     | 629      | 4             | 1.41    | Tier2      |
| ABCC2    | 5   | 0.33      | 0.47        | 8177     | 0.63    | 9.1E-03   | 3.2E-02     | 641      | 2             | 0.63    | Tier2      |
| ARHGEF40 | 5   | 0.94      | 0.94        | 16854    | 0.48    | 9.3E-03   | 3.3E-02     | 652      | 2             | 0.48    | Tier2      |
| C12orf65 | 5   | 0.92      | 0.92        | 16445    | 1.15    | 9.3E-03   | 3.3E-02     | 654      | 3             | 1.15    | Tier2      |
| C1QTNF5  | 5   | 0.99      | 0.99        | 17849    | 1.24    | 9.3E-03   | 3.3E-02     | 653      | 4             | 1.24    | Unassigned |
| C21orf33 | 5   | 0.93      | 0.93        | 16610    | 1.37    | 9.0E-03   | 3.2E-02     | 638      | 4             | 1.37    | Singleton  |
| CYP7A1   | 5   | 0.99      | 0.99        | 17742    | 1.57    | 9.4E-03   | 3.3E-02     | 657      | 4             | 1.57    | Unassigned |
| DNAJA4   | 4   | 0.99      | 0.99        | 17751    | 1.48    | 9.9E-03   | 3.3E-02     | 681      | 4             | 1.48    | Unassigned |
| FGGY     | 5   | 0.03      | 0.08        | 1484     | -0.30   | 9.2E-03   | 3.3E-02     | 644      | 2             | -0.30   | Unassigned |
| GPR141   | 5   | 0.91      | 0.91        | 16206    | 1.30    | 9.3E-03   | 3.3E-02     | 651      | 4             | 1.30    | Unassigned |
| MMD2     | 5   | 0.95      | 0.95        | 16990    | 1.68    | 9.2E-03   | 3.3E-02     | 646      | 3             | 1.68    | Tier3      |

| Gene ID    | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|------------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| MTX2       | 4   | 0.99      | 0.99        | 17754    | 1.37    | 9.8E-03   | 3.3E-02     | 676      | 4             | 1.37    | Tier3      |
| NMRK2      | 5   | 0.03      | 0.08        | 1546     | -0.34   | 9.3E-03   | 3.3E-02     | 650      | 2             | -0.34   | Tier2      |
| P4HA1      | 5   | 0.36      | 0.50        | 8667     | -0.01   | 9.4E-03   | 3.3E-02     | 658      | 1             | -0.01   | Singleton  |
| PHOX2A     | 5   | 0.98      | 0.98        | 17485    | 1.13    | 9.4E-03   | 3.3E-02     | 656      | 4             | 1.13    | Unassigned |
| POTED      | 4   | 0.99      | 0.99        | 17760    | 1.04    | 9.6E-03   | 3.2E-02     | 670      | 4             | 1.04    | Unassigned |
| PRIMPOL    | 4   | 0.02      | 0.06        | 1276     | 0.24    | 9.6E-03   | 3.2E-02     | 667      | 2             | 0.24    | Unassigned |
| PXMP2      | 5   | 0.93      | 0.93        | 16501    | 0.74    | 9.3E-03   | 3.3E-02     | 649      | 3             | 0.74    | Singleton  |
| RGS7       | 4   | 0.99      | 0.99        | 17757    | 1.28    | 9.7E-03   | 3.2E-02     | 672      | 4             | 1.28    | Unassigned |
| S100A7A    | 2   | 0.98      | 0.98        | 17584    | 1.75    | 1.7E-02   | 3.2E-02     | 1082     | 2             | 1.75    | Singleton  |
| SLC8A3     | 11  | 0.97      | 0.97        | 17264    | 0.96    | 6.2E-03   | 3.3E-02     | 471      | 8             | 0.96    | Tier3      |
| SLCO6A1    | 5   | 0.65      | 0.68        | 11847    | 1.69    | 9.2E-03   | 3.3E-02     | 648      | 3             | 1.69    | Tier3      |
| TM2D1      | 5   | 0.60      | 0.65        | 11261    | 1.16    | 9.2E-03   | 3.3E-02     | 645      | 3             | 1.16    | Singleton  |
| TMEM210    | 5   | 0.90      | 0.90        | 16030    | 1.64    | 9.2E-03   | 3.3E-02     | 647      | 4             | 1.64    | Tier3      |
| TMEM212    | 4   | 0.17      | 0.27        | 5280     | 1.53    | 9.7E-03   | 3.3E-02     | 675      | 3             | 1.53    | Unassigned |
| WIPI1      | 5   | 0.98      | 0.98        | 17527    | 1.67    | 9.1E-03   | 3.2E-02     | 643      | 3             | 1.67    | Tier3      |
| ZNF259     | 5   | 0.12      | 0.24        | 4178     | 1.69    | 9.0E-03   | 3.2E-02     | 639      | 3             | 1.69    | Tier3      |
| MRPS12     | 5   | 0.94      | 0.94        | 16756    | 1.52    | 9.4E-03   | 3.3E-02     | 661      | 4             | 1.52    | Tier2      |
| SMS        | 5   | 0.87      | 0.87        | 15497    | 1.71    | 9.4E-03   | 3.3E-02     | 660      | 3             | 1.71    | Tier2      |
| KIAA1683   | 5   | 0.73      | 0.73        | 12945    | 1.26    | 9.5E-03   | 3.3E-02     | 663      | 4             | 1.26    | Unassigned |
| GSTA3      | 4   | 0.85      | 0.85        | 15063    | 1.09    | 1.0E-02   | 3.4E-02     | 688      | 2             | 1.09    | Tier2      |
| KRTAP10-10 | 4   | 0.99      | 0.99        | 17745    | 1.00    | 1.0E-02   | 3.4E-02     | 685      | 4             | 1.00    | Unassigned |
| MRGPRX3    | 5   | 0.28      | 0.42        | 7328     | 0.59    | 9.5E-03   | 3.4E-02     | 664      | 2             | 0.59    | Singleton  |
| PPP4C      | 5   | 0.68      | 0.70        | 12332    | -0.13   | 9.6E-03   | 3.4E-02     | 668      | 1             | -0.13   | Singleton  |
| PMVK       | 5   | 0.85      | 0.85        | 15075    | 0.78    | 9.6E-03   | 3.4E-02     | 671      | 3             | 0.78    | Tier2      |
| GRAPL      | 4   | 0.93      | 0.93        | 16552    | 1.63    | 1.0E-02   | 3.4E-02     | 694      | 3             | 1.63    | Tier3      |
| RFK        | 4   | 0.42      | 0.49        | 9632     | 1.23    | 1.0E-02   | 3.4E-02     | 693      | 3             | 1.23    | Singleton  |
| SCGN       | 5   | 0.21      | 0.35        | 6113     | 0.18    | 9.7E-03   | 3.4E-02     | 674      | 2             | 0.18    | Tier2      |
| TCP10L     | 5   | 0.95      | 0.95        | 16996    | 1.33    | 9.7E-03   | 3.4E-02     | 673      | 4             | 1.33    | Tier2      |
| LMBRD1     | 4   | 0.41      | 0.49        | 9550     | 0.11    | 1.0E-02   | 3.4E-02     | 697      | 1             | 0.11    | Singleton  |
| CHMP3      | 5   | 0.20      | 0.33        | 5866     | 1.04    | 9.8E-03   | 3.5E-02     | 678      | 3             | 1.04    | Singleton  |
| NHSL1      | 5   | 0.97      | 0.97        | 17335    | 1.24    | 9.8E-03   | 3.5E-02     | 680      | 3             | 1.24    | Tier2      |
| WDR53      | 5   | 0.95      | 0.95        | 17017    | 1.17    | 9.8E-03   | 3.5E-02     | 679      | 4             | 1.17    | Singleton  |
| HIST2H2BE  | 1   | 0.97      | 0.97        | 17256    | 2.40    | 3.5E-02   | 3.5E-02     | 1846     | 1             | 2.40    | Singleton  |
| CLPSL2     | 6   | 0.60      | 0.69        | 11323    | 0.58    | 8.9E-03   | 3.5E-02     | 632      | 3             | 0.58    | Tier2      |
| FRMD7      | 5   | 0.07      | 0.16        | 2890     | -0.35   | 1.0E-02   | 3.5E-02     | 683      | 1             | -0.35   | Singleton  |
| KRTAP4-8   | 2   | 0.98      | 0.98        | 17556    | 1.61    | 1.9E-02   | 3.5E-02     | 1138     | 2             | 1.61    | Unassigned |
| SMARCD2    | 5   | 0.98      | 0.98        | 17498    | 1.16    | 9.9E-03   | 3.5E-02     | 682      | 4             | 1.16    | Singleton  |
| ALDOC      | 5   | 0.83      | 0.83        | 14781    | 0.94    | 1.0E-02   | 3.5E-02     | 687      | 3             | 0.94    | Tier2      |
| ARL3       | 5   | 0.57      | 0.63        | 10998    | 1.33    | 1.1E-02   | 3.6E-02     | 712      | 3             | 1.33    | Tier2      |

| Gene ID   | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|-----------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| C19orf18  | 5   | 0.13      | 0.26        | 4545     | 1.64    | 1.0E-02   | 3.6E-02     | 709      | 3             | 1.64    | Tier3      |
| CDC20     | 5   | 0.46      | 0.57        | 9933     | 1.70    | 1.1E-02   | 3.6E-02     | 711      | 3             | 1.70    | Tier3      |
| CDH24     | 5   | 0.93      | 0.93        | 16558    | 1.37    | 1.0E-02   | 3.6E-02     | 703      | 4             | 1.37    | Singleton  |
| CNFN      | 5   | 0.89      | 0.89        | 15908    | 1.10    | 1.0E-02   | 3.6E-02     | 691      | 4             | 1.10    | Unassigned |
| CYCS      | 2   | 0.50      | 0.50        | 10355    | 1.44    | 1.9E-02   | 3.6E-02     | 1162     | 1             | 1.44    | Singleton  |
| CYP3A43   | 2   | 0.98      | 0.98        | 17540    | 1.91    | 1.9E-02   | 3.6E-02     | 1171     | 2             | 1.91    | Singleton  |
| ERCC3     | 5   | 0.63      | 0.66        | 11617    | 1.66    | 1.0E-02   | 3.6E-02     | 701      | 3             | 1.66    | Tier3      |
| F7        | 5   | 0.62      | 0.66        | 11553    | 1.68    | 1.1E-02   | 3.7E-02     | 715      | 3             | 1.68    | Tier2      |
| FAM43B    | 5   | 0.86      | 0.86        | 15315    | 1.66    | 1.0E-02   | 3.6E-02     | 690      | 3             | 1.66    | Tier2      |
| FGD6      | 5   | 0.72      | 0.73        | 12903    | 1.28    | 1.0E-02   | 3.6E-02     | 708      | 4             | 1.28    | Tier3      |
| GANAB     | 5   | 0.99      | 0.99        | 17819    | 1.34    | 1.0E-02   | 3.6E-02     | 705      | 4             | 1.34    | Unassigned |
| GRID1     | 5   | 0.66      | 0.68        | 11974    | 1.09    | 1.1E-02   | 3.7E-02     | 713      | 4             | 1.09    | Unassigned |
| IGDCC4    | 5   | 0.21      | 0.34        | 6012     | 1.12    | 1.0E-02   | 3.6E-02     | 700      | 4             | 1.12    | Unassigned |
| KLF3      | 5   | 0.95      | 0.95        | 16975    | 1.30    | 1.0E-02   | 3.5E-02     | 686      | 4             | 1.30    | Singleton  |
| KRTAP19-4 | 3   | 0.99      | 0.99        | 17676    | 1.13    | 1.4E-02   | 3.6E-02     | 863      | 3             | 1.13    | Unassigned |
| LRAT      | 5   | 0.28      | 0.42        | 7374     | -0.23   | 1.0E-02   | 3.5E-02     | 684      | 2             | -0.23   | Tier2      |
| NR1D1     | 5   | 0.79      | 0.79        | 14003    | 0.61    | 1.0E-02   | 3.6E-02     | 704      | 2             | 0.61    | Tier2      |
| PALM2     | 5   | 0.37      | 0.51        | 8888     | 1.63    | 1.0E-02   | 3.6E-02     | 698      | 4             | 1.63    | Unassigned |
| PGS1      | 5   | 0.44      | 0.57        | 9806     | 0.75    | 1.0E-02   | 3.5E-02     | 689      | 3             | 0.75    | Tier3      |
| PKD1L2    | 5   | 0.86      | 0.86        | 15304    | 1.21    | 1.0E-02   | 3.6E-02     | 707      | 4             | 1.21    | Tier2      |
| PRDX6     | 5   | 0.31      | 0.45        | 7903     | 0.60    | 1.0E-02   | 3.6E-02     | 695      | 2             | 0.60    | Singleton  |
| PRPF19    | 5   | 0.74      | 0.74        | 13159    | 1.27    | 1.0E-02   | 3.6E-02     | 692      | 4             | 1.27    | Tier2      |
| RMI1      | 4   | 0.22      | 0.34        | 6260     | 1.23    | 1.1E-02   | 3.7E-02     | 736      | 2             | 1.23    | Tier2      |
| SAFB2     | 5   | 0.87      | 0.87        | 15431    | 1.18    | 1.0E-02   | 3.6E-02     | 699      | 4             | 1.18    | Unassigned |
| SERPINA1  | 5   | 0.41      | 0.55        | 9531     | 0.85    | 1.0E-02   | 3.6E-02     | 702      | 3             | 0.85    | Tier3      |
| SPAG11A   | 4   | 0.99      | 0.99        | 17725    | 1.30    | 1.1E-02   | 3.6E-02     | 720      | 4             | 1.30    | Singleton  |
| SYCP2L    | 5   | 0.99      | 0.99        | 17694    | 1.70    | 1.0E-02   | 3.6E-02     | 710      | 4             | 1.70    | Tier3      |
| TACR1     | 5   | 0.02      | 0.05        | 1028     | -0.83   | 1.0E-02   | 3.6E-02     | 696      | 2             | -0.83   | Unassigned |
| TMCO2     | 5   | 0.17      | 0.30        | 5243     | -0.44   | 1.0E-02   | 3.6E-02     | 706      | 1             | -0.44   | Singleton  |
| TMX3      | 4   | 0.84      | 0.84        | 15004    | 0.88    | 1.1E-02   | 3.6E-02     | 733      | 2             | 0.88    | Tier3      |
| VAR52     | 4   | 0.99      | 0.99        | 17732    | 1.46    | 1.1E-02   | 3.5E-02     | 714      | 4             | 1.46    | Unassigned |
| B3GALNT1  | 4   | 0.69      | 0.69        | 12367    | 1.46    | 1.1E-02   | 3.7E-02     | 739      | 3             | 1.46    | Unassigned |
| AARS      | 5   | 0.78      | 0.78        | 13852    | 0.15    | 1.5E-02   | 4.8E-02     | 923      | 2             | 0.15    | Singleton  |
| ABAT      | 5   | 0.26      | 0.40        | 7009     | 1.64    | 1.1E-02   | 3.8E-02     | 732      | 3             | 1.64    | Singleton  |
| ACTR3     | 4   | 0.07      | 0.15        | 2805     | 1.69    | 1.1E-02   | 3.7E-02     | 748      | 3             | 1.69    | Tier2      |
| ACVR2B    | 5   | 0.96      | 0.96        | 17058    | 1.47    | 1.1E-02   | 3.8E-02     | 741      | 4             | 1.47    | Unassigned |
| ADD3      | 5   | 0.91      | 0.91        | 16258    | 1.62    | 1.2E-02   | 4.2E-02     | 806      | 3             | 1.62    | Tier3      |
| ADPGK     | 5   | 0.97      | 0.97        | 17390    | 1.19    | 1.5E-02   | 4.8E-02     | 919      | 4             | 1.19    | Tier3      |
| AKAP3     | 4   | 0.99      | 0.99        | 17698    | 1.06    | 1.2E-02   | 4.1E-02     | 807      | 4             | 1.06    | Singleton  |

| Gene ID   | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|-----------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| ALG5      | 4   | 0.88      | 0.88        | 15651    | 1.64    | 1.3E-02   | 4.2E-02     | 818      | 3             | 1.64    | Tier2      |
| ALG9      | 5   | 0.46      | 0.58        | 9991     | 1.30    | 1.4E-02   | 4.6E-02     | 876      | 4             | 1.30    | Unassigned |
| ARF4      | 3   | 0.11      | 0.18        | 3973     | 1.90    | 1.8E-02   | 4.6E-02     | 1088     | 2             | 1.90    | Tier3      |
| ARHGAP44  | 5   | 0.97      | 0.97        | 17385    | 1.12    | 1.3E-02   | 4.4E-02     | 845      | 4             | 1.12    | Singleton  |
| ARL14     | 4   | 0.99      | 0.99        | 17689    | 1.20    | 1.3E-02   | 4.2E-02     | 819      | 4             | 1.20    | Singleton  |
| ARMC6     | 5   | 0.43      | 0.56        | 9681     | 1.18    | 1.2E-02   | 3.9E-02     | 764      | 4             | 1.18    | Tier2      |
| ARRDC3    | 5   | 0.47      | 0.58        | 10057    | 1.61    | 1.2E-02   | 4.2E-02     | 804      | 3             | 1.61    | Tier3      |
| ASB14     | 5   | 0.76      | 0.77        | 13601    | 0.33    | 1.5E-02   | 4.9E-02     | 938      | 2             | 0.33    | Tier2      |
| ATG7      | 5   | 0.90      | 0.90        | 15968    | 1.24    | 1.3E-02   | 4.3E-02     | 828      | 4             | 1.24    | Tier2      |
| ATP10A    | 5   | 0.90      | 0.90        | 15983    | 0.99    | 1.5E-02   | 4.9E-02     | 924      | 3             | 0.99    | Tier2      |
| B4GALT7   | 5   | 0.99      | 0.99        | 17697    | 1.03    | 1.5E-02   | 4.9E-02     | 945      | 4             | 1.03    | Unassigned |
| BDP1      | 3   | 0.98      | 0.98        | 17596    | 1.34    | 1.7E-02   | 4.4E-02     | 1051     | 3             | 1.34    | Unassigned |
| BMS1      | 5   | 0.12      | 0.25        | 4352     | 0.34    | 1.2E-02   | 4.2E-02     | 798      | 2             | 0.34    | Singleton  |
| BRPF1     | 5   | 0.93      | 0.93        | 16496    | 1.14    | 1.1E-02   | 3.7E-02     | 716      | 4             | 1.14    | Singleton  |
| C10orf118 | 5   | 0.37      | 0.51        | 8876     | 0.73    | 1.5E-02   | 5.0E-02     | 946      | 2             | 0.73    | Tier3      |
| C11orf31  | 5   | 0.56      | 0.62        | 10833    | 0.50    | 1.3E-02   | 4.2E-02     | 814      | 2             | 0.50    | Singleton  |
| C3orf80   | 5   | 0.74      | 0.75        | 13245    | 1.13    | 1.5E-02   | 4.9E-02     | 928      | 4             | 1.13    | Singleton  |
| C5orf49   | 4   | 0.60      | 0.62        | 11325    | 0.14    | 1.1E-02   | 3.8E-02     | 759      | 1             | 0.14    | Singleton  |
| CAND2     | 5   | 0.98      | 0.98        | 17627    | 1.20    | 1.5E-02   | 4.9E-02     | 935      | 4             | 1.20    | Singleton  |
| CAPZA2    | 3   | 0.58      | 0.58        | 11060    | 1.34    | 1.9E-02   | 4.8E-02     | 1121     | 2             | 1.34    | Singleton  |
| CASP2     | 6   | 0.37      | 0.52        | 8889     | 1.07    | 9.6E-03   | 3.7E-02     | 666      | 3             | 1.07    | Tier3      |
| CCDC150   | 5   | 0.96      | 0.96        | 17151    | 0.21    | 1.1E-02   | 3.9E-02     | 756      | 2             | 0.21    | Tier2      |
| CCDC64    | 5   | 0.23      | 0.36        | 6418     | 1.09    | 1.4E-02   | 4.7E-02     | 899      | 3             | 1.09    | Tier2      |
| CD151     | 5   | 0.80      | 0.80        | 14301    | 1.49    | 1.2E-02   | 4.1E-02     | 793      | 4             | 1.49    | Tier3      |
| CD3G      | 4   | 0.67      | 0.67        | 12144    | 1.12    | 1.5E-02   | 4.7E-02     | 940      | 2             | 1.12    | Tier3      |
| CD46      | 5   | 0.78      | 0.78        | 13811    | 0.58    | 1.3E-02   | 4.4E-02     | 835      | 2             | 0.58    | Tier3      |
| CDH11     | 5   | 0.97      | 0.97        | 17340    | 1.18    | 1.3E-02   | 4.2E-02     | 811      | 4             | 1.18    | Unassigned |
| CGRRF1    | 5   | 0.91      | 0.91        | 16136    | 1.03    | 1.4E-02   | 4.7E-02     | 884      | 4             | 1.03    | Unassigned |
| CHP1      | 5   | 0.27      | 0.41        | 7132     | 1.09    | 1.3E-02   | 4.4E-02     | 842      | 4             | 1.09    | Unassigned |
| CLASRP    | 5   | 0.17      | 0.30        | 5283     | 1.17    | 1.5E-02   | 4.8E-02     | 920      | 4             | 1.17    | Singleton  |
| CMPK1     | 5   | 0.99      | 0.99        | 17731    | 1.47    | 1.1E-02   | 3.7E-02     | 726      | 4             | 1.47    | Tier2      |
| COMMD10   | 4   | 0.93      | 0.93        | 16649    | 1.55    | 1.4E-02   | 4.5E-02     | 906      | 3             | 1.55    | Tier2      |
| COQ10B    | 5   | 0.98      | 0.98        | 17559    | 1.21    | 1.1E-02   | 3.7E-02     | 721      | 4             | 1.21    | Unassigned |
| CORO6     | 4   | 0.78      | 0.78        | 13880    | 1.34    | 1.5E-02   | 4.7E-02     | 933      | 3             | 1.34    | Singleton  |
| CST8      | 5   | 0.99      | 0.99        | 17652    | 1.50    | 1.4E-02   | 4.7E-02     | 900      | 4             | 1.50    | Tier2      |
| CSTF3     | 8   | 0.99      | 0.99        | 17869    | 1.29    | 1.1E-02   | 4.7E-02     | 738      | 5             | 1.29    | Tier3      |
| CTSZ      | 5   | 0.98      | 0.98        | 17466    | 1.56    | 1.4E-02   | 4.6E-02     | 877      | 3             | 1.56    | Tier3      |
| DBH       | 5   | 0.49      | 0.59        | 10224    | 1.60    | 1.1E-02   | 3.9E-02     | 757      | 3             | 1.60    | Unassigned |
| DDX6      | 4   | 0.92      | 0.92        | 16441    | 1.68    | 1.4E-02   | 4.4E-02     | 875      | 3             | 1.68    | Tier3      |

| Gene ID  | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|----------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| DEFB108B | 2   | 0.94      | 0.94        | 16851    | 2.10    | 2.7E-02   | 5.0E-02     | 1533     | 2             | 2.10    | Singleton  |
| DENND2C  | 5   | 0.57      | 0.63        | 10985    | 1.58    | 1.5E-02   | 4.9E-02     | 927      | 3             | 1.58    | Tier3      |
| DHRS11   | 5   | 0.36      | 0.50        | 8755     | 0.91    | 1.4E-02   | 4.6E-02     | 883      | 3             | 0.91    | Tier2      |
| DIRAS1   | 5   | 0.95      | 0.95        | 16896    | 1.56    | 1.4E-02   | 4.8E-02     | 915      | 3             | 1.56    | Singleton  |
| DIRAS2   | 4   | 0.37      | 0.46        | 8781     | 0.75    | 1.2E-02   | 4.0E-02     | 781      | 2             | 0.75    | Singleton  |
| DOCK10   | 4   | 0.66      | 0.66        | 12021    | 0.13    | 1.6E-02   | 5.0E-02     | 1012     | 1             | 0.13    | Singleton  |
| DOK1     | 5   | 0.34      | 0.48        | 8376     | 0.26    | 1.4E-02   | 4.8E-02     | 914      | 2             | 0.26    | Singleton  |
| DUSP27   | 5   | 0.98      | 0.98        | 17515    | 1.07    | 1.1E-02   | 3.9E-02     | 760      | 4             | 1.07    | Unassigned |
| DUSP3    | 5   | 0.92      | 0.92        | 16448    | 0.71    | 1.5E-02   | 4.9E-02     | 936      | 3             | 0.71    | Singleton  |
| ECH1     | 5   | 0.78      | 0.78        | 13875    | 1.15    | 1.4E-02   | 4.5E-02     | 868      | 4             | 1.15    | Unassigned |
| EEA1     | 5   | 0.23      | 0.36        | 6380     | 0.34    | 1.2E-02   | 4.1E-02     | 782      | 1             | 0.34    | Singleton  |
| EIF2S2   | 4   | 0.13      | 0.22        | 4433     | 1.04    | 1.6E-02   | 4.9E-02     | 987      | 2             | 1.04    | Tier2      |
| EPN1     | 4   | 0.05      | 0.11        | 2119     | -0.35   | 1.2E-02   | 4.0E-02     | 791      | 2             | -0.35   | Singleton  |
| ESRP1    | 5   | 0.56      | 0.63        | 10915    | 0.96    | 1.3E-02   | 4.3E-02     | 831      | 3             | 0.96    | Tier2      |
| ETHE1    | 5   | 0.93      | 0.93        | 16534    | 1.06    | 1.2E-02   | 4.0E-02     | 765      | 4             | 1.06    | Singleton  |
| FAM21B   | 1   | 0.96      | 0.96        | 17149    | 2.36    | 4.0E-02   | 4.0E-02     | 2061     | 1             | 2.36    | Singleton  |
| FAM96B   | 5   | 0.95      | 0.95        | 16948    | 1.38    | 1.1E-02   | 3.9E-02     | 751      | 4             | 1.38    | Tier3      |
| FANCA    | 5   | 0.17      | 0.30        | 5244     | 1.13    | 1.1E-02   | 3.8E-02     | 737      | 3             | 1.13    | Tier3      |
| FBXO39   | 5   | 0.87      | 0.87        | 15434    | 1.50    | 1.2E-02   | 4.0E-02     | 775      | 3             | 1.50    | Tier2      |
| FBXO48   | 5   | 0.14      | 0.27        | 4650     | 0.38    | 1.2E-02   | 4.1E-02     | 787      | 2             | 0.38    | Tier2      |
| FBXW4    | 5   | 0.55      | 0.62        | 10810    | 1.10    | 1.2E-02   | 4.0E-02     | 769      | 3             | 1.10    | Singleton  |
| FCER1G   | 5   | 0.99      | 0.99        | 17856    | 1.20    | 1.1E-02   | 3.8E-02     | 730      | 4             | 1.20    | Singleton  |
| FEN1     | 5   | 0.68      | 0.70        | 12303    | 1.22    | 1.3E-02   | 4.3E-02     | 820      | 3             | 1.22    | Tier2      |
| FIP1L1   | 4   | 0.38      | 0.47        | 9053     | 0.82    | 1.6E-02   | 4.9E-02     | 1001     | 2             | 0.82    | Tier2      |
| FRYL     | 5   | 0.03      | 0.08        | 1562     | -0.93   | 1.2E-02   | 4.2E-02     | 802      | 2             | -0.93   | Singleton  |
| FTSJ3    | 5   | 0.92      | 0.92        | 16404    | 1.55    | 1.1E-02   | 3.7E-02     | 718      | 4             | 1.55    | Tier2      |
| FZD4     | 4   | 0.77      | 0.77        | 13638    | 1.32    | 1.4E-02   | 4.6E-02     | 911      | 2             | 1.32    | Tier2      |
| GAB2     | 4   | 0.25      | 0.37        | 6766     | 1.62    | 1.1E-02   | 3.8E-02     | 753      | 3             | 1.62    | Tier3      |
| GBAS     | 4   | 0.52      | 0.55        | 10487    | 1.18    | 1.3E-02   | 4.3E-02     | 841      | 2             | 1.18    | Tier2      |
| GCNT3    | 5   | 0.22      | 0.36        | 6289     | 0.62    | 1.3E-02   | 4.3E-02     | 833      | 2             | 0.62    | Tier2      |
| GCOM1    | 5   | 0.76      | 0.76        | 13505    | 1.53    | 1.5E-02   | 4.9E-02     | 939      | 3             | 1.53    | Tier3      |
| GJB5     | 5   | 0.28      | 0.42        | 7391     | 1.03    | 1.5E-02   | 4.9E-02     | 925      | 4             | 1.03    | Singleton  |
| GNB2L1   | 5   | 0.25      | 0.39        | 6791     | 1.73    | 1.1E-02   | 3.7E-02     | 719      | 3             | 1.73    | Tier2      |
| GPR135   | 5   | 0.10      | 0.22        | 3836     | 0.41    | 1.4E-02   | 4.6E-02     | 878      | 2             | 0.41    | Tier2      |
| GPR180   | 5   | 0.29      | 0.43        | 7600     | 1.60    | 1.2E-02   | 4.2E-02     | 809      | 3             | 1.60    | Tier3      |
| GPX7     | 4   | 0.99      | 0.99        | 17696    | 1.00    | 1.3E-02   | 4.1E-02     | 813      | 4             | 1.00    | Unassigned |
| GSTM3    | 5   | 0.03      | 0.08        | 1565     | -0.82   | 1.4E-02   | 4.6E-02     | 879      | 2             | -0.82   | Tier2      |
| GTF2A1L  | 4   | 0.91      | 0.91        | 16170    | 0.58    | 1.3E-02   | 4.3E-02     | 836      | 2             | 0.58    | Singleton  |
| GZMK     | 5   | 0.99      | 0.99        | 17762    | 1.44    | 1.4E-02   | 4.5E-02     | 870      | 4             | 1.44    | Tier3      |

| Gene ID   | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|-----------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| HBM       | 5   | 0.98      | 0.98        | 17604    | 1.15    | 1.5E-02   | 4.9E-02     | 941      | 4             | 1.15    | Unassigned |
| HDAC9     | 5   | 0.89      | 0.89        | 15893    | 0.94    | 1.3E-02   | 4.5E-02     | 850      | 3             | 0.94    | Singleton  |
| HEPN1     | 5   | 0.01      | 0.03        | 580      | -0.98   | 1.4E-02   | 4.6E-02     | 872      | 1             | -0.98   | Singleton  |
| HIST1H4H  | 4   | 0.38      | 0.47        | 9079     | 1.08    | 1.3E-02   | 4.3E-02     | 854      | 2             | 1.08    | Singleton  |
| HJURP     | 5   | 0.17      | 0.30        | 5247     | 1.13    | 1.5E-02   | 4.8E-02     | 917      | 4             | 1.13    | Singleton  |
| HNRNPA1   | 4   | 0.95      | 0.95        | 16921    | 1.64    | 1.1E-02   | 3.8E-02     | 761      | 3             | 1.64    | Tier3      |
| HPS6      | 5   | 0.40      | 0.54        | 9416     | 0.11    | 1.5E-02   | 4.8E-02     | 918      | 2             | 0.11    | Singleton  |
| HYAL1     | 15  | 0.49      | 0.75        | 10257    | 0.70    | 8.3E-03   | 4.7E-02     | 599      | 8             | 0.70    | Tier3      |
| IGIP      | 3   | 0.98      | 0.98        | 17612    | 1.16    | 1.6E-02   | 4.2E-02     | 1003     | 3             | 1.16    | Unassigned |
| IKBKAP    | 5   | 0.79      | 0.79        | 13986    | 1.61    | 1.3E-02   | 4.4E-02     | 837      | 4             | 1.61    | Tier2      |
| IL25      | 5   | 0.75      | 0.76        | 13428    | -0.41   | 1.4E-02   | 4.7E-02     | 897      | 2             | -0.41   | Tier2      |
| INIP      | 5   | 0.14      | 0.27        | 4743     | 0.66    | 1.4E-02   | 4.8E-02     | 913      | 2             | 0.66    | Singleton  |
| INO80B    | 5   | 0.95      | 0.95        | 16912    | 1.65    | 1.2E-02   | 4.2E-02     | 801      | 4             | 1.65    | Tier3      |
| INVS      | 4   | 0.90      | 0.90        | 15937    | 1.80    | 1.4E-02   | 4.4E-02     | 874      | 3             | 1.80    | Tier2      |
| IPPK      | 5   | 0.83      | 0.83        | 14849    | 1.24    | 1.5E-02   | 4.9E-02     | 943      | 3             | 1.24    | Singleton  |
| JADE3     | 5   | 0.87      | 0.87        | 15494    | 1.30    | 1.3E-02   | 4.4E-02     | 834      | 4             | 1.30    | Tier2      |
| KCNH7     | 5   | 0.32      | 0.46        | 8001     | 0.29    | 1.5E-02   | 4.9E-02     | 934      | 2             | 0.29    | Tier2      |
| KCNK1     | 5   | 0.01      | 0.03        | 541      | 1.17    | 1.4E-02   | 4.7E-02     | 886      | 4             | 1.17    | Unassigned |
| KNOP1     | 5   | 0.85      | 0.85        | 15116    | 0.27    | 1.2E-02   | 4.1E-02     | 790      | 2             | 0.27    | Singleton  |
| KRIT1     | 5   | 0.19      | 0.32        | 5648     | -0.38   | 1.1E-02   | 3.7E-02     | 727      | 2             | -0.38   | Singleton  |
| KRTAP20-1 | 3   | 0.98      | 0.98        | 17631    | 1.14    | 1.5E-02   | 4.0E-02     | 950      | 3             | 1.14    | Unassigned |
| KRTAP5-1  | 3   | 0.98      | 0.98        | 17625    | 1.97    | 1.5E-02   | 4.0E-02     | 954      | 3             | 1.97    | Tier3      |
| LCE5A     | 4   | 0.27      | 0.39        | 7052     | 0.71    | 1.6E-02   | 5.0E-02     | 1013     | 2             | 0.71    | Tier2      |
| LDB1      | 5   | 0.93      | 0.93        | 16497    | 1.62    | 1.3E-02   | 4.3E-02     | 825      | 3             | 1.62    | Singleton  |
| LDLRAP1   | 5   | 0.05      | 0.12        | 2196     | 1.64    | 1.2E-02   | 4.1E-02     | 792      | 3             | 1.64    | Tier2      |
| LGR5      | 5   | 0.91      | 0.91        | 16217    | 0.77    | 1.3E-02   | 4.3E-02     | 823      | 4             | 0.77    | Tier2      |
| LIN28A    | 5   | 0.95      | 0.95        | 16983    | 1.17    | 1.2E-02   | 4.1E-02     | 786      | 4             | 1.17    | Unassigned |
| LOH12CR1  | 4   | 0.71      | 0.71        | 12765    | 0.79    | 1.4E-02   | 4.6E-02     | 916      | 2             | 0.79    | Tier2      |
| LRRC16A   | 5   | 0.95      | 0.95        | 16992    | 1.71    | 1.1E-02   | 3.8E-02     | 745      | 3             | 1.71    | Tier3      |
| LRRC6     | 4   | 0.77      | 0.77        | 13707    | 1.42    | 1.6E-02   | 4.9E-02     | 998      | 3             | 1.42    | Unassigned |
| LSG1      | 5   | 0.44      | 0.57        | 9794     | 1.14    | 1.5E-02   | 5.0E-02     | 947      | 3             | 1.14    | Tier2      |
| LTC4S     | 5   | 0.45      | 0.57        | 9914     | 1.58    | 1.2E-02   | 4.2E-02     | 810      | 3             | 1.58    | Tier3      |
| MAP1LC3A  | 5   | 0.83      | 0.83        | 14711    | 1.23    | 1.1E-02   | 3.8E-02     | 729      | 4             | 1.23    | Tier2      |
| MARS      | 5   | 0.23      | 0.36        | 6351     | 1.61    | 1.2E-02   | 4.0E-02     | 770      | 3             | 1.61    | Tier3      |
| MAU2      | 5   | 0.32      | 0.45        | 7955     | 0.92    | 1.4E-02   | 4.7E-02     | 904      | 3             | 0.92    | Tier2      |
| MBD2      | 5   | 0.13      | 0.27        | 4607     | 1.58    | 1.4E-02   | 4.7E-02     | 902      | 3             | 1.58    | Unassigned |
| MBNL2     | 5   | 0.91      | 0.91        | 16133    | 1.60    | 1.1E-02   | 3.8E-02     | 743      | 3             | 1.60    | Tier2      |
| MBOAT1    | 5   | 0.34      | 0.48        | 8424     | -0.14   | 1.3E-02   | 4.3E-02     | 816      | 2             | -0.14   | Singleton  |
| MCTP1     | 5   | 0.97      | 0.97        | 17316    | 1.10    | 1.2E-02   | 4.2E-02     | 794      | 3             | 1.10    | Tier2      |

| Gene ID  | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|----------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| MED23    | 5   | 0.03      | 0.08        | 1541     | -0.24   | 1.3E-02   | 4.3E-02     | 832      | 2             | -0.24   | Singleton  |
| MEN1     | 5   | 0.78      | 0.78        | 13797    | 1.26    | 1.2E-02   | 4.1E-02     | 779      | 4             | 1.26    | Tier3      |
| MFAP1    | 5   | 0.63      | 0.67        | 11706    | 0.48    | 1.1E-02   | 3.8E-02     | 740      | 2             | 0.48    | Tier2      |
| MGAT3    | 5   | 0.81      | 0.81        | 14312    | 0.61    | 1.2E-02   | 4.1E-02     | 789      | 2             | 0.61    | Singleton  |
| MIA2     | 5   | 0.03      | 0.08        | 1442     | -1.29   | 1.5E-02   | 4.9E-02     | 932      | 1             | -1.29   | Singleton  |
| MPHOSPH8 | 5   | 0.05      | 0.12        | 2289     | 0.18    | 1.1E-02   | 3.7E-02     | 723      | 2             | 0.18    | Singleton  |
| MPP5     | 5   | 0.57      | 0.63        | 11022    | 1.67    | 1.3E-02   | 4.5E-02     | 846      | 3             | 1.67    | Tier3      |
| MRPL1    | 4   | 0.13      | 0.23        | 4616     | 1.65    | 1.6E-02   | 4.9E-02     | 991      | 3             | 1.65    | Tier3      |
| MSRB3    | 5   | 0.90      | 0.90        | 15976    | 1.13    | 1.2E-02   | 4.0E-02     | 767      | 4             | 1.13    | Unassigned |
| MUM1     | 5   | 0.98      | 0.98        | 17482    | 0.50    | 1.3E-02   | 4.2E-02     | 812      | 1             | 0.50    | Singleton  |
| MYBL2    | 5   | 0.76      | 0.76        | 13513    | 1.56    | 1.4E-02   | 4.8E-02     | 912      | 3             | 1.56    | Tier3      |
| MZF1     | 5   | 0.02      | 0.06        | 1192     | -0.60   | 1.1E-02   | 3.9E-02     | 750      | 2             | -0.60   | Unassigned |
| NAA35    | 5   | 0.25      | 0.38        | 6728     | -0.58   | 1.1E-02   | 3.7E-02     | 722      | 2             | -0.58   | Tier2      |
| NAV1     | 5   | 0.38      | 0.52        | 9076     | 0.79    | 1.2E-02   | 4.1E-02     | 785      | 3             | 0.79    | Tier2      |
| NDFIP2   | 4   | 0.69      | 0.69        | 12457    | 1.66    | 1.4E-02   | 4.5E-02     | 898      | 3             | 1.66    | Tier2      |
| NDUFAF4  | 3   | 0.82      | 0.82        | 14543    | 1.88    | 1.6E-02   | 4.2E-02     | 1010     | 2             | 1.88    | Tier3      |
| NEK8     | 5   | 0.93      | 0.93        | 16520    | 0.81    | 1.1E-02   | 3.8E-02     | 742      | 3             | 0.81    | Singleton  |
| NELFE    | 5   | 0.70      | 0.71        | 12508    | 0.28    | 1.5E-02   | 4.8E-02     | 921      | 2             | 0.28    | Singleton  |
| NGLY1    | 4   | 0.18      | 0.29        | 5530     | 1.52    | 1.4E-02   | 4.5E-02     | 910      | 3             | 1.52    | Singleton  |
| NINJ2    | 5   | 0.99      | 0.99        | 17775    | 1.61    | 1.2E-02   | 4.2E-02     | 796      | 3             | 1.61    | Unassigned |
| NIPBL    | 5   | 0.99      | 0.99        | 17807    | 1.39    | 1.4E-02   | 4.7E-02     | 885      | 4             | 1.39    | Singleton  |
| NMNAT2   | 5   | 0.98      | 0.98        | 17599    | 1.26    | 1.3E-02   | 4.5E-02     | 857      | 4             | 1.26    | Singleton  |
| NRIP3    | 5   | 0.96      | 0.96        | 17061    | 1.65    | 1.2E-02   | 4.0E-02     | 776      | 3             | 1.65    | Tier3      |
| NSUN4    | 5   | 0.79      | 0.79        | 13993    | -0.36   | 1.4E-02   | 4.6E-02     | 880      | 1             | -0.36   | Singleton  |
| NT5E     | 4   | 0.57      | 0.59        | 10984    | 1.10    | 1.6E-02   | 5.0E-02     | 1011     | 2             | 1.10    | Singleton  |
| NUP88    | 4   | 0.13      | 0.22        | 4413     | 1.40    | 1.3E-02   | 4.3E-02     | 848      | 3             | 1.40    | Singleton  |
| ORC4     | 4   | 0.15      | 0.25        | 4918     | 1.75    | 1.2E-02   | 3.9E-02     | 777      | 3             | 1.75    | Tier2      |
| PAFAH1B1 | 4   | 0.65      | 0.66        | 11927    | 1.41    | 1.5E-02   | 4.8E-02     | 969      | 3             | 1.41    | Singleton  |
| PBX3     | 5   | 0.85      | 0.85        | 15139    | 0.60    | 1.1E-02   | 3.9E-02     | 749      | 2             | 0.60    | Singleton  |
| PDCD5    | 4   | 0.43      | 0.50        | 9732     | 1.68    | 1.6E-02   | 4.9E-02     | 989      | 3             | 1.68    | Tier2      |
| PDE4B    | 5   | 0.18      | 0.31        | 5531     | 0.39    | 1.3E-02   | 4.3E-02     | 821      | 1             | 0.39    | Singleton  |
| PDRG1    | 5   | 0.83      | 0.83        | 14779    | 0.17    | 1.1E-02   | 3.8E-02     | 744      | 1             | 0.17    | Singleton  |
| PECR     | 5   | 0.78      | 0.78        | 13869    | 1.06    | 1.3E-02   | 4.5E-02     | 856      | 4             | 1.06    | Tier2      |
| PHTF1    | 4   | 0.53      | 0.56        | 10585    | 1.46    | 1.4E-02   | 4.5E-02     | 891      | 3             | 1.46    | Tier2      |
| PHYHIP   | 5   | 0.16      | 0.29        | 5089     | -0.02   | 1.5E-02   | 4.9E-02     | 944      | 2             | -0.02   | Tier2      |
| PIAS1    | 5   | 0.84      | 0.84        | 14971    | -0.41   | 1.4E-02   | 4.6E-02     | 882      | 2             | -0.41   | Singleton  |
| PIDD     | 5   | 0.88      | 0.88        | 15711    | 1.05    | 1.3E-02   | 4.4E-02     | 844      | 4             | 1.05    | Tier3      |
| PIK3R5   | 5   | 0.97      | 0.97        | 17263    | 1.09    | 1.2E-02   | 4.1E-02     | 788      | 4             | 1.09    | Tier2      |
| PLA2G4A  | 5   | 0.99      | 0.99        | 17723    | 1.45    | 1.1E-02   | 3.7E-02     | 725      | 4             | 1.45    | Tier3      |

| Gene ID     | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|-------------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| PLCD4       | 5   | 0.99      | 0.99        | 17734    | 1.45    | 1.4E-02   | 4.7E-02     | 890      | 4             | 1.45    | Singleton  |
| POMP        | 5   | 0.48      | 0.58        | 10161    | 0.21    | 1.2E-02   | 4.0E-02     | 771      | 2             | 0.21    | Tier2      |
| PPAN-P2RY11 | 1   | 0.95      | 0.95        | 17019    | 2.22    | 4.7E-02   | 4.7E-02     | 2341     | 1             | 2.22    | Singleton  |
| PPP2R5A     | 5   | 0.14      | 0.27        | 4736     | 1.32    | 1.3E-02   | 4.3E-02     | 824      | 4             | 1.32    | Tier2      |
| PRPF8       | 5   | 0.99      | 0.99        | 17717    | 1.04    | 1.5E-02   | 5.0E-02     | 951      | 4             | 1.04    | Unassigned |
| PSMA1       | 4   | 0.09      | 0.17        | 3411     | -0.66   | 1.6E-02   | 4.8E-02     | 972      | 1             | -0.66   | Singleton  |
| PTPN1       | 5   | 0.96      | 0.96        | 17226    | 1.52    | 1.4E-02   | 4.7E-02     | 903      | 4             | 1.52    | Tier2      |
| RAB1A       | 5   | 0.02      | 0.06        | 1070     | 1.60    | 1.1E-02   | 3.9E-02     | 752      | 3             | 1.60    | Unassigned |
| RAB22A      | 4   | 0.77      | 0.77        | 13765    | 1.33    | 1.2E-02   | 4.1E-02     | 800      | 2             | 1.33    | Tier2      |
| RAB9B       | 5   | 0.12      | 0.24        | 4160     | 0.76    | 1.3E-02   | 4.5E-02     | 858      | 3             | 0.76    | Singleton  |
| RABL3       | 4   | 0.18      | 0.29        | 5534     | 0.56    | 1.6E-02   | 4.9E-02     | 985      | 2             | 0.56    | Tier2      |
| RAD1        | 4   | 0.00      | 0.00        | 14       | -2.94   | 1.5E-02   | 4.7E-02     | 949      | 1             | -2.94   | Unassigned |
| RAF1        | 5   | 0.41      | 0.55        | 9495     | 0.19    | 1.4E-02   | 4.7E-02     | 907      | 2             | 0.19    | Singleton  |
| RANBP1      | 5   | 0.07      | 0.16        | 2867     | 0.12    | 1.3E-02   | 4.3E-02     | 822      | 2             | 0.12    | Tier2      |
| RANBP3      | 5   | 0.23      | 0.37        | 6486     | 1.61    | 1.4E-02   | 4.7E-02     | 896      | 3             | 1.61    | Tier2      |
| RASA3       | 5   | 0.73      | 0.73        | 12954    | 1.56    | 1.4E-02   | 4.6E-02     | 871      | 3             | 1.56    | Unassigned |
| RASL11B     | 5   | 0.48      | 0.58        | 10167    | 1.62    | 1.2E-02   | 4.1E-02     | 780      | 4             | 1.62    | Tier3      |
| RBM45       | 5   | 0.20      | 0.34        | 5927     | 0.93    | 1.3E-02   | 4.4E-02     | 843      | 3             | 0.93    | Singleton  |
| RHD         | 5   | 0.05      | 0.13        | 2391     | -0.55   | 1.4E-02   | 4.7E-02     | 892      | 2             | -0.55   | Singleton  |
| ROCK1       | 5   | 0.78      | 0.78        | 13802    | 1.67    | 1.3E-02   | 4.3E-02     | 829      | 3             | 1.67    | Tier3      |
| RPH3A       | 5   | 0.85      | 0.85        | 15059    | 1.39    | 1.1E-02   | 3.8E-02     | 746      | 3             | 1.39    | Tier2      |
| RPL32       | 2   | 0.13      | 0.17        | 4469     | 0.38    | 2.6E-02   | 4.7E-02     | 1468     | 1             | 0.38    | Singleton  |
| RPL35A      | 3   | 0.03      | 0.07        | 1568     | -1.82   | 1.6E-02   | 4.3E-02     | 1022     | 1             | -1.82   | Singleton  |
| RPS29       | 2   | 0.74      | 0.74        | 13194    | 1.70    | 2.0E-02   | 3.8E-02     | 1218     | 1             | 1.70    | Singleton  |
| RRAGA       | 5   | 0.85      | 0.85        | 15076    | 1.58    | 1.3E-02   | 4.5E-02     | 855      | 3             | 1.58    | Singleton  |
| RRM2        | 5   | 0.22      | 0.35        | 6158     | 1.33    | 1.4E-02   | 4.5E-02     | 864      | 4             | 1.33    | Tier2      |
| SACM1L      | 5   | 0.96      | 0.96        | 17237    | 0.56    | 1.5E-02   | 5.0E-02     | 948      | 2             | 0.56    | Singleton  |
| SARS        | 5   | 0.40      | 0.54        | 9378     | 0.66    | 1.2E-02   | 4.0E-02     | 774      | 2             | 0.66    | Singleton  |
| SDAD1       | 5   | 0.00      | 0.01        | 125      | -1.61   | 1.3E-02   | 4.5E-02     | 851      | 2             | -1.61   | Tier3      |
| SERPINB1    | 5   | 0.02      | 0.06        | 1107     | 1.56    | 1.5E-02   | 4.9E-02     | 929      | 4             | 1.56    | Unassigned |
| SERPINE2    | 5   | 0.82      | 0.82        | 14680    | 1.27    | 1.3E-02   | 4.3E-02     | 826      | 4             | 1.27    | Singleton  |
| SF3A3       | 4   | 0.98      | 0.98        | 17550    | 1.56    | 1.2E-02   | 4.1E-02     | 797      | 3             | 1.56    | Unassigned |
| SFTPB       | 5   | 0.99      | 0.99        | 17678    | 1.27    | 1.3E-02   | 4.4E-02     | 839      | 4             | 1.27    | Unassigned |
| SGSM2       | 5   | 0.96      | 0.96        | 17144    | 1.09    | 1.4E-02   | 4.6E-02     | 881      | 4             | 1.09    | Unassigned |
| SIAH1       | 4   | 0.81      | 0.81        | 14491    | 1.18    | 1.2E-02   | 4.1E-02     | 803      | 2             | 1.18    | Tier2      |
| SIPA1L2     | 5   | 0.50      | 0.60        | 10366    | 0.02    | 1.4E-02   | 4.7E-02     | 908      | 2             | 0.02    | Singleton  |
| SLC16A6     | 5   | 0.02      | 0.06        | 1054     | -1.00   | 1.3E-02   | 4.4E-02     | 838      | 2             | -1.00   | Unassigned |
| SLC25A11    | 5   | 0.98      | 0.98        | 17505    | 1.07    | 1.1E-02   | 3.8E-02     | 747      | 4             | 1.07    | Tier3      |
| SLC35A2     | 5   | 0.35      | 0.49        | 8456     | 0.97    | 1.1E-02   | 3.9E-02     | 755      | 3             | 0.97    | Tier2      |

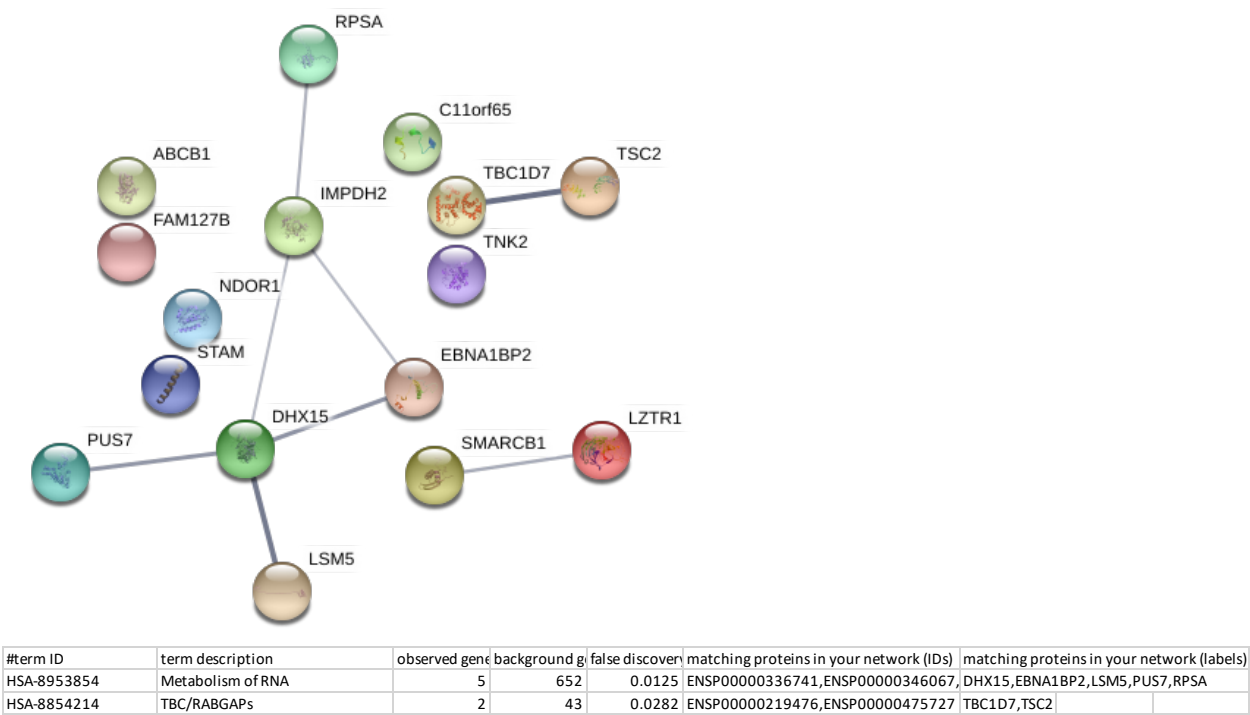
| Gene ID      | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|--------------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| SLC35A3      | 5   | 0.00      | 0.02        | 374      | -1.81   | 1.1E-02   | 3.9E-02     | 763      | 2             | -1.81   | Singleton  |
| SLC38A2      | 5   | 0.99      | 0.99        | 17726    | 1.21    | 1.1E-02   | 3.8E-02     | 735      | 4             | 1.21    | Tier3      |
| SMARCA1      | 5   | 0.35      | 0.49        | 8525     | 0.34    | 1.4E-02   | 4.5E-02     | 865      | 2             | 0.34    | Singleton  |
| SMCO4        | 3   | 0.97      | 0.97        | 17297    | 1.87    | 1.6E-02   | 4.3E-02     | 1014     | 3             | 1.87    | Tier3      |
| SNX9         | 4   | 0.52      | 0.56        | 10540    | 0.51    | 1.5E-02   | 4.7E-02     | 930      | 2             | 0.51    | Singleton  |
| SPAST        | 5   | 0.03      | 0.08        | 1435     | 0.31    | 1.2E-02   | 4.0E-02     | 766      | 2             | 0.31    | Unassigned |
| SPATA31A3    | 1   | 0.96      | 0.96        | 17201    | 2.35    | 3.8E-02   | 3.8E-02     | 1980     | 1             | 2.35    | Singleton  |
| SRFBP1       | 5   | 0.71      | 0.72        | 12733    | 1.65    | 1.2E-02   | 4.1E-02     | 784      | 3             | 1.65    | Tier3      |
| SRP19        | 4   | 0.99      | 0.99        | 17702    | 1.43    | 1.2E-02   | 4.1E-02     | 799      | 4             | 1.43    | Tier3      |
| SRP54        | 4   | 0.00      | 0.01        | 224      | -1.28   | 1.6E-02   | 4.9E-02     | 983      | 2             | -1.28   | Singleton  |
| SSBP2        | 4   | 0.23      | 0.35        | 6442     | 1.24    | 1.1E-02   | 3.8E-02     | 758      | 2             | 1.24    | Tier2      |
| SSX2         | 3   | 0.20      | 0.30        | 5949     | 1.44    | 1.7E-02   | 4.4E-02     | 1047     | 2             | 1.44    | Tier3      |
| SUB1         | 4   | 0.00      | 0.01        | 192      | -2.54   | 1.6E-02   | 4.9E-02     | 997      | 1             | -2.54   | Singleton  |
| SUMO2        | 2   | 0.85      | 0.85        | 15220    | 1.94    | 2.2E-02   | 4.0E-02     | 1296     | 1             | 1.94    | Singleton  |
| SYNGR3       | 5   | 0.94      | 0.94        | 16838    | 1.29    | 1.3E-02   | 4.5E-02     | 860      | 4             | 1.29    | Unassigned |
| TAAR8        | 5   | 0.30      | 0.44        | 7673     | 1.63    | 1.3E-02   | 4.5E-02     | 862      | 4             | 1.63    | Unassigned |
| TAGLN2       | 5   | 0.92      | 0.92        | 16308    | 0.75    | 1.4E-02   | 4.7E-02     | 895      | 3             | 0.75    | Tier2      |
| TDGF1        | 3   | 0.99      | 0.99        | 17660    | 1.47    | 1.4E-02   | 3.7E-02     | 893      | 3             | 1.47    | Unassigned |
| TKT          | 5   | 0.93      | 0.93        | 16639    | 1.06    | 1.4E-02   | 4.7E-02     | 889      | 4             | 1.06    | Unassigned |
| TMED7-TICAM2 | 2   | 0.97      | 0.97        | 17396    | 1.45    | 2.7E-02   | 4.9E-02     | 1513     | 2             | 1.45    | Unassigned |
| TMEM109      | 5   | 0.65      | 0.68        | 11966    | 1.21    | 1.2E-02   | 4.2E-02     | 805      | 3             | 1.21    | Tier2      |
| TMEM192      | 5   | 0.30      | 0.44        | 7665     | 1.66    | 1.2E-02   | 4.2E-02     | 808      | 3             | 1.66    | Tier2      |
| TMEM50A      | 4   | 0.80      | 0.80        | 14293    | 1.34    | 1.5E-02   | 4.8E-02     | 959      | 2             | 1.34    | Tier2      |
| TNFRSF17     | 5   | 0.21      | 0.34        | 6005     | 1.60    | 1.3E-02   | 4.5E-02     | 861      | 3             | 1.60    | Tier3      |
| TNS4         | 5   | 0.12      | 0.24        | 4215     | 1.59    | 1.4E-02   | 4.6E-02     | 873      | 3             | 1.59    | Tier3      |
| TOX4         | 5   | 0.21      | 0.34        | 6077     | 1.17    | 1.4E-02   | 4.7E-02     | 905      | 3             | 1.17    | Tier2      |
| TRIM45       | 5   | 0.97      | 0.97        | 17407    | 1.11    | 1.3E-02   | 4.5E-02     | 849      | 4             | 1.11    | Unassigned |
| TSFM         | 5   | 0.94      | 0.94        | 16859    | 1.34    | 1.2E-02   | 4.1E-02     | 783      | 4             | 1.34    | Tier3      |
| TSPAN13      | 5   | 0.92      | 0.92        | 16457    | 1.54    | 1.2E-02   | 4.0E-02     | 773      | 4             | 1.54    | Tier3      |
| TTC17        | 4   | 0.44      | 0.50        | 9773     | 1.64    | 1.3E-02   | 4.2E-02     | 817      | 3             | 1.64    | Tier3      |
| TYR          | 4   | 0.95      | 0.95        | 16885    | 1.48    | 1.3E-02   | 4.3E-02     | 859      | 3             | 1.48    | Singleton  |
| UBA2         | 4   | 0.07      | 0.15        | 2865     | 0.31    | 1.5E-02   | 4.6E-02     | 922      | 2             | 0.31    | Tier2      |
| UBE3D        | 5   | 0.20      | 0.34        | 5933     | 1.37    | 1.1E-02   | 3.9E-02     | 762      | 4             | 1.37    | Singleton  |
| UGCG         | 5   | 0.04      | 0.11        | 2006     | 1.55    | 1.4E-02   | 4.7E-02     | 909      | 3             | 1.55    | Tier3      |
| UNC13D       | 5   | 0.99      | 0.99        | 17832    | 1.46    | 1.3E-02   | 4.4E-02     | 840      | 4             | 1.46    | Singleton  |
| UQCC2        | 5   | 0.58      | 0.64        | 11083    | 1.58    | 1.3E-02   | 4.5E-02     | 847      | 3             | 1.58    | Unassigned |
| UROD         | 5   | 0.01      | 0.02        | 512      | 1.17    | 1.2E-02   | 4.0E-02     | 772      | 3             | 1.17    | Unassigned |
| USF2         | 5   | 0.98      | 0.98        | 17549    | 1.18    | 1.4E-02   | 4.5E-02     | 869      | 4             | 1.18    | Tier2      |
| VASH1        | 5   | 0.21      | 0.34        | 5979     | -0.44   | 1.1E-02   | 3.9E-02     | 754      | 1             | -0.44   | Singleton  |

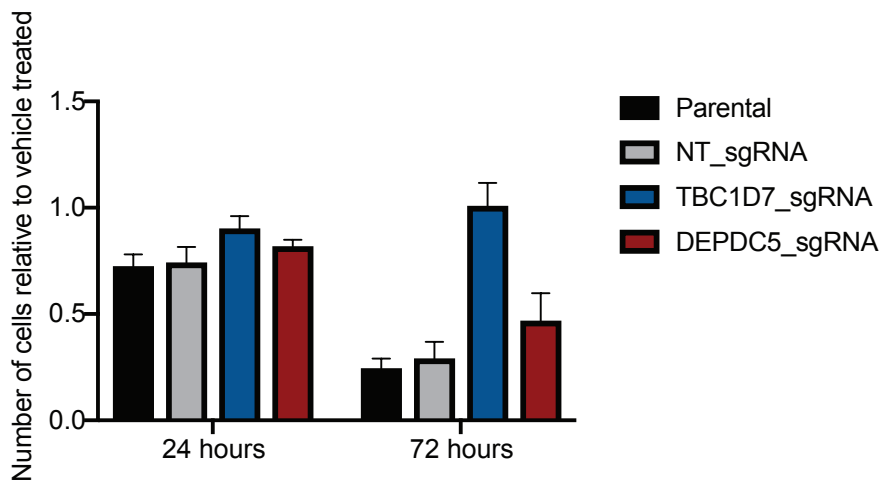
| Gene ID | Num | neg score | neg p-value | neg rank | neg lfc | pos score | pos p-value | pos rank | pos goodsgrna | pos lfc | Tiers      |
|---------|-----|-----------|-------------|----------|---------|-----------|-------------|----------|---------------|---------|------------|
| VPREB1  | 5   | 0.84      | 0.84        | 14963    | 1.27    | 1.3E-02   | 4.5E-02     | 853      | 4             | 1.27    | Tier2      |
| WNT6    | 4   | 0.40      | 0.48        | 9368     | -0.23   | 1.5E-02   | 4.6E-02     | 926      | 1             | -0.23   | Singleton  |
| WNT7A   | 5   | 0.54      | 0.61        | 10654    | 1.15    | 1.1E-02   | 3.8E-02     | 728      | 4             | 1.15    | Singleton  |
| WNT8A   | 5   | 0.43      | 0.56        | 9696     | 1.72    | 1.1E-02   | 3.8E-02     | 731      | 4             | 1.72    | Tier2      |
| XPO4    | 5   | 0.99      | 0.99        | 17855    | 1.01    | 1.5E-02   | 4.9E-02     | 931      | 4             | 1.01    | Tier2      |
| ZDHHC6  | 5   | 0.95      | 0.95        | 16957    | 0.44    | 1.3E-02   | 4.5E-02     | 852      | 2             | 0.44    | Tier2      |
| ZFP2    | 5   | 0.58      | 0.64        | 11072    | 1.63    | 1.2E-02   | 4.0E-02     | 778      | 4             | 1.63    | Tier2      |
| ZIC4    | 11  | 0.02      | 0.06        | 941      | 0.87    | 7.7E-03   | 4.0E-02     | 565      | 6             | 0.87    | Tier3      |
| ZNF285  | 5   | 0.25      | 0.38        | 6745     | 1.16    | 1.4E-02   | 4.5E-02     | 866      | 4             | 1.16    | Tier2      |
| ZNF468  | 7   | 0.09      | 0.22        | 3339     | -0.28   | 9.1E-03   | 3.8E-02     | 642      | 2             | -0.28   | Tier2      |
| ZNF556  | 5   | 0.82      | 0.82        | 14545    | 1.38    | 1.4E-02   | 4.7E-02     | 888      | 4             | 1.38    | Tier2      |
| ZNF683  | 5   | 0.77      | 0.77        | 13645    | 0.50    | 1.2E-02   | 4.0E-02     | 768      | 2             | 0.50    | Tier2      |
| ZSWIM2  | 5   | 0.99      | 0.99        | 17661    | 1.60    | 1.3E-02   | 4.3E-02     | 827      | 4             | 1.60    | Unassigned |

Supplementary Table 2. GSEA analyses for combined tiers 1,2,3.

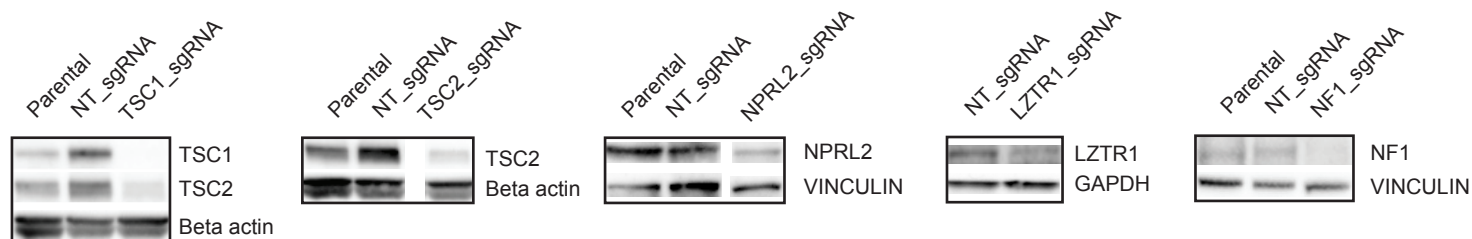
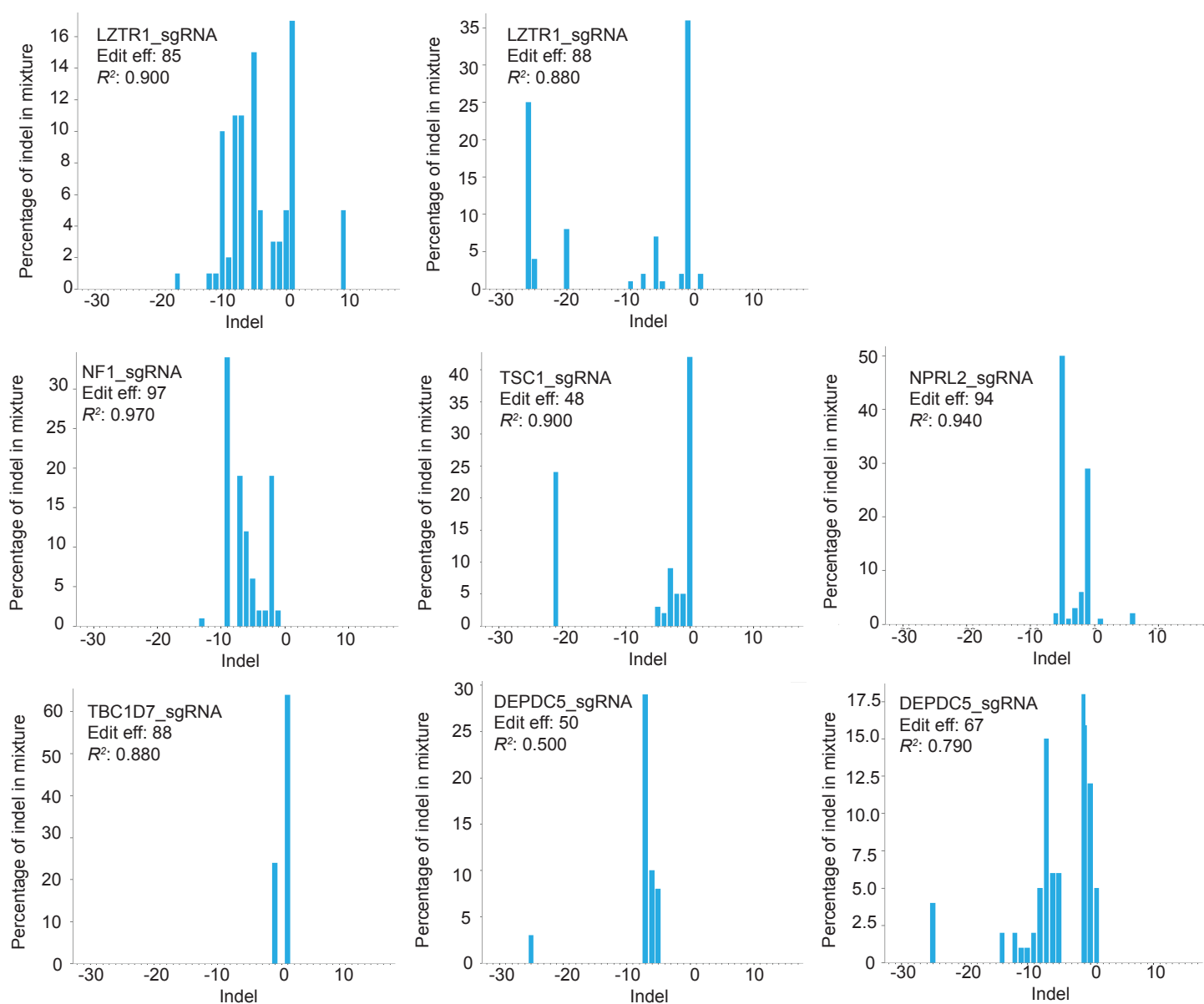
| geneSet  | description                          | normalizedEn | pValue     | size | userId                                                           |
|----------|--------------------------------------|--------------|------------|------|------------------------------------------------------------------|
| hsa03018 | RNA degradation                      | 1.72759804   | 0.00104932 | 12   | CNOT3;CNOT6;EXOSC10;EXOSC8;LSM5                                  |
| hsa05168 | Herpes simplex infection             | 1.65370929   | 0.00205973 | 14   | CCL2;CDK1;IFNGR2;SRPK1;TNFRSF14                                  |
| hsa04910 | Insulin signaling pathway            | 1.61328357   | 0.00539374 | 9    | EIF4E;PHKG1;TSC1;TSC2                                            |
| hsa05231 | Choline metabolism in cancer         | 1.5763168    | 0.0030896  | 14   | TSC1;TSC2                                                        |
| hsa04211 | Longevity regulating pathway         | 1.59041059   | 0.00661521 | 7    | EIF4E;TSC1;TSC2                                                  |
| hsa04640 | Hematopoietic cell lineage           | -1.0538121   | 0.36082474 | 7    | CD3G;GP5;HLA-DQA1;ITGA2;ITGA3;ITGAM;TFRC                         |
| hsa03010 | Ribosome                             | 1.33807098   | 0.07331976 | 14   | MRPL1;MRPL17;MRPL32;MRPS10;MRPS12;RPL19;RPL27A;RPS13;RPS27L;RPSA |
| hsa04115 | p53 signaling pathway                | 1.3442413    | 0.07724426 | 13   | CDK1;TSC2                                                        |
| hsa04150 | mTOR signaling pathway               | 1.47487899   | 0.01004016 | 24   | EIF4E;FZD10;NPRL2;RPS6KA6;SLC7A5;TBC1D7;TSC1;TSC2                |
| hsa03022 | Basal transcription factors          | 1.34659342   | 0.11135857 | 7    | GTF2H4;TAF2;TAF7                                                 |
| hsa04216 | Ferroptosis                          | -1.003018    | 0.46666666 | 9    | ACSL4;ATG7;FTL;MAP1LC3A;MAP1LC3C;SLC39A14;SLC40A1;STEAP3;TFRC    |
| hsa04919 | Thyroid hormone signaling pathway    | 1.34742967   | 0.09284952 | 10   | TSC2                                                             |
| hsa01524 | Platinum drug resistance             | -1.0668721   | 0.34782608 | 8    | ABCC2;AKT2;BBC3;BIRC5;CASP9;GSTA3;GSTM3;GSTO2                    |
| hsa04012 | ErbB signaling pathway               | -1.1045096   | 0.28571428 | 5    | ABL2;AKT2;JUN;MAP2K2;PRKCB                                       |
| hsa05160 | Hepatitis C                          | -1.154562    | 0.23913043 | 6    | AKT2;CLDN14;CLDN4;IRF3;NR1H3;RIPK1                               |
| hsa04370 | VEGF signaling pathway               | -0.6652701   | 0.96350364 | 6    | AKT2;CASP9;MAP2K2;PLA2G4A;PLA2G4C;PRKCB                          |
| hsa04730 | Long-term depression                 | -0.7126874   | 0.91538461 | 6    | LYN;MAP2K2;PLA2G4A;PLA2G4C;PRKCB;PRKG2                           |
| hsa04514 | Cell adhesion molecules (CAMs)       | -1.2628601   | 0.17142857 | 8    | CLDN14;CLDN4;HLA-DQA1;ITGAM;MPZL1;NRXN1;PTPRC;SELL               |
| hsa04620 | Toll-like receptor signaling pathway | -1.2985066   | 0.12380952 | 7    | AKT2;FOS;IRF3;JUN;MAP2K2;RIPK1;TICAM2                            |
| hsa04917 | Prolactin signaling pathway          | -1.1642552   | 0.22222222 | 5    | AKT2;CCND2;CYP17A1;FOS;MAP2K2                                    |

Supplementary Figure 1. String Network analyses of Tier 1 candidates

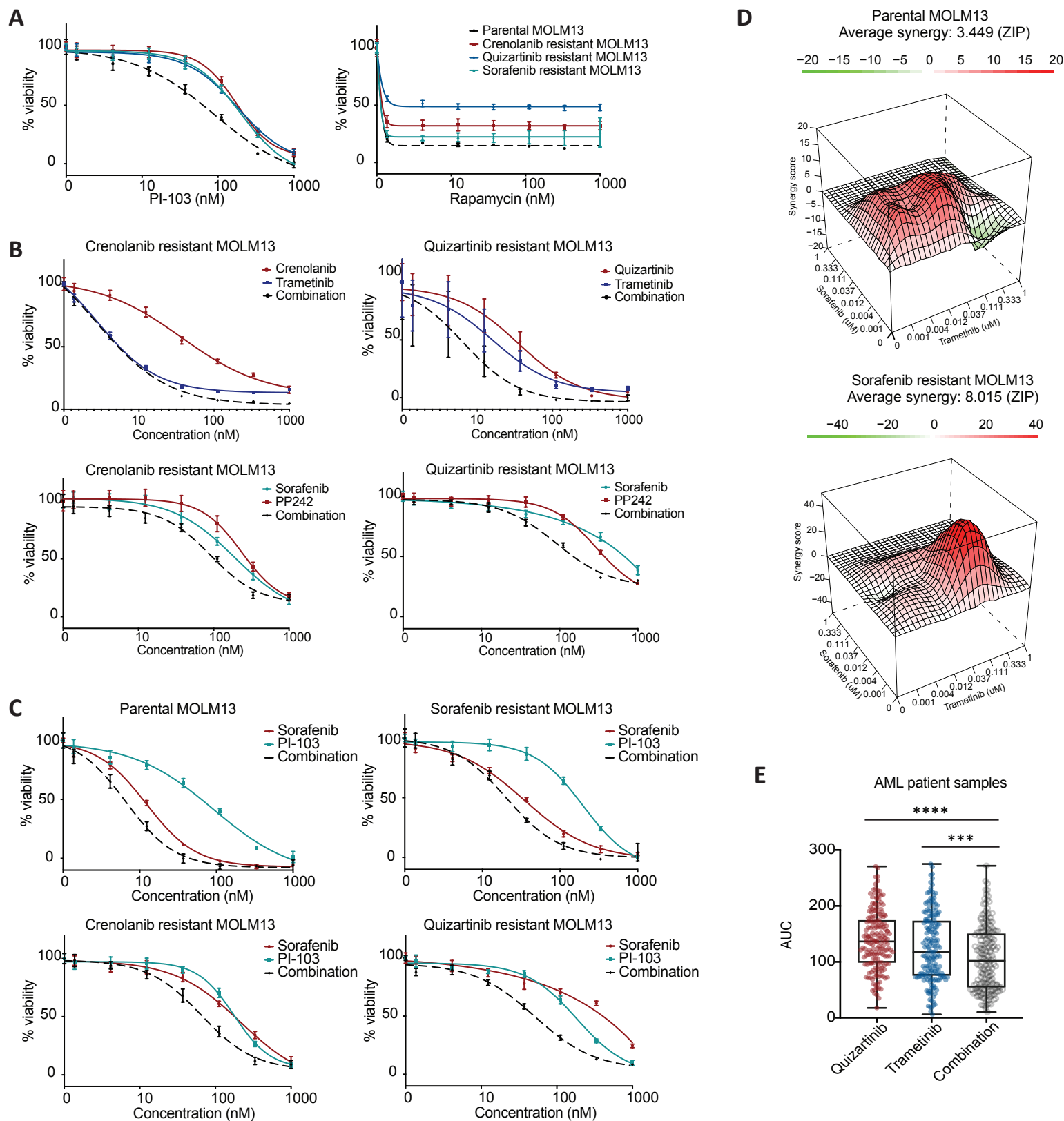




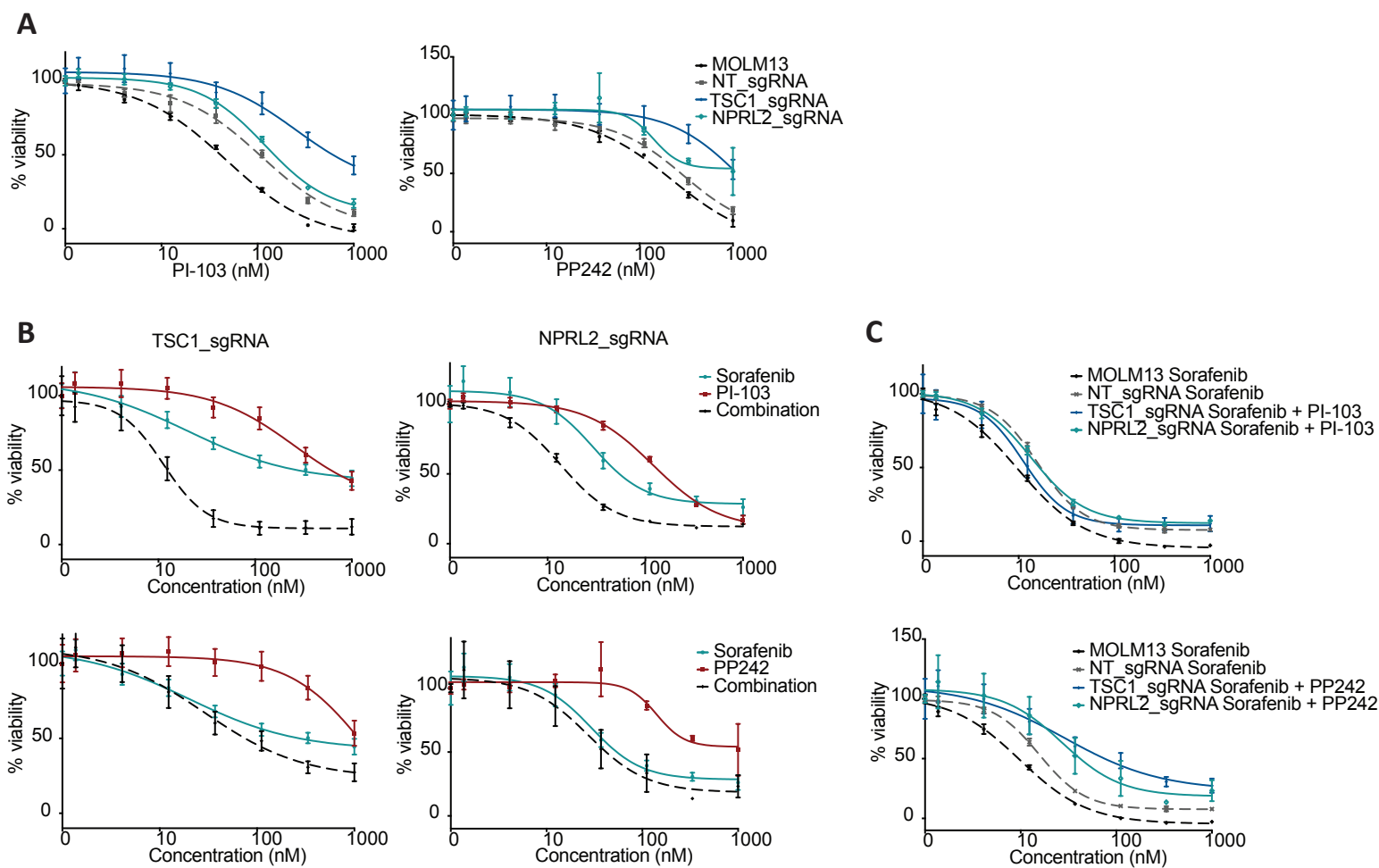
**Supplementary figure 2** Sorafenib sensitivity in TBC1D7 and DEPDC5 deficient MOLM13 cells. Cells were treated with 50nM sorafenib or vehicle alone (DMSO) for indicated times and the number of viable cells were determined using Guava® ViaCount™ (Luminex). Histogram represents number of viable cells in sorafenib treated cultures relative to vehicle alone.

**A****B**

**Supplementary figure 3** Validation of sgRNA efficiency using Western blot analysis and ICE assay. **A.** Immunoblot analysis of protein lysates from MOLM13 parental and MOLM13 transduced with non-targeting control, TSC1, TSC2, NPRL2, LZTR1, and NF1 sgRNAs using indicated antibodies. **B.** Analyses for sgRNA effectiveness in MOLM13 cells inactivated for LZTR1, TSC1, NF1 and NPRL2 individually using corresponding sgRNAs. Chromatograms were analyzed for percent of various deletions using ICE assay.



**Supplementary figure 4.** Evaluation of sensitivity to MTOR inhibitors and combination of FLT3 and trametinib or FLT3 and MTOR inhibitors. **A.** FLT3i-resistant MOLM13 cell lines described in Fig 3A were tested for sensitivity to MTOR inhibitors, PI-103 and rapamycin, in 72 hour drug sensitivity assays as described in Fig 3A. **B, C.** Dose response curves of indicated single agents or their combination on parental and FLT3 inhibitor resistant MOLM13 cells. Drug combinations were tested at equimolar concentrations and sensitivity was assessed as in Fig 3A. **D.** Surface plots generated by R\_SynergyFinder for the combination of sorafenib and trametinib on parental (top) or sorafenib resistant (bottom) MOLM13 cells. **E.** Scatter plots showing sensitivity to quizartinib, trametinib, or their combination as area under the dose response curve (AUC) in ex vivo AML patient samples (n =181). AUCs were analyzed using a one-way ANOVA/Friedman test: \*\*\* denotes  $p < 0.0001$ , \*\*\*\*,  $p < 0.00001$ , n.s.



**Supplementary figure 5.** Evaluation of sensitivity to MTOR inhibitors and combination of FLT3 and MTOR inhibitors in TSC1 and NPRL2 deficient cells. **A.** Sensitivity to MTOR inhibitors, PI-103 and PP242, of TSC1 and NPRL2 deficient MOLM13 cell lines were determined in 72 hour drug sensitivity assays as in Fig 3A. **B, C.** Dose response curves of indicated single agents or their combination on TSC1 and NPRL2 deficient MOLM13 cells. Drug combinations were tested at equimolar concentrations and sensitivity was assessed as in Fig 3A.