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| **Supplementary Table S1 CircRNA-miRNA-mRNA regulations in network** |
| mRNA | circRNA | miRNA | PCC | -log10 *p*-value |
| KLC2 | hsa\_circ\_0084333 | hsa-miR-3127-3p | 0.99  | 5.20  |
| KLC2 | hsa\_circ\_0084333 | hsa-miR-6765-5p | 0.99  | 5.20  |
| TPO | hsa\_circ\_0081368 | hsa-miR-4691-3p | 0.99  | 5.16  |
| MEN1 | hsa\_circ\_0086018 | hsa-miR-1207-5p | 0.98  | 4.69  |
| MEN1 | hsa\_circ\_0086018 | hsa-miR-4685-5p | 0.98  | 4.69  |
| MEN1 | hsa\_circ\_0086018 | hsa-miR-744-5p | 0.98  | 4.69  |
| MEN1 | hsa\_circ\_0086018 | hsa-miR-762 | 0.98  | 4.69  |
| BHLHA9 | hsa\_circ\_0045828 | hsa-miR-4739 | 0.98  | 4.42  |
| TNXB | hsa\_circ\_0118639 | hsa-miR-5193 | 0.97  | 4.34  |
| PDZD4 | hsa\_circ\_0081368 | hsa-miR-145-5p | 0.97  | 4.34  |
| PDZD4 | hsa\_circ\_0081368 | hsa-miR-4749-5p | 0.97  | 4.34  |
| PDZD4 | hsa\_circ\_0081368 | hsa-miR-6793-3p | 0.97  | 4.34  |
| LRRC31 | hsa\_circ\_0045828 | hsa-miR-6788-5p | 0.97  | 4.19  |
| KLC2 | hsa\_circ\_0086018 | hsa-miR-1207-5p | 0.97  | 4.18  |
| KLC2 | hsa\_circ\_0086018 | hsa-miR-149-5p | 0.97  | 4.18  |
| KLC2 | hsa\_circ\_0086018 | hsa-miR-4640-5p | 0.97  | 4.18  |
| KLC2 | hsa\_circ\_0086018 | hsa-miR-4685-5p | 0.97  | 4.18  |
| KLC2 | hsa\_circ\_0086018 | hsa-miR-6751-5p | 0.97  | 4.18  |
| KLC2 | hsa\_circ\_0086018 | hsa-miR-6803-5p | 0.97  | 4.18  |
| KLC2 | hsa\_circ\_0086018 | hsa-miR-6812-5p | 0.97  | 4.18  |
| KLC2 | hsa\_circ\_0086018 | hsa-miR-6836-5p | 0.97  | 4.18  |
| KLC2 | hsa\_circ\_0086018 | hsa-miR-7155-5p | 0.97  | 4.18  |
| RILPL2 | hsa\_circ\_0061761 | hsa-miR-4691-3p | 0.96  | 3.89  |
| KIFC3 | hsa\_circ\_0045828 | hsa-miR-5193 | 0.96  | 3.86  |
| KIFC3 | hsa\_circ\_0045828 | hsa-miR-6810-5p | 0.96  | 3.86  |
| TIGD5 | hsa\_circ\_0007372 | hsa-miR-6722-3p | 0.96  | 3.84  |
| MYCBP2 | hsa\_circ\_0045828 | hsa-miR-6861-5p | 0.96  | 3.81  |
| MYCBP2 | hsa\_circ\_0045828 | hsa-miR-6884-5p | 0.96  | 3.81  |
| MYCBP2 | hsa\_circ\_0045828 | hsa-miR-8073 | 0.96  | 3.81  |
| NPNT | hsa\_circ\_0045828 | hsa-miR-4739 | 0.96  | 3.80  |
| APBB1 | hsa\_circ\_0045828 | hsa-miR-3192-5p | 0.96  | 3.80  |
| APBB1 | hsa\_circ\_0045828 | hsa-miR-5193 | 0.96  | 3.80  |
| TTLL9 | hsa\_circ\_0045828 | hsa-miR-8073 | 0.96  | 3.73  |
| SYMPK | hsa\_circ\_0086913 | hsa-miR-330-5p | 0.96  | 3.72  |
| SYMPK | hsa\_circ\_0086913 | hsa-miR-4656 | 0.96  | 3.72  |
| SYMPK | hsa\_circ\_0086913 | hsa-miR-6829-3p | 0.96  | 3.72  |
| APP | hsa\_circ\_0073391 | hsa-miR-3064-5p | 0.96  | 3.66  |
| APP | hsa\_circ\_0073391 | hsa-miR-6787-5p | 0.96  | 3.66  |
| TTLL9 | hsa\_circ\_0081368 | hsa-miR-3667-3p | 0.95  | 3.63  |
| TTLL9 | hsa\_circ\_0081368 | hsa-miR-4685-3p | 0.95  | 3.63  |
| PCYT2 | hsa\_circ\_0081368 | hsa-miR-548b-3p | 0.95  | 3.61  |
| PCYT2 | hsa\_circ\_0081368 | hsa-miR-6889-5p | 0.95  | 3.61  |
| MYCBP2 | hsa\_circ\_0081368 | hsa-miR-520f-3p | 0.95  | 3.61  |
| MYCBP2 | hsa\_circ\_0081368 | hsa-miR-766-3p | 0.95  | 3.61  |
| TRAF4 | hsa\_circ\_0081368 | hsa-miR-1343-3p | 0.95  | 3.56  |
| TRAF4 | hsa\_circ\_0081368 | hsa-miR-6857-3p | 0.95  | 3.56  |
| KRTAP10-3 | hsa\_circ\_0037782 | hsa-miR-4722-5p | 0.95  | 3.55  |
| TPO | hsa\_circ\_0007372 | hsa-miR-6722-3p | 0.95  | 3.43  |
| PXN | hsa\_circ\_0007372 | hsa-miR-6846-5p | 0.94  | 3.40  |
| DNAJA3 | hsa\_circ\_0045828 | hsa-miR-5193 | 0.94  | 3.39  |
| FANCC | hsa\_circ\_0045828 | hsa-miR-3192-5p | 0.94  | 3.36  |
| MEN1 | hsa\_circ\_0045828 | hsa-miR-3192-5p | 0.94  | 3.35  |
| MEN1 | hsa\_circ\_0045828 | hsa-miR-6089 | 0.94  | 3.35  |
| SBK3 | hsa\_circ\_0086018 | hsa-miR-4685-5p | 0.94  | 3.35  |
| SBK3 | hsa\_circ\_0086018 | hsa-miR-6891-3p | 0.94  | 3.35  |
| SBK3 | hsa\_circ\_0086018 | hsa-miR-762 | 0.94  | 3.35  |
| HAGHL | hsa\_circ\_0065188 | hsa-miR-2277-3p | 0.94  | 3.34  |
| NKAIN1 | hsa\_circ\_0086018 | hsa-miR-4640-5p | 0.94  | 3.33  |
| NKAIN1 | hsa\_circ\_0086018 | hsa-miR-608 | 0.94  | 3.33  |
| NKAIN1 | hsa\_circ\_0086018 | hsa-miR-6756-5p | 0.94  | 3.33  |
| NKAIN1 | hsa\_circ\_0086018 | hsa-miR-6812-5p | 0.94  | 3.33  |
| NKAIN1 | hsa\_circ\_0086018 | hsa-miR-744-5p | 0.94  | 3.33  |
| NKAIN1 | hsa\_circ\_0086018 | hsa-miR-762 | 0.94  | 3.33  |
| MEN1 | hsa\_circ\_0078460 | hsa-miR-6744-5p | 0.94  | 3.32  |
| MEN1 | hsa\_circ\_0084333 | hsa-miR-3620-5p | 0.94  | 3.30  |
| MEN1 | hsa\_circ\_0084333 | hsa-miR-4505 | 0.94  | 3.30  |
| MEN1 | hsa\_circ\_0084333 | hsa-miR-5001-5p | 0.94  | 3.30  |
| MEN1 | hsa\_circ\_0084333 | hsa-miR-762 | 0.94  | 3.30  |
| DNAJC13 | hsa\_circ\_0078460 | hsa-miR-6509-3p | 0.94  | 3.29  |
| DNAJC22 | hsa\_circ\_0037782 | hsa-miR-212-5p | 0.94  | 3.28  |
| DNAJC22 | hsa\_circ\_0037782 | hsa-miR-4722-5p | 0.94  | 3.28  |
| DNAJC22 | hsa\_circ\_0037782 | hsa-miR-7107-5p | 0.94  | 3.28  |
| ZNF574 | hsa\_circ\_0081368 | hsa-miR-93-5p | 0.93  | 3.17  |
| APBB1 | hsa\_circ\_0007372 | hsa-miR-6873-3p | 0.93  | 3.17  |
| PDZD4 | hsa\_circ\_0045828 | hsa-miR-2392 | 0.93  | 3.16  |
| PDZD4 | hsa\_circ\_0045828 | hsa-miR-4268 | 0.93  | 3.16  |
| PDZD4 | hsa\_circ\_0045828 | hsa-miR-5193 | 0.93  | 3.16  |
| PDZD4 | hsa\_circ\_0045828 | hsa-miR-6089 | 0.93  | 3.16  |
| NSMF | hsa\_circ\_0084333 | hsa-miR-1587 | 0.93  | 3.12  |
| NSMF | hsa\_circ\_0084333 | hsa-miR-3620-5p | 0.93  | 3.12  |
| NSMF | hsa\_circ\_0084333 | hsa-miR-762 | 0.93  | 3.12  |
| NPNT | hsa\_circ\_0007372 | hsa-miR-6722-3p | 0.93  | 3.10  |
| NSMF | hsa\_circ\_0086018 | hsa-miR-1207-5p | 0.93  | 3.09  |
| NSMF | hsa\_circ\_0086018 | hsa-miR-4640-5p | 0.93  | 3.09  |
| NSMF | hsa\_circ\_0086018 | hsa-miR-4685-5p | 0.93  | 3.09  |
| NSMF | hsa\_circ\_0086018 | hsa-miR-4717-5p | 0.93  | 3.09  |
| NSMF | hsa\_circ\_0086018 | hsa-miR-4728-5p | 0.93  | 3.09  |
| NSMF | hsa\_circ\_0086018 | hsa-miR-608 | 0.93  | 3.09  |
| NSMF | hsa\_circ\_0086018 | hsa-miR-6751-5p | 0.93  | 3.09  |
| NSMF | hsa\_circ\_0086018 | hsa-miR-6756-5p | 0.93  | 3.09  |
| NSMF | hsa\_circ\_0086018 | hsa-miR-6803-5p | 0.93  | 3.09  |
| NSMF | hsa\_circ\_0086018 | hsa-miR-6806-5p | 0.93  | 3.09  |
| NSMF | hsa\_circ\_0086018 | hsa-miR-762 | 0.93  | 3.09  |
| PAX7 | hsa\_circ\_0086018 | hsa-miR-149-5p | 0.93  | 3.08  |
| PAX7 | hsa\_circ\_0086018 | hsa-miR-4268 | 0.93  | 3.08  |
| PAX7 | hsa\_circ\_0086018 | hsa-miR-4685-5p | 0.93  | 3.08  |
| PAX7 | hsa\_circ\_0086018 | hsa-miR-6751-5p | 0.93  | 3.08  |
| PAX7 | hsa\_circ\_0086018 | hsa-miR-6812-5p | 0.93  | 3.08  |
| PAX7 | hsa\_circ\_0086018 | hsa-miR-762 | 0.93  | 3.08  |
| CRTC1 | hsa\_circ\_0037782 | hsa-miR-4722-5p | 0.93  | 3.08  |
| NPNT | hsa\_circ\_0086018 | hsa-miR-608 | 0.93  | 3.06  |
| TM4SF1 | hsa\_circ\_0086913 | hsa-miR-103a-3p | 0.93  | 3.06  |
| TM4SF1 | hsa\_circ\_0086913 | hsa-miR-107 | 0.93  | 3.06  |
| FERMT3 | hsa\_circ\_0086913 | hsa-miR-4688 | 0.93  | 3.04  |
| PAX7 | hsa\_circ\_0007372 | hsa-miR-6846-5p | 0.93  | 3.03  |
| DNAJC22 | hsa\_circ\_0081368 | hsa-miR-93-5p | 0.93  | 3.02  |
| MGP | hsa\_circ\_0061761 | hsa-miR-3934-5p | 0.93  | 3.00  |
| FERMT3 | hsa\_circ\_0073391 | hsa-miR-3147 | 0.92  | 2.96  |
| FERMT3 | hsa\_circ\_0073391 | hsa-miR-6893-3p | 0.92  | 2.96  |
| TIGD5 | hsa\_circ\_0086018 | hsa-miR-1207-5p | 0.92  | 2.95  |
| TIGD5 | hsa\_circ\_0086018 | hsa-miR-4685-5p | 0.92  | 2.95  |
| TIGD5 | hsa\_circ\_0086018 | hsa-miR-7155-5p | 0.92  | 2.95  |
| TIGD5 | hsa\_circ\_0086018 | hsa-miR-7156-3p | 0.92  | 2.95  |
| TIGD5 | hsa\_circ\_0086018 | hsa-miR-762 | 0.92  | 2.95  |
| DNAJC22 | hsa\_circ\_0045828 | hsa-miR-8073 | 0.92  | 2.94  |
| DUS2 | hsa\_circ\_0081368 | hsa-miR-766-3p | 0.92  | 2.94  |
| MYCBP2 | hsa\_circ\_0086018 | hsa-miR-2861 | 0.92  | 2.93  |
| MYCBP2 | hsa\_circ\_0086018 | hsa-miR-4685-5p | 0.92  | 2.93  |
| MYCBP2 | hsa\_circ\_0086018 | hsa-miR-6806-5p | 0.92  | 2.93  |
| PAX7 | hsa\_circ\_0045828 | hsa-miR-4268 | 0.92  | 2.92  |
| PAX7 | hsa\_circ\_0045828 | hsa-miR-4739 | 0.92  | 2.92  |
| PAX7 | hsa\_circ\_0045828 | hsa-miR-6788-5p | 0.92  | 2.92  |
| PAX7 | hsa\_circ\_0045828 | hsa-miR-6861-5p | 0.92  | 2.92  |
| PXN | hsa\_circ\_0045828 | hsa-miR-4739 | 0.92  | 2.91  |
| EMD | hsa\_circ\_0086913 | hsa-miR-7161-3p | 0.92  | 2.89  |
| SYMPK | hsa\_circ\_0073391 | hsa-miR-15a-5p | 0.92  | 2.89  |
| SYMPK | hsa\_circ\_0073391 | hsa-miR-6749-5p | 0.92  | 2.89  |
| SYMPK | hsa\_circ\_0073391 | hsa-miR-6765-5p | 0.92  | 2.89  |
| SYMPK | hsa\_circ\_0073391 | hsa-miR-6893-3p | 0.92  | 2.89  |
| PAX7 | hsa\_circ\_0081368 | hsa-miR-326 | 0.92  | 2.89  |
| PAX7 | hsa\_circ\_0081368 | hsa-miR-4685-3p | 0.92  | 2.89  |
| FPGS | hsa\_circ\_0045828 | hsa-miR-130b-5p | 0.92  | 2.88  |
| VPS37D | hsa\_circ\_0086018 | hsa-miR-4640-5p | 0.92  | 2.88  |
| VPS37D | hsa\_circ\_0086018 | hsa-miR-4685-5p | 0.92  | 2.88  |
| VPS37D | hsa\_circ\_0086018 | hsa-miR-762 | 0.92  | 2.88  |
| PCYT2 | hsa\_circ\_0007372 | hsa-miR-6722-3p | 0.92  | 2.87  |
| NKAIN1 | hsa\_circ\_0081368 | hsa-miR-1976 | 0.92  | 2.87  |
| NKAIN1 | hsa\_circ\_0081368 | hsa-miR-6889-5p | 0.92  | 2.87  |
| PLB1 | hsa\_circ\_0037782 | hsa-miR-212-5p | 0.91  | 2.84  |
| TPO | hsa\_circ\_0086018 | hsa-miR-1207-5p | 0.91  | 2.82  |
| TPO | hsa\_circ\_0086018 | hsa-miR-608 | 0.91  | 2.82  |
| NPNT | hsa\_circ\_0037782 | hsa-miR-6740-3p | 0.91  | 2.78  |
| TRAF4 | hsa\_circ\_0045828 | hsa-miR-4739 | 0.91  | 2.78  |
| APBB1 | hsa\_circ\_0086018 | hsa-miR-149-5p | 0.91  | 2.77  |
| APBB1 | hsa\_circ\_0086018 | hsa-miR-6836-5p | 0.91  | 2.77  |
| APBB1 | hsa\_circ\_0086018 | hsa-miR-6891-3p | 0.91  | 2.77  |
| FAM189B | hsa\_circ\_0073391 | hsa-miR-1908-5p | 0.91  | 2.76  |
| FAM189B | hsa\_circ\_0073391 | hsa-miR-4739 | 0.91  | 2.76  |
| FAM189B | hsa\_circ\_0073391 | hsa-miR-6754-5p | 0.91  | 2.76  |
| FAM189B | hsa\_circ\_0073391 | hsa-miR-6893-3p | 0.91  | 2.76  |
| FAM189B | hsa\_circ\_0073391 | hsa-miR-7111-3p | 0.91  | 2.76  |
| PXN | hsa\_circ\_0086018 | hsa-miR-1207-5p | 0.91  | 2.76  |
| PXN | hsa\_circ\_0086018 | hsa-miR-149-5p | 0.91  | 2.76  |
| PXN | hsa\_circ\_0086018 | hsa-miR-6511a-5p | 0.91  | 2.76  |
| PXN | hsa\_circ\_0086018 | hsa-miR-6756-5p | 0.91  | 2.76  |
| PXN | hsa\_circ\_0086018 | hsa-miR-6780b-5p | 0.91  | 2.76  |
| PXN | hsa\_circ\_0086018 | hsa-miR-6836-5p | 0.91  | 2.76  |
| PXN | hsa\_circ\_0086018 | hsa-miR-762 | 0.91  | 2.76  |
| QSOX1 | hsa\_circ\_0118639 | hsa-miR-4421 | 0.91  | 2.75  |
| QSOX1 | hsa\_circ\_0118639 | hsa-miR-4731-5p | 0.91  | 2.75  |
| DNAJC13 | hsa\_circ\_0086018 | hsa-miR-6812-5p | 0.91  | 2.72  |
| SMIM1 | hsa\_circ\_0086913 | hsa-miR-3192-5p | 0.91  | 2.71  |
| SMIM1 | hsa\_circ\_0086913 | hsa-miR-3620-5p | 0.91  | 2.71  |
| SMIM1 | hsa\_circ\_0086913 | hsa-miR-4656 | 0.91  | 2.71  |
| DNAJC13 | hsa\_circ\_0081368 | hsa-miR-145-5p | 0.91  | 2.70  |
| DNAJC13 | hsa\_circ\_0081368 | hsa-miR-766-3p | 0.91  | 2.70  |
| PRSS3 | hsa\_circ\_0034846 | hsa-miR-541-3p | 0.90  | 2.70  |
| SGTA | hsa\_circ\_0037782 | hsa-miR-4524b-3p | 0.90  | 2.70  |
| SGTA | hsa\_circ\_0037782 | hsa-miR-6740-3p | 0.90  | 2.70  |
| NSMF | hsa\_circ\_0034846 | hsa-miR-874-5p | 0.90  | 2.69  |
| NKAIN1 | hsa\_circ\_0045828 | hsa-miR-6788-5p | 0.90  | 2.69  |
| ZER1 | hsa\_circ\_0086913 | hsa-miR-1182 | 0.90  | 2.67  |
| ZER1 | hsa\_circ\_0086913 | hsa-miR-4656 | 0.90  | 2.67  |
| ZER1 | hsa\_circ\_0086913 | hsa-miR-4688 | 0.90  | 2.67  |
| ZER1 | hsa\_circ\_0086913 | hsa-miR-6783-3p | 0.90  | 2.67  |
| RAB44 | hsa\_circ\_0045828 | hsa-miR-1273h-5p | 0.90  | 2.66  |
| RAB44 | hsa\_circ\_0045828 | hsa-miR-5193 | 0.90  | 2.66  |
| RAB44 | hsa\_circ\_0045828 | hsa-miR-6780a-5p | 0.90  | 2.66  |
| RAB44 | hsa\_circ\_0045828 | hsa-miR-6868-3p | 0.90  | 2.66  |
| TM4SF1 | hsa\_circ\_0073391 | hsa-miR-4446-3p | 0.90  | 2.66  |
| ZNF574 | hsa\_circ\_0084333 | hsa-miR-6081 | 0.90  | 2.66  |
| KIFC3 | hsa\_circ\_0007372 | hsa-miR-6846-5p | 0.90  | 2.65  |
| TNXB | hsa\_circ\_0013996 | hsa-miR-3616-3p | 0.90  | 2.65  |
| TNXB | hsa\_circ\_0013996 | hsa-miR-378a-3p | 0.90  | 2.65  |
| TNXB | hsa\_circ\_0013996 | hsa-miR-378c | 0.90  | 2.65  |
| TNXB | hsa\_circ\_0013996 | hsa-miR-378h | 0.90  | 2.65  |
| TIGD5 | hsa\_circ\_0037782 | hsa-miR-370-3p | 0.90  | 2.64  |