

ORIGINAL ARTICLE

Construction of ceRNA Regulatory Network in Human Oocytes

MingMing Liang^{1,2}, YongMei Tang^{1,2}, WenTing Zhou^{1,2}, Ming Zhang^{1,2},
LiLi Wie^{1,2}, Nan Li^{1,2}

¹Reproductive Medicine Center, Liuzhou Hospital of Guangzhou Women and Children's Medical Center, Liuzhou City,
Guangxi Zhuang Autonomous Region, China

²Guangxi Gynecology and Obstetrics Clinical Medical Research Center, Liuzhou City, Guangxi Zhuang Autonomous Region, China

SUMMARY

Background: Cryogenic freezing, often known as cryopreservation, is a technique for preserving human oocytes.

Methods: In this study, differentially expressed long non-coding RNAs (lncRNAs) and messenger RNAs (mRNAs) were identified using the human frozen oocyte dataset GSE69768 from the Gene Expression Database (GEO). Subsequently, combined with the microRNA atlas database, the miRNAs combined with differentially expressed lncRNAs (DELncRNAs) were predicted, and the lncRNA-miRNA-mRNA interaction relationship and competitive endogenous (ceRNA) regulatory network were obtained.

Results: The results revealed that multiple DELncRNAs and DEMRNAs were involved in the ceRNA network of the human oocyte. Finally, GO functional annotation and KEGG pathway enrichment analysis were performed on the differentially expressed mRNA (DEM RNA) in the ceRNA network, and the biological processes and pathways that may be related to the ceRNA network in frozen oocytes were explored.

Conclusions: In conclusion, in the ceRNA network for human oocyte, lncRNA, mRNA, and miRNA do not each operate via a distinct, independent mechanism. Not only does the RNA-RNA contact involve the ceRNA regulatory mechanism, but it also involves interactions between proteins that are encoded by genes. Furthermore, the negative effects of inter-individual variations and instability on the quality of high-throughput detection cannot be completely ruled out due to the paucity of human oocyte data containing both mRNA and lncRNA expression profiles.

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Correspondence:

Nan Li
Reproductive Medicine Center
Liuzhou Hospital of Guangzhou Women and
Children's Medical Center
No. 50, Boyuan Avenue
Yufeng District
Liuzhou City
Guangxi Zhuang Autonomous Region, 545001
China
Email: l_nanpetter@hotmail.com

Supplementary Data

Table S1. lncRNA, DEMRNA and miRNA in the ceRNA network.

Name	Regulation type of DElncRNA	Name	Regulation type of DEMRNA	Name	Regulation type of DEMRNA	Name	Type
SHANK2-AS3	Up	HDAC4	up	MXD1	down	miR-17-5p	miRNA
TTY14	Up	SP1	up	ITGAV	down	miR-31	miRNA
LINC00334	Up	MAPK14	up	DNAJB11	down	miR-145	miRNA
LINC00265	Up	KLF13	up	CD36	down	miR-155	miRNA
C9orf163	Up	APP	up	ARRDC4	down	miR-221	miRNA
TERC	Up	ARID4B	up	PEG3	down	miR-205	miRNA
MEG3	Up	RARA	up	IL15RA	down	miR-206	miRNA
LINC00243	Up	RPL29	up	PDK1	down	miR-128	miRNA
HCG18	Up	IRAK1	up	PLAG1	down	miR-365-3p	miRNA
IDI2-AS1	Up	DAPK1	up	MAPK9	down	miR-375	miRNA
LINC00504	Up	SAMD11	up	LACTB	down	miR-107	miRNA
LINC00471	Down	UCHL3	up	E2F3	down	miR-140-5p	miRNA
SNHG6	Down	RLF	up	MYCBP	down	miR-27a-3p	miRNA
AACSP1	Down	CHPF	up	MAP3K7	down	miR-24-3p	miRNA
		ELL2	up	LIN28B	down	miR-125b-5p	miRNA
		JPT1	up	RGS2	down	miR-22-3p	miRNA
		ZNF776	up	XIAP	down	miR-20b-5p	miRNA
		TPSG1	up	RND3	down	miR-125a-5p	miRNA
		GATAD2A	up	HK2	down	miR-146b-5p	miRNA
		CSNK1G2	up	TAB3	down	miR-10a-5p	miRNA
		CTCF	up	CHUK	down	miR-429	miRNA
		AGPAT3	up	RCOR1	down	miR-23b-3p	miRNA
		MED24	up	RIN2	down	miR-425-5p	miRNA
		MARCKSL1	up	MZT1	down	miR-142-3p	miRNA
		CTDSP1	up	RRAGB	down	miR-193a-3p	miRNA
		COMMD9	up	ENAH	down	miR-217	miRNA
		PLAGL2	up	DNAJC2	down	miR-139-5p	miRNA
		TSC22D4	up	MRE11	down	miR-1297	miRNA
		CCDC8	up	IGFBP3	down	miR-363-3p	miRNA
		PPP2R5E	up	WTAP	down	miR-301b-3p	miRNA
		LBX2	up	SP110	down	miR-137	miRNA
		RPS2	up	RRAGC	down	miR-212-3p	miRNA
		CGNL1	up	SNX25	down	miR-129-5p	miRNA
		AGTRAP	up	EBAG9	down	miR-135a-5p	miRNA
		THAP3	up	CYP20A1	down	miR-490-3p	miRNA
		CHPF2	up	C11orf54	down	miR-613	miRNA
		GRINA	up	CSTF2	down	miR-508-3p	miRNA
		HSPBP1	up	ZNF404	down	miR-590-5p	miRNA
		EXTL3	up	KLHL7	down	miR-449c-5p	miRNA
		WNK1	up	CMAS	down	miR-338-3p	miRNA
		ATF7IP	up	SERP1	down	miR-216b-5p	miRNA

ceRNA Network in Human Oocytes

Name	Regulation type of DEIncRNA	Name	Regulation type of DEmRNA	Name	Regulation type of DEmRNA	Name	Type
		NSD1	up	CORO1C	down	miR-184	miRNA
		RTKN2	up	PHTF2	down	miR-455-5p	miRNA
		PSMD13	up	HERPUD1	down		
		EHD4	up	STX3	down		
		ATF3	up	RAB28	down		
		NOC2L	up	CUL5	down		
		NUCKS1	up	ALMS1	down		
		DCAF1	up	TTC7B	down		
		PPP2R1A	up	PHF20L1	down		
		STIL	up	NUMB	down		
		CDH5	up	HSP90AA1	down		
		SLC7A5	up	GJA1	down		
		KRT10	up	ERMP1	down		
		MINK1	up	ZNF701	down		
		TET3	up	ALAD	down		
		BLOC1S3	up	NCKAP1	down		
		FGFRL1	up	DNAJB4	down		
		CASP2	up	RPE	down		
		PIP5K1A	up	C9orf72	down		
		GPRC5A	up	ACAT1	down		
		SLCO3A1	up	BLOC1S2	down		
		EVI5L	up	SERBP1	down		
		LGALS1	up	CMPK1	down		
		DOCK3	up	LBR	down		
		MAFB	up	MYO9A	down		
		ZFPM1	up	TBPL1	down		
		NUDT8	up	SNRPB2	down		
		AKT1S1	up	GTF2E1	down		
		SIGLEC14	up	NAE1	down		
		GUF1	up	NASP	down		
		ZNF367	up	BCL2L2	down		
		STK38	up	MAG11	down		
		PATL1	up	SLC35B2	down		
		TSPAN1	up	RRP12	down		
		CSNK1A1	up	ADD3	down		
		C8orf58	up	HMGB2	down		
		CTPS2	up	NET1	down		
		VAV3	up	PCNA	down		
		PDRG1	up	GAB1	down		
		RTL8A	up	TPM4	down		
		CPEB2	up	NME2	down		
		PNMA8B	up	NPM1	down		
		MORC1	up	LAMB1	down		
		AP3B2	up	WDR11	down		
		EPS15L1	up	ACLY	down		

Name	Regulation type of DEIncRNA	Name	Regulation type of DEmRNA	Name	Regulation type of DEmRNA	Name	Type
		BCL2L15	up	NSUN2	down		
		PAK2	up	FAM199X	down		
		LY6G5B	up	NRARP	down		
		DMPK	up	RYBP	down		
		SSU72	up	HERC3	down		
		F2RL3	up	PPM1A	down		
		RACGAP1	up	ZMYM2	down		
		DCUN1D3	up	PPARGC1B	down		
		N4BP1	up	PDCD6IP	down		
		RANGAP1	up	SLC16A1	down		
		PRKCD	up	KLHL2	down		
		HLA-E	up	GTF2I	down		
		LHX9	up	POLR2A	down		
		XRCC2	up	HSPA4	down		
		PTAFR	up	NUP37	down		
		MPIG6B	up	STT3A	down		
		NUGGC	up	ERLIN1	down		
		ENTPD4	up	TRPM7	down		
		GOLGA2	up	SLC26A2	down		
		SLK	up	ATG3	down		
		ITPKB	up	NF2	down		
		GYS1	up	RPAIN	down		
		PIN1	up	RPS18	down		
		MTA1	up	CUL1	down		
		HYOU1	up	ZNF638	down		
		BCAR1	up	RANBP1	down		
		PPP1R14B	up	DDX5	down		
		PTPA	up	RBM39	down		
		RRAS	up	PIGS	down		
		RBM38	up	ASNS	down		
		VPS18	up	AZIN1	down		
		GPR75	up	CNEP1R1	down		
		ZDHHC24	up	RPL7	down		
		ASB8	up	OFD1	down		
		CLDN19	up	GPM6A	down		
				NBR1	down		
				ARPC2	down		
				CCT6A	down		
				CPS1	down		
				FXR2	down		
				PCTP	down		
				RAP1B	down		
				VPS4B	down		
				SHOC2	down		
				PFKP	down		

ceRNA Network in Human Oocytes

Name	Regulation type of DEIncRNA	Name	Regulation type of DEmRNA	Name	Regulation type of DEmRNA	Name	Type
				TSNAX	down		
				NHLRC3	down		
				RAB12	down		
				UBXN4	down		
				TANC1	down		
				USP13	down		
				TMA16	down		
				RRS1	down		
				KLHL15	down		
				ACADSB	down		
				DYNC2LI1	down		
				CHIC1	down		
				MOB4	down		
				SKIL	down		
				SERF1A	down		
				ANP32B	down		
				ZNF449	down		
				EIF1AX	down		
				PPP1R14C	down		
				ARID1B	down		
				COPG1	down		
				GPD2	down		
				SUCO	down		
				TP63	down		
				TACC3	down		
				TMEM59	down		
				KIF5B	down		
				ATP2B1	down		
				PFKFB2	down		
				VPS50	down		
				METRNL	down		
				PHF14	down		
				MED30	down		
				SNRPE	down		
				C9orf78	down		
				SNRPD1	down		
				PSPC1	down		
				PHAX	down		
				PDHX	down		
				GTF2A1	down		
				ERGIC2	down		
				CDC5L	down		
				PPIL4	down		
				ARHGEF28	down		
				CYP1A1	down		

Name	Regulation type of DEIncRNA	Name	Regulation type of DEmRNA	Name	Regulation type of DEmRNA	Name	Type
				ZDHHC21	down		
				ZNF485	down		
				DNAJA1	down		
				CLEC2D	down		
				SREK1	down		
				CAMSAP2	down		
				C9orf40	down		
				MRPL51	down		
				ZNF202	down		
				PCMTD1	down		
				HNRNPR	down		
				ZNF682	down		
				ZNF641	down		
				PAWR	down		
				PSMA2	down		
				HYPK	down		
				GPATCH11	down		
				XIRP2	down		
				ICOSLG	down		
				ADCY7	down		
				DNAJC21	down		
				PRPF38B	down		
				GOLGA3	down		
				BUB1	down		
				RAB32	down		
				SESN3	down		
				RUNX1T1	down		
				PAG1	down		
				ENTPD5	down		
				HDDC2	down		
				DSN1	down		
				TRIM59	down		
				HDGFL2	down		
				DAD1	down		
				HNRNPD1	down		
				CBX1	down		
				BRAP	down		
				SDE2	down		
				YEATS4	down		
				EIF4A2	down		
				ZNF662	down		
				ZWINT	down		
				HNRNPA1L2	down		
				GTF2H1	down		
				CCDC77	down		

ceRNA Network in Human Oocytes

Name	Regulation type of DEIncRNA	Name	Regulation type of DEmRNA	Name	Regulation type of DEmRNA	Name	Type
				WDR53	down		
				DUSP10	down		
				LRAT	down		
				PAPOLA	down		
				NGDN	down		
				CBX5	down		
				GRK4	down		
				ZSCAN29	down		
				C17orf75	down		
				FBXL2	down		
				FAM9C	down		
				RAB3GAP2	down		
				PHF7	down		
				ZNF623	down		
				DBF4	down		
				LIAS	down		
				ESF1	down		
				SLC25A25	down		
				DYM	down		
				FOSL2	down		
				GTF2H5	down		
				TAF1	down		
				GTF3C6	down		
				MTO1	down		
				SNX1	down		
				TTC9C	down		
				PNPLA3	down		
				RMND1	down		
				ZNF7	down		
				MSH3	down		
				SERINC1	down		
				ACOT13	down		
				TOPBP1	down		
				SPAST	down		
				NCAPG2	down		
				HNRNPA3	down		
				ZNF770	down		
				VPS13C	down		
				UBR5	down		
				TMEM123	down		
				TCF4	down		
				AKTIP	down		
				NTN4	down		
				SAP30	down		
				XRCC1	down		

Name	Regulation type of DElncRNA	Name	Regulation type of DEmRNA	Name	Regulation type of DEmRNA	Name	Type
				TYMS	down		
				PINK1	down		
				C1GALT1C1	down		
				RPL23	down		
				KANSL3	down		
				RBM26	down		
				RNF14	down		
				RPS6KA6	down		
				CASP7	down		
				EXOSC3	down		
				MXD2	down		

Table S2. lncRNA-miRNA-mRNA interaction relationship.

Node 1	Node 2	Line	Node 1	Node 2	Line
SHANK2-AS3	miR-145	lncRNA	miR-17-5p	MXD1	miRNA
SHANK2-AS3	miR-146b-5p	lncRNA	miR-31	ITGAV	miRNA
SHANK2-AS3	miR-205	lncRNA	miR-145	DNAJB11	miRNA
SHANK2-AS3	miR-24-3p	lncRNA	miR-155	CD36	miRNA
SHANK2-AS3	miR-27a-3p	lncRNA	miR-221	ARRDC4	miRNA
TTYTY14	miR-137	lncRNA	miR-205	PEG3	miRNA
TTYTY14	miR-146b-5p	lncRNA	miR-205	IL15RA	miRNA
TTYTY14	miR-17-5p	lncRNA	miR-206	HDAC4	miRNA
TTYTY14	miR-20b-5p	lncRNA	miR-128	SP1	miRNA
TTYTY14	miR-184	lncRNA	miR-365-3p	HDAC4	miRNA
TTYTY14	miR-205	lncRNA	miR-375	PDK1	miRNA
TTYTY14	miR-217	lncRNA	miR-107	PLAG1	miRNA
TTYTY14	miR-508-3p	lncRNA	miR-140-5p	HDAC4	miRNA
TTYTY14	miR-22-3p	lncRNA	miR-27a-3p	SP1	miRNA
TTYTY14	miR-24-3p	lncRNA	miR-24-3p	MAPK14	miRNA
TTYTY14	miR-1297	lncRNA	miR-375	PLAG1	miRNA
TTYTY14	miR-31	lncRNA	miR-125b-5p	KLF13	miRNA
TTYTY14	miR-338-3p	lncRNA	miR-17-5p	APP	miRNA
TTYTY14	miR-125a-5p	lncRNA	miR-22-3p	HDAC4	miRNA
TTYTY14	miR-125b-5p	lncRNA	miR-20b-5p	ARID4B	miRNA
TTYTY14	miR-10a-5p	lncRNA	miR-17-5p	MAPK9	miRNA
TTYTY14	miR-129-5p	lncRNA	miR-125a-5p	RARA	miRNA
TTYTY14	miR-490-3p	lncRNA	miR-125b-5p	LACTB	miRNA
LINC00471	miR-216b-5p	lncRNA	miR-125b-5p	RPL29	miRNA
LINC00471	miR-24-3p	lncRNA	miR-125a-5p	KLF13	miRNA
LINC00471	miR-1297	lncRNA	miR-146b-5p	IRAK1	miRNA
LINC00471	miR-490-3p	lncRNA	miR-125b-5p	E2F3	miRNA
LINC00334	miR-145	lncRNA	miR-22-3p	MYCBP	miRNA

Node 1	Node 2	Line	Node 1	Node 2	Line
LINC00334	miR-449c-5p	lncRNA	miR-10a-5p	MAP3K7	miRNA
LINC00265	miR-212-3p	lncRNA	miR-125b-5p	LIN28B	miRNA
LINC00265	miR-139-5p	lncRNA	miR-17-5p	E2F3	miRNA
LINC00265	miR-184	lncRNA	miR-22-3p	RGS2	miRNA
LINC00265	miR-193a-3p	lncRNA	miR-429	XIAP	miRNA
LINC00265	miR-216b-5p	lncRNA	miR-17-5p	RND3	miRNA
LINC00265	miR-217	lncRNA	miR-107	DAPK1	miRNA
LINC00265	miR-24-3p	lncRNA	miR-375	SP1	miRNA
LINC00265	miR-31	lncRNA	miR-125a-5p	HK2	miRNA
LINC00265	miR-107	lncRNA	miR-125b-5p	HK2	miRNA
LINC00265	miR-338-3p	lncRNA	miR-23b-3p	TAB3	miRNA
LINC00265	miR-10a-5p	lncRNA	miR-23b-3p	CHUK	miRNA
C9orf163	miR-205	lncRNA	miR-125b-5p	MAPK14	miRNA
C9orf163	miR-590-5p	lncRNA	miR-22-3p	RCOR1	miRNA
C9orf163	miR-107	lncRNA	miR-22-3p	SP1	miRNA
C9orf163	miR-425-5p	lncRNA	miR-429	RIN2	miRNA
C9orf163	miR-125a-5p	lncRNA	miR-425-5p	MZT1	miRNA
C9orf163	miR-125b-5p	lncRNA	miR-375	RRAGB	miRNA
TERC	miR-449c-5p	lncRNA	miR-375	SAMD11	miRNA
TERC	miR-129-5p	lncRNA	miR-375	ENAH	miRNA
MEG3	miR-301b-3p	lncRNA	miR-375	DNAJC2	miRNA
MEG3	miR-212-3p	lncRNA	miR-375	UCLH3	miRNA
MEG3	miR-135a-5p	lncRNA	miR-375	MRE11	miRNA
MEG3	miR-140-5p	lncRNA	miR-375	IGFBP3	miRNA
MEG3	miR-142-3p	lncRNA	miR-375	WTAP	miRNA
MEG3	miR-145	lncRNA	miR-375	SP110	miRNA
MEG3	miR-155	lncRNA	miR-375	RRAGC	miRNA
MEG3	miR-17-5p	lncRNA	miR-375	SNX25	miRNA
MEG3	miR-20b-5p	lncRNA	miR-375	EBAG9	miRNA
MEG3	miR-184	lncRNA	miR-375	CYP20A1	miRNA
MEG3	miR-206	lncRNA	miR-375	C11orf54	miRNA
MEG3	miR-613	lncRNA	miR-375	CSTF2	miRNA
MEG3	miR-429	lncRNA	miR-375	RLF	miRNA
MEG3	miR-205	lncRNA	miR-375	ZNF404	miRNA
MEG3	miR-590-5p	lncRNA	miR-375	KLHL7	miRNA
MEG3	miR-216b-5p	lncRNA	miR-375	CMAS	miRNA
MEG3	miR-217	lncRNA	miR-375	CHPF	miRNA
MEG3	miR-508-3p	lncRNA	miR-375	HK2	miRNA
MEG3	miR-22-3p	lncRNA	miR-375	SERP1	miRNA
MEG3	miR-221	lncRNA	miR-375	CORO1C	miRNA
MEG3	miR-23b-3p	lncRNA	miR-375	PHTF2	miRNA
MEG3	miR-24-3p	lncRNA	miR-375	HERPUD1	miRNA
MEG3	miR-1297	lncRNA	miR-375	STX3	miRNA
MEG3	miR-27a-3p	lncRNA	miR-375	RAB28	miRNA
MEG3	miR-31	lncRNA	miR-375	CUL5	miRNA
MEG3	miR-107	lncRNA	miR-375	ALMS1	miRNA
MEG3	miR-338-3p	lncRNA	miR-375	ELL2	miRNA

Node 1	Node 2	Line	Node 1	Node 2	Line
MEG3	miR-365-3p	lncRNA	miR-375	TTC7B	miRNA
MEG3	miR-449c-5p	lncRNA	miR-375	PHF20L1	miRNA
MEG3	miR-125a-5p	lncRNA	miR-375	NUMB	miRNA
MEG3	miR-125b-5p	lncRNA	miR-375	JPT1	miRNA
MEG3	miR-10a-5p	lncRNA	miR-375	HSP90AA1	miRNA
MEG3	miR-455-5p	lncRNA	miR-206	GJA1	miRNA
MEG3	miR-128	lncRNA	miR-125a-5p	CORO1C	miRNA
MEG3	miR-129-5p	lncRNA	miR-125a-5p	ZNF776	miRNA
MEG3	miR-490-3p	lncRNA	miR-125a-5p	ERMP1	miRNA
LINC00243	miR-135a-5p	lncRNA	miR-142-3p	ZNF701	miRNA
LINC00243	miR-145	lncRNA	miR-142-3p	TPSG1	miRNA
LINC00243	miR-17-5p	lncRNA	miR-142-3p	ALAD	miRNA
LINC00243	miR-20b-5p	lncRNA	miR-142-3p	NCKAP1	miRNA
LINC00243	miR-206	lncRNA	miR-142-3p	ENAH	miRNA
LINC00243	miR-613	lncRNA	miR-142-3p	DNAJB4	miRNA
LINC00243	miR-205	lncRNA	miR-142-3p	RPE	miRNA
LINC00243	miR-24-3p	lncRNA	miR-142-3p	ITGAV	miRNA
LINC00243	miR-338-3p	lncRNA	miR-142-3p	C9orf72	miRNA
LINC00243	miR-375	lncRNA	miR-23b-3p	ACAT1	miRNA
LINC00243	miR-10a-5p	lncRNA	miR-23b-3p	BLOC1S2	miRNA
LINC00243	miR-455-5p	lncRNA	miR-10a-5p	SERBP1	miRNA
LINC00243	miR-129-5p	lncRNA	miR-10a-5p	CMPK1	miRNA
HCG18	miR-301b-3p	lncRNA	miR-10a-5p	GATAD2A	miRNA
HCG18	miR-212-3p	lncRNA	miR-107	CSNK1G2	miRNA
HCG18	miR-135a-5p	lncRNA	miR-27a-3p	PLAG1	miRNA
HCG18	miR-137	lncRNA	miR-27a-3p	LBR	miRNA
HCG18	miR-142-3p	lncRNA	miR-27a-3p	MYO9A	miRNA
HCG18	miR-145	lncRNA	miR-24-3p	TBPL1	miRNA
HCG18	miR-146b-5p	lncRNA	miR-24-3p	SNRPB2	miRNA
HCG18	miR-155	lncRNA	miR-24-3p	GTF2E1	miRNA
HCG18	miR-17-5p	lncRNA	miR-24-3p	CYP20A1	miRNA
HCG18	miR-20b-5p	lncRNA	miR-24-3p	NAE1	miRNA
HCG18	miR-193a-3p	lncRNA	miR-24-3p	NASP	miRNA
HCG18	miR-206	lncRNA	miR-24-3p	CTCF	miRNA
HCG18	miR-613	lncRNA	miR-24-3p	BCL2L2	miRNA
HCG18	miR-205	lncRNA	miR-24-3p	MAGI1	miRNA
HCG18	miR-216b-5p	lncRNA	miR-24-3p	SLC35B2	miRNA
HCG18	miR-217	lncRNA	miR-24-3p	AGPAT3	miRNA
HCG18	miR-22-3p	lncRNA	miR-24-3p	RRP12	miRNA
HCG18	miR-23b-3p	lncRNA	miR-24-3p	MED24	miRNA
HCG18	miR-24-3p	lncRNA	miR-24-3p	MARCKSL1	miRNA
HCG18	miR-363-3p	lncRNA	miR-24-3p	ADD3	miRNA
HCG18	miR-27a-3p	lncRNA	miR-24-3p	LBR	miRNA
HCG18	miR-107	lncRNA	miR-24-3p	E2F3	miRNA
HCG18	miR-338-3p	lncRNA	miR-24-3p	CTDSP1	miRNA
HCG18	miR-365-3p	lncRNA	miR-24-3p	COMMD9	miRNA
HCG18	miR-449c-5p	lncRNA	miR-24-3p	HMGB2	miRNA

Node 1	Node 2	Line	Node 1	Node 2	Line
HCG18	miR-375	lncRNA	miR-24-3p	PLAGL2	miRNA
HCG18	miR-128	lncRNA	miR-24-3p	NET1	miRNA
HCG18	miR-129-5p	lncRNA	miR-24-3p	PCNA	miRNA
IDI2-AS1	miR-212-3p	lncRNA	miR-22-3p	TSC22D4	miRNA
IDI2-AS1	miR-145	lncRNA	miR-17-5p	GAB1	miRNA
IDI2-AS1	miR-146b-5p	lncRNA	miR-425-5p	HSP90AA1	miRNA
IDI2-AS1	miR-205	lncRNA	miR-193a-3p	SNRPB2	miRNA
IDI2-AS1	miR-217	lncRNA	miR-193a-3p	CCDC8	miRNA
IDI2-AS1	miR-221	lncRNA	miR-125a-5p	PPP2R5E	miRNA
IDI2-AS1	miR-338-3p	lncRNA	miR-125a-5p	LIN28B	miRNA
IDI2-AS1	miR-449c-5p	lncRNA	miR-125a-5p	LBX2	miRNA
IDI2-AS1	miR-455-5p	lncRNA	miR-125a-5p	SP1	miRNA
SNHG6	miR-135a-5p	lncRNA	miR-125a-5p	RPS2	miRNA
SNHG6	miR-137	lncRNA	miR-125a-5p	TPM4	miRNA
SNHG6	miR-139-5p	lncRNA	miR-125a-5p	NME2	miRNA
SNHG6	miR-146b-5p	lncRNA	miR-125a-5p	CGNL1	miRNA
SNHG6	miR-193a-3p	lncRNA	miR-125a-5p	NPM1	miRNA
SNHG6	miR-429	lncRNA	miR-125a-5p	AGTRAP	miRNA
SNHG6	miR-205	lncRNA	miR-125a-5p	LAMB1	miRNA
SNHG6	miR-22-3p	lncRNA	miR-125b-5p	XIAP	miRNA
SNHG6	miR-24-3p	lncRNA	miR-125b-5p	THAP3	miRNA
SNHG6	miR-1297	lncRNA	miR-125b-5p	WDR11	miRNA
SNHG6	miR-27a-3p	lncRNA	miR-125b-5p	ACLY	miRNA
SNHG6	miR-449c-5p	lncRNA	miR-125b-5p	NPM1	miRNA
SNHG6	miR-490-3p	lncRNA	miR-125b-5p	NSUN2	miRNA
LINC00504	miR-212-3p	lncRNA	miR-125b-5p	CHPF2	miRNA
LINC00504	miR-140-5p	lncRNA	miR-125b-5p	LBX2	miRNA
LINC00504	miR-205	lncRNA	miR-125b-5p	CTDSP1	miRNA
LINC00504	miR-24-3p	lncRNA	miR-125b-5p	GRINA	miRNA
LINC00504	miR-363-3p	lncRNA	miR-125b-5p	HSPBP1	miRNA
LINC00504	miR-338-3p	lncRNA	miR-125b-5p	EXTL3	miRNA
LINC00504	miR-375	lncRNA	miR-125b-5p	WNK1	miRNA
LINC00504	miR-128	lncRNA	miR-125b-5p	FAM199X	miRNA
LINC00504	miR-129-5p	lncRNA	miR-125b-5p	NRARP	miRNA
AACSP1	miR-301b-3p	lncRNA	miR-125b-5p	NME2	miRNA
AACSP1	miR-135a-5p	lncRNA	miR-125b-5p	RYBP	miRNA
AACSP1	miR-137	lncRNA	miR-23b-3p	HERC3	miRNA
AACSP1	miR-140-5p	lncRNA	miR-23b-3p	PPM1A	miRNA
AACSP1	miR-590-5p	lncRNA	miR-23b-3p	ATF7IP	miRNA
AACSP1	miR-22-3p	lncRNA	miR-23b-3p	ZMYM2	miRNA
AACSP1	miR-221	lncRNA	miR-23b-3p	GJA1	miRNA
AACSP1	miR-24-3p	lncRNA	miR-23b-3p	PPARGC1B	miRNA
AACSP1	miR-1297	lncRNA	miR-23b-3p	PDCD6IP	miRNA
AACSP1	miR-27a-3p	lncRNA	miR-23b-3p	SLC16A1	miRNA
AACSP1	miR-31	lncRNA	miR-23b-3p	KLHL2	miRNA
AACSP1	miR-107	lncRNA	miR-23b-3p	LBR	miRNA
AACSP1	miR-338-3p	lncRNA	miR-23b-3p	NSD1	miRNA

Node 1	Node 2	Line	Node 1	Node 2	Line
AACSP1	miR-125a-5p	lncRNA	miR-23b-3p	GTF2I	miRNA
AACSP1	miR-125b-5p	lncRNA	miR-23b-3p	NPM1	miRNA
AACSP1	miR-128	lncRNA	miR-10a-5p	HSP90AA1	miRNA
AACSP1	miR-129-5p	lncRNA	miR-10a-5p	EXTL3	miRNA