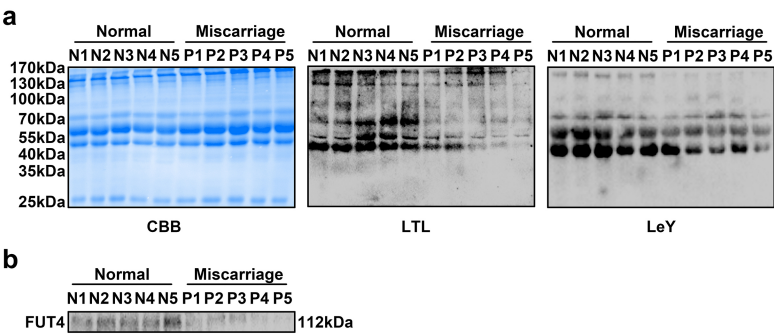


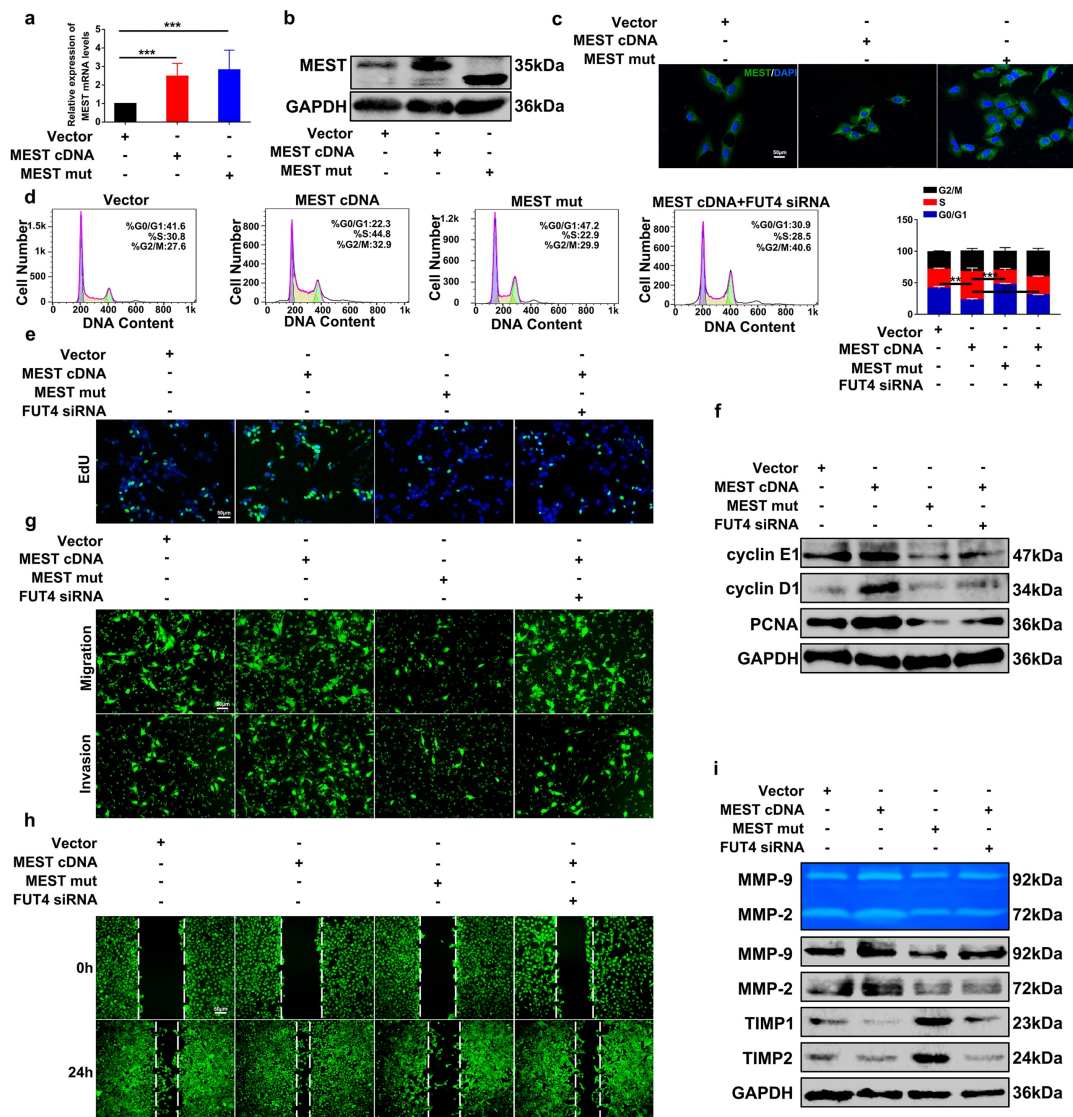
Supplementary

Supplementary Fig. 1



Supplementary Fig. 1 Levels of α 1,3-fucosylation, LeY and FUT4 in serum from early pregnant women and miscarriage patients. a Lectin blot and western blot analysis showed the α 1,3-linkage fucose and LeY levels in serum from early pregnancy women and abortion patients. **b** Detection of FUT4 expression Western blot in serum.

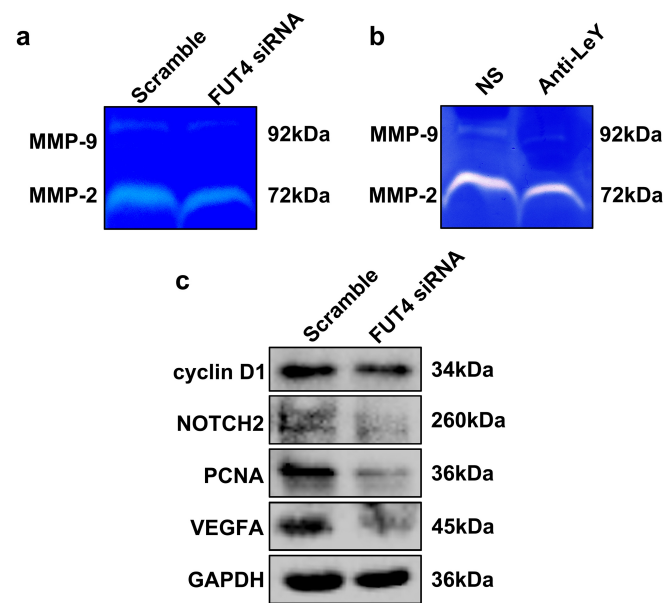
Supplementary Fig. 2



Supplementary Fig. 2 FUT4 siRNA inhibits LeY biosynthesis, further impairs trophoblast implantation potential. **a, b** Real-time PCR and western blot analysis of MEST at the mRNA level (a) and protein level (b). **c** Immunofluorescence staining of MEST on HTR-8/SVneo cells after transfected with vector, MEST cDNA or MEST mut plasmid. **d** The cell cycle arrest phases were assessed by Flow cytometry in HTR-8/SVneo cells after transfected with vector, MEST cDNA, MEST mut plasmid or co transfected MEST cDNA and FUT4 siRNA. **e** Edu assay evaluated cell proliferation potential. **f** Western blot detected the change of cyclin E1, D1 and PCNA. **g h** Matrigel transwell assay and Cell scratch test detected cell invading ability of HTR-8/SVneo cells. **i**

Gelatin zymography assay and western blot detected the activation and alteration of MMPs and TIMP-1/2. *** $p < .001$.

Supplementary Fig. 3



Supplementary Fig. 3 Silencing FUT4 and anti LeY antibody blockage inhibit MMPs secretion and implantation relation protein expression of embryo *in vivo*. Mice embryo transfected with scramble RNA, FUT4 siRNA, or treated with normal saline (NS) or anti-LeY antibody, respectively, culture medium and outgrowth trophoblast were collected for detection. **a b** Gelatin zymography assay detected the activation MMP2/9 of cultured medium. **c** Western blot detected the change of cyclin D1, NOTCH2, PCNA and VEGFA in outgrowth trophoblast.

Supplementary Table. 1

Symbol	GO Term	
UniProtKB - Q5EB52~MEST	GO:0003824	catalytic activity
	GO:0005783	endoplasmic reticulum
	GO:0016020	membrane
	GO:0016021	integral component of membrane
	GO:0016787	hydrolase activity
	GO:0007498	mesoderm development
	GO:0005515	protein binding
	GO:0005789	endoplasmic reticulum membrane
	GO:0070062	extracellular exosome
	GO:0005783	endoplasmic reticulum
	GO:0010883	regulation of lipid storage
	GO:0005783	endoplasmic reticulum
	GO:0005179	hormone activity
UniProtKB - P0DML2~CSH1	GO:0005576	extracellular region
	GO:0046872	metal ion binding
	GO:0005783	endoplasmic reticulum
	GO:0031982	vesicle
	GO:0005576	extracellular region
	GO:0031904	endosome lumen
	GO:0005515	protein binding
	GO:0008083	growth factor activity
	GO:0031667	response to nutrient levels
	GO:0046427	positive regulation of receptor signaling pathway via JAK-STAT
	GO:0045927	positive regulation of growth
	GO:0042531	positive regulation of tyrosine phosphorylation of STAT protein
	GO:0005179	hormone activity
UniProtKB - P02647~APOA1	GO:0034364	high-density lipoprotein particle C
	GO:0005102	signaling receptor binding F

	GO:0001540	amyloid-beta binding F
	GO:0015485	cholesterol binding F
	GO:0030300	regulation of intestinal cholesterol absorption P
	GO:0005543	phospholipid binding F
	GO:0034380	high-density lipoprotein particle assembly P
	GO:0034372	very-low-density lipoprotein particle remodeling P
	GO:0033700	phospholipid efflux P
	GO:0033344	cholesterol efflux P
	GO:0010898	positive regulation of triglyceride catabolic process P
	GO:0010873	positive regulation of cholesterol esterification P
	GO:0006695	cholesterol biosynthetic process P
	GO:0031210	phosphatidylcholine binding F
	GO:0042627	chylomicron C
	GO:0051006	positive regulation of lipoprotein lipase activity P
	GO:0046889	positive regulation of lipid biosynthetic process P
	GO:0046470	phosphatidylcholine metabolic process P
	GO:0045723	positive regulation of fatty acid biosynthetic process P
	GO:0060228	phosphatidylcholine-sterol O-acyltransferase activator activity F
	GO:0043691	reverse cholesterol transport P
	GO:0070653	high-density lipoprotein particle receptor binding F
	GO:0042632	cholesterol homeostasis P
	GO:0042157	lipoprotein metabolic process P
	GO:0070328	triglyceride homeostasis P

	GO:0005515	protein binding F
	GO:0018206	peptidyl-methionine modification P
	GO:0018158	protein oxidation P
	GO:0005576	extracellular region C
	GO:0006869	lipid transport P
	GO:0008289	lipid binding F
	GO:0008203	cholesterol metabolic process P
	GO:0008202	steroid metabolic process P
	GO:0006629	lipid metabolic process P
	GO:0030301	cholesterol transport P
	GO:0005615	extracellular space C
	GO:0051180	vitamin transport P
	GO:0005788	endoplasmic reticulum lumen C
	GO:0005769	early endosome C
	GO:0034774	secretory granule lumen C
	GO:0005829	cytosol C
	GO:0071682	endocytic vesicle lumen C
	GO:0005886	plasma membrane C
	GO:0042802	identical protein binding F
	GO:0005319	lipid transporter activity F
	GO:0030325	adrenal gland development P
	GO:0008035	high-density lipoprotein particle binding F
	GO:0019915	lipid storage P
	GO:0001935	endothelial cell proliferation P
	GO:0001932	regulation of protein phosphorylation P
	GO:0008211	glucocorticoid metabolic process P
	GO:0006644	phospholipid metabolic process P
	GO:0120020	cholesterol transfer activity F
	GO:0051346	negative regulation of hydrolase activity P
	GO:0071813	lipoprotein particle binding F
	GO:0043534	blood vessel endothelial cell migration P
	GO:0042158	lipoprotein biosynthetic process P

	GO:0019899	enzyme binding F
	GO:0034384	high-density lipoprotein particle clearance P
	GO:0034375	high-density lipoprotein particle remodeling P
	GO:0034115	negative regulation of heterotypic cell-cell adhesion P
	GO:0031410	cytoplasmic vesicle C
	GO:0032691	negative regulation of interleukin-1 beta production P
	GO:0032489	regulation of Cdc42 protein signal transduction P
	GO:0007186	G protein-coupled receptor signaling pathway P
	GO:0006656	phosphatidylcholine biosynthetic process P
	GO:0010903	negative regulation of very-low-density lipoprotein particle remodeling P
	GO:0010804	negative regulation of tumor necrosis factor-mediated signaling pathway P
	GO:0002719	negative regulation of cytokine production involved in immune response P
	GO:0030139	endocytic vesicle C
	GO:0062023	collagen-containing extracellular matrix C
	GO:0034361	very-low-density lipoprotein particle C
	GO:0034366	spherical high-density lipoprotein particle C
	GO:0034190	apolipoprotein receptor binding F
	GO:0034191	apolipoprotein A-I receptor binding F
	GO:0051345	positive regulation of hydrolase activity P
	GO:0050821	protein stabilization P
	GO:0050728	negative regulation of inflammatory response P
	GO:0060761	negative regulation of response to cytokine stimulus P

	GO:0060354	negative regulation of cell adhesion molecule production P
	GO:0055091	phospholipid homeostasis P
	GO:0070508	cholesterol import P
	GO:0120009	intermembrane lipid transfer P
	GO:0031072	heat shock protein binding F
	GO:1903561	extracellular vesicle C
	GO:0070062	extracellular exosome C
	GO:0007229	integrin-mediated signaling pathway P
	GO:0007179	transforming growth factor beta receptor signaling pathway P
	GO:0010875	positive regulation of cholesterol efflux P
	GO:0072562	blood microparticle C
	GO:0051496	positive regulation of stress fiber assembly P
	GO:0050919	negative chemotaxis P
	GO:0050766	positive regulation of phagocytosis P
	GO:0070371	ERK1 and ERK2 cascade P
	GO:0045499	chemorepellent activity F
	GO:1902995	positive regulation of phospholipid efflux P
	GO:0035025	positive regulation of Rho protein signal transduction P
	GO:1900026	positive regulation of substrate adhesion-dependent cell spreading P
UniProtKB - P11464~PSG1	GO:0005576	extracellular region C
	GO:0007565	female pregnancy P
	GO:0005515	protein binding F