

Supplementary Table 1: Upregulated genes with a log fold change of > 2 in TGF- β treated HBVP

Symbol	Gene Name	Log fold change	Functions	Associated with	Reference
FOXS1	forkhead box S1	8.25 \uparrow	<ul style="list-style-type: none"> • Promotes cell proliferation and EMT in gastric cancer. • TGFβ-induced FOXS1 controls EMT. • Forkhead proteins required for brain pericyte differentiation, development and maintenance of the BBB. 	TGF- β proliferation cell motility EMT Cancer pericyte development BBB	Sci Rep. 2019 (1):5281. doi: 10.1038/s41598-019-41717-w Hepatology Comm. 2022, 6 (5): 1157 Dev Cell 2015, 6;34(1): 19
ESM1	endothelial cell-specific molecule 1 /Endocan	7.60 \uparrow	<ul style="list-style-type: none"> • Specific biomarker of tip cells during neo-angiogenesis. • Expression increased by pro-angiogenic growth factors. • Role in endothelium-dependent pathological disorders. • Secreted proteoglycan that has been shown to indicate angiogenic activity. • Putative indicator of new blood vessels that are not functional. 	angiogenesis cancer BBB (?)	Front Oncol. 2021;11: 687120. Immunol Methods 2013;398-399:27
COMP5/TSP5	cartilage oligomeric matrix protein/thrombospondin 5	7.20 \uparrow	<ul style="list-style-type: none"> • Extracellular matrix protein. • Member of the TSP family. • Cell adhesion. • Induced by TGF-β • Remodeling of the tumor microenvironment 	cell motility cancer angiogenesis TGF- β	JBC 2005, 280;(38): 32655. Arteriosclerosis, Thrombosis, and Vascular Biology. 2001;21:47 Vessel Plus. 2018;2:30.
GPR183	G protein-coupled receptor 183	7.13 \uparrow	<ul style="list-style-type: none"> • Regulates migration of astrocytes. • Communication between astrocytes and macrophages. • Suggested to be involved in the regulation of the neuro-vascular unit. • G protein coupled receptors are essential for the integrity of the BBB. 	cell motility BBB	Glia 63:341-351(2015) Front Cell Neurosci. 2020;14:139.
TSPAN2	tetraspanin 2	6.04 \uparrow	<ul style="list-style-type: none"> • Forms large transmembrane protein networks. • Regulate cell motility and invasion. • Regulates cell/ECM adhesion, cell/cell interaction and migration. • Involved in the progression of the lung tumor metastasis. 	cell motility cancer	J Cell Biol (2001) 155;(7): 1103 Biochem Soc Trans. 2017;45(2):465-475.

NOX4	NADPH oxidase 4	5.99 ↑	<ul style="list-style-type: none"> Regulates glycolysis, glucose & fatty acid oxidation in heart. Overexpression predicts poor prognosis and promotes tumor progression in human colorectal cancer. Upregulation of NOX4 by TGF-beta is required for its pro-apoptotic activity in hepatocytes. Inhibition of NOX4/ROS suppresses neuronal and BBB injury 	metabolism cancer TGF-β BBB	JCI Insight 2017;2: e96184 Oncotarget. 2017;8(20):33586-33600 J Hepatol 2008, 49(6):965 Front. Cell. Neurosci., 2020, Sect. Cell. Neuropath.doi.org/10.3389/fncel.2020.578060
ELN	elastin	5.95 ↑	<ul style="list-style-type: none"> ECM protein that lends elasticity and resilience to tissues such as the arteries. TGF-β is involved in regulation of elastin deposition during fetal development, tissue repair, and in pathological conditions. In many malignancies, the remodeled ECM expresses high levels of the elastin which may have either positive or negative effects on tumor growth. 	cell motility TGF-β cancer	Lab Invest. 1992;66(5):580-8 Tumor Microenvironment 2020: Extracellular Matrix Components – Part B: 1
AMIGO2	adhesion molecule with Ig-like domain 2	5.49 ↑	<ul style="list-style-type: none"> Controls cell survival and angiogenesis via Akt activation. Loss of AMIGO2 in ECs led to apoptosis and inhibition of angiogenesis with Akt inactivation. Extracellular vesicle-derived AMIGO2 stimulates endothelial cell adhesion to cancer cells. Most upregulated gene in TGFβ-treated human embryonic palatal mesenchymal cells. 	angiogenesis cancer metastasis TGF-β EMT?	J Cell Biol (2015) 211 (3): 619. Scientific Reports 2020,12, Art.No.: 792 Front Physiol. 2012;3:85.
AC112721.1	uncharacterized	5.30 ↑	<ul style="list-style-type: none"> Autophagy-related lncRNA. Associated with pathways closely related to tumor metastasis and invasion (cytoskeleton regulation, gap junctions, focal adhesion, ECM receptor interaction) 	autophagy cell motility cancer	Front Oncol. 2021;11:647236. doi:10.3389/fonc.2021.647236
CHRNA9	cholinergic receptor, nicotinic, alpha 9 (neuronal)	5.22 ↑	<ul style="list-style-type: none"> Member of the ligand-gated ionic channel family and nicotinic acetylcholine receptor gene super-family Involved in ROS regulation. Important for lung tumor carcinogenesis. 	ROS regulation cancer	Int. J. Mol. Sci. 2020, 21(14): 4918 J Exp Clin Med 2011, 3(6): 246
PRR5L	proline rich 5 like	4.94 ↑	<ul style="list-style-type: none"> modulates mTORC2 activity which is known to regulate glucose uptake, glycolysis and the pentose phosphate pathway (PPP). 	metabolism	Nature Cell Biology 2012, 14:686
EGR2	early growth response 2	4.92 ↑	<ul style="list-style-type: none"> Regulation of cholesterol/lipid biosynthetic genes during peripheral nerve myelination. 	metabolism senescence	J Neurochem 2005;93:737 Aging Cell. 2021, 20(3):e13318

			<ul style="list-style-type: none"> • Regulator of senescence. 		
MMP-10	matrix metallo-peptidase 10	4.81 ↑	<ul style="list-style-type: none"> • Upregulated by TGF-β. • Promotes migration, invasion and angiogenesis. • In the brain, MMPs are critical for BBB integrity. 	cell motility angiogenesis TGF-β Cancer BBB (?)	PLoS One 2011, 6(10):e25438 Front Oncol. 2019, 9:1370. doi:10.3389/fonc.2019.0137 J Cereb Blood Flow Metab. 2016;36(9):1481
RP11-492E3.2	non coding RNA	4.79 ↑	<ul style="list-style-type: none"> • Exosomal antisense ncRNA. 		lncRNAfunc: Functional analysis of Long non-coding RNAs - Search (uth.edu)
ADAM19	ADAM metallo-peptidase domain 19	4.53 ↑	<ul style="list-style-type: none"> • Endopeptidase that cleaves ECM proteins. • Protective biomarker in human prostate cancer. • Target for metabolic syndrome in human and mice. • Regulated by TGF-β. 	cell motility cancer metabolism TGF-β	Curr Pharm Des. 2009;15(20):2336 BMC Cancer 2016, 16: Art.No. 15 Mediators of Inflammation 2017, Art.No.: 7281986
NXPH4	neurexophilin 4	4.47 ↑	<ul style="list-style-type: none"> • Secreted neuropeptide-like glycoproteins. • Regulates specific synapse function. • Exerts co-receptor function for TGF-β on the membrane of cancer cells and enhances responses to TGF-β 	cancer TGF- β	eLife 2019;8:e46773 Carcinogenesis 2011, 32(4): 613
IL11	interleukin 11	4.43 ↑	<ul style="list-style-type: none"> • TGF-β1 stimulates IL11 expression in epithelial cells and fibroblasts. • Stimulates fibrosis which also needs activated pericytes. • Stimulate survival and proliferation of cancer cells alongside angiogenesis of the primary tumor. 	cancer TGF- β proliferation angiogenesis	Exp Mol Med 2020, 52: 1871 Front. Cell Dev. Biol.2020, 14: 1 J Clin Periodontol. 2006, 33(3):165 Cytokine & Growth Factor Reviews 2015, 26 (5): 489
RP11-509E16.1	lncRNA	4.33 ↑	<ul style="list-style-type: none"> • Involved in T cell differentiation. • Triggers the dissemination of colorectal cancer cells via upregulation of Zeb1. 	cancer EMT	Nature Comm 2015, 6:6932; doi: 10.1038/ncomms7932 Mol Cancer. 2019 Apr 13;18(1):87
SAMD11	sterile alpha motif domain containing 11	4.32 ↑	<ul style="list-style-type: none"> • Predicted to enable histone binding activity. • Protein domain specific binding activity. • Protein self-association. • Suggested to be involved in cervical cancer. 	cancer	SAMD11 Gene - GeneCards Clin Exp Pharmacol Physiol. 2022, 49(1):175
DIO3	deiodinase, iodothyronine, type III	4.24 ↑	<ul style="list-style-type: none"> • Crucial role in human carcinogenesis. • Role in the regulation of cell proliferation in several neoplastic contexts. • Expression induced by TGF-β. 	cancer proliferation TGF-β	Minerva Endocrinol. 2012, 37(4):315-27 Oncogene 2021, 40: 6248 Molecular Endocrinology 2005, 19(12): 3126
PTH1H	parathyroid hormone-like hormone	4.23 ↑	<ul style="list-style-type: none"> • Autocrine/paracrine ligand, regulates cell differentiation and proliferation. • Possible role in angiogenesis. • Important in normal and abnormal calcium metabolism. • TGF-β stimulates PTH1H and osteolytic metastases. 	proliferation angiogenesis cancer TGF-β	Entry - *168470 - PARATHYROID HORMONE-LIKE HORMONE; PTH1H - OMIM J Biol Chem 2002, 277(27):24571

BMF	Bcl2 modifying factor	4.16 ↑	<ul style="list-style-type: none"> • BCL2 protein family. • Binds BCL2 proteins and function as an apoptotic activator. • Might act as a sentinel for stress-impaired protein translation machinery. • Upregulated by TGF-β. 	apoptosis translation cancer TGF-β	Cell Death Differ. 2010, 17 (11): 1672. Oncogene 2007, 26(7): 970
SEMA7A	semaphorin 7A	4.15 ↑	<ul style="list-style-type: none"> • Involvement in migration and differentiation of neurons. • Promotes axon outgrowth. • Neuronal guidance protein. • Promotes chemokine-driven dendritic cell migration. • Plays a critical role in TGF-β-induced pulmonary fibrosis. • Up-regulated in breast cancer and promotes macrophage production of angiogenic molecules. 	cell motility cartilage intermediate layer protein, nucleotide pyrophosphohydrolase cancer angiogenesis	Immunol Res. 2014, 58(1):159 Immunol Res. 2013, 57(1-3):81 J Exp Med 2007, 204(5): 1083 J Immunol 2014, 192 (1 Suppl.) 138.34
AC020571.3	lncRNA	4.11 ↑	<ul style="list-style-type: none"> • Unknown function. 		
LBH	limb bud and heart development	3.94 ↑	<ul style="list-style-type: none"> • Functions as a Tumor Suppressor of Nasopharyngeal carcinoma by inducing G1/S cell cycle arrest. • Mediates proliferation, fibroblast-to-myofibroblast transition and EMT-like processes in cardiac fibro-blasts. • TGF-β induces LBH expression in nasopharyngeal epithelial cells. 	proliferation cancer EMT	Scientific Rep. 2015, 5, Art.No. 7626 Mol Cell Biol 2021, 476(7): doi.org/ 10.1007/s11010-021-04111-7
RP1-27K12.4	Lnc RNA	3.91 ↑	<ul style="list-style-type: none"> • Unknown function 		
ALQX5AP	Arachidonate 5-lipoxygenase-activating protein	3.87 ↑	<ul style="list-style-type: none"> • Arachidonate binding protein. • Essential for cellular leukotriene (LT) synthesis • Predicts poor prognosis by enhancing M2 macrophage polarization and immunosuppression in ovarian cancer microenvironment. 	metabolism cancer	FEBS Lett. 1993, 8, 318(3):277 Front. Oncol. 2021,Sec. Gynecological Oncology, doi.org/10.3389/fonc.2021. 675104
CLIP	cartilage intermediate layer protein, nucleotide pyrophosphohydrolase	3.66 ↑	<ul style="list-style-type: none"> • Matrix protein that resides in the middle of human articular cartilage. • Regulates the extracellular microenvironment of the NVU. • Suppresses TGF-β signaling in cardiac fibroblasts. 	TGF-β	Int J Mol Med 2021, 47(2):475 <u>Int J Gerontology</u> 2017, 11(2): 67
PLEK2	Pleckstrin 2	3.61 ↑	<ul style="list-style-type: none"> • Regulates cell protrusions such as lamellipodia and filopodia. • Involved in tumorigenesis and metastasis. 	cell motility cancer TGF-β	Front. Cell Dev. Biol., 2021 Sec. Molecular and Cellular Oncology https://doi.org/10.3389/fcell.2021.768238 Cell Death & Disease 2021,12, Art.NO.: 901

			<ul style="list-style-type: none"> • TGF-β-induced PLEK2 promotes metastasis and chemoresistance in oesophageal squamous cell carcinoma. 		
NEDD9	neural precursor cell expressed, developmentally down-regulated 9	3.60 \uparrow	<ul style="list-style-type: none"> • Docking protein which plays a central coordinating role in cell adhesion. • Functions in transmitting growth control signals between focal adhesions and the mitotic spindle, this initiating cell proliferation. • Role in integrin beta-1 signaling in B- and T-cells. • TGF-β target gene. • Promotes oncogenic signaling and a stem/mesenchymal gene signature in ovarian cancer. 	cell motility proliferation TGF- β cancer EMT (?)	Immunity 2006, 25:907 PLoS One. 2016;11(6): e0157992. Oncogene 2018, 37: 4854
PPP1R14C	Protein phosphatase 1, regulatory subunit 14C	3.58 \uparrow	<ul style="list-style-type: none"> • Modulates capabolic response of osteoblasts. • Upregulated in triple-negative breast cancer. • Might regulate TGF-β signaling. 	metabolism cancer TGF- β	EBioMedicine 9, 2016: 45 Biochem J. 2010;430(2):191
FOXQ1	Foxhead box Q1	3.53 \uparrow	<ul style="list-style-type: none"> • Regulates including cell proliferation, differentiation and development, especially tumor proliferation. • Overexpression delayed cellular senescence in human fibroblasts. • Mediates the crosstalk between TGF-β and Wnt signaling pathways. 	proliferation cancer TGF- β	Cell Death & Disease 2017, 8:2946 Cancer Biol Ther 2015;16(7):1099
CDH6	Cadherin 6	3.46 \uparrow	<ul style="list-style-type: none"> • Cell adhesion molecule involved in renal cancer. • Target in TGF-β signalling pathway. 	cell motility cancer TGF- β	Cancer Res. 1997, 57(13):2741 PLoS One 2013,12;8(9): e75489
RASD1	RAS, dexamethasone-induced 1	3,41 \uparrow	<ul style="list-style-type: none"> • Can activate G proteins in a receptor-independent manner and inhibits signal transduction through different G protein-coupled receptors. • Pivotal role in maintaining the equilibrium between adipogenesis and osteogenesis. • Overexpression of RASD1 inhibits glioma cell migration/invasion. 	Metabolism cancer cell motility	Metabolism 2020, 108: 154250 Scientific Reports 2017, 7, Art.No.: 320
F2RL1	Coagulation factor 2 receptor like 1	3,25 \uparrow	<ul style="list-style-type: none"> • Promotes TGF-β dependent cell motility in pancreatic cancer cells. 	cell motility cancer TGF- β	Oncotarget. 2016, 7(27):41095
SYTL5	synaptotagmin-like 5	3.22 \uparrow	<ul style="list-style-type: none"> • Rab effector protein. • Binds phospholipids in neuroendocrine cells. • Regulates exocytosis. • Involved in EMT processes in NSCLC. 	cancer EMT proliferation cell motility	NextProt, Madame Curie Bioscience Database EBioMedicine 2019, 46: 42-53

			<ul style="list-style-type: none"> Promotes proliferation, invasion, and metastasis and inhibited cell <u>apoptosis</u> of NSCLC cells. 		
DHRS2	dehydrogenase/reductase (SDR family) member 2	3.22 ↑	<ul style="list-style-type: none"> Mitochondrial gene. Involved in energy generation processes. Closely associated with the inhibition of cell proliferation, migration and quiescence in cancers. 	metabolism cancer proliferation cell motility	UniProt J Exp Clin Cancer Res 2019, 38, Art. No.: 30
IFIH1	Inferferon induced with helicase C domain 1	3,20 ↑	<ul style="list-style-type: none"> Involved in virus-induced autoimmune diabetes type II 	metabolism	Arq Bras Endocrinol Metabol 2013, 57(9):667
WNT5B	wingless-type MMTV integration site family, member 5B	3.16 ↑	<ul style="list-style-type: none"> Supresses Smad2/3 activation. Regulates canonical and non-canonical Wnt-pathway during adipositas and diabetes type II. 	metabolism TGF-β	J Diab Invest 2020, 11(2): 307 Signal Transduction 2010, 285 (18): 14031 J Diabetes Investig 2020,11(2): 307
MGP	matrix Gla protein	3.14 ↑	<ul style="list-style-type: none"> Highly expressed by vascular smooth muscle cells (VSMCs). Lack of MGP causes vascular abnormalities. Might contribute to breast cancer resistance mechanism by augmenting the interaction of cells with ECM components. 	Angiogenesis cell motility (?)	Curr Med Chem 2020, 27(10):1647 Angiogenesis 2016, 19: 1 Int. J. Mol. Sci. 2018, 19: 2901
ZNF365	Zinc finger protein 365	3.13 ↑	<ul style="list-style-type: none"> Maternal LPS-binding protein. Downregulation associated with poor prognosis in colon cancer. Overexpressed in TGF-β mediated pulmonary fibrosis 	Cancer TGF-β	FASEB 2018, 31 (2): 979 Oncol Lett. 2020;20(4):85 FASEB 2020, 34 (S1, Exp. Biology): 1
CLDN14	Claudin 14	3.08 ↑	<ul style="list-style-type: none"> Extracellular calcium metabolism Cell adhesion molecule, upregulated in gastric cancer. Part of endothelial tight junctions 	cell motility proliferation cancer BBB (?)	JASN 2014,25 (4) 745 Diagnostic Pathology 2013, 8: Art. No.: 205 Tissue Barriers. 2013;1(3): e24782
HAS2	hyaluronan synthase 2	3.07 ↑	<ul style="list-style-type: none"> Responsible for the synthesis and deposition of hyaluronan in the ECM. Overexpression of HAS2 lin renal epithelial tip cells led to enhanced cell migration. Silencing of HAS2 suppresses the malignant phenotype of invasive breast cancer cells. TGFβ-induced EMT depends on hyaluronan synthase HAS2. 	cell motility cancer EMT TGF-β	JASN June 2006, 17 (6):1553 Int J Cancer 2007, 120(12): 2557 Oncogene 2013,32(37): 435
KCNN4	K ⁺ intermediate /small conductance calcium-activated channel, subfamily N, member 4	3.06 ↑	<ul style="list-style-type: none"> Forms a voltage-independent potassium channel Promotes invasion and metastasis through MAPK/ERK. Targeted inhibition of KCa3.1 attenuates TGF-β-induced reactive astrogliosis. 	cell motility TGF-β	J Investig Med. 2020, 68(1):68 J Neurochem 2014, 130(1): 41

HECW2	HECT, C2 and WW domain containing E3 ubiquitin protein ligase 2	3.06 ↑	<ul style="list-style-type: none"> Ubiquitin ligase. Stabilises p73 promotes endothelial cell junctions 	BBB (?)	J Med Genet. 2017;54(2):84 Cellular Signalling 2016, 28: 1642
SLC46A3	solute carrier family 46, member 3	3.05 ↑	<ul style="list-style-type: none"> Involved in plasma membrane electron transport. Plasma membrane analog of the mitochondrial electron transport chain. 	metabolism	Current Molecular Med 2006. 6 (8): 895
GPR68	G protein-coupled receptor 68	2.95 ↑	<ul style="list-style-type: none"> Involved in pH homeostasis. Modulates intestinal inflammation and fibrosis. Mediates the interaction of cancer-associated fibroblasts and cancer cells Expression regulated by TGF-β Indirectly influences glycolysis 	cancer TGF-β metabolism	Inflamm Intest Dis 2021;6:140 FASEB J. 2018, 32(3):1170 J Immunol May 1, 2020, 204 (1 Supplement) 76.22 BBA - Molecular Basis of Disease 2019, 1865 (12): 165537
STK38L	serine/threonine kinase 38 like	2.87 ↑	<ul style="list-style-type: none"> Ablation promotes loss of cell viability in a subset of KRAS-dependent PCC. 	cancer	Oncotarget 2017,8(45):78556
PMEPA1	prostate transmembrane protein, androgen induced 1	2,83 ↑	<ul style="list-style-type: none"> Suppresses the aTGF-β signaling pathways though interactions with Smad proteins. Overexpression of this gene may play a role in multiple types of cancer. 	TGF-β proliferation cell motility cancer	PMEPA1 prostate transmembrane protein, androgen induced 1 [Homo sapiens (human)] - Gene - NCBI (nih.gov)
ITGB3/CD61	integrin, beta 3 (platelet glycoprotein IIIa, antigen CD61)	2.83 ↑	<ul style="list-style-type: none"> Associated with the risk of human cancers. Key regulator in reactive oxygen species-induced migration and invasion of CRC. In breast cancer cells enhances TGF-β signaling. Facilitates EMT and angiogenesis. 	cancer cell motility TGF-β EMT angiogenesis	Mol Cell Proteomics. 2011;10(10): M110.005397 Oncotarget. 2017;8(70):114856 Am J Transl Res. 2019;11(12):7195
RGS9	regulator of G-protein signaling 9	2,82 ↑	<ul style="list-style-type: none"> Increases GTPase activity of G protein alpha subunits. 		RGS9 regulator of G protein signaling 9 [Homo sapiens (human)] - Gene - NCBI (nih.gov)
SLC19A2	solute carrier family 19 (thiamine transporter), member 2	2.80 ↑	<ul style="list-style-type: none"> Thiamin transporter. Upregulation in stem cell like cancer cells of NPCC contributes to enhanced glycolysis. 	cancer (?) metabolism	Int J Radiation Oncoll Bio Physics 2016,96 (2) Suppl. E582
SKIL	SKI-like oncogene	2.77 ↑	<ul style="list-style-type: none"> component of the SMAD pathway, which regulates cell growth and differentiation through TGF-β involved in EMT processes. 	TGF-β cancer EMT	SKIL SKI like proto-oncogene [Homo sapiens (human)] - Gene - NCBI (nih.gov) Cell Death Differ 2021,28(1):267
MFSD7	major facilitator superfamily domain containing 7	2.77 ↑	<ul style="list-style-type: none"> Predicted to enable transmembrane transporter activity. Predicted to be involved in transmembrane transport. 		SLC49A3 Gene - GeneCard
MYO1D	myosin ID	2.75 ↑	<ul style="list-style-type: none"> Evolutionarily conserved regulator of animal left-right asymmetry. 	cancer TGF-β	Nat Commun. 2018;9(1):1942. Oncogene 2019, 38:7416 Int J Mol Sci. 2019;20(16):3913.

			<ul style="list-style-type: none"> • Overexpressed MYO1D promotes colorectal tumor progression through upregulating the EGFR in the plasma membrane. • Might regulate TGF-β receptor trafficking 		
NEBL	nebulette	2.74 \uparrow	<ul style="list-style-type: none"> • cardiac-specific isoform of nebulin family proteins. • Regulates stability and length of actin thin filaments. • New susceptibility gene for endocardial fibroelastosis. 	vessel dilatation (?)	J Am Coll Cardiol. 2010, 56 (18) 1493
PRG4	proteoglycan 4	2.73 \uparrow	<ul style="list-style-type: none"> • Codes for lubricin. • Protects cartilage surface from protein deposition and cell adhesion. • Close analog to vitronectin. • Putative role in cell-cell and cell-ECM interactions. • TGF-β regulates PRG expression in vascular smooth muscle cells. • Involved in tumor angiogenesis. 	cell motility (?) TGF- β angiogenesis	J Diabetes 2010, 2(4):233 Semin Cancer Biol. 2020;62:1
HEY1	hes-related family bHLH transcription factor with YRPW motif 1	2.73 \uparrow	<ul style="list-style-type: none"> • Basic HLH transcription factor, inhibits myogenesis • Induces cell proliferation in neural stem cells • Upregulated in glioma. • Promotes migration& invasion of melanoma cells 	cancer proliferation cell motility	J Cell Mol Med 2009,13(1):136 J Cancer. 2021;12(23):6979
CLDN4	claudin 4	2.72 \uparrow	<ul style="list-style-type: none"> • silencing promotes proliferation of gastric cancer cells through activation of PI3K/Akt. • in GBM TGF-β mediated upregulation of CLDN4 induces EMT. • tight junction protein, expressed in endothelial cells. 	proliferation cancer cell motility EMT TGF- β BBB	Exp Physiol 2020,105(6):979 Cell Death & Disease 2022,13, Art.No.: 339 Neoplasia 2012,14: 974
AC002454.1	LncRNA	2.70 \uparrow	<ul style="list-style-type: none"> • AC002454.1 and CDK6 synergistically promote endometrial cell migration and invasion in endometriosis. 	cell motility	Reproduction 2019,157(6):535
WNT2	wingless-type MMTV integration site family member 2	2.70 \uparrow	<ul style="list-style-type: none"> • Autocrine WNT2 signaling in fibroblasts promotes colorectal cancer progression. • Cooperates with TGF-β signaling. • Increases tumor angiogenesis in colon cancer. 	Cancer TGF- β angiogenesis	Oncogene 2017, 36: 5460 Angiogenesis 2020, 23: 159
REPS2	RALBP1 associated Eps domain containing 2	2.64 \uparrow	<ul style="list-style-type: none"> • Regulates the endocytosis of growth factor receptors (downregulated in cancer cells) 	cancer	Asian Pac J Cancer Prev 2013, 14(5):2851
TPM1	tropomyosin 1 (alpha)	2.63 \uparrow	<ul style="list-style-type: none"> • Functions as a tumor suppressor (proliferation, angiogenesis &, metastasis) in renal cell carcinoma. • Expression regulated by TGF-β. • Cell elasticity is regulated by the tropomyosin isoform composition of the actin cytoskeleton. 	cancer proliferation cell motility	J Cancer. 2019;10(10): 2220 J Cell Mol Med 2017, 21(5): 916 PlosOne 2015, doi.org/10.1371/journal.pone.0126214

PPP1R13L	protein phosphatase 1, regulatory subunit 13 like	2.63 ↑	<ul style="list-style-type: none"> • Encodes the inhibitor of apoptosis-stimulating protein of p53 protein (iASPP). • Causes paediatric dilated cardiomyopathy. • Acts as a regulator of desmosomes. • Has been implicated in inflammatory pathways. • iASPP is essential for HIF-1alpha stabilization to promote angiogenesis and glycolysis via attenuating VHL-mediated protein degradation. • Downregulation of iASPP expression suppresses proliferation and invasion of HNSCC. 	angiogenesis metabolism cancer cell motility proliferation	Clin Genet 2020, 98(4):331 Oncogene 2022, 41: 1944 Chin Med Sci J 2019, 34(3):184
STK17B	serine/threonine kinase 17b	2.63 ↑	<ul style="list-style-type: none"> • promotes carcinogenesis and metastasis via AKT/GSK-3β/SNAIL signaling in HCC. 	cancer EMT cell motility	Cell Death & Disease 2018, 9, Art.No.: 236
CDH2	cadherin 2, type 1, N-cadherin (neuronal)	2.62 ↑	<ul style="list-style-type: none"> • E-Cadherin to N-Cadherin switch in EMT. 	EMT cell motility cancer	Cells. 2019;8(10):1118.
CASC15	cancer susceptibility candidate 15 (non-protein coding)	2.61 ↑	<ul style="list-style-type: none"> • Tumor-Associated Long Non-Coding RNA • Can affect proliferation, invasion and apoptosis of tumors 	proliferation cancer cell motility	Curr Pharm Des 2021, 27(1):127
ANKRD44	ankyrin repeat domain 44	2.61 ↑	<ul style="list-style-type: none"> • Putative regulatory subunit of PP6 that may be involved in the recognition of phosphoprotein substrates. 		ANKRD44 - Serine/threonine-protein phosphatase 6 regulatory ankyrin repeat subunit B - Homo sapiens (Human) UniProtKB UniProt
ADAMTS6	ADAM metalloproteinase with thrombospondin type 1 motif, 6	2.60 ↑	<ul style="list-style-type: none"> • Suppresses tumor progression via the ERK signaling pathway. • Differentially expressed in brain pericytes, putatively associated to BBB density. 	cancer BBB (?)	Oncotarget 2016,7(38):61273 Cells 2021, 10, 963, doi.org/10.3390/cells10040963
PDGFA	platelet-derived growth factor alpha polypeptide	2.58 ↑	<ul style="list-style-type: none"> • Activator of the PDGFR-beta who's expression is upregulated in activated pericytes. • essential and autocrine regulator of VEGFR expression in NSCLC. • regulation of cell motility during wound healing. 	cancer angiogenesis cell motility	Neuropathol Appl Neurobiol 2021, 47(6):768 Cancer Res 2005,65(16):7241 Cell Physiol Biochem 2010, 25(2-3):279
INSC	inscuteable homolog (Drosophila)	2.58 ↑	<ul style="list-style-type: none"> • Involved in spindle orientation during mitosis. • May regulate cell proliferation and differentiation in the developing nervous system. 	Proliferation (?)	INSC - Protein inscuteable homolog - Homo sapiens (Human) UniProtKB UniProt
CRLF1	cytokine receptor-like factor 1	2.58 ↑	<ul style="list-style-type: none"> • may have an ability to change the composition of ECM in fibrosis. • positively regulated by TGF-β in the mouse chondrogenic cells. 	cell motility (?) TGF-β proliferation	World J Hepatol. 2012;4(12):356 Calcified Tissue Int 2010, 86:47
DNAJB5/Hsc40	DnaJ (Hsp40) homolog, subfamily B, member 5	2.56 ↑	<ul style="list-style-type: none"> • Involved in the regulation of ROS 	cancer	Antioxid Redox Signal. 2013;18(10):1165

NUAK1	NUAK family, SNF1-like kinase, 1	2,52 ↑	<ul style="list-style-type: none"> • Phosphorylates p53 and regulates proliferation. • Cytosolic NUAK1 enhances ATP production by maintaining proper glycolysis and mitochondrial function in cancer cells. • Expression induced by TGF-β. 	proliferation cancer metabolism TGF-β	Oncogene 2011,30(26):2933 Front. Oncol., 2020, Sec. Cancer Metabolism, doi.org/10.3389/fonc.2020.01123 J Biol Chem 2019,15;294(11):4119
TNFSF11	tumor necrosis factor (ligand) superfamily, member 11	2.51 ↑	<ul style="list-style-type: none"> • Cytokine that binds to TNFRSF11B/OPG and to TNFRSF11A/RANK. • Osteoclast differentiation and activation factor. 		TNFSF11 - Tumor necrosis factor ligand superfamily member 11 - Homo sapiens (Human) UniProtKB UniProt
EDN1	endothelin 1	2.51 ↑	<ul style="list-style-type: none"> • Potent vasoconstrictor peptide produced by vascular endothelial cells. • Elevated plasma concentration in several solid tumors, multiple functions in cancer cells. 	cancer proliferation angiogenesis cell motility	Pharmacolog Rev 2016, 68 (2): 357 Br J Cancer. 2003;88(2):163.
BPGM	2,3-bisphosphoglycerate mutase	2.50 ↑	<ul style="list-style-type: none"> • central part of the <u>Rapoport-Luebering-cycle</u>, a side pathway of glycolysis. • controls the serine pathway flux. 	metabolism	Nat Chem Biol 2017,13(10):1081
VGLL3	vestigial like 3 (Drosophila)	2.50 ↑	<ul style="list-style-type: none"> • inhibitor of adipocyte differentiation. • regulates cranial neural crest migration. 	cell motility differentiation	J Lipid Res 2013, 54(2):473 Biol Open. 2017;6(10):1528 J Cell Mol Med 2022, 26 (9):2686
F3	coagulation factor III (thromboplastin, tissue factor)	2.47 ↑	<ul style="list-style-type: none"> • Enables cells to initiate the blood coagulation cascades. • Participates in many tumour-related processes that contribute to malignant disease progression 	cancer angiogenesis BBB	Breast Cancer Res. 2008;10(2):204
SMAD7	SMAD family member 7	2.47 ↑	<ul style="list-style-type: none"> • Negatively regulates TGF-β signaling 	TGF-β cancer	Acta Biochim Biophys Sin 2009;41(4):263
BHLHE40	basic helix-loop-helix family, member e40	2.46 ↑	<ul style="list-style-type: none"> • confers pro-survival and pro-metastatic phenotype to breast cancer. • overexpression in multiple cell types has been shown to inhibit cell proliferation, migration, or invasion. • Regulates TWIST transcription in cancer cells. 	proliferation cell motility EMT cancer	Breast Cancer Res 2018, 20, Art.No.: 117 Mol Cellular Biol 2015, 35(24): 4096
DIXDC1	DIX domain containing 1	2.46 ↑	<ul style="list-style-type: none"> • Regulate β-catenin stability. • Regulates cell stickyness. 	cell motility cancer	Mol Cell Biol. 1999;19(6):4414 medicalxpress.com
DGKI	diacylglycerol kinase, iota	2.45 ↑	<ul style="list-style-type: none"> • regulates intracellular concentration of diacylglycerol • can mediate growth factors to induce mitosis • overexpressed in cancer 	cancer proliferation	J Biol Chem. (1998) 273:32746 Biochim Biophys Acta. (2000) 1483:199 Front. Med., 2020, Sec. Gastroenterology doi.org/10.3389/fmed.2020.00320
PODXL	podocalyxin-like	2.42 ↑	<ul style="list-style-type: none"> • Might be a new prognostic biomarker in various cancers. • In B cell lymphoma promotes cell proliferation, survival, migration, resistance. 	cancer proliferation cell motility EMT	BMC Cancer 2020, 20, Art.No.: 620 Cancers 2020;12(2):396 PLoS One 2011,12;6(4):e18715

			<ul style="list-style-type: none"> • Requirement of podocalyxin in TGF-beta induced epithelial mesenchymal transition. 	TGF-β	
LTBP2	latent transforming growth factor beta binding protein 2	2.41 ↑	<ul style="list-style-type: none"> • a major component of arterial tissue. • Modulator of TGF-β activity. • Promotes the migration and invasion of gastric cancer cells • As an angiogenic factor, LTBP2 upregulation elevated the tube formation of HUVECs 	TGF-β cancer cell motility angiogenesis	Int J Oncol. 2018;52(6):1886 Mol Cell Endocrinology, 2022, 550: 111647,
TNS1	tensin 1	2.41 ↑	<ul style="list-style-type: none"> • localizes to focal adhesions. • may promote EMT and cancer cell metastasis. • Plays an essential role in TGF-β-induced myofibroblast differentiation and myofibroblast-mediated formation of extracellular fibronectin and collagen. 	EMT Cancer TGF-β cell motility (?)	Arch Med Sci 2020, doi.org/10.5114/aoms/127085 Am J Respir Cell Mol Biol 2017, 56(4):465
RASGRP3	RAS guanyl releasing protein 3 (calcium and DAG-regulated)	2.38 ↑	<ul style="list-style-type: none"> • Controls cell proliferation and migration in cancer 	cancer cell motility	Gene 2017,633:35 Clin Exp Pharmacol Physiol 2018,45(7):720
XYLT1	xylosyltransferase I	2.38 ↑	<ul style="list-style-type: none"> • XYLT1 is actively regulated by TGF-β. • Initiates glycosaminoglycan synthesis 	metabolism (?) TGF-β	Thesis: The regulation of XYLT1, the enzyme initiating glycosaminoglycan synthesis; An in vitro study with human immortalized fibroblasts with integrated reporter plasmid (uni-muenchen.de)
JUNB	jun B proto-oncogene	2.35 ↑	<ul style="list-style-type: none"> • governs a feed-forward network of TGF-β signaling that aggravates breast cancer invasion. • Stimulates proliferation. 	cell motility cancer TGF-β proliferation	JunB proto-oncogene-NCBI (nih.gov) The EMBO Journal (2002)21:4104
NEK7	NIMA-related kinase 7	2.34 ↑	<ul style="list-style-type: none"> • Regulation of mitosis • activation of the NLRP3 inflammasome 	proliferation inflammation	Genome Res. 2003, 13: 1366 Nat. Immunol. 2016, 17: 250
GPR115	G protein-coupled receptor 115	2.33 ↑	<ul style="list-style-type: none"> • Contributes to lung adenocarcinoma metastasis. • Involved in processes of proliferation, migration, invasion and angiogenesis 	cancer proliferation cell motility angiogenesis	Front. Oncol., 2020, Sec. Molecular and Cellular Oncology doi.org/10.3389/fonc.2020.577530
TGFBR1	transforming growth factor, beta receptor 1	2.29 ↑	<ul style="list-style-type: none"> • Receptor for TGF-β. • If activated induces EMT, cell motility and proliferation of pericytes. • Controls angiogenesis by two unique TGFBR1 signaling pathways. 	cell motility TGF-β proliferation EMT Cancer angiogenesis	Neuropathol Appl Neurobiol 2021, 47(6):768 Histol Histopathol 2011,26(9):1219
TMEM2	transmembrane protein 2	2.24 ↑	<ul style="list-style-type: none"> • Expression induced by TGF-β. • Hyaluronidase • Predicts poor prognosis in PDAC. 	TGF-β cancer cell motility	Biochem Biophys Res Commun 2018, 505(1):74 Pancreatology 2020,20(7):1479

			<ul style="list-style-type: none"> Regulates cell adhesion and migration via degradation of hyaluronan at focal adhesion sites. 		J Biol Chem 2021;296:100481
SRRM3	serine/arginine repetitive matrix 3	2.24 ↑	<ul style="list-style-type: none"> RNA splicing factor. Associated with cancer. 	cancer	Cancer Res 2021;81(18):4736
SYN1	synapsin I	2.22 ↑	<ul style="list-style-type: none"> Mutations may be associated with X-linked disorders with primary neuronal degeneration 	neuronal development	BMC Med Genomics 2021;14(1):182
WNT9A	wingless-type MMTV integration site family, member 9A	2.21 ↑	<ul style="list-style-type: none"> Induction linked to suppression of human colorectal cancer cell proliferation. 	Cancer proliferation	Int J Mol Sci. 2016;17(4):495.
TSPAN13	tetraspanin 13	2.20 ↑	<ul style="list-style-type: none"> modulates voltage-gated Cav2.2 Ca²⁺ channels. play a role in the regulation of cell development, activation, growth and motility. tumor suppressor. 	cell motility cancer proliferation	Scientific Reports 2013, 3, Art.No.: 1777 Bosn J Basic Med Sci. ,19(2):146
GREM1	gremlin 1, DAN family BMP antagonist	2.19 ↑	<ul style="list-style-type: none"> inhibitor in the TGF-β signaling pathway. expression is found in many cancers. plays a BMP-dependent role. in angiogenesis on endothelium of human lung tissue. 	TGF-β cancer angiogenesis	BMC Cancer 2006, 6: 74 Blood 2007, 109 (5): 1834
SNAI1	snail family zinc finger 1	2.18 ↑	<ul style="list-style-type: none"> encodes the SLUG protein induction of EM in human brain pericytes associated with enhanced migration and proliferation of brain pericytes 	cell motility cancer proliferation TGF-β	Neuropathol Appl Neurobiol 2021;47(6): 768
VDR	vitamin D (1,25-dihydroxyvitamin D3) receptor	2.18 ↑	<ul style="list-style-type: none"> VDR signaling enhances adhesion and suppresses the invasive capacity of cells. loss of VDR can lead to abnormal tumor angiogenesis. Required for proliferation, migration, and differentiation of epidermal stem cells and progeny during cutaneous wound repair. Negative regulator of TGF-β/Smad signalling in systemic sclerosis. 	cell motility angiogenesis cancer proliferation	Endocrinol Metab Clin North Am. 2017;46(4):1009 Cancer Res. 2009;69(3):967 J Invest Dermatol 2018;138(11):2423 Ann Rheum Dis 2015;74(3):e20
VAT1L	vesicle amine transport 1-like	2.17 ↑	<ul style="list-style-type: none"> Function unknown 		
SPDL1	spindle apparatus coiled-coil protein 1	2.14 ↑	<ul style="list-style-type: none"> Functions in mitotic spindle formation 	proliferation cancer	Front. Genet 2022, 18 Sec. Compl. Gen. doi.org/10.3389/fgene.2022.79802
ARHGEF40	Rho guanine nucleotide exchange factor (GEF) 40	2.11 ↑	<ul style="list-style-type: none"> Rho family GTPases control numerous cellular processes including cytoskeletal reorganization 	cell motility (?)	JBC - Mech Signal Transduction 2001, 276(7): 4948
LRRC17	leucine rich repeat containing 17	2.10 ↑	<ul style="list-style-type: none"> Anti-apoptotic protein linked to prognosis of ovarian cancer. 	cancer	Anticancer Res 2020;40(10): 5601
SLITRK6	SLIT and NTRK-like family, member 6	2.10 ↑	<ul style="list-style-type: none"> moderately negatively correlated with tumor malignancy. 	cancer	Biochem Biophys Rep 2021, 28: 101157

IL21R	interleukin 21 receptor	2.09 ↑	<ul style="list-style-type: none"> • Transduces the growth promoting signal of IL21. • Controversial functions in cancer • Modulates functions of T, B, natural killer (NK), and myeloid cells. 	cancer immune surveillance	Clin Cancer Res 2007, 13 (23): 6926 Blood (2007) 109 (10): 4135
RP11-64D22.2	pseudogene	2.09 ↑	<ul style="list-style-type: none"> • Promotes growth and tumorigenesis of breast cancer 	cancer	Molecular Therapy: Nucleic Acids 2020, 21: 916
TMC7	transmembrane channel-like 7	2.08 ↑	<ul style="list-style-type: none"> • Predicted to enable mechanosensitive ion channel activity. Predicted to be involved in ion transmembrane transport 		TMC7 transmembrane channel like 7 [Homo sapiens (human)] - Gene - NCBI (nih.gov)
SPSB1	spla/ryanodine receptor domain and SOCS box containing 1	2.08 ↑	<ul style="list-style-type: none"> • Involved in protein ubiquitination and ubiquitin-dependent protein catabolic process • Negative regulator of TGFBR2 	TGF-β cancer	J Biol Chem 2015, 290(29):17894
ARHGAP31	Rho GTPase activating protein 31	2.07 ↑	<ul style="list-style-type: none"> • Negative regulator of Rho GTPase 	cancer	J Hematol Oncol 2021,14, Art.No.: 171
DAAM1	dishevelled associated activator of morphogenesis 1	2.06 ↑	<ul style="list-style-type: none"> • Promotes new actin filaments, regulates cell growth through the stabilization of microtubules. • Overexpression correlates with metastasis in breast cancer. • Activation of DAAM1 leads to inhibition of endothelial cell proliferation, migration, and angiogenesis. 	cancer cell motility angiogenesis	Pathol Res Pract 2020, 216(3):152736 PNAS 2010;107(15):6906
SPOCK1	sparc/osteonectin, cwcv and kazal-like domains proteoglycan (testican) 1	2.05 ↑	<ul style="list-style-type: none"> • Extracellular proteoglycan. • Induces EMT in several cancer cells lines • Promotes migration, degradation of the basement membrane, invasion, adhesion and angiogenesis. • Regulates BBB integrity. 	cancer EMT TGF- β cell motility proliferation angiogenesis BBB	Biochem. Biophys. Res. Commun. 2013, 440: 792 Molecular Cancer 2015,14, Art.No.: 12 Cell Physiol 2022, 322 (4): C688
PCDH9	protocadherin 9	2.05 ↑	<ul style="list-style-type: none"> • acts as a tumor suppressor inducing arrest at G₀/G₁, is frequently methylated in HCC • inhibits EMT in cancer 	cancer EMT cell motility	Mol Med Rep. 2017;16(4):4475 Cell Death & Disease 2018, 9, Art. No.: 27
MB21D2	Mab-21 domain containing 2	2.04 ↑	<ul style="list-style-type: none"> • Promotes a pro-oncogenic phenotype in HNSCC. 	cancer proliferation	Mol Oncol 2020, 14(12):306
RAP1GAP2	RAP1 GTPase activating protein 2	2.02 ↑	<ul style="list-style-type: none"> • GTPase-activating protein that activates the small guanine-nucleotide-binding protein Rap1 in thrombocytes. • Inhibits cytoskeletal remodeling and motility in thyroid cancer cells. 	cancer cell motility	Endocr Relat Cancer. 2012;19(4):575
HS3ST3A1	heparan sulfate (glucosamine) 3-O-sulfotransferase 3A1	2.01 ↑	<ul style="list-style-type: none"> • novel tumor regulator and a prognostic marker in breast cancer. 	cancer	Oncogene, 2016 Sep 22. PMID 27041583

KIAA1549L	KIAA1549-like	2.01 ↑	<ul style="list-style-type: none">• Predicted to be integral component of membrane		KIAA1549 like [Homo sapiens (human)] - Gene - NCBI (nih.gov)
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