

Supplementary Tables

Supplementary Table S1. PHLDA1 expression in various cancers from the Oncomine database.

Cancer	Cancer subtype	p-value	Fold change	Rank (%)	Sample	Reference
Brain	Oligodendroglioma	2.55E-17	3.416	1	180	(Sun et al., 2006)
	Glioblastoma	8.30E-20	2.903	1	180	(Sun et al., 2006)
	Anaplastic Astrocytoma	3.63E-7	2.461	3	180	(Sun et al., 2006)
	Anaplastic Oligoastrocytoma	9.51E-6	6.347	1	33	(French et al., 2005)
	Anaplastic Oligodendroglioma	2.23E-7	5.73	2	33	(French et al., 2005)
	Glioblastoma	2.64E-9	3.511	2	54	(Bredel et al., 2005)
	Brain Glioblastoma	4.72E-10	3.550	4	557	TCGA
	Glioblastoma	1.72E-8	2.377	3	84	(Murat et al., 2008)
Breast	Invasive Ductal Breast Carcinoma	5.54E-7	-16.882	1	66	(Ma et al., 2009)
	Ductal Breast Carcinoma in Situ	1.84E-6	-10.087	1	66	(Ma et al., 2009)
	Invasive Lobular Breast Carcinoma	9.38E-9	-2.537	9	593	TCGA
Cervical	High Grade Cervical Squamous Intraepithelial Neoplasia	9.53E-5	-3.731	2	41	(Ma et al., 2009)
	Cervical Squamous Cell Carcinoma	1.86E-5	-2.157	6	66	(Scotto et al., 2008)
Colorectal	Colorectal Carcinoma	3.29E-20	6.686	1	105	(Skrzypczak et al., 2010)
	Colorectal Adenocarcinoma	1.24E-21	6.684	1	105	(Skrzypczak et al., 2010)

Colorectal Adenoma	5.86E-7	2.342	1	78	(Gaspar et al., 2008)
Colon Adenoma	2.23E-9	8.212	1	40	(Skrzypczak et al., 2010)
Colon Adenoma	5.52E-8	3.534	2	40	(Skrzypczak et al., 2010)
Colon Carcinoma	1.10E-8	6.033	3	40	(Skrzypczak et al., 2010)
Colon Carcinoma	6.81E-7	2.651	8	40	(Skrzypczak et al., 2010)
Colon Mucinous Adenocarcinoma	4.62E-14	8.109	1	237	TCGA
Rectal Mucinous Adenocarcinoma	1.08E-6	11.495	2	237	TCGA
Rectosigmoid Adenocarcinoma	5.01E-7	2.591	2	237	TCGA
Cecum Adenocarcinoma	1.04E-11	5.851	3	237	TCGA
Rectal Adenocarcinoma	1.81E-13	6.095	7	237	TCGA
Rectal Adenocarcinoma	6.78E-32	3.898	1	130	(Gaedcke et al., 2010)
Rectal Adenocarcinoma	1.15E-5	3.130	2	105	(Kaiser et al., 2007)
Colon Mucinous Adenocarcinoma	1.77E-6	3.536	3	105	(Kaiser et al., 2007)
Rectosigmoid Adenocarcinoma	4.90E-5	2.806	6	105	(Kaiser et al., 2007)
Cecum Adenocarcinoma	3.10E-5	2.619	8	105	(Kaiser et al., 2007)
Colon Adenoma	2.33E-14	4.933	2	64	(Sabates-Bellver et al., 2007)
Rectal Adenoma	2.94E-5	7.588	8	64	(Sabates-Bellver et al., 2007)

	Colorectal Carcinoma	1.66E-12	7.220	3	82	(Hong et al., 2010)
Esophagus	Barrett's Esophagus	4.41E-7	-4.319	2	52	(Wang et al., 2006)
	Esophageal Adenocarcinoma	5.26E-5	-6.831	5	52	(Wang et al., 2006)
	Esophageal Adenocarcinoma	8.77E-24	-8.856	2	118	(Kim et al., 2010)
	Barrett's Esophagus	1.75E-8	-16.920	9	118	(Kim et al., 2010)
	Esophageal Squamous Cell Carcinoma	2.02E-8	-4.170	4	34	(Hu et al., 2010)
	Esophageal Squamous Cell Carcinoma	1.23E-12	-2.471	3	106	(Su et al., 2011)
Kidney	Clear Cell Renal Cell Carcinoma	1.35E-5	2.186	3	44	(Higgins et al., 2003)
Liver	Hepatocellular Carcinoma	1.54E-25	-4.366	1	197	(Chen et al., 2002)
	Hepatocellular Carcinoma	1.10E-6	-2.339	2	75	(Wurmbach et al., 2007)
Lymphoma	Germinal Center B-Cell-Like Diffuse Large B-Cell Lymphoma	2.11E-9	2.652	1	136	(Compagno et al., 2009) Compagno
	Follicular Lymphoma	1.56E-21	2.857	2	136	(Compagno et al., 2009)
	Diffuse Large B-Cell Lymphoma	2.53E-19	2.989	3		(Compagno et al., 2009)
	Diffuse Large B-Cell Lymphoma	2.53E-19	2.989	3	136	(Compagno et al., 2009)
	Activated B-Cell-Like Diffuse Large B-Cell Lymphoma	5.79E-7	2.911	10	136	(Compagno et al., 2009)
	Unspecified Peripheral T-Cell Lymphoma	1.28E-13	-6.514	2	60	(Piccaluga et al., 2007)

	Angioimmunoblastic T-Cell Lymphoma	2.37E-5	-6.341	6	60	(Piccaluga et al., 2007)
Melanoma	Melanoma	2.27E-5	11.079	1	37	(Haqq et al., 2005)
	Cutaneous Melanoma	3.99E-9	4.490	2	70	(Talantov et al., 2005)
	Benign Melanocytic Skin Nevus	6.39E-5	9.571	4	70	(Talantov et al., 2005)(24)-Dmitri Talantov
Myeloma	Multiple Myeloma	9.38E-14	2.599	1	158	(Agnelli et al., 2009)
Ovarian	Ovarian Carcinoma	1.05E-7	2.012	10	195	(Bonome et al., 2008)
Pancreas	Pancreatic Carcinoma	1.65E-8	2.578	2	52	(Pei et al., 2009)
	Pancreatic Ductal Adenocarcinoma	1.39E-8	2.501	8	58	(Badea et al., 2008)

Supplementary Table S2. PHLDA2 expression in various cancers from the Oncomine database.

Cancer	Cancer subtype	p-value	Fold change	Rank (%)	Sample	Reference
Brain	Glioblastoma	2.08E-6	8.475	3	101	(Lee et al., 2006)
Breast	Ductal Breast Carcinoma in Situ	6.61E-5	3.366	2	66	(Ma et al., 2009)
Colorectal	Colon Mucinous Adenocarcinoma	6.01E-9	2.974	6	237	TCGA
	Colorectal Carcinoma	6.96E-7	2.116	7	105	(Skrzypczak et al., 2010)
	Colorectal Carcinoma	1.85E-8	2.701	8	82	(Hong et al., 2010)
Esophagus	Barrett's Esophagus	1.235E-12	3.064	1	118	(Kim et al., 2010)

	Barrett's Esophagus	6.99E-5	2.532	5	52	(Wang et al., 2006)
Head and Neck	Tongue Squamous Cell Carcinoma	7.53E-12	5.155	2	93	(Talbot et al., 2005)
	Tongue Squamous Cell Carcinoma	8.55E-11	6.263	2	58	(Estilo et al., 2009)
Kidney	Clear Cell Renal Cell Carcinoma	2.30E-5	4.012	4	67	(Yusenko et al., 2009)
	Renal Pelvis Urothelial Carcinoma	5.25E-6	3.263	8	92	(Jones et al., 2005)
Lung	Lung Adenocarcinoma	2.05E-11	2.799	1	96	(Beer et al., 2002)
	Lung Adenocarcinoma	1.99E-19	4.027	1	107	(Landi et al., 2008)
	Lung Adenocarcinoma	9.11E-8	4.015	2	39	(Stearman et al., 2005)
	Lung Adenocarcinoma	1.09E-7	3.634	2	66	(Su et al., 2007)
	Lung Adenocarcinoma	1.42E-17	2.387	2	116	(Selamat et al., 2012)
	Squamous Cell Lung Carcinoma	1.18E-6	2.744	10	93	(Talbot et al., 2005)
Lymphoma	Diffuse Large B-Cell Lymphoma	1.12E-27	5.683	1	136	(Piccaluga et al., 2007)
	Activated B-Cell-Like Diffuse Large B-Cell Lymphoma	1.01E-11	4.274	2	136	(Piccaluga et al., 2007)
	Follicular Lymphoma	1.18E-18	2.958	3	136	(Piccaluga et al., 2007)
	Germinal Center B-Cell-Like Diffuse Large B-Cell Lymphoma	1.18E-18	3.675	5	136	(Piccaluga et al., 2007)
	Hodgkin's Lymphoma	1.35E-7	6.336	1	67	(Brune et al., 2008)

	Centroblastic Lymphoma	1.25E-9	4.164	6	336	(Basso et al., 2005)
	Diffuse Large B-Cell Lymphoma	1.01E-5	2.591	6	336	(Basso et al., 2005)
Ovarian	Ovarian Mucinous Adenocarcinoma	8.87E-5	3.756	1	50	(Lu et al., 2004)
	Ovarian Mucinous Adenocarcinoma	8.87E-9	2.178	1	103	(Hendrix et al., 2006)
Pancreas	Pancreatic Ductal Adenocarcinoma	6.53E-14	7.481	1	78	(Badea et al., 2008)
	Pancreatic Carcinoma	8.27E-7	9.600	3	52	(Pei et al., 2009)

Supplementary Table S3. *PHLDA3* expression in various cancers from the Oncomine database.

Cancer	Cancer subtype	p-value	Fold change	Rank (%)	Sample	Reference
Colorectal	Colon Adenocarcinoma	4.23E-13	3.297	3	123	(Ki et al., 2007)
Esophagus	Esophageal Adenocarcinoma	1.47E-19	-3.107	3	118	(Kim et al., 2010)
	Barrett's Esophagus	8.64E-9	-3.315	8	118	(Kim et al., 2010)
Gastric	Gastric Intestinal Type Adenocarcinoma	6.63E-7	2.481	1	90	(Cho et al., 2011)
Kidney	Clear Cell Renal Cell Carcinoma	2.31E-9	2.190	9	92	(Jones et al., 2005)
Lymphoma	Diffuse Large B-Cell Lymphoma	1.56E-22	2.188	2	136	(Compagno et al., 2009)
	Germinal Center B-Cell-Like Diffuse Large B-Cell Lymphoma	4.68E-7	2.470	2	136	(Compagno et al., 2009)
	Activated B-Cell-Like Diffuse Large B-Cell Lymphoma	7.67E-9	2.104	5	136	(Compagno et al., 2009)

Other	Testicular Seminoma	5.18E-13	5.144	1	74	(Sperger et al., 2003)
	Mixed Germ Cell Tumor, NOS	9.65E-15	2.211	1	107	(Korkola et al., 2006)
	Seminoma, NOS	2.02E-8	5.102	3	107	(Korkola et al., 2006)
	Seminoma, NOS	8.74E-6	2.434	4	107	(Korkola et al., 2006)
	Embryonal Carcinoma, NOS	4.43E-7	2.412	7	107	(Korkola et al., 2006)
Sarcoma	Pleomorphic Liposarcoma	8.98E-7	-2.378	3	158	(Barretina et al., 2010)
	Pleomorphic Myxofibrosarcoma	9.29E-5	-2.070	3	158	(Barretina et al., 2010)
	Myxoid/Round Cell Liposarcoma	4.43E-7	-2.812	4	158	(Barretina et al., 2010)
	Myxofibrosarcoma	2.69E-6	-2.248	6	158	(Barretina et al., 2010)
	Leiomyosarcoma	8.91E-6	-2.138	6	158	(Barretina et al., 2010)
	Dedifferentiated Liposarcoma	2.06E-5	-2.013	7	158	(Barretina et al., 2010)

Supplementary Table S4. Association of PHLDA1 expression and survival of cancer patients (PrognScan database).

Cancer type	Endpoint	N	Dataset	Probe ID	Cox P-value	HR [95% CI ^{low} - CI ^{upp}]
Bladder cancer	Overall survival	30	GSE5287	218000_s_at	0.0036	2.78 [1.40 - 5.51]
Brain cancer	Overall survival	70	GSE7696	217997_at	0.0083	0.73 [0.57 - 0.92]

Brain cancer	Overall survival	70	GSE7696	217997_at	0.0324	0.77[0.06-0.98]
Brain cancer	Overall survival	70	GSE7696	217996_at	0.0175	0.69[0.51-0.94]
Brain cancer	Overall survival	70	GSE7696	217998_at	0.0056	0.36[0.17-0.74]
Brain cancer	Overall survival	50	MGH-glioma	35909_at	0.0197	0.73[0.56-0.95]
Brain cancer	Overall survival	74	GSE4412-GPL96	217997_at	0.0008	0.48[0.31-0.74]
Brain cancer	Overall survival	74	GSE4412-GPL96	218000_s_at	0.0259	0.76[0.60-0.97]
Brain cancer	Overall survival	74	GSE4412-GPL96	217998_at	0.0033	0.55[0.37-0.82]
Brain cancer	Overall survival	74	GSE4412-GPL96	217996_at	0.0065	0.55[0.36-0.85]
Brain cancer	Overall survival	74	GSE4412-GPL96	217999_s_at	0.0001	0.45[0.28-0.73]
Brain cancer	Overall survival	74	GSE4412-GPL97	225842_at	0.2191	0.59[0.38-0.93]
Breast cancer	Relapse-free survival	60	GSE1397	4920	0.0018	0.17[0.06-0.52]
Breast cancer	Overall survival	155	GSE9893	6574	0.0042	0.49[0.30-0.80]
Breast cancer	Distant metastasis-free survival	286	GSE2034	218000_s_at	0.0054	0.78[0.66-0.93]
Breast cancer	Disease-specific survival	159	GSE1456-GPL96	218000_s_at	0.0388	1.44[1.02-2.03]
Breast cancer	Disease-specific survival	159	GSE1456-GPL96	217996_at	0.0358	1.79[1.04-3.09]

Breast cancer	Distant metastasis-free survival	117	E-TABM-158	217998_at	0.0468	0.38[0.14-0.99]
Breast cancer	Relapse-free survival	198	GSE7390	217996_at	0.0297	1.20[1.02-1.43]
Breast cancer	Relapse-free survival	198	GSE7390	217997_at	0.0359	1.20[1.01-1.43]
Colorectal cancer	Disease free survival	145	GSE17536	217996_at	0.0300	1.59[1.05-2.42]
Colorectal cancer	Disease free survival	145	GSE17536	218000_s_at	0.0482	2.00[1.01-3.99]
Colorectal cancer	Disease Specific survival	177	GSE17536	217996_at	0.0317	1.45[1.03-2.02]
Colorectal cancer	Overall survival	177	GSE17536	217996_at	0.0419	1.35[1.01-1.80]
Colorectal cancer	Disease free survival	226	GSE14333	217997_at	0.0299	1.42[1.03-1.96]
Colorectal cancer	Disease free survival	226	GSE14333	217996_at	0.0131	1.52[1.09-2.13]
Colorectal cancer	Disease free survival	55	GSE17537	217999_s_at	0.0288	1.75[1.06-2.89]
Colorectal cancer	Overall survival	55	GSE17537	217997_at	0.0406	1.62[1.02-2.58]
Colorectal cancer	Disease free survival	55	GSE17537	217997_at	0.0283	1.82[1.07-3.11]
Colorectal cancer	Overall survival	55	GSE17537	217996_at	0.0222	1.76[1.08-2.86]
Colorectal cancer	Disease Specific	49	GSE17537	217997_at	0.0127	2.35[1.20-4.61]

	survival					
Colorectal cancer	Disease free survival	55	GSE17537	217996_at	0.0096	2.15[1.20-3.83]
Colorectal cancer	Disease Specific survival	49	GSE17537	217996_at	0.0165	2.28[1.16-4.47]
Esophagus cancer	Overall survival	34	GSE11595	667883	0.00578	1.80[1.18-2.72]
Eye cancer	Distant metastasis-free survival	63	GSE22138	217998_at	0.0027	0.42[0.24-0.74]
Eye cancer	Distant metastasis-free survival	63	GSE22138	217997_at	0.0002	0.70[0.57-0.84]
Eye cancer	Distant metastasis-free survival	63	GSE22138	225842_at	0.0028	0.66[0.50-0.87]
Eye cancer	Distant metastasis-free survival	63	GSE22138	217996_at	0.0001	0.66[0.54-0.81]
Eye cancer	Distant metastasis-free survival	63	GSE22138	217999_s_at	0.0001	0.57[0.41-0.79]
Lung cancer	Overall survival	82	Jacob-00182-CANDF	217996_at	0.0293	1.63[1.05-2.53]
Lung cancer	Overall survival	82	Jacob-00182-CANDF	217997_at	0.0309	1.70[1.05-2.74]
Lung cancer	Overall survival	82	Jacob-00182-CANDF	218000_s_at	0.0054	1.71[1.17-2.50]
Lung cancer	Relapse-free survival	204	GSE31210	217998_at	0.0221	0.57[0.35-0.92]
Lung cancer	Overall survival	111	GSE3141	217996_at	0.0084	1.53[1.11-2.10]

Lung cancer	Overall survival	111	GSE3141	225842_at	0.0389	1.56[1.02-2.37]
Lung cancer	Overall survival	111	GSE3141	217997_at	0.0314	1.55[1.04-2.32]
Lung cancer	Overall survival	50	GSE4716-GPL3694	2733	0.0393	1.94[1.03-3.65]
Ovarian cancer	Overall survival	133	DUKE-OC	217996_at	0.0309	0.86[0.76-0.99]
Ovarian cancer	Overall survival	133	DUKE-OC	217997_at	0.0395	.85[0.72-0.99]
Ovarian cancer	Disease free survival	185	GSE26712	217998_at	0.0352	1.49[1.03-2.17]
Ovarian cancer	Progression free survival	110	GSE17260	A_24_P943597	0.0331	0.82[0.69-0.99]
Skin cancer	Overall survival	38	GSE19234	218000_s_at	0.0056	1.87[1.20-2.91]
Skin cancer	Overall survival	38	GSE19234	217999_s_at	0.0261	2.28[1.10-4.72]
Skin cancer	Overall survival	38	GSE19234	217998_at	0.0315	2.50[1.08-5.78]
Skin cancer	Overall survival	38	GSE19234	217997_at	0.0172	2.09[1.14-3.82]

Supplementary Table 5. Association of PHLDA2 expression and survival of cancer patients (PrognScan database).

Cancer type	Endpoint	N	Dataset	Probe ID	Cox P-value	HR [95% CI ^{low} - CI ^{upp}]
Bladder cancer	Disease Specific survival	165	GSE 13507	ILMN_1671557	0.0328	1.60[1.04-2.46]
Blood cancer	Overall survival	158	GSE4475	209803_s_at	0.0316	0.52[0.28-0.94]

Brain cancer	Overall survival	70	GSE7696	209803_s_at	0.0356	0.82[0.69-0.99]
Brain cancer	Overall survival	50	MGH-glioma	31888_s_at	0.0001	1.67[1.27-2.18]
Brain cancer	Overall survival	74	GSE4412-GPL96	209803_s_at	0.0128	1.46[1.08-1.97]
Brain cancer	Overall survival	67	GSE16581	229494_s_at	0.0299	2193.45[2.11-2276203.77]
Breast cancer	Overall survival	158	GSE3143	31888_s_at	0.0455	1.61[1.01-2.57]
Breast cancer	Overall survival	158	GSE3143	40237_at	0.0047	2.01[1.24-3.25]
Breast cancer	Distant metastasis-free survival	200	GSE11121	209802_at	0.0196	2.01[1.12-3.60]
Breast cancer	Distant metastasis-free survival	286	GSE2034	209803_s_at	0.0002	1.54[1.23-1.94]
Breast cancer	Disease Specific survival	159	GSE1456-GPL96	209803_s_at	0.0085	1.79[1.16-2.77]
Breast cancer	Overall survival	159	GSE1456-GPL96	209803_s_at	0.0034	1.74[1.20-2.53]
Breast cancer	Disease Specific survival	236	GSE3494-GPL96	209803_s_at	0.0281	1.50[1.04-2.14]
Breast cancer	Disease free survival	249	GSE4922-GPL96	209803_s_at	0.0201	1.42[1.06-1.91]
Breast cancer	Distant metastasis-free survival	125	GSE2990	209803_s_at	0.0074	1.55[1.12-2.12]
Breast cancer	Relapse-free survival	125	GSE2990	209803_s_at	0.0161	1.36[1.06-1.74]

Breast cancer	Distant metastasis-free survival	198	GSE7390	209803_s_at	0.0264	1.28[1.03-1.58]
Breast cancer	Overall survival	198	GSE7390	209803_s_at	0.0391	1.27[1.01-1.59]
Colorectal cancer	Overall survival	62	GSE12945	209803_s_at	0.0312	2.26[1.08-4.74]
Eye cancer	Distant metastasis-free survival	63	GSE22138	209803_s_at	0.0464	1.23[1.00-1.52]
Lung cancer	Overall survival	86	MICHIGAN-LC	AF001294_at	0.0081	3.79[1.39-10.28]
Lung cancer	Overall survival	204	GSE31210	209803_s_at	0.0021	2.36[1.37-4.06]
Lung cancer	Overall survival	204	GSE31210	229494_s_at	0.0444	1.45[1.01-2.08]
Lung cancer	Relapse-free survival	204	GSE31210	209803_s_at	<u>0.0026</u>	<u>1.86[1.24-2.80]</u>
Lung cancer	Relapse-free survival	204	GSE31210	229494_s_at	<u>0.0404</u>	<u>1.31[1.01-1.70]</u>
Lung cancer	Relapse-free survival	204	GSE31210	209802_at	<u>0.0330</u>	1.89[1.05-3.04]
Lung cancer	Disease Specific survival	90	GSE14814	209802_at	0.0367	6.40[1.12-36.55]
Lung cancer	Relapse-free survival	138	GSE8894	209803_s_at	0.0279	1.24[1.02-1.51]
Ovarian cancer	Overall survival	278	GSE9891	229494_s_at	0.0205	0.15[0.03-0.75]
Ovarian cancer	Overall survival	133	DUKE-OC	209802_at	0.0095	4.19[1.42-12.38]
Ovarian cancer	Overall survival	80	GSE14764	209802_at	0.0394	1.77[1.03-3.06]

Supplementary Table 6. Association of PHLDA3 expression and survival of cancer patients (PrognScan database).

Cancer type	Endpoint	N	Dataset	Probe ID	Cox P-value	HR [95% CI ^{low} -CI ^{upp}]
Breast cancer	Relapse-free survival	204	GSE7390	218634_at	0.0059	0.58[0.39-0.85]
Breast cancer	Distant metastasis - free survival	286	GSE2034	218634_at	0.0221	0.51[0.28-0.91]
Colorectal cancer	Disease free survival	226	GSE14333	218634_at	0.0291	1.85[1.06-3.22]
Lung cancer	Relapse-free survival	204	GSE31210	218634_at	0.0162	3.18[1.24-8.19]
Skin cancer	Overall survival	384	GSE19234	218634_at	0.0296	2.29[1.09-4.84]

Supplementary Table S7. Alteration frequency of a ten-gene signature (PHLDA1, EIF3D, PLK2, DUSP6, RND3, MCL1, KLF6,SLC20A1, PABPC4, RPL14) in various cancers (cBioPortal web).

Cancer	Data source	N	Frequency (%)	Mutation % (N)	Amplification % (N)	Deletion % (N)	Multiple alterations % (N)
Bladder	TCGA, Cell2017	408	35.54%	8.09% (33)	20.59% (84)	2.94% (12)	3.92% (13)
Uterine	TCGA,	509	26.52%	14.93% (76)	10.02% (51)	0.98%(5cases)	0.59%(3cases)

Glioblastoma	ancer Atlas TCG A, PanC ancer Atlas	378	5.56%	3.17% (12)	1.85% (1)	0.26% (1)	0.26% (1)
Brain	TCG A, PanC ancer Atlas	511	5.28%	1.17% (6)	2.35% (12)	1.17% (9)	-
Testicular	TCG A, PanC ancer Atlas	144	4.17%	-	1.39% (2)	2.78% (4)	-
Kidney Renal	TCG A, PanC ancer Atlas	354	3.67%	0.855% (3)	0.56% (2)	2.26% (8)	-
Kidney Chro	TCG A, Canc er Cell 2014	65	3.08%	-	3.08%(2)	-	-
Mesothelioma	TCG A, PanC ancer Atlas	82	2.44%	-	1.22% (1)	1.22% (1)	-
Leukemia	TCG A, PanC ancer Atlas	190	1.58%	1.58% (3)	-	-	-
Thyroid	TCG A, PanC ancer Atlas	482	1.04%	1.04% (5)			

Supplementary Table S8. Alteration frequency of a ten-gene signature (PHLDA2, PHLDA3, DUSP6, TAGLN2, BAMBI, SLC19A1, UPP1, FOSL1, S100P, MAFF) in various cancer (cBioPortal web).

Cancer	Data source	N	Frequency (%)	Mutation % (N)	Amplification % (N)	Deletion % (N)	Multiple alterations % (N)
Bladder	TCGA, PanCancer Atlas	406	26.11%	5.91% (24)	16.5% (67)	2.71% (11)	0.99% (4)
Uterine	TCGA, PanCancer Atlas	509	22%	11.79% (60)	9.43% (48)	0.79% (4)	-
Esophageal	TCGA, PanCancer Atlas	182	20.88%	4.4% (8)	10.99% (20)	5.49% (10)	-
Lung	TCGA, PanCancer Atlas	507	19.92%	4.73% (24)	12.03% (61)	1.97% (10)	1.18% (6)
Breast	TCGA, PanCancer Atlas	996	19.08%	1.2% (12)	16.06% (160)	1.61% (16)	0.2% (2)
Ovarian	TCGA, PanCancer Atlas	398	18.34%	0.5% (2)	15.08% (60)	2.01% (8)	0.75% (3)
Melanoma Skin	TCGA, PanCancer Atlas	363	17.91%	6.06% (22)	10.19% (37)	1.38% (5)	0.28% (1)
Sarcoma	TCGA, PanCancer Atlas	253	17.79%	0.79% (2)	13.44% (34)	3.16% (8)	0.4% (1)
Liver	TCGA, PanCancer Atlas	353	17%	1.98% (7)	13.88% (49)	1.13% (14)	-

Lung Squ	TCGA, PanCancer Atlas	469	14.5%	2.99% (14)	8.53% (40)	2.13% (10)	0.85% (4)
Head and Neck Squ	TCGA, PanCancer Atlas	496	13.91%	3.43% (17)	7.66% (38)	2.22% (11)	0.6% (3)
Cholangiocarcinoma	TCGA, PanCancer Atlas	36	13.89%	-	13.89% (5)	-	-
Stomach	TCGA, PanCancer Atlas	434	12.9%	4.38% (19)	4.38% (19)	3.69% (16)	0.42% (2)
Uterine	TCGA, PanCancer Atlas	56	12.5%	1.79% (1)	10.71% (6)	-	-
Adrenocortical	TCGA, PanCancer Atlas	89	12.36%	1.12% (1)	7.87% (	3.37% (3)	-
Pancreatic	TCGA, PanCancer Atlas	175	9.14%	2.29% (4)	6.29% (11)	0.57% (1)	-
Cervical	TCGA, PanCancer Atlas	278	8.99%	2.52% (7)	4.68% (13)	1.44% (4)	0.36% (1)
Brain	TCGA, PanCancer Atlas	511	8.02%	0.59% (3)	3.52% (18)	3.91% (20)	-
Colorectal	TCGA, PanCancer Atlas	526	7.98%	6.08% (32)	0.95% (5)	0.95% (5)	-
Pheochromocytoma and Paragangloma	TCGA, PanCancer Atlas	161	7.45%	-	6.83% (11)	0.62% (1)	-

Prostate	TCGA, PanCancer Atlas	489	7.36%	1.02% (5)	3.48% (17)	2.86% (14)	-
Glioblastoma Multi	TCGA, PanCancer Atlas	378	6.88%	1.85% (7)	3.7% (14)	1.06% (4)	0.26% (1)
Lymphoma	TCGA, PanCancer Atlas	37	5.41%	2.7% (1)	2.7% (1)	-	-
Testicular	TCGA, PanCancer Atlas	144	4.17%	1.39% (2)	0.69% (1)	2.08% (3)	-
Thymoma	TCGA, PanCancer Atlas	123	4.07%	-	1.63% (2)	2.44% (3)	-
Kidney	TCGA, PanCancer Atlas	274	4.01%	2.19% (6)	1.09% (3)	0.73% (2)	-
Melanoma	TCGA, PanCancer Atlas	80	2.5%	1.25% (1)	1.25% (1)	-	-
Mesothelioma	TCGA, PanCancer Atlas	82	2.44%	1.22% (1)	1.22% (1)	-	-
Leukemia	TCGA, PanCancer Atlas	198	2.11%	-	2.11%(4)	-	-
Kidney	TCGA, Nature 2013	65	1.54%	1.54% (1)	-	-	-
Kidney	TCGA, cell 2014	354	1.13%	0.28% (1)	0.28% (1)	0.56% (2)	-
Thyroid	TCGA, cell 2014	482	0.83%	0.41% (2)	0.41% (2)	-	-

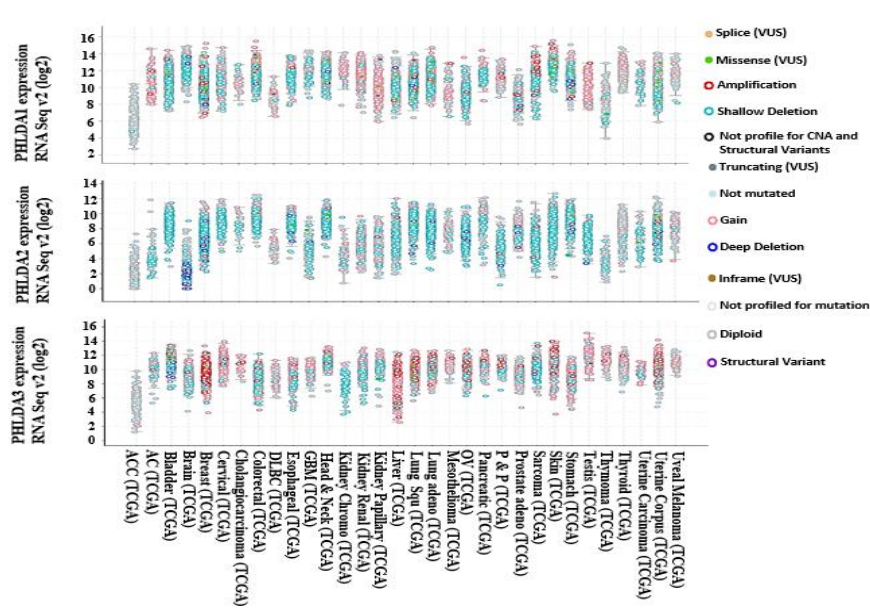
Supplementary Table S9. Alteration frequency of a ten-gene signature (PHLDA3, PHLDA2, DYNLL1, NPAS1, RARS2, DNAJB2, GSN, ZMAT3, ME1, SAAL1) in various cancer (cBioPortal web).

Cancer	Data source	N	Frequency (%)	Mutation % (N)	Amplification % (N)	Deletion % (N)	Multiple alterations % (N)
Lung Squ	TCGA, PanCancer Atlas	469	43.07%	3.2% (15)	36.25% (170)	1.49% (7)	2.13% (10)
Uterine	TCGA, PanCancer Atlas	509	29.27%	16.31% (83)	10.61% (54)	1.18% (6)	1.18% (6)
Ovarian	TCGA, PanCancer Atlas	398	27.64%	1.01% (4)	24.87% (99)	1.26% (5)	0.5% (2)
Esophageal	TCGA, PanCancer Atlas	182	26.37%	2.75% (5)	19.23% (35)	3.85% (7)	0.55% (1)
Skin	TCGA, PanCancer Atlas	363	26.17%	18.73% (68)	4.41% (16)	1.65% (6)	1.38% (5)
Head and Neck Squ	TCGA, PanCancer Atlas	496	22.18%	4.23% (21)	15.52% (77)	1.61% (8)	0.81% (4)
Cervical	TCGA, PanCancer Atlas	278	20.5%	3.24% (9)	14.39% (40)	1.8% (5)	1.08% (3)
Uterine	TCGA, PanCancer Atlas	56	19.64%	5.36% (3)	14.29% (8)	-	-
Bladder	TCGA, PanCancer Atlas	406	17.98%	7.14% (29)	6.4% (26)	3.94% (16)	0.49% (2)

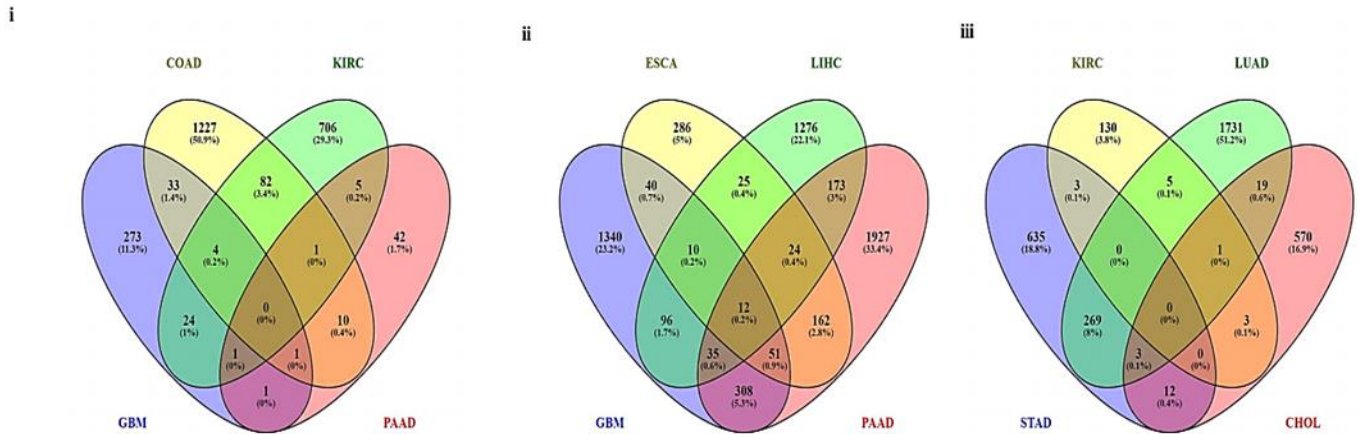
Prostate	TCGA, PanCancer Atlas	489	17.38%	1.23% (6)	4.7% (23)	11.45% (56)	-
Lymphoma	TCGA, PanCancer Atlas	37	16.22%	5.41% (2)	2.7% (1)	8.11% (3)	-
Breast	TCGA, PanCancer Atlas	996	16.16%	1.61% (16)	12.55% (125)	1.81% (18)	0.2% (2)
Stomach	TCGA, PanCancer Atlas	434	16.13%	6.68% (29)	6.91% (30)	2.3% (10)	0.23% (1)
Lung	TCGA, PanCancer Atlas	507	15.98%	7.3% (37)	5.92% (30)	2.17% (11)	0.59% (3)
Liver	TCGA, PanCancer Atlas	353	12.46%	1.42% (4)	8.22% (29)	2.27% (8)	0.57% (2)
Sarcoma	TCGA, PanCancer Atlas	253	11.86%	1.98% (5)	7.11% (18)	2.77% (7)	-
Carcinoma	TCGA, PanCancer Atlas	89	11.24%	4.49% (4)	6.74% (6)	-	-
Colorectal	TCGA, PanCancer Atlas	526	10.46%	9.32% (49)	0.76% (4)	0.38% (2)	-
Melanoma	TCGA, PanCancer Atlas	80	8.75%	1.25% (1)	2.5% (2)	5% (4)	-
Brain	TCGA, PanCancer Atlas	511	8.61%	0.78% (4)	2.54% (13)	5.09% (26)	0.2% (1)
Cholangiocar cinoma	TCGA, PanCancer Atlas	36	8.33%	2.78% (1)	5.56% (2)	-	-

Glioblastoma	TCGA, PanCancer Atlas	378	7.41%	2.65% (10)	4.5% (17)	0.26% (1)	-
Kidney	TCGA, PanCancer Atlas	274	6.57%	3.65% (10)	1.82% (5)	1.09% (3)	-
Pheochromocytoma and paraganglioma	TCGA, PanCancer Atlas	161	5.59%	4.35% (7)	1.24% (2)	-	-
Kidney	TCGA, PanCancer Atlas	354	4.24%	1.41% (5)	1.69% (6)	0.85% (3)	0.28% (1)
Testicular	TCGA, PanCancer Atlas	144	4.17%	2.08% (3)	1.39% (2)	0.69% (1)	-
Thymoma	TCGA, PanCancer Atlas	123	4.07%	2.44% (3)	1.63% (2)	-	-
Mesothelioma	TCGA, PanCancer Atlas	82	3.66%	1.22% (1)	2.44% (2)	-	-
Kidney	TCGA, PanCancer Atlas	65	3.08%	1.54% (1)	1.54% (1)	-	-
Leukemia	TCGA, PanCancer Atlas	190	2.11% (4)	-	-	-	--
Thyroid	TCGA, PanCancer Atlas	482	1.87%	0.83% (4)	0.21% (1)	0.83% (4)	

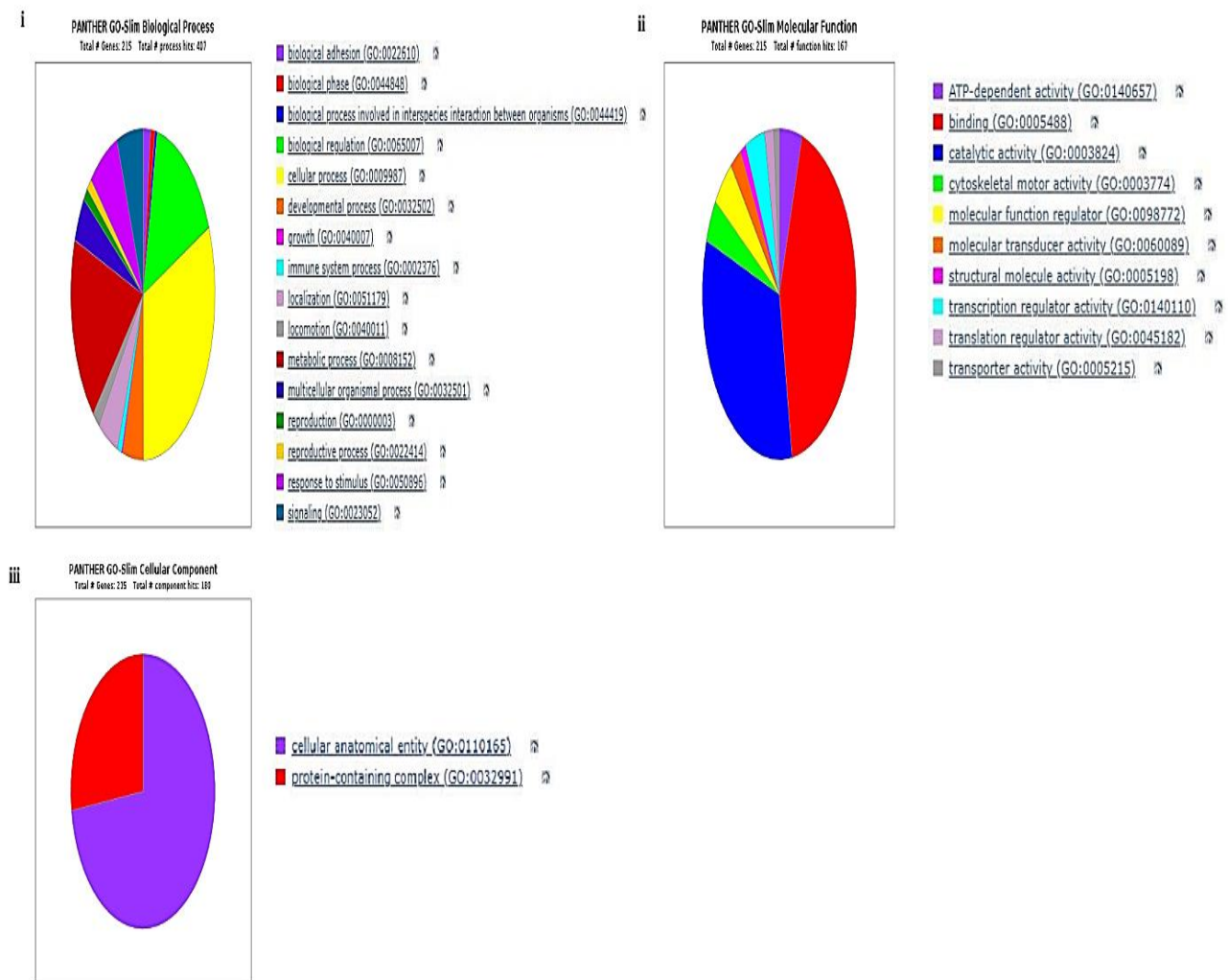
Supplementary Figures



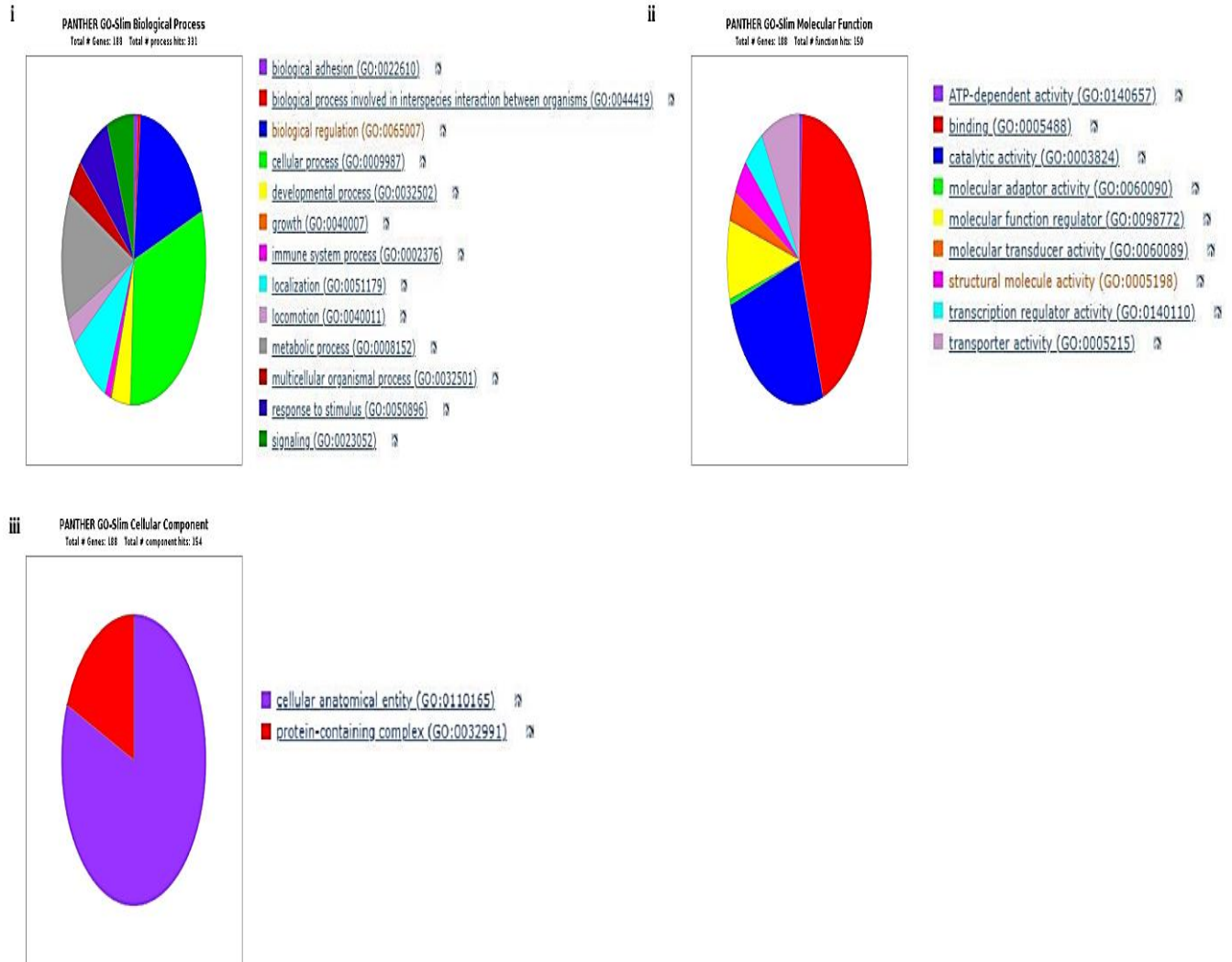
Supplementary Figure S1. The cBioPortal database (<http://www.cbioportal.org/index.do>) was analyzed to determine the expression of PHLDA family genes in 32 different forms of human cancer. Each dot corresponds to a distinct study. Green dots denote missense mutations, blue dots represent typical gene sequencing results (no mutation), and white dots indicate those without profiled data. Each box displays the median and interquartile ranges.



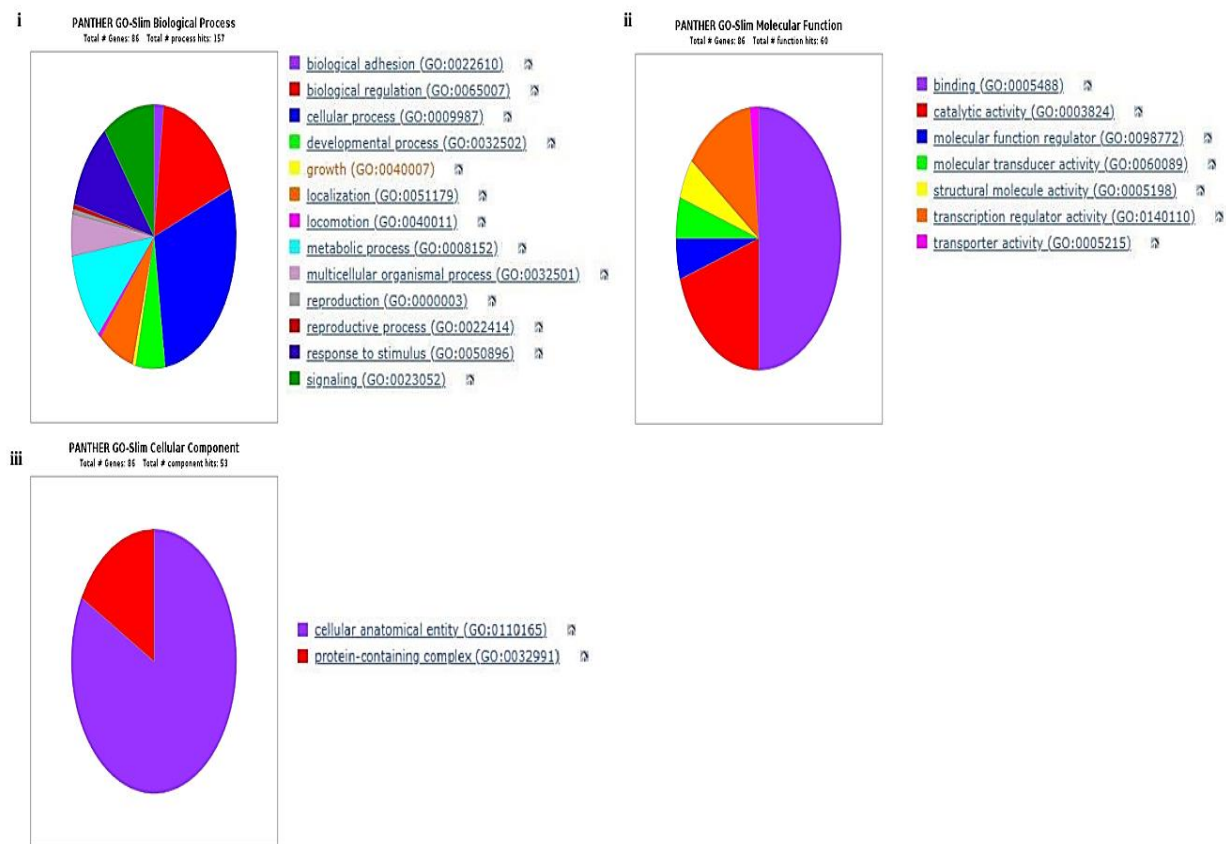
Supplementary Figure S2. Venn diagram shows the coincident genes with PHLDA1(i), PHLDA2 (ii), and PHLDA3 (iii) that are negatively associated.



Supplementary Figure S3. Gene ontology (GO) analysis of positively correlated genes of *PHLDA1* using PANTHER. Here, Molecular function (**i**), Biological Process (**ii**), and Cellular component (**iii**).



Supplementary Figure S4. Gene ontology (GO) analysis of positively correlated genes of *PHLDA2* using PANTHER. Here, Molecular function (**i**), Biological Process (**ii**), and Cellular component (**iii**).



Supplementary Figure S5. Gene ontology (GO) analysis of positively correlated genes of *PHLDA3* using PANTHER. Here, Molecular function (**i**), Biological Process (**ii**), and Cellular component (**iii**).

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