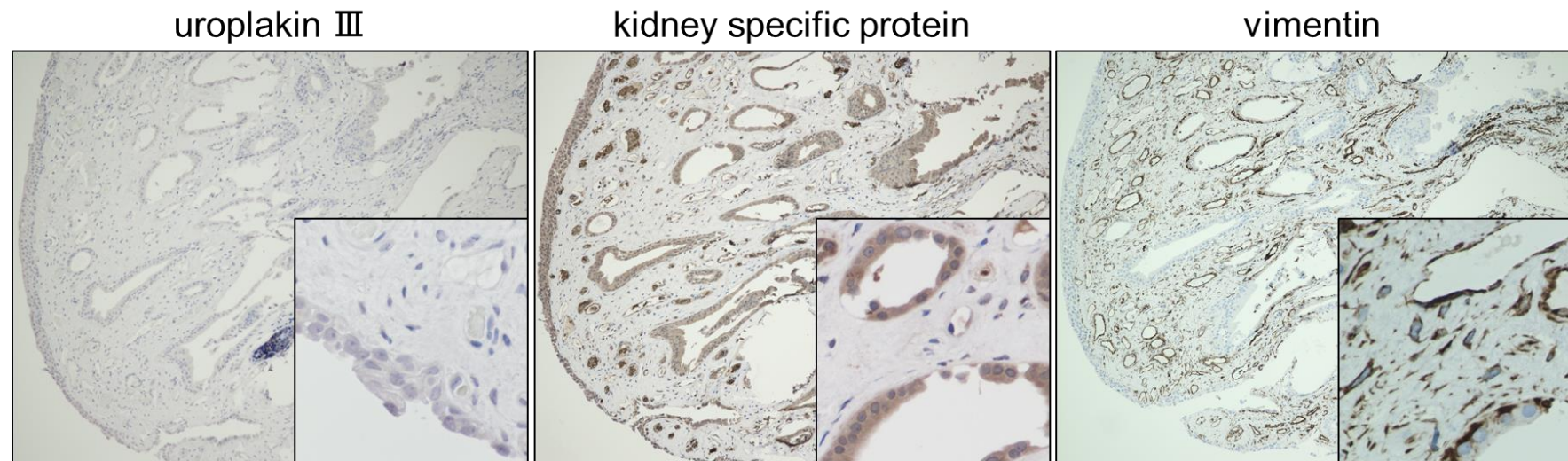


- 1 **Supplementary Figure 1.** Immunohistochemical distribution of urothelial cells, renal tubular cells, and interstitial cells stained
- 2 by uroplakin III, kidney specific protein, and vimentin, respectively. Magnification,  $\times 100$  (inset  $\times 400$ ). Representative
- 3 micrographs were obtained from normal papillary tissues of CaOx stone formers.



**Supplementary Table 1.** Top 100 upregulated genes in papillary tissue of both Randall's Plaque and normal mucosa with calcium oxalate stone formers compared to those with control patients.

Agilent ID	Gene Symbol	Description	Fold change
A_23_P128868	OR11H12	Homo sapiens olfactory receptor, family 11, subfamily H, member 12 (OR11H12), mRNA [NM_001013354]	26.613
A_23_P130815	KIR2DS2	Homo sapiens killer cell immunoglobulin-like receptor, two domains, short cytoplasmic tail, 2 (KIR2DS2), mRNA [NM_012312]	26.224
A_24_P402855	PROL1	Homo sapiens proline rich, lacrimal 1 (PROL1), mRNA [NM_021225]	23.733
A_24_P917306	ZNF385D	zinc finger protein 385D [Source:HGNC Symbol;Acc:26191] [ENST00000494108]	23.050
A_33_P3260667	OR2T34	Homo sapiens olfactory receptor, family 2, subfamily T, member 34 (OR2T34), mRNA [NM_001001821]	20.948
A_33_P3259440	GOLGA6A	Homo sapiens golgin A6 family, member A (GOLGA6A), mRNA [NM_001038640]	20.628
A_33_P3417281	MUC4	Homo sapiens mucin 4, cell surface associated (MUC4), transcript variant 1, mRNA [NM_018406]	20.610
A_24_P239176	MUC4	Homo sapiens mucin 4, cell surface associated (MUC4), transcript variant 1, mRNA [NM_018406]	19.965
A_21_P0006968	SFTA1P	Homo sapiens surfactant associated 1, pseudogene (SFTA1P), non-coding RNA [NR_027082]	19.344
A_23_P144512	GK2	Homo sapiens glycerol kinase 2 (GK2), mRNA [NM_033214]	19.311
A_33_P3370001	OR2L8	Homo sapiens olfactory receptor, family 2, subfamily L, member 8 (OR2L8), mRNA [NM_001001963]	18.255
A_24_P239177	MUC4	Homo sapiens mucin 4, cell surface associated (MUC4), transcript variant 1, mRNA [NM_018406]	17.474
A_23_P145159	DNAH8	Homo sapiens dynein, axonemal, heavy chain 8 (DNAH8), mRNA [NM_001206927]	16.324
A_33_P3369975	OR2L3	Homo sapiens olfactory receptor, family 2, subfamily L, member 3 (OR2L3), mRNA [NM_001004687]	15.979
A_33_P3216008	SKA3	Homo sapiens spindle and kinetochore associated complex subunit 3 (SKA3), transcript variant 1, mRNA [NM_145061]	15.735
A_33_P3372217	PSG5	pregnancy specific beta-1-glycoprotein 5 [Source:HGNC Symbol;Acc:9522] [ENST00000401992]	15.619
A_33_P3411682	TRIM49C	tripartite motif containing 49C [Source:HGNC Symbol;Acc:38877] [ENST00000432771]	15.554
A_33_P3271276	PSG5	Homo sapiens pregnancy specific beta-1-glycoprotein 5 (PSG5), transcript variant 2, mRNA [NM_001130014]	14.939
A_21_P0013761	SSX4B	Homo sapiens synovial sarcoma, X breakpoint 4B (SSX4B), transcript variant 1, mRNA [NM_001034832]	14.693
A_23_P45579	HSFY2	Homo sapiens heat shock transcription factor, Y linked 2 (HSFY2), transcript variant 1, mRNA [NM_153716]	14.631
A_24_P626932	MUC3	Homo sapiens SIB 276 intestinal mucin (MUC3) mRNA, partial cds. [AF007191]	14.574
A_23_P11397	TTY13	Homo sapiens testis-specific transcript, Y-linked 13 (non-protein coding) (TTY13), long non-coding RNA [NR_001537]	14.513
A_23_P66180	CACNG3	Homo sapiens calcium channel, voltage-dependent, gamma subunit 3 (CACNG3), mRNA [NM_006539]	14.484
A_33_P3405680	ARHGEF3-AS1	Homo sapiens ARHGEF3 antisense RNA 1 (ARHGEF3-AS1), long non-coding RNA [NR_046572]	14.480
A_33_P3384133	C17orf99	Homo sapiens chromosome 17 open reading frame 99 (C17orf99), mRNA [NM_001163075]	14.017
A_24_P167377	OR10P1	Homo sapiens olfactory receptor, family 10, subfamily P, member 1 (OR10P1), mRNA [NM_206899]	13.627
A_33_P3212764	FLJ40039	Homo sapiens cDNA FLJ40039 fis, clone SYNOV2000397. [AK097358]	13.562

A_33_P3346448	PCDH11X	Homo sapiens protocadherin 11 X-linked (PCDH11X), transcript variant c, mRNA [NM_032968]	13.213
A_21_P0014000	KIR3DL2	Homo sapiens killer cell immunoglobulin-like receptor, three domains, long cytoplasmic tail, 2, transcript variant 1, mRNA [NM_006737]	13.198
A_24_P375322	GGT8P	Homo sapiens gamma-glutamyltransferase 8 pseudogene (GGT8P), non-coding RNA [NR_003503]	13.154
A_33_P3424122	TCHHL1	Homo sapiens trichohyalin-like 1 (TCHHL1), mRNA [NM_001008536]	13.146
A_33_P3381777	TREML1	Homo sapiens triggering receptor expressed on myeloid cells-like 1 (TREML1), transcript variant 1, mRNA [NM_178174]	13.097
A_33_P3292886	KRT6A	Homo sapiens keratin 6A (KRT6A), mRNA [NM_005554]	12.978
A_23_P54736	GNG13	Homo sapiens guanine nucleotide binding protein (G protein), gamma 13 (GNG13), mRNA [NM_016541]	12.929
A_33_P3278279	TXNDC8	Homo sapiens thioredoxin domain containing 8 (spermatzoa) (TXNDC8), transcript variant 3, mRNA [NM_001286947]	12.755
A_33_P3395581	TRIM53AP	Homo sapiens tripartite motif containing 53A, pseudogene (TRIM53AP), non-coding RNA [NR_028346]	12.684
A_24_P16353	TRIM53AP	Homo sapiens tripartite motif containing 53A, pseudogene (TRIM53AP), non-coding RNA [NR_028346]	12.583
A_23_P150467	OR5I1	Homo sapiens olfactory receptor, family 5, subfamily I, member 1 (OR5I1), mRNA [NM_006637]	12.507
A_33_P3364488	FCAMR	Homo sapiens Fc receptor, IgA, IgM, high affinity (FCAMR), transcript variant 3, mRNA [NM_001170631]	12.445
A_33_P3405479	OR4C45	Homo sapiens olfactory receptor, family 4, subfamily C, member 45 (OR4C45), mRNA [NM_001005513]	12.445
A_24_P623782	FRG2	Homo sapiens FSHD region gene 2 (FRG2), transcript variant 2, mRNA [NM_001005217]	12.288
A_23_P76234	RPH3A	Homo sapiens rabphilin 3A homolog (mouse) (RPH3A), transcript variant 1, mRNA [NM_001143854]	12.194
A_32_P720220	C12orf36	Homo sapiens chromosome 12 open reading frame 36 (C12orf36), long non-coding RNA [NR_036555]	12.117
A_24_P400604	RBM1B	Homo sapiens RNA binding motif protein, Y-linked, family 1, member B (RBM1B), mRNA [NM_001006121]	12.099
A_33_P3424507	OR51F1	Homo sapiens olfactory receptor, family 51, subfamily F, member 1 (OR51F1), mRNA [NM_001004752]	11.966
A_33_P3358143	C10orf71	Homo sapiens chromosome 10 open reading frame 71 (C10orf71), mRNA [NM_001135196]	11.840
A_23_P81018	PDHA2	Homo sapiens pyruvate dehydrogenase (lipoamide) alpha 2 (PDHA2), mRNA [NM_005390]	11.814
A_23_P409502	NLRP9	Homo sapiens NLR family, pyrin domain containing 9 (NLRP9), mRNA [NM_176820]	11.811
A_23_P94647	OR1L3	Homo sapiens olfactory receptor, family 1, subfamily L, member 3 (OR1L3), mRNA [NM_001005234]	11.775
A_33_P3319900	PRG1	Homo sapiens p53-responsive gene 1 (PRG1), long non-coding RNA [NR_026881]	11.738
A_23_P96291	MAGEA1	Homo sapiens melanoma antigen family A, 1 (directs expression of antigen MZ2-E) (MAGEA1), mRNA [NM_004988]	11.698
A_33_P3363071	ITIH6	Homo sapiens inter-alpha-trypsin inhibitor heavy chain family, member 6 (ITIH6), mRNA [NM_198510]	11.618
A_23_P62099	MAGEC2	Homo sapiens melanoma antigen family C, 2 (MAGEC2), mRNA [NM_016249]	11.546
A_33_P3317225	OR2L5	Homo sapiens olfactory receptor, family 2, subfamily L, member 5 (OR2L5), mRNA [NM_001258284]	11.510
A_21_P0012072	REG1P	Homo sapiens regenerating islet-derived 1 pseudogene (REG1P), non-coding RNA [NR_002714]	11.507
A_33_P3216570	MUC5AC	PREDICTED: Homo sapiens mucin 5AC, oligomeric mucus/gel-forming (MUC5AC), partial mRNA [XM_003119481]	11.473
A_23_P15832	OR1D5	Homo sapiens olfactory receptor, family 1, subfamily D, member 5 (OR1D5), mRNA [NM_014566]	11.419
A_33_P3239278	OR4D10	Homo sapiens olfactory receptor, family 4, subfamily D, member 10 (OR4D10), mRNA [NM_001004705]	11.413
A_23_P409888	FAM83C	Homo sapiens family with sequence similarity 83, member C (FAM83C), mRNA [NM_178468]	11.399
A_24_P794458	MOBP	Homo sapiens myelin-associated oligodendrocyte basic protein (MOBP), transcript variant 3, mRNA [NM_182935]	11.388

A_24_P70906	PDILT	Homo sapiens protein disulfide isomerase-like, testis expressed (PDILT), mRNA [NM_174924]	11.383
A_32_P196193	PAQR9	Homo sapiens progesterin and adipoQ receptor family member IX (PAQR9), mRNA [NM_198504]	11.343
A_33_P3326075	CYP2C19	Homo sapiens cytochrome P450, family 2, subfamily C, polypeptide 19 (CYP2C19), mRNA [NM_000769]	11.256
A_21_P0012346	FAM230C	family with sequence similarity 230, member C [Source:HGNC Symbol;Acc:24482] [ENST00000411581]	11.142
A_33_P3387781	OR2L1P	Homo sapiens olfactory receptor, family 2, subfamily L, member 1 pseudogene (OR2L1P), non-coding RNA [NR_002145]	11.126
A_23_P65189	PDX1	Homo sapiens pancreatic and duodenal homeobox 1 (PDX1), mRNA [NM_000209]	11.056
A_24_P298716	FAM197Y2	Homo sapiens family with sequence similarity 197, Y-linked, member 2 (FAM197Y2), non-coding RNA [NR_001553]	11.055
A_33_P3300312	DMBT1	Homo sapiens deleted in malignant brain tumors 1 (DMBT1), transcript variant 2, mRNA [NM_007329]	11.018
A_23_P411157	WNT1	Homo sapiens wingless-type MMTV integration site family, member 1 (WNT1), mRNA [NM_005430]	11.008
A_23_P28023	OR7A17	Homo sapiens olfactory receptor, family 7, subfamily A, member 17 (OR7A17), mRNA [NM_030901]	10.994
A_23_P321892	HRG	Homo sapiens histidine-rich glycoprotein (HRG), mRNA [NM_000412]	10.983
A_33_P3258206	OR6N2	Homo sapiens olfactory receptor, family 6, subfamily N, member 2 (OR6N2), mRNA [NM_001005278]	10.952
A_33_P3342153	USP17L8	Homo sapiens ubiquitin specific peptidase 17-like family member 8 (USP17L8), mRNA [NM_001256872]	10.950
A_23_P84000	CACNG2	Homo sapiens calcium channel, voltage-dependent, gamma subunit 2 (CACNG2), mRNA [NM_006078]	10.884
A_33_P3391439	MOBP	Homo sapiens myelin-associated oligodendrocyte basic protein (MOBP), transcript variant 6, non-coding RNA [NR_103505]	10.858
A_21_P0001324	MGC27382	Homo sapiens cDNA FLJ34438 fis, clone HLUNG2001144. [AK091757]	10.853
A_24_P30557	TBX5	Homo sapiens T-box 5 (TBX5), transcript variant 1, mRNA [NM_000192]	10.808
A_32_P129120	FAM182A	Homo sapiens family with sequence similarity 182, member A (FAM182A), long non-coding RNA [NR_026713]	10.792
A_33_P3270360	OR1S1	Homo sapiens olfactory receptor, family 1, subfamily S, member 1 (OR1S1), mRNA [NM_001004458]	10.741
A_33_P3290577	MS4A14	Homo sapiens membrane-spanning 4-domains, subfamily A, member 14 (MS4A14), transcript variant 4, mRNA [NM_001261828]	10.725
A_33_P3525377	FLJ41130	Homo sapiens cDNA FLJ41130 fis, clone BRACE2022549. [AK123125]	10.676
A_23_P93169	LGSN	Homo sapiens lengsin, lens protein with glutamine synthetase domain (LGSN), transcript variant 1, mRNA [NM_016571]	10.663
A_23_P97826	TECTB	Homo sapiens tectorin beta (TECTB), mRNA [NM_058222]	10.650
A_33_P3213288	AIF1	Homo sapiens allograft inflammatory factor 1 (AIF1), transcript variant 2, mRNA [NM_004847]	10.645
A_24_P325146	KRTAP4-8	Homo sapiens keratin associated protein 4-8 (KRTAP4-8), mRNA [NM_031960]	10.621
A_23_P350396	CDSN	Homo sapiens corneodesmosin (CDSN), mRNA [NM_001264]	10.614
A_23_P102694	DEFB129	Homo sapiens defensin, beta 129 (DEFB129), mRNA [NM_080831]	10.475
A_23_P353667	MIR7-3HG	Homo sapiens MIR7-3 host gene (non-protein coding) (MIR7-3HG), long non-coding RNA [NR_027148]	10.464
A_24_P387875	KCNJ10	Homo sapiens potassium inwardly-rectifying channel, subfamily J, member 10 (KCNJ10), mRNA [NM_002241]	10.456
A_32_P88262	SLC7A14	Homo sapiens solute carrier family 7, member 14 (SLC7A14), mRNA [NM_020949]	10.455
A_33_P3286846	TP53TG3C	Homo sapiens TP53 target 3C (TP53TG3C), transcript variant 1, mRNA [NM_001205259]	10.446
A_33_P3209406	RTBDN	Homo sapiens retbindin (RTBDN), transcript variant 3, mRNA [NM_001270440]	10.437

A_32_P219660	SPANXA1	Homo sapiens sperm protein associated with the nucleus, X-linked, family member A1 (SPANXA1), mRNA [NM_013453]	10.419
A_24_P342484	CRP	Homo sapiens C-reactive protein, pentraxin-related (CRP), mRNA [NM_000567]	10.414
A_23_P376124	RNASE8	Homo sapiens ribonuclease, RNase A family, 8 (RNASE8), mRNA [NM_138331]	10.399
A_23_P380526	DPPA4	Homo sapiens developmental pluripotency associated 4 (DPPA4), mRNA [NM_018189]	10.387
A_23_P1691	MMP1	Homo sapiens matrix metalloproteinase 1 (interstitial collagenase) (MMP1), transcript variant 1, mRNA [NM_002421]	10.378
A_21_P0000439	SNORD115-3	Homo sapiens small nucleolar RNA, C/D box 115-3 (SNORD115-3), small nucleolar RNA [NR_003295]	10.372
A_21_P0012347	FAM230C	family with sequence similarity 230, member C [Source:HGNC Symbol;Acc:24482] [ENST00000411581]	10.366

**Supplementary Table 2.** Top 100 downregulated genes in papillary tissue of both Randall's Plaque and normal mucosa with calcium oxalate stone formers compared to those with control patients.

Agilent ID	Gene Symbol	Description	Fold change
A_23_P58082	CCDC80	Homo sapiens coiled-coil domain containing 80 (CCDC80), transcript variant 1, mRNA [NM_199511]	-13.184
A_23_P150053	ACTA2	Homo sapiens actin, alpha 2, smooth muscle, aorta (ACTA2), transcript variant 2, mRNA [NM_001613]	-12.840
A_24_P277934	COL1A2	Homo sapiens collagen, type I, alpha 2 (COL1A2), mRNA [NM_000089]	-12.467
A_23_P216361	COL14A1	Homo sapiens collagen, type XIV, alpha 1 (COL14A1), mRNA [NM_021110]	-12.049
A_33_P3281191	NID1	Homo sapiens nidogen 1 (NID1), mRNA [NM_002508]	-11.939
A_23_P33196	COL5A2	Homo sapiens collagen, type V, alpha 2 (COL5A2), mRNA [NM_000393]	-11.736
A_23_P350001	GUCY1A2	Homo sapiens guanylate cyclase 1, soluble, alpha 2 (GUCY1A2), transcript variant 2, mRNA [NM_000855]	-11.347
A_33_P3382924	SPARC	Homo sapiens secreted protein, acidic, cysteine-rich (osteonectin) (SPARC), mRNA [NM_003118]	-11.297
A_33_P3238166	PXDN	Homo sapiens peroxidasin homolog (Drosophila) (PXDN), mRNA [NM_012293]	-11.209
A_24_P935491	COL3A1	Homo sapiens collagen, type III, alpha 1 (COL3A1), mRNA [NM_000090]	-11.107
A_23_P143817	MYLK	Homo sapiens myosin light chain kinase (MYLK), transcript variant 1, mRNA [NM_053025]	-11.035
A_24_P921366	CALD1	Homo sapiens caldesmon 1 (CALD1), transcript variant 1, mRNA [NM_033138]	-10.885
A_33_P3210488	COL6A3	Homo sapiens collagen, type VI, alpha 3 (COL6A3), transcript variant 1, mRNA [NM_004369]	-10.735
A_23_P152305	CDH11	Homo sapiens cadherin 11, type 2, OB-cadherin (osteoblast) (CDH11), mRNA [NM_001797]	-10.719
A_23_P99063	LUM	Homo sapiens lumican (LUM), mRNA [NM_002345]	-10.322
A_23_P31064	MOXD1	Homo sapiens monooxygenase, DBH-like 1 (MOXD1), transcript variant 2, mRNA [NM_015529]	-10.303
A_33_P3304668	COL1A1	Homo sapiens collagen, type I, alpha 1 (COL1A1), mRNA [NM_000088]	-10.261
A_24_P168925	CHRDL1	Homo sapiens chordin-like 1 (CHRDL1), transcript variant 1, mRNA [NM_001143981]	-10.190
A_33_P3382856	DCN	Homo sapiens decorin (DCN), transcript variant E, mRNA [NM_133507]	-10.138
A_23_P21618	PDZRN3	Homo sapiens PDZ domain containing ring finger 3 (PDZRN3), mRNA [NM_015009]	-9.845
A_24_P373152	CFL2	Homo sapiens cofilin 2 (muscle) (CFL2), transcript variant 1, mRNA [NM_021914]	-9.827
A_23_P151805	FBLN5	Homo sapiens fibulin 5 (FBLN5), mRNA [NM_006329]	-9.626
A_23_P2492	C1S	Homo sapiens complement component 1, s subcomponent (C1S), transcript variant 2, mRNA [NM_001734]	-9.518
A_23_P88069	LHFP	Homo sapiens lipoma HMGIC fusion partner (LHFP), mRNA [NM_005780]	-9.487
A_23_P415791	KIAA1210	Homo sapiens KIAA1210 (KIAA1210), mRNA [NM_020721]	-9.485
A_23_P214168	COL12A1	Homo sapiens collagen, type XII, alpha 1 (COL12A1), transcript variant long, mRNA [NM_004370]	-9.454
A_33_P3271455	PXDN	Homo sapiens peroxidasin homolog (Drosophila) (PXDN), mRNA [NM_012293]	-9.297
A_32_P80850	COL14A1	Homo sapiens collagen, type XIV, alpha 1 (COL14A1), mRNA [NM_021110]	-9.180

A_23_P132956	UCHL1	Homo sapiens ubiquitin carboxyl-terminal esterase L1 (ubiquitin thiolesterase) (UCHL1), mRNA [NM_004181]	-9.083
A_33_P3351416	SMOC2	Homo sapiens SPARC related modular calcium binding 2 (SMOC2), transcript variant 1, mRNA [NM_022138]	-9.041
A_21_P0004312	MIR143HG	Homo sapiens MIR143 host gene (non-protein coding) (MIR143HG), long non-coding RNA [NR_027180]	-9.036
A_23_P64873	DCN	Homo sapiens decorin (DCN), transcript variant A1, mRNA [NM_001920]	-8.994
A_21_P0000096	CPXM1	Homo sapiens carboxypeptidase X (M14 family), member 1 (CPXM1), transcript variant 1, mRNA [NM_019609]	-8.896
A_32_P32254	COL6A1	Homo sapiens collagen, type VI, alpha 1 (COL6A1), mRNA [NM_001848]	-8.858
A_23_P88404	TGFB3	Homo sapiens transforming growth factor, beta 3 (TGFB3), mRNA [NM_003239]	-8.841
A_33_P3373358	GJC1	Homo sapiens gap junction protein, gamma 1, 45kDa (GJC1), transcript variant 1, mRNA [NM_005497]	-8.834
A_23_P85015	MAOB	Homo sapiens monoamine oxidase B (MAOB), mRNA [NM_000898]	-8.795
A_23_P50786	CLIP3	Homo sapiens CAP-GLY domain containing linker protein 3 (CLIP3), transcript variant 2, mRNA [NM_015526]	-8.544
A_24_P136866	SLC8A1	Homo sapiens solute carrier family 8 (sodium/calcium exchanger), member 1 (SLC8A1), transcript variant A, mRNA [NM_021097]	-8.541
A_32_P192376	ENPP1	Homo sapiens ectonucleotide pyrophosphatase/phosphodiesterase 1 (ENPP1), mRNA [NM_006208]	-8.457
A_33_P3348239	FBN1	Homo sapiens fibrillin 1 (FBN1), mRNA [NM_000138]	-8.441
A_23_P101093	COPZ2	Homo sapiens coatomer protein complex, subunit zeta 2 (COPZ2), mRNA [NM_016429]	-8.434
A_24_P334130	FN1	Homo sapiens fibronectin 1 (FN1), transcript variant 7, mRNA [NM_054034]	-8.398
A_23_P58251	CPZ	Homo sapiens carboxypeptidase Z (CPZ), transcript variant 3, mRNA [NM_001014448]	-8.391
A_23_P34744	CTSK	Homo sapiens cathepsin K (CTSK), mRNA [NM_000396]	-8.355
A_23_P205031	COL4A2	Homo sapiens collagen, type IV, alpha 2 (COL4A2), mRNA [NM_001846]	-8.336
A_24_P12626	CAV1	Homo sapiens caveolin 1, caveolae protein, 22kDa (CAV1), transcript variant 1, mRNA [NM_001753]	-8.321
A_33_P3212257	MMRN1	Homo sapiens multimerin 1 (MMRN1), mRNA [NM_007351]	-8.315
A_23_P67661	COX7A1	Homo sapiens cytochrome c oxidase subunit VIIa polypeptide 1 (muscle) (COX7A1), mRNA [NM_001864]	-8.296
A_32_P152437	AKAP12	Homo sapiens A kinase (PRKA) anchor protein 12 (AKAP12), transcript variant 1, mRNA [NM_005100]	-8.245
A_32_P133072	SPON1	Homo sapiens spondin 1, extracellular matrix protein (SPON1), mRNA [NM_006108]	-8.229
A_23_P157299	AEBP1	Homo sapiens AE binding protein 1 (AEBP1), mRNA [NM_001129]	-8.214
A_23_P157865	TNC	Homo sapiens tenascin C (TNC), mRNA [NM_002160]	-8.136
A_19_P00324470	MIR143HG	Homo sapiens MIR143 host gene (non-protein coding) (MIR143HG), long non-coding RNA [NR_027180]	-8.096
A_23_P83028	RECK	Homo sapiens reversion-inducing-cysteine-rich protein with kazal motifs (RECK), mRNA [NM_021111]	-8.088
A_33_P3254096	PI15	Homo sapiens peptidase inhibitor 15 (PI15), mRNA [NM_015886]	-8.032
A_33_P3278313	MSRB3	Homo sapiens methionine sulfoxide reductase B3 (MSRB3), transcript variant 3, mRNA [NM_001193460]	-7.980
A_23_P157914	MAMDC2	Homo sapiens MAM domain containing 2 (MAMDC2), mRNA [NM_153267]	-7.957
A_33_P3269539	COL6A2	Homo sapiens collagen, type VI, alpha 2 (COL6A2), transcript variant 2C2a, mRNA [NM_058174]	-7.950
A_23_P50426	KANK2	Homo sapiens KN motif and ankyrin repeat domains 2 (KANK2), transcript variant 1, mRNA [NM_015493]	-7.930
A_23_P64879	KCNJ8	Homo sapiens potassium inwardly-rectifying channel, subfamily J, member 8 (KCNJ8), mRNA [NM_004982]	-7.928

A_23_P41476	SHISA3	Homo sapiens shisa family member 3 (SHISA3), mRNA [NM_001080505]	-7.910
A_24_P354689	SPOCK1	Homo sapiens sparc/osteonectin, cwcv and kazal-like domains proteoglycan (testican) 1 (SPOCK1), mRNA [NM_004598]	-7.857
A_33_P3382177	TIMP2	Homo sapiens TIMP metalloproteinase inhibitor 2 (TIMP2), mRNA [NM_003255]	-7.781
A_21_P0003931	MIR143HG	Homo sapiens MIR143 host gene (non-protein coding) (MIR143HG), long non-coding RNA [NR_027180]	-7.717
A_23_P361014	TSHZ3	Homo sapiens teashirt zinc finger homeobox 3 (TSHZ3), mRNA [NM_020856]	-7.717
A_33_P3229617	SGCE	Homo sapiens sarcoglycan, epsilon (SGCE), transcript variant 1, mRNA [NM_001099401]	-7.663
A_23_P213857	C7	Homo sapiens complement component 7 (C7), mRNA [NM_000587]	-7.650
A_23_P216596	SVEP1	Homo sapiens sushi, von Willebrand factor type A, EGF and pentraxin domain containing 1 (SVEP1), mRNA [NM_153366]	-7.649
A_24_P879740	MAP1B	Homo sapiens microtubule-associated protein 1B (MAP1B), mRNA [NM_005909]	-7.603
A_33_P3363799	NCAM1	Homo sapiens neural cell adhesion molecule 1 (NCAM1), transcript variant 5, mRNA [NM_001242607]	-7.556
A_23_P356554	BAG2	Homo sapiens BCL2-associated athanogene 2 (BAG2), mRNA [NM_004282]	-7.543
A_23_P144959	VCAN	Homo sapiens versican (VCAN), transcript variant 1, mRNA [NM_004385]	-7.522
A_23_P100711	PMP22	Homo sapiens peripheral myelin protein 22 (PMP22), transcript variant 1, mRNA [NM_000304]	-7.508
A_33_P3321432	FAM198B	Homo sapiens family with sequence similarity 198, member B (FAM198B), transcript variant 2, mRNA [NM_016613]	-7.467
A_23_P82990	OGN	Homo sapiens osteoglycin (OGN), transcript variant 1, mRNA [NM_033014]	-7.426
A_33_P3230478	C1S	Homo sapiens complement component 1, s subcomponent (C1S), transcript variant 1, mRNA [NM_201442]	-7.389
A_23_P210425	MYL9	Homo sapiens myosin, light chain 9, regulatory (MYL9), transcript variant 2, mRNA [NM_181526]	-7.367
A_33_P3344477	FERMT2	Homo sapiens fermitin family member 2 (FERMT2), transcript variant 2, mRNA [NM_001134999]	-7.341
A_23_P257649	RBP1	Homo sapiens retinol binding protein 1, cellular (RBP1), transcript variant 1, mRNA [NM_002899]	-7.333
A_24_P261417	DKK3	Homo sapiens dickkopf WNT signaling pathway inhibitor 3 (DKK3), transcript variant 1, mRNA [NM_015881]	-7.298
A_23_P113351	SPARCL1	Homo sapiens SPARC-like 1 (hevin) (SPARCL1), transcript variant 2, mRNA [NM_004684]	-7.279
A_23_P432573	MRGPRF	Homo sapiens MAS-related GPR, member F (MRGPRF), transcript variant 2, mRNA [NM_145015]	-7.246
A_24_P131522	ANTXR1	Homo sapiens anthrax toxin receptor 1 (ANTXR1), transcript variant 1, mRNA [NM_032208]	-7.239
A_24_P55496	OSR2	Homo sapiens odd-skipped related transcription factor 2 (OSR2), transcript variant 2, mRNA [NM_053001]	-7.235
A_33_P3231953	COL12A1	Homo sapiens collagen, type XII, alpha 1 (COL12A1), transcript variant long, mRNA [NM_004370]	-7.216
A_23_P97990	HTRA1	Homo sapiens HtrA serine peptidase 1 (HTRA1), mRNA [NM_002775]	-7.184
A_23_P98645	DCHS1	Homo sapiens dachshous cadherin-related 1 (DCHS1), mRNA [NM_003737]	-7.147
A_24_P925062	MXRA7	Homo sapiens matrix-remodelling associated 7 (MXRA7), transcript variant 1, mRNA [NM_001008528]	-7.105
A_23_P303671	ECM2	Homo sapiens extracellular matrix protein 2, female organ and adipocyte specific (ECM2), transcript variant 1, mRNA [NM_001393]	-7.092
A_33_P3364741	MRC2	Homo sapiens mannose receptor, C type 2 (MRC2), mRNA [NM_006039]	-7.072
A_23_P369899	TMEM158	Homo sapiens transmembrane protein 158 (gene/pseudogene) (TMEM158), mRNA [NM_015444]	-7.038



A_24_P937405	PRSS23	Homo sapiens protease, serine, 23 (PRSS23), mRNA [NM_007173]	-7.002
A_19_P00807411	RNF180	Homo sapiens ring finger protein 180 (RNF180), transcript variant 1, mRNA [NM_001113561]	-6.993
A_32_P36694	JAZF1	Homo sapiens JAZF zinc finger 1 (JAZF1), mRNA [NM_175061]	-6.980
A_33_P3270599	TPM2	Homo sapiens tropomyosin 2 (beta) (TPM2), transcript variant 2, mRNA [NM_213674]	-6.974
A_19_P00324839	MALAT1	Homo sapiens metastasis associated lung adenocarcinoma transcript 1 (non-protein coding) (MALAT1), long non-coding RNA [NR_002819]	-6.965
A_33_P3236102	IER5L	Homo sapiens immediate early response 5-like (IER5L), mRNA [NM_203434]	-6.866
A_33_P3366120	FLNA	Homo sapiens filamin A, alpha (FLNA), transcript variant 2, mRNA [NM_001110556]	-6.822

**Supplementary Table 3.** Top 15 networks in both Randall's Plaque and normal papillary tissue gene expressions are differed from control mucosa by 2 folds

Network ID	Molecules in Network	Score	Focus Molecules	Top Diseases and Functions
1	ABO,ATP10A,C11orf54,CDHR1,CRY1,CSTF2T,DNAAF3,DPF3,DPM2,DTWD1,FAM53C,FNDC3B,FOXRED1,GOLIM4,HAAO,HHLA2,HIST1H2BG,HNF4A,KDEL1,LINC00574,LINC01558,PRODH2,REG1A,RNF113A,SGCB,SGCE,SPATA5L1,STXBP5L,TCEAL3,TMEM79,TMEM242,TMIGD1,TTC22,VAC14,ZNHIT6	41	35	Developmental Disorder, Hereditary Disorder, Respiratory Disease
2	ABCC9,C1QTNF6,CDC42SE2,CENPM,CENPN,CFL2,DCBLD2,DDX54,DNAH2,DNAH3,DNAH8,DNAH9,DNAH10,DNAH12,DNAH17,DNAI1,EML1,ESR1,GAL,GULP1,Kcnj,KCNJ8,KCTD6,KLHL24,NPW,ONECUT2,PCDHB5,PCDHB17P,PGC,PRDM2,RBM23,RTN4RL1,TMEM72,UMODL1,VEZF1	38	34	Cardiac Arteriopathy, Cardiovascular Disease, Organismal Injury and Abnormalities
3	ADGRA1,ADGRG4,ADGRG5,ADGRG7,Gpcr,GPR12,GPR35,GPR55,GPR61,GPR62,GPR88,GPR101,GPR139,GPR148,GPR155,GPR157,GPR182,GPR137C,HTR6,HTR5A,MC3R,MC5R,MCHR1,NMBR,NPBWR2,NTSR1,NTSR2,OPRL1,RGR,RRH,RXFP2,SLC52A1,TAAR5,TAAR8,XCR1	38	34	Cell-To-Cell Signaling and Interaction, Cell Signaling, Nucleic Acid Metabolism
4	BNIP3,CCDC57,CCDC155,CD302,CDC20B,FAM90A1,FATE1,FRA10AC1,Gsk3,H2AFB3 (includes others),KRTAP10-1,KRTAP10-5,KRTAP2-3/KRTAP2-4,KRTAP3-2,KRTAP4-2,LCE3E,LCE4A,LDLRAD1,LNPEP,MOBP,OTX1,PAQR9,PLAGL2,PRM2,S6K1,SPATA8,STRIP2,SUN3,TMCC2,TMEM190,TRAF3IP3,TRIM36,TSGA10IP,TSHZ3,ZFC3H1	36	33	Cardiovascular System Development and Function, Auditory and Vestibular System Development and Function, Embryonic Development
5	ABI2,ACTN2,ADAM29,APBA1,Caspase 3/7,CFAP61,CTAGE1,DDN,DENND2A,DLG4,DLGAP2,DLGAP3,ENPP1,FAM81A,GAS2L2,GRM5,HUNK,KCNJ5,KCNJ6,KCNJ10,MAGI1,MARCH10,NEFL,NLGN1,NMDA Receptor,PRAMEF4 (includes others),ROBO2,RTKN2,SDK2,SLIT1,SNX22,SPATA16,SYNPO2L,ZDHHC8,ZIC5	36	33	Cancer, Connective Tissue Disorders, Dermatological Diseases and Conditions
6	alpha2-adrenergic receptor,ALX4,B4GAT1,DLX1,ELAVL2,Focal adhesion kinase,GUCY,GUCY1A2,HOXC13,HOXD12,IRX4,LHX2,LHX9,LMX1B,LPP,NEUROD1,NHLH1,NR2E1,NR2E3,OLFM1,OR8B8,OSR2,PALLD,PAX9,POLK,POU4F1,POU4F2,PRRX1,RCVRN,RUNDC3A,SHPRH,SSBP3,SSX4/SSX4B,TBL3,ZFH4	34	32	Embryonic Development, Organismal Development, Gene Expression
7	AHSG,ASIC2,ATP13A4,AZGP1,BOLL,BPIFA1,BRIP1,C1orf94,CD177,COL1A2,COL6A1,DMRT1,ENaC,ERCC2,FGF18,GJA3,HIST1H2BC,HNRNPLL,IFN alpha receptor,KLK14,NR2F2,P4HA1,P4HA2,p85 (pik3r),PPP3R1,PSG1,QKI,RBMY1A1 (includes others),RFX2,SEMG2,SHBG,STRA8,TFIIH,UVSSA,ZNF385C	32	31	Amino Acid Metabolism, Post-Translational Modification, Small Molecule Biochemistry
8	AKR1D1,ALPP,CDYL2,CHURC1,CRABP2,FBXL7,FHL1,FLRT2,GF11,H3F3A/H3F3B,HOXA10,HSD3B1,KDEL2,KDM4B,KLK12,KMT2D,LZYL1,MMRN1,MYOM3,N4BP2L2,NAA38,NDUFS7,Neurotrophin,NFIL3,NKTR,PAX7,PTGR1,RELL1,Shc,SLC38A6,Sos,TFAP2D,TPP1,Trk Receptor,XKRX	32	31	Organismal Injury and Abnormalities, Dermatological Diseases and Conditions, Cell-mediated Immune Response
9	ACKR3,Adaptor protein 2,Beta Arrestin,C1orf74,CALCR,CFC1/CFC1B,Clathrin,DAB2,DPPA2,DPPA4,EDNRA,ESPL1,F2RL2,Fgf,FGF13,FGF16,FOXJ3,FZD1,FZD2,HK3,KIFC1,KIT,LGALS1,MICAL1,MITF,MUC16,PAX3,PITX2,RAMP1,SLC19A1,SLC45A2,SPC24,SYT6,TBX4,TFAP2A	32	31	Cardiovascular Disease, Congenital Heart Anomaly, Developmental Disorder

10	ABCC2,BCAN,chymotrypsin,Collagen type XVIII,CTRC,DKK3,EFEMP2,FBLN1,FBN1,FN1,FXR ligand-FXR-Retinoic acid-RXR $\alpha$ ,GYPA,GYPB,HAPLN4,HBE1,HBG1,HBQ1,HBZ,hemoglobin,HIST1H2BD,HIST1H4C,HIST1H4E,HIST1H4F,HIST1H4H,HIST1H4K,IL22RA1,KIF21B,KLF1,KMT2E,MDM4,SLC4A1,TMPRS S6,TRIM10,Trypsinogen,ZAK	30	30	Post-Translational Modification, Protein Synthesis, Cellular Development
11	ANKRA2,ARNT,CARTPT,CCKBR,CPS1,Creb,CRHR2,DAPK3,DRD3,FFAR4,FSH,GHRHR,GIPR,GNPAT,GNRH,GPR119,HNF1A,HRH3,INS,KIAA1324,LEP,Lh,NDN,P2RY14,PDX1,Proinsulin,PTGER 3,QRFP,REG1B,REG1P,SLC2A2,SST,SSTR3,XKR4,ZNF331	30	30	Cell Signaling, Nucleic Acid Metabolism, Small Molecule Biochemistry
12	ARRDC3,CAGE1,CCDC33,CHRDL1,CT55,Ctnna,CTNNA3,DYDC1,Filamin,FLNA,HAS1,HEXB,HOXD10,Integrin $\beta$ ,KLHL38,LGALS14,MAGEC2,MAOB,MBIP,NCS1,NREP,OR4D6,PAK1,PARP2,POLR1C,PRSS21,Rnr,Sapk,SAXO1,STARD6,TRIM42,TXLNB,UBIQUITIN LIGASE,USHBP1,ZFYVE26	28	29	Inflammatory Disease, Respiratory Disease, Hereditary Disorder
13	26s Proteasome,ADAMTS17,ADARB2,AHNAK2,APCDD1,ASB10,CDKN1B,CNOT6L,DCLK3,DNAJC5B,DNAJC5G,GLI3,GPT2,GRPR,HISTONE,HSP,Hsp70,Hsp90,HSPA12A,HSPB9,KLK3,LOXL2,MGEA5,NAP1L1,NEAT1,ODF1,PRDM9,PUM1,SPATA2L,SSX3,SSX5,TSACC,TSSK6,Ubiquitin,ZSCAN1	28	29	Cell Cycle, Dermatological Diseases and Conditions, Developmental Disorder
14	AKAP,AKAP4,AKAP12,AKAP14,CABYR,cldn,CLDN9,CLDN17,CTPS1,DCD,DCT,Dlg,EMX1,ESX1,FAM107A,FLVCR2,HOXB1,LHX5,MEIS1,MITF-p300/CBP,MPDZ,OR1D2,OR2AG2,OR5D16,OTX2,Pka,RAD51D,ROPN1,SLC39A12,SLC6A20,SOX2-OCT4-NANOG,sPla2,TPH1,TPH2,XKR3	26	28	Nervous System Development and Function, Organ Morphology, Organismal Development
15	Ampa Receptor,CABP1,CABP2,cacn,CACNA1S,Cacng,CACNG2,CACNG3,CACNG7,CALML5,Calmodulin,CaMKII,CNTN2,CPLX2,CPLX4,EEA1,GPHA2,N-type Calcium Channel,NEUROD2,PCP4,PHOSPHO1,RAB22A,RIMBP2,RIMS1,RPH3A,SCN2A,SEZ6,Snare,SRY,SYN3,SYT1,SYT3,TRPM3,TSHB,WNK4	26	28	Cell-To-Cell Signaling and Interaction, Nervous System Development and Function, Cellular Assembly and Organization

**Supplementary Table 4.** All networks in Randall's Plaque tissue gene expression is differed from normal papillary tissue by 2 folds

Network ID	Molecules in Network	Score	Focus Molecules	Top Diseases and Functions
1	ADAMTS12,Akt,C8orf4,CAPG,CCL20,CCL22,cyclooxygenase,ERK1/2,FAM3B,gelatinase,GHRH,IL1,IL11,IL17C,IRF6,Kcnj,KCNJ1,LCN2,MEOX2,MMD,MUC4,NALCN,NFAT5,PI3K (complex),Pka,POU3F3,Pro-inflammatory Cytokine,PROK1,PRTN3,PTGS1,S100a7a,SFTPb,SLC12A1,SLPI,Tgf beta	25	10	Inflammatory Response, Endocrine System Disorders, Hereditary Disorder
2	ADAT2,ADRB2,ANLN,ATF5,CAPG,CCL17,CKAP2,CORO1C,DHRS9,DRD4,GABBR2,GDPD1,Girk,GPX3,KCNJ1,KCNJ5,KCNJ6,KCNJ10,KIF23,NAV2,OXSR1,PGRMC1,PPRC1,PRDM16,PTGFR,RBM15B,RGS9,SCGB1D2,SEPHS1,SREBF1,TAGLN2,TP53,TRIO,UBC,ZNF705G	19	8	Molecular Transport, Cellular Development, Cellular Growth and Proliferation

**Supplementary Table 5.** Upstream regulators for genes which showed over/lower 2 folds between Randall's Plaque and normal papillary tissue in CaOx stone formers.

Upstream Regulator	Molecule Type	Predicted Activation State	Activation z-score	p-value of overlap	Target molecules in dataset
IL1B	cytokine	Activated	2.400	0.000028	IL11,KCNJ1,LCN2,MUC4,PTGS1,SLC12A1
lipopolysaccharide	chemical drug	Activated	2.360	0.000141	AQP1,IL11,KCNJ1,LCN2,PTGS1,SLC12A1,SLPI
TNF	cytokine	Activated	2.214	0.000001	AQP1,IL11,KCNJ1,LCN2,MMD,MUC4,PTGS1,SLC12A1,SLPI
phorbol myristate acetate	chemical drug	Activated	2.169	0.000696	IL11,LCN2,MUC4,PTGS1,SLPI
TGFB1	growth factor		1.972	0.006700	AQP1,IL11,LCN2,MUC4,PTGS1
TGFA	growth factor		1.969	0.000001	LCN2,MUC4,PTGS1,SLPI
IFNG	cytokine		1.424	0.000025	AQP1,IL11,KCNJ1,LCN2,MUC4,SLC12A1,SLPI
tretinoin	chemical - endogenous mammalian		1.102	0.000490	AQP1,DHRS9,MUC4,NAV2,PTGS1,SLPI
HOXA10	transcription regulator		0.000	0.000010	AQP1,DHRS9,IL11,LCN2
beta-estradiol	chemical - endogenous mammalian		-0.302	0.000020	AQP1,C8orf4,DHRS9,GPX3,LCN2,MMD,PTGS1,SLPI
dexamethasone	chemical drug		-0.358	0.000011	AQP1,C8orf4,IL11,KCNJ1,LCN2,PTGS1,SLC12A1,SLPI
NR3C1	ligand-dependent nuclear receptor		-1.000	0.001410	AQP1,C8orf4,GPX3,IL11

**Supplementary Table 6.** TaqMan primer information which were used for Quantitative Reverse Transcription polymerase chain reaction.

Probe	Gene Name	TaqMan Assay ID
LCN2	lipocalin 2	Hs01008571_m1
IL11	interleukin 11	Hs01055413_g1
SLPI	secretory leukocyte peptidase inhibitor	Hs00268204_m1
MUC4	mucin 4, cell surface associated	Hs00366414_m1
PTGS1	prostaglandin-endoperoxide synthase 1	Hs00377726_m1
GPX3	glutathione peroxidase 3	Hs01078668_m1
MMD	monocyte to macrophage differentiation-associated	Hs00948031_m1
C8orf4	chromosome 8 open reading frame 4	Hs00535539_s1
SCGB1D2	secretoglobin, family 1D, member 2	Hs00255208_m1
KCNJ1	potassium channel, inwardly rectifying subfamily J, member 1	Hs00165012_m1
NAV2	neuron navigator 2	Hs01093707_m1
GDPD1	glycerophosphodiester phosphodiesterase domain containing 1	Hs00402246_m1
SLC12A1	solute carrier family 12 (sodium/potassium/chloride transporter), member 1	Hs00165731_m1
NALCN	sodium leak channel, non selective	Hs00291166_m1
AQP1	aquaporin 1	Hs01028916_m1
IL1B	interleukin 1 $\beta$	Hs00174097_m1
IL6	interleukin 6	Hs00985639_m1
NOS2	nitric oxide synthase 2	Hs01075529_m1
TNF	tumor necrosis factor	Hs01113624_g1
GAPDH	glyceraldehyde-3-phosphate dehydrogenase	Hs02758991_g1

**Supplementary Table 7.** Primary antibodies for immunohistochemical stain.

<b>Protein Name</b>	<b>Antibodies</b>	<b>Product Codes</b>
LCN2	anti-human lipocalin-2 / NGAL rat monoclonal IgG (R&D Systems)	MAB1757
IL11	anti-human interleukin 11 rabbit polyclonal IgG (Novus Biologicals)	NBP1-19815
SLPI	anti-human SLPI mouse monoclonal IgG (abcam)	ab17157
PTGS1	anti-human COX1 / Cyclooxygenase 1 rabbit monoclonal IgG (abcam)	ab109025
GPX3	anti-human Glutathione Peroxidase 3 rabbit polyclonal IgG (abcam)	ab170313
MMD	anti-human MMD (N-14) goat polyclonal IgG (Santa Cruz)	sc-243494
SCGB1D2	anti-human SCGB1D2 / Lipophilin B (T-14) goat polyclonal IgG (Santa Cruz)	sc-48327
SLC12A1	anti-human SLC12A1 rabbit polyclonal IgG (abcam)	ab60301
NALCN	anti-human NALCN (N-20) rabbit polyclonal IgG (Santa Cruz)	sc-84520
CD68	anti-human CD68 (KP1) mouse monoclonal IgG (Dako)	M0814
CD138	anti-human CD138 (MI15) mouse monoclonal IgG (Dako)	M7228
Neutrophil Elastase	anti-human Neutrophil Elastase (NP57) mouse monoclonal IgG (Dako)	M0752
uroplakin III	anti-human uroplakin III (SFI-1) mouse monoclonal IgG (abcam)	ab78196
KSP	anti-human KSP (aa1-30) rabbit polyclonal IgG (LSBio)	LS-C164201
vimentin	anti-human vimentin (V9) mouse monoclonal IgG (Dako)	M0725