

## Supplementary Materials and Methods

### In situ hybridization probes

In situ hybridization was carried out using the following mouse cDNA probe templates: pSport1-Fn1-31-38 (nt +4891 - +6157), pCMV-Sport6-Cd74 (IMAGE ID 2650401), pBSK-Prokr2-II (nt -275 - +741), pBSK-Nrp2-II (nt +1147 - +3503), pBSK-Gli1 and pBSK-Sox9 (kindly provided by T. Willnow), pCMV-Sport6.1-Frem1 (IMAGE ID 6510171), pCMV-Sport6.1-Mmp9 (IMAGE ID 6309245), pCMV-Sport6-Etv4 (IMAGE ID 4021693), pYX-Asc-Scube1 (IMAGE ID 6850999), pFLCI-Madcam1 (FANTOM Full Length cDNA clone 9430044H04), pGEM-Foxi3 (nt 3851 - 4461, GeneID: 232077), pGEM-Ascl4 (nt -180 - +785, GeneID:67341), pCR-BluntII-TOPO-Tnc (IMAGE ID 40099596), pCMV-Sport6-Pthlh (IMAGE ID 3594509), pYX-Asc-Tnfaip3 (IMAGE ID 6838303), pCR-BluntII-TOPO-Tsku (IMAGE-ID 40095311), pGEM-Ctgf (kindly provided by M. Mikkola), Bmp2 and Ptch1 (kindly provided by J. Huelsken).

### qRT-PCR primers

Reference genes :

mActb_RT_fwd sense:	5' TTACTGCTCTGGCTCCTAG 3'
mActb_RT_rev antisense:	5' CTCATCGTACTCCTGCTTG 3'
mGapdh_RT_fwd2 sense:	5'TGTGAACCACGAGAAATATGAC 3'
mGapdh_RT_rev2 antisense:	5' GTGATGGCATGGACTGTG 3'
mHmbs_RT_fwd sense:	5' CTGAAAGCCTTGTACCCTG 3'
mHmbs_RT_rev antisense:	5' GCGTTTTCTAGCTCCTTGG 3'

Target genes:

mAscl4_RT_fwd2 sense:	5' TAGCAGCATCCTAGCCCACT 3'
mAscl4_RT_rev2 antisense:	5' ACTCGGAACCAATGAAGGTG 3'
mBmp2_RT_fwd sense:	5' GCAGCTTCCATCACGAA 3'
mBmp2_RT_rev antisense:	5' TTCCTGTATCTGTTCCCG 3'
mBmp4_RT_fwd2 sense	5' GTAGTGCCATTCGGAGCG 3'
mBmp4_RT_rev2 antisense	5' ATCAGCATTCGGTTACCAGG 3'
mCd74_RT_fwd sense:	5' GAAATCTGCCAAACCTGTG 3'
mCd74_RT_rev antisense:	5' GGTGATGTTGCCGTAATT 3'
mColl1a1_RT_fwd1 sense	5' CTGCACGAGTCACACCGGAA 3'
mCoL1a1_RT_rev1 antisense	5' GGGAGGGAACCAGATTGGGG 3'
mCtgf_RT_fwd sense:	5' CCACCCGAGTTACCAATG 3'
mCtgf_RT_rev antisense:	5' TGGCGATTTTAGGTGTCC 3'
mDkk4_RT_fwd sense:	5' AGCAGAGGAAAACAGACC 3'
mDkk4_RT_rev antisense:	5' CCACAGTCAGAGGTTCTAAG 3'
mEdaR_RT_fwd2 sense:	5' GGATGTGTATGCCAACGTG 3'
mEdaR_RT_rev2 antisense:	5' GCCATGTTTTACGACCG 3'
mEtv4_RT_fwd sense:	5' ACCTCAGTCACTTCCAAGAG 3'
mEtv4_RT_rev antisense:	5' GTTCCTTCTTGATCCTGGTG 3'
mEtv5_RT_fwd2 sense:	5' GCAGTTTGCCAGATTTTCA 3'
mEtv5_RT_rev2 antisense:	5' GGCACTTTTCTCATACTTAGC 3'
mFn1_RT_fwd sense:	5'GGAGAACAAAGACAGAGACAA 3'
mFn1_RT_rev antisense:	5' GGTGGATCTTGTAGTCAGTG 3'
mFoxi3_RT_fwd sense:	5' AACTCCATCCGCCACAAC 3'
mFoxi3_RT_rev2 antisense:	5' CTTCCCACTCACTCTTAGTC 3'
mFrem1_RT_fwd sense:	5' ACCAGTTCACAGTATATGCC 3'
mFrem1_RT_rev antisense:	5' CCAGTTCACCATGTGCC 3'
mGli1_RT_fwd2 sense:	5' TCAATCCAATGACTCCACC 3'
mGli1_RT_rev2 antisense:	5' GGACCCTGACATAAAGTTG 3'
mIrx1_RT_fwd1 sense	5' ACCCAACTACAGCGCCTTCTT 3'
mIrx1_RT_rev1 antisense	5' TCATACTGAGAGCCCCTCTGCG 3'
mItgb8_RT_fwd sense:	5' GCAGCCTGGGTATTTTCAC 3'

mItgb8_RT_rev antisense:	5' GCACAGGAGACCACATTTG 3'
mLhx2_RT_fwd sense:	5' GCAGCCAAAAGACAAAGCG 3'
mLhx2_RT_rev antisense:	5' GTAAAAGGTTGCGCCTGAAC 3'
mMadcam1_RT_fwd3 sense:	5' CCAATCTGTATGTTCTTGGC 3'
mMadcam1_RT_rev3 antisense:	5' TCTCTGCCTCCTTTAGTCTG 3'
mMmp9_RT_fwd sense:	5' GGACAGCCAGACACTAAAG 3'
mMmp9_RT_rev antisense:	5' CGGCAAGTCTTCAGAGTAG 3'
mNcam1_RT_fwd sense:	5' CCCACAGGAGTTTAAGGAAG 3'
mNcam1_RT_rev antisense:	5' GGACAGGACTATGAACCG 3'
mNgfr_RT_fwd1 sense	5' GCCTGGACAGTGTTACGTTCTC 3'
mNgfr_RT_rev1 antisense	5' CGGACATACTCTGCAGGCC 3'
mNrp1_RT_fwd sense:	5' TCCGAATCAAACCTGTATCCTG 3'
mNrp1_RT_rev antisense:	5'GATGCTGTAATCTGGGAGTCTG 3'
mNrp2_RT_fwd sense:	5' TTCCTGACCTTTGACCTG 3'
mNrp2_RT_rev antisense:	5' GGAGTTTGGAGGGTGTTT 3'
mProkr2_RT_fwd sense:	5' CTCCGTCAACTACCTTCGTAC 3'
mProkr2_RT_rev2 antisense:	5' GACCAAAGCGATCAGGAAGG 3'
mPthlh_RT_fwd sense:	5' GGAGTGTCTTGGTATTCCTG 3'
mPthlh_RT_rev antisense:	5' ACTTGCCCTTGTCATGC 3'
mPtch1_RT_fwd sense:	5' GGTCTCGCTTACAAACTC 3'
mPtch1_RT_rev antisense:	5' CGGTCAGGTAGATGTAGAAAG 3'
mPtch2_RT_fwd2 sense:	5' GCTTACTTCCAAGGTCTACTC 3'
mPtch2_RT_rev2 antisense:	5' AGTCTGAATCAACATCTGGG 3'
mRelb_RT_fwd2 sense:	5' GCTGTACTTGCTCTGTGAC 3'
mRelb_RT_rev2 antisense:	5' GGTGGCGTTTTGAACAC 3'
mScube1_RT_fwd2 sense:	5' CCTTGCCCAAACCAGAAG 3'
mScube1_RT_rev2 antisense:	5' GACCATCTGCATGTAAGGC 3'
mSfrp1_RT_fwd sense:	5' CGGAAGCCTCTAAGCCC 3'
mSfrp1_RT_rev antisense:	5' TCTTGTACCCGTTTTCTTTC 3'
mShh_RT_fwd sense:	5' GGCAGATATGAAGGGAAGATC 3'
mShh_RT_rev antisense:	5' CATTAACTTGTCTTTGCACC 3'
mSox9_RT_fwd2 sense:	5' GCAAGACTCTGGGCAAG 3'
mSox9_RT_rev2 antisense:	5' GCTGGTACTTGTAATCGGG 3'
mSox21_RT_fwd sense:	5' TGGTGTTTGCTTTGCACTTC 3'
mSox21_RT_rev antisense:	5' GGAGGGAGGAAGGATGAGAC 3'
mTnc_RT_fwd sense:	5' GAGGACTTCTATCGCAACTGG 3'
mTnc_RT_rev antisense:	5' CTTGGGCTGTGATTTTGCTC 3'
mTnfaip3_RT_fwd2 sense:	5'GGAACAGGACTTTGCTACG3'
mTnfaip3_RT_rev2 antisense:	5'GATGTTGCTGAGGACAAATATG3'
mTrps1_RT_fwd sense:	5' GCCATTCCAAAGACTTCCAG 3'
mTrps1_RT_rev antisense:	5' AGTTTTCCGTCCAATGCC 3'
mTsku_RT_fwd sense:	5' GCTCCCCCTTGAGTGACATC 3'
mTsku_RT_rev antisense:	5' GGAAGCAGGCGATGGATAAG 3'
mTspan18_RT_fwd2 sense:	5' CTTACCAAGCACTACCAAGG 3'
mTspan18_RT_rev2 antisense:	5' TCAGTGTCCAGCGTCAG 3'
mWif1_RT_fwd sense:	5' CCACTCCATGAATTTTACCTG 3'
mWif1_RT_rev antisense:	5' AGGGACATTGACAGTTGG 3'

### Chromatin immunoprecipitation primers

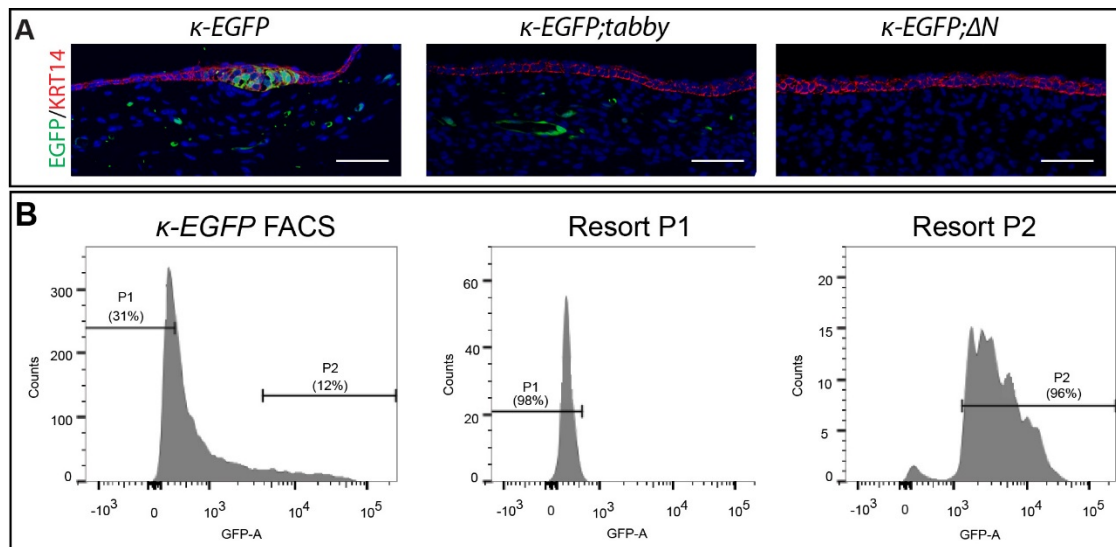
Reference region:

mGapdh-ChIP-TSS-fwd sense:	5' GCCTGAGCTAGGACTGG 3'
mGapdh-ChIP-TSS-rev2 antisense:	5' AGGGCTGCAGTCCGTATTTA 3'

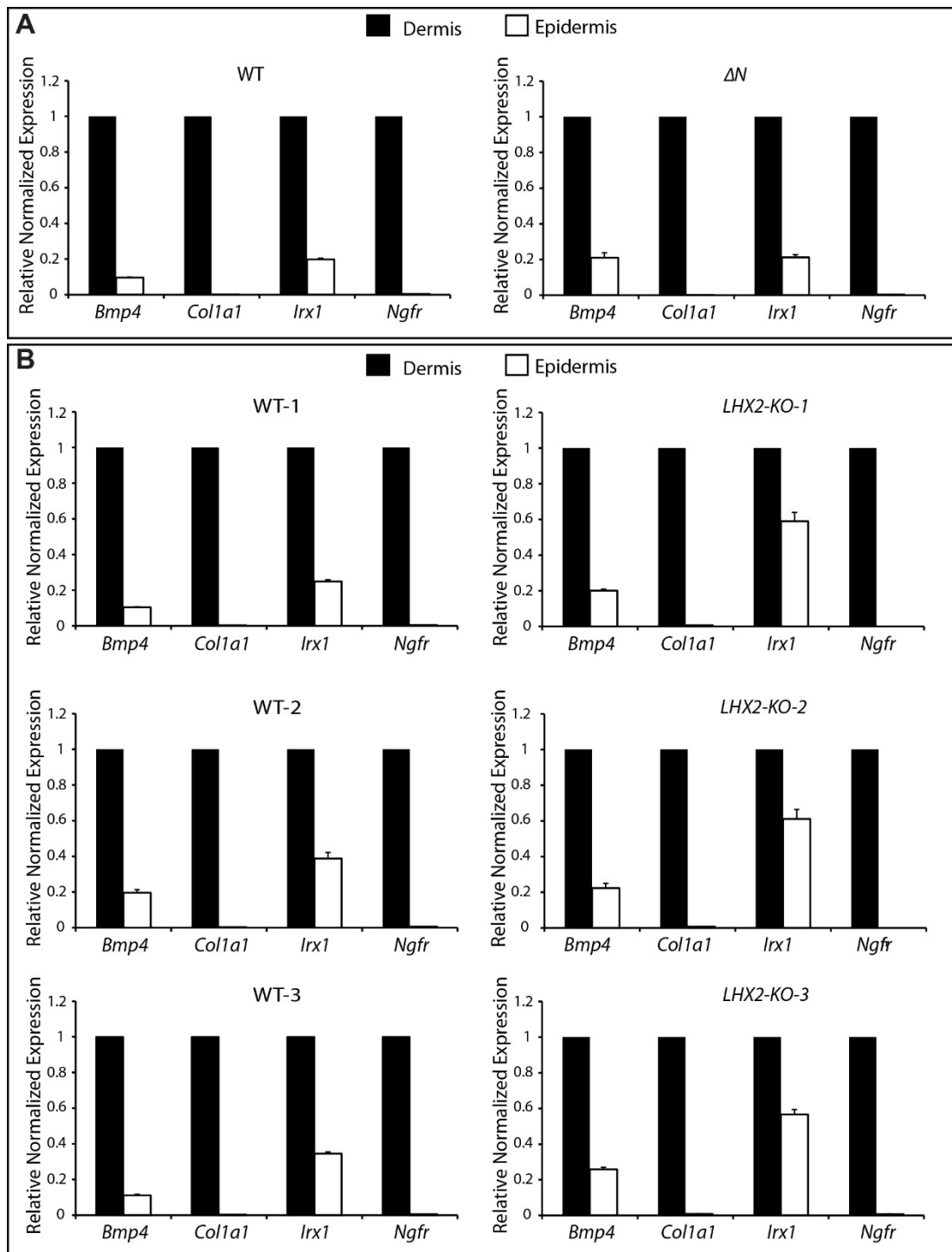
NF-κB binding sites:

mLhx2-ChIP-+14550-fwd2 sense:	5' CATCCTGATTCCCTTCTGGA 3'
mLhx2-ChIP-+14550-rev antisense:	5' GGGCTGACTTTCTGCACTTT 3'
mSox9-ChIP-+2903-fwd2 sense:	5' CATTGCTGGAGGGAGAAAAG 3'

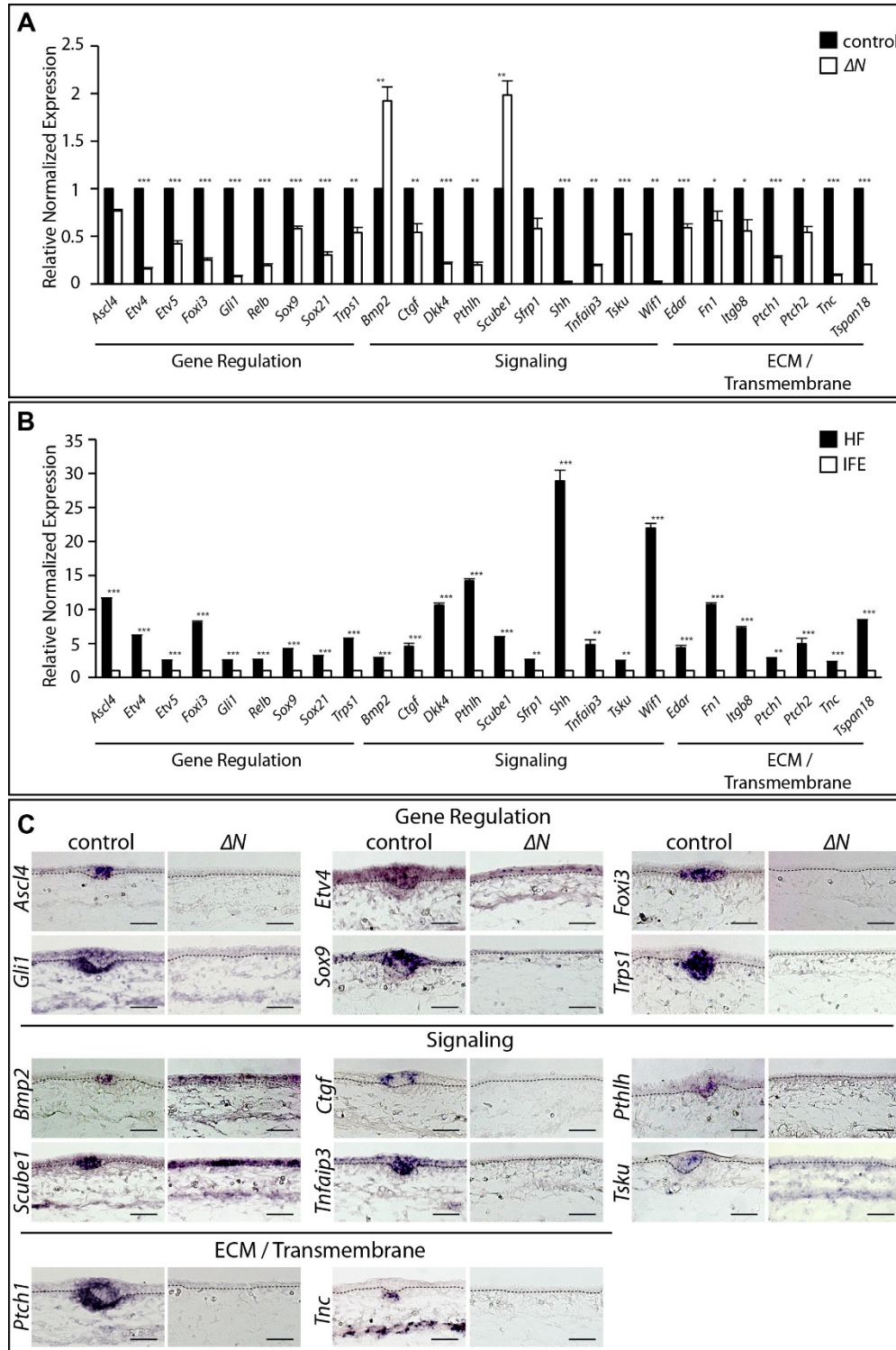
mSox9-ChIP-+2903-rev2 antisense:	5' GCCTAGAGGTGGATGGATGA 3'
mTrps1-ChIP--62449-fwd sense:	5' TGTTGCAGACCTAAGAAGGACA 3'
mTrps1-ChIP--62449-rev antisense:	5' CAACCTCACATGCCCACTT 3'
mMmp9-ChIP-+46fwd sense:	5' TCTTTCCTTCCCAAGGAGT 3'
mMmp9-ChIP-+46rev antisense:	5' CCATCCCCACACTGTAGGTT 3'



**Fig. S1. Isolation of primary placode keratinocytes using NF- $\kappa$ B-specific EGFP reporter mice ( $\kappa$ -EGFP).** (A) EGFP expression pattern in  $\kappa$ -EGFP,  $\kappa$ -EGFP;tabby and  $\kappa$ -EGFP; $\Delta$ N embryos at E14.5. (B) Enzymatically and mechanically separated epidermal keratinocytes from  $\kappa$ -EGFP embryos (n = 5) were sorted via FACS into an EGFP-positive (primary placode-specific, P2) and EGFP-negative (interfollicular keratinocytes, P1) cell population. Purity of both populations was determined over a resort, in which both populations showed a recovery rate of over 95%. Purified cell populations were used for microarray analysis, qRT-PCR and ChIP experiments.

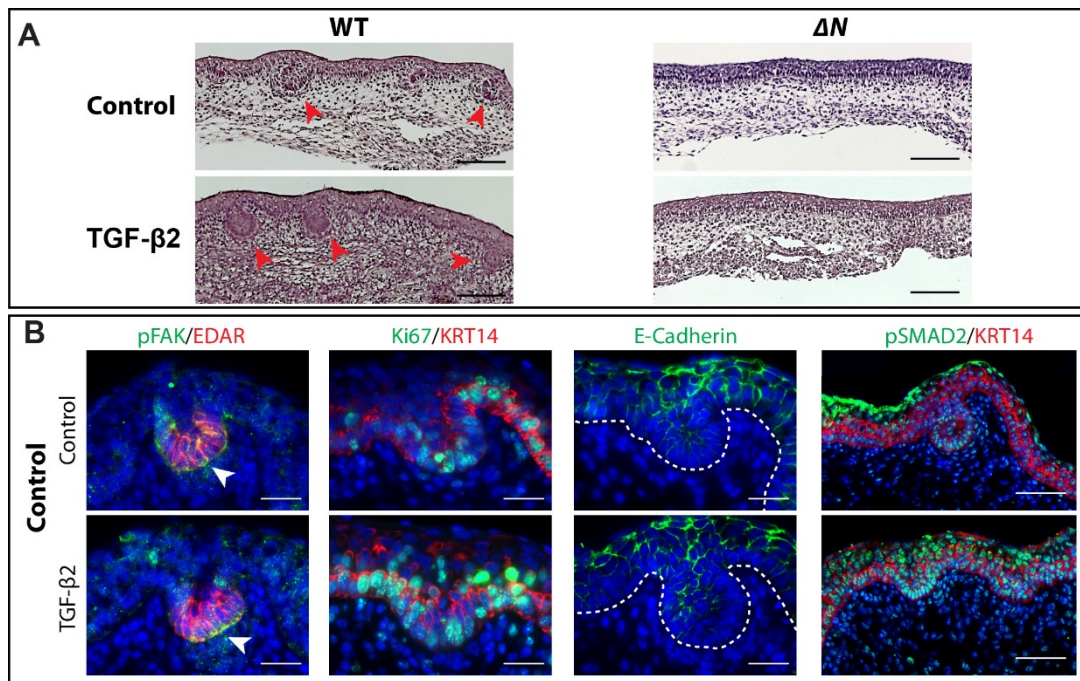


**Fig. S2. Dermal markers were absent in epidermal keratinocyte samples of  $\Delta N$ , *Lhx2*-KOs and of corresponding controls. (A,B)** Quantitative real-time PCR (qRT-PCR) analysis for *Bmp4*, *Col1a1*, *Irx1* and *Ngfr* expression using either RNA samples from epidermal keratinocytes of  $n = 3$   $\Delta N$  (A), *Lhx2*-KO (B) and corresponding control embryos at E14.5. Statistical analyses were performed using a two-tailed unpaired t-test. Data are presented as mean $\pm$ s.e.m.



**Fig. S3. Verification of placode-specific expression and of NF- $\kappa$ B dependence of selected genes from microarray analysis. (A,B)** Quantitative real-time PCR (qRT-PCR) analysis using either RNA samples from epidermal keratinocytes of  $n = 3$  controls or  $\Delta N$  embryos (A), or RNA samples isolated from EGFP- positive (placode) or EGFP-negative (IFE) sorted keratinocytes (B) at E14.5. Statistical analyses were performed using a two-tailed unpaired t-test. Data are presented as mean $\pm$ s.e.m. \*  $P < 0.05$ ; \*\*  $P < 0.01$ ; \*\*\*  $P < 0.001$ . (C) In situ hybridization for mRNAs of NF- $\kappa$ B target genes using representative sagittal sections of  $n = 3$   $\Delta N$  and control embryos at E14.5. Dashed lines indicate boundary between epidermis and dermis. Scale bars: 50  $\mu$ m.





**Fig. S4. Treatment of embryonic control skin explants with recombinant TGF $\beta$ 2 slightly enhanced primary HF induction.** (A) Embryonic skin explants from  $n = 3$  E14.5 control and  $\Delta N$  embryos were either left untreated (Control) or treated with recombinant TGF $\beta$ 2 (100 ng/ml) for 24 hrs.  $n = 18$  samples of each experimental group were stained with H&E and follicles were quantified in numbers of hair follicle placodes/microscopic field in relation to the control group. Scale bars: 100 $\mu$ m. (B) Immunostaining on TGF- $\beta$ 2-stimulated embryonic control skin sections corresponding to E15.5 using antibodies against pFAK, Ki67 and E-Cadherin, as well as against EDAR and KRT14 to indicate placodes. Scale bars: 20  $\mu$ m / 50  $\mu$ m (pSMAD2). Arrowheads indicate pFAK expression in HF placodes; dashed lines delineate dermal-epidermal boundaries.

**Supplementary Table S1.** Representative lists of genes enriched in E14.5 primary hair follicle placodes (**upper list**) or in the interfollicular epidermis (IFE; **lower list**). Only mRNAs differentially regulated  $\geq 1.5x$  in **hair follicle placodes vs. IFE** are listed. Hair follicle placode keratinocytes correspond to EGFP-expressing and IFE keratinocytes to EGFP-non-expressing cells separated by FACS (see main text and Fig. S1).

**Genes enriched in primary hair follicle placodes at E14.5:**

Genes symbol	Description	Ref_Seq	Fold change
Frem1	Fras1 related extracellular matrix protein 1	NM_177863	6.72678
Dkk4	dickkopf homolog 4 ( <i>Xenopus laevis</i> )	NM_145592	5.82304
Fn1	fibronectin 1	NM_010233	5.04024
Ascl4	achaete-scute complex homolog 4 ( <i>Drosophila</i> )	NM_001163614	4.84369
Slc14a1	solute carrier family 14 (urea transporter), member 1	NM_001171010	4.59977
Trps1	trichorhinophalangeal syndrome I (human)	NM_032000	4.32476
Prokr2	prokineticin receptor 2	NM_144944	4.31001
Foxi3	forkhead box I3	NM_001101464	4.23003
Nrp2	neuropilin 2	NM_001077403	4.15898
Wif1	Wnt inhibitory factor 1	NM_011915	4.10489
Tspan18	tetraspanin 18	NM_183180	4.02829
Socs2	suppressor of cytokine signaling 2	NM_007706	3.96253
Ltb	lymphotoxin B	NM_008518	3.72502
Cd74	CD74 antigen	NM_001042605	3.448
Tgfb2	transforming growth factor, beta 2	NM_009367	3.40851
Necab1	N-terminal EF-hand calcium binding protein 1	NM_178617	3.33139
Fgf20	fibroblast growth factor 20	NM_030610	3.29271
Dusp6	dual specificity phosphatase 6	NM_026268	3.21706
Tmem100	transmembrane protein 100	NM_026433	3.17391
Edar	ectodysplasin-A receptor	NM_010100	3.15788
Rragd	Ras-related GTP binding D	NM_027491	3.11128
Itgb8	integrin beta 8	NM_177290	3.08216
Tll1	tolloid-like	NM_009390	3.07956
Mical2	microtubule associated monooxygenase, calponin and LIM domain containing 2	NM_177282	3.06069
Steap4	STEAP family member 4	NM_054098	3.0561
Adamts3	a disintegrin-like and metallopeptidase with thrombospondin motifs 3	NM_177872	2.97619
Has3	hyaluronan synthase 3	NM_008217	2.95032
Fgd5	FYVE, RhoGEF and PH domain containing 5	NM_172731	2.88688
Tnf	tumor necrosis factor	NM_013693	2.83063
Etv4	ets variant gene 4 (E1A enhancer binding protein, E1AF)	NM_008815	2.82086



Nkain3	Na <sup>+</sup> /K <sup>+</sup> transporting ATPase interacting 3	NM_172987	2.77675
Shh	sonic hedgehog	NM_009170	2.76033
Prss35	protease, serine, 35	NM_178738	2.71064
Ifitm1	interferon induced transmembrane protein 1	NM_026820	2.7034
Lgr6	leucine-rich repeat-containing G protein-coupled receptor 6	NM_001033409	2.67464
Aff2	AF4/FMR2 family, member 2	NM_008032	2.67125
Clip3	CAP-GLY domain containing linker protein 3	NM_001081114	2.66474
C1s	complement component 1, s subcomponent	NM_144938	2.63794
Ncam1	neural cell adhesion molecule 1	NM_001081445	2.63623
Madcam1	mucosal vascular addressin cell adhesion molecule 1	NM_013591	2.63337
Cntnap1	contactin associated protein-like 1	NM_016782	2.62987
Rasgef1b	RasGEF domain family, member 1B	NM_145839	2.60963
Myb	myeloblastosis oncogene	NM_010848	2.59304
Moxd1	monooxygenase, DBH-like 1	NM_021509	2.59
Tnfaip3	tumor necrosis factor, alpha-induced protein 3	NM_009397	2.58453
Csgalnact1	chondroitin sulfate N-acetylgalactosaminyltransferase 1	NM_172753	2.58372
Mapk4	mitogen-activated protein kinase 4	NM_172632	2.5564
Stra6	stimulated by retinoic acid gene 6	NM_009291	2.55396
Krt17	keratin 17	NM_010663	2.55127
Kcnmb4	potassium large conductance calcium-activated channel, subfamily M beta member 4	NM_021452	2.53788
Mmp9	matrix metalloproteinase 9	NM_013599	2.53534
Srgap1	SLIT-ROBO Rho GTPase activating protein 1	NM_001081037	2.53366
Ctgf	connective tissue growth factor	NM_010217	2.50581
Stxbp6	syntaxin binding protein 6 (amisyn)	NM_144552	2.50082
Lass4	LAG1 homolog, ceramide synthase 4	NM_026058	2.47589
Scube1	signal peptide, CUB domain, EGF-like 1	NM_022723	2.46246
Cpe	carboxypeptidase E	NM_013494	2.4328
Pthlh	parathyroid hormone-like peptide	NM_008970	2.42713
Alox12e	arachidonate lipoxygenase, epidermal	NM_145684	2.42105
Ptch2	patched homolog 2	NM_008958	2.39458
Scd1	stearoyl-Coenzyme A desaturase 1	NM_009127	2.37643
Dchs1	dachsous 1 (Drosophila)	NM_001162943	2.33643
Cyfp2	cytoplasmic FMR1 interacting protein 2	NM_133769	2.32122
Rhpn2	rhophilin, Rho GTPase binding protein 2	NM_027897	2.31369
Prnd	prion protein dublet	NM_023043	2.3072
Cxcr4	chemokine (C-X-C motif) receptor 4	NM_009911	2.30564
Cxcl9	chemokine (C-X-C motif) ligand 9	NM_008599	2.28395
Setbp1	SET binding protein 1	NM_053099	2.25846
Lgi2	leucine-rich repeat LGI family, member 2	NM_144945	2.2534

Sox9	SRY-box containing gene 9	NM_011448	2.24712
Fgfr1	fibroblast growth factor receptor 1	NM_010206	2.2423
Runx1	runt related transcription factor 1	NM_001111023	2.22868
Fndc1	fibronectin type III domain containing 1	NM_001081416	2.21535
Eif4e3	eukaryotic translation initiation factor 4E member 3	NM_025829	2.20993
Heg1	HEG homolog 1 (zebrafish)	NM_175256	2.1946
Lhx2	LIM homeobox protein 2	NM_010710	2.19298
Lrp4	low density lipoprotein receptor-related protein 4	NM_172668	2.18112
Ccdc85a	coiled-coil domain containing 85A	NM_181577	2.1585
Zdhhc2	zinc finger, DHHC domain containing 2	NM_178395	2.15626
Mill1	MHC I like leukocyte 1	NM_153749	2.14469
Micalcl	MICAL C-terminal like	AB359922	2.14146
Pstpip2	proline-serine-threonine phosphatase-interacting protein 2	NM_013831	2.08008
Il2rg	interleukin 2 receptor, gamma chain	NM_013563	2.06742
Bnc2	basonuclin 2	NM_172870	2.05488
Mybpc1	myosin binding protein C, slow-type	NM_175418	2.04995
Cabp1	calcium binding protein 1	NM_013879	2.0347
Kcnh3	potassium voltage-gated channel, subfamily H (eag-related) member 3	NM_010601	2.03291
Syt5	synaptotagmin V	NM_016908	2.02779
Fam13a	family with sequence similarity 13, member A	NM_153574	1.99645
Grik4	glutamate receptor, ionotropic, kainate 4	NM_175481	1.98605
1110012J17Rik	RIKEN cDNA 1110012J17 gene	NM_001114098	1.98034
Plk3	polo-like kinase 3 (Drosophila)	NM_013807	1.97215
Cxcl10	chemokine (C-X-C motif) ligand 10	NM_021274	1.96566
Ptch1	patched homolog 1	NM_008957	1.96207
Alcam	activated leukocyte cell adhesion molecule	NM_009655	1.93344
Tgfb1	transforming growth factor, beta 1	NM_011577	1.92935
Vldlr	very low density lipoprotein receptor	NM_013703	1.92326
Mpa2l	macrophage activation 2 like	NM_194336	1.92065
Wnt10b	wingless related MMTV integration site 10b	NM_011718	1.91905
Trib1	tribbles homolog 1 (Drosophila)	NM_144549	1.91708
Arhgef3	Rho guanine nucleotide exchange factor (GEF) 3	NM_027871	1.91348
H2-Ab1	histocompatibility 2, class II antigen A, beta 1	NM_207105	1.91304
C130021I20Rik	Riken cDNA C130021I20 gene	AK147796	1.90649
Mtmr10	myotubularin related protein 10	NM_172742	1.90315
Dab1	disabled homolog 1 (Drosophila)	NM_177259	1.89918
Wnt2b	wingless related MMTV integration site 2b	NM_009520	1.89907
Stx11	syntaxin 11	NM_029075	1.89836
Sv2b	synaptic vesicle glycoprotein 2 b	NM_001109753	1.89017

Nfkbia	nuclear factor of kappa light polypeptide gene enhancer in B-cells inhibitor alpha	NM_010907	1.88282
Rnf152	ring finger protein 152	NM_178779	1.87965
Fads2	fatty acid desaturase 2	NM_019699	1.87774
Gli1	GLI-Kruppel family member GLI1	NM_010296	1.87315
Pdzd2	PDZ domain containing 2	NM_001081064	1.86608
6330403K07Rik	RIKEN cDNA 6330403K07 gene	NM_134022	1.85268
Nr3c2	nuclear receptor subfamily 3, groupC, member2	NM_001083906	1.83938
Krt18	keratin 18	NM_010664	1.83723
Etv5	ets variant gene 5	NM_023794	1.8353
Kcnh2	potassium voltage-gated channel, subfamily H (eag-related) member 2	NM_013569	1.83401
Ptgir	prostaglandin I receptor (IP)	NM_008967	1.83208
Sh3rf3	SH3 domain containing ring finger 3	NM_172788	1.8301
Ptk2b	PTK2 protein tyrosine kinase 2 beta	NM_001162365	1.82897
Mtap2	microtubule-associated protein 2	NM_001039934	1.82823
Mtmr7	myotubularin related protein 7	NM_001040699	1.82822
Robo2	roundabout homolog 2 (Drosophila)	NM_175549	1.82721
Kalrn	kalirin, RhoGEF kinase	NM_177357	1.8251
Bcl3	B-cell leukemia/lymphoma 3	NM_033601	1.82083
Tarm1	T cell-interacting, activating receptor on myeloid cells 1	NM_177363	1.80831
Rerg	RAS-like, estrogen-regulated, growth-inhibitor	NM_181988	1.80721
Pgf	placental growth factor	NM_008827	1.80406
Stap1	signal transducing adaptor family member 1	NM_019992	1.80181
Adamts15	a disintegrin-like and metallopeptidase with thrombospondin motifs 15	NM_001024139	1.78899
Nnat	neuronatin	NM_010923	1.78484
3110082D06Rik	RIKEN cDNA 3110082D06 gene	NM_028474	1.77842
Peli2	pellino 2	NM_033602	1.77669
Unc5b	unc-5 homolog B (C. elegans)	NM_029770	1.77391
Tspan5	tetraspanin 5	NM_019571	1.77279
Galnt6	UDP-N-acetyl-alpha-D-galactosamine: polypeptide N-acetylgalactosaminyltransferase 6	NM_001161767	1.7722
Pion	pigeon homolog (Drosophila)	NM_175437	1.76624
Kcnip1	Kv channel-interacting protein 1	NM_027398	1.76196
Drp2	dystrophin related protein 2	NM_010078	1.76107
Neto1	neuropilin (NRP) and tolloid (TLL)-like 1	NM_144946	1.75975
Serinc2	serine incorporator 2	NM_172702	1.75794
Bach2	BTB and CNC homology 2	NM_001109661	1.75674
Ptges	prostaglandin E synthase	NM_022415	1.75584
Tapbp	TAP binding protein	NM_001025313	1.75121
Plcb2	phospholipase C, beta 2	NM_177568	1.74533

Meis1	Meis homeobox 1	NM_010789	1.73948
Ajap1	adherens junction associated protein 1	NM_001099299	1.73929
Sh3gl3	SH3-domain GRB2-like 3	NM_017400	1.73684
Sema3d	sema domain, immunoglobulin domain (Ig), short basic domain secreted (semaphorin) 3D	NM_028882	1.73535
Sox2	SRY-box containing gene 2	NM_011443	1.7348
Hhip	Hedgehog-interacting protein	NM_020259	1.73156
Hoxc6	homeobox C6	NM_010465	1.72724
Tsku	tsukushin	NM_001168541	1.72657
Rtn1	reticulon 1	NM_153457	1.72548
Smox	spermine oxidase	NM_001177833	1.72453
Pxdn	peroxidasin homolog (Drosophila)	NM_181395	1.71855
AY512949	cDNA sequence AY512949	AY512949	1.71621
Rcn3	reticulocalbin 3, EF-hand calcium binding domain	NM_026555	1.71433
Rnf32	ring finger protein 32	NM_021470	1.711
Il23a	interleukin 23, alpha subunit p19	NM_031252	1.70695
Cpne5	copine V	NM_153166	1.70401
Slit3	slit homolog 3 (Drosophila)	NM_011412	1.70263
Susd4	sushi domain containing 4	NM_144796	1.70162
Atp1b1	ATPase, Na <sup>+</sup> /K <sup>+</sup> transporting, beta 1 polypeptide	NM_009721	1.69741
Sox21	SRY-box containing gene 21	NM_177753	1.69563
Bmp2	bone morphogenetic protein 2	NM_007553	1.69554
2010300C02Rik	RIKEN cDNA 2010300C02 gene	NM_028096	1.68928
Sema4c	sema domain, immunoglobulin domain (Ig), transmembrane domain (TM) and short cytoplasmic domain, (Semaphorin) 4C	NM_001126047	1.68679
Cacna1h	calcium channel, voltage-dependent, T type, alpha 1H subunit	NM_021415	1.68588
1110028C15Rik	RIKEN cDNA 1110028C15 gene	NM_001122738	1.68216
D19Ert652e	DNA segment, Chr 19, ERATO Doi 652, expressed	BC107403	1.68043
Igfbp4	insulin-like growth factor binding protein 4	NM_010517	1.68001
Slco3a1	solute carrier organic anion transporter family, member 3A1	NM_023908	1.67316
Cntn2	contactin 2	NM_177129	1.66761
Gm5077	predicted gene 5077	NM_173864	1.66026
Runx2	runt related transcription factor 2	NM_001146038	1.65805
Clec2d	C-type lectin domain family 2, member d	NM_053109	1.65631
Ptgs2	prostaglandin-endoperoxide synthase 2	NM_011198	1.65597
Ehf	ets homologous factor	NM_007914	1.65559
Hr	hairless	NM_021877	1.65486
Arl6	ADP-ribosylation factor-like 6	NM_019665	1.6485

Nup210	nucleoporin 210	NM_018815	1.6388
Rnf122	ring finger protein 122	NM_175136	1.63805
Galnt14	UDP-N-acetyl-alpha-D-galactosamine: poly-peptide N-acetylgalactosaminyltransferase 14	NM_027864	1.63479
Bcar3	breast cancer anti-estrogen resistance 3	NM_013867	1.63365
Doc2b	double C2, beta	NM_007873	1.63109
Gpc2	glypican 2 (cerebroglycan)	NM_172412	1.63104
Mfap2	microfibrillar-associated protein 2	NM_008546	1.6301
Parp8	poly (ADP-ribose) polymerase family, member 8	NM_001081009	1.62741
Csf1	colony stimulating factor 1 (macrophage)	NM_007778	1.62535
Hpca	hippocalcin	NM_010471	1.62412
Robo1	roundabout homolog 1 (Drosophila)	NM_019413	1.62296
Gata6	GATA binding protein 6	NM_010258	1.62065
Slc2a4	solute carrier family 2 (facilitated glucose transporter) member 4	NM_009204	1.61892
Tnip1	TNFAIP3 interacting protein 1	NM_021327	1.61539
Snai3	snail homolog 3 (Drosophila)	NM_013914	1.61109
Adamts17	a disintegrin-like and metallopeptidase with thrombospondin motifs 17	NM_001033877	1.61011
Slc39a2	solute carrier family 39 (zinc transporter), member 2	NM_001039676	1.60699
Ntsr1	neurotensin receptor 1	NM_018766	1.60654
Ston2	stonin 2	NM_175367	1.60549
Chst1	carbohydrate (keratan sulfate Gal-6) sulfotransferase 1	NM_023850	1.60363
Igfbp7	insulin-like growth factor binding protein 7	NM_001159518	1.60225
Pdlim4	PDZ and LIM domain 4	NM_019417	1.6007
Flrt1	fibronectin leucine rich transmembrane protein 1	NM_201411	1.6
Ankrd45	ankyrin repeat domain 45	NM_028664	1.59378
Scn4b	sodium channel, type IV, beta	NM_001013390	1.59078
Ifitm3	interferon induced transmembrane protein 3	NM_025378	1.5882
Vwa2	von Willebrand factor A domain containing 2	NM_172840	1.58769
Zfp703	zinc finger protein 703	NM_001101502	1.58643
Aplp1	amyloid beta (A4) precursor-like protein 1	NM_007467	1.58109
Pcdh20	protocadherin 20	NM_178685	1.5777
Efha2	EF-hand domain family, member A2	NM_030110	1.57743
Ctxn1	cortexin 1	NM_183315	1.57693
Pcdhb17	protocadherin beta 17	NM_053142	1.5748
Sox4	SRY-box containing gene 4	NM_009238	1.57435
Birc3	baculoviral IAP repeat-containing 3	NM_007464	1.56615
Pcdhb16	protocadherin beta 16	NM_053141	1.566
Gria3	glutamate receptor, ionotropic, AMPA3 (alpha 3)	NM_016886	1.56142

Itga8	integrin alpha 8	NM_001001309	1.55968
Cobll1	Cobl-like 1	NM_177025	1.55902
Mpped1	metallophosphoesterase domain containing 1	NM_172610	1.55823
Tnc	tenascin C	NM_011607	1.55711
Fam134b	family with sequence similarity 134, member B	NM_001034851	1.5547
Bdnf	brain derived neurotrophic factor	NM_001048139	1.55203
Pfn2	profilin 2	NM_019410	1.55202
Ednra	endothelin receptor type A	NM_010332	1.55142
Ltbp1	latent transforming growth factor beta binding protein 1	NM_019919	1.54781
Orai2	ORAI calcium release-activated calcium modulator 2	NM_178751	1.54545
Prkar1b	protein kinase, cAMP dependent regulatory, type I beta	NM_008923	1.54434
Oasl2	2'-5' oligoadenylate synthetase-like 2	NM_011854	1.5437
Pck2	phosphoenolpyruvate carboxykinase 2 (mitochondrial)	NM_028994	1.543
Kcnj13	potassium inwardly-rectifying channel, subfamily J, member 13	NM_001110227	1.54167
Lzts1	leucine zipper, putative tumor suppressor 1	NM_199364	1.54108
Grasp	GRP1 (general receptor for phosphoinositides 1)-associated scaffold protein	NM_019518	1.54028
Abhd12b	abhydrolase domain containing 12B	ENSMUST00000095662	1.53875
Olfr332	olfactory receptor 332	NM_001011770	1.53477
Olfr354	olfactory receptor 354	NM_146939	1.53475
Slc8a2	solute carrier family 8 (sodium/calcium exchanger), member 2	NM_148946	1.53388
H2-M2	histocompatibility 2, M region locus 2	NM_008204	1.53362
Gpc4	glypican 4	NM_008150	1.52993
Sema6a	sema domain, transmembrane domain (TM), and cytoplasmic domain (semaphorin) 6A	NM_018744	1.52824
Sfrp1	secreted frizzled-related protein 1	NM_013834	1.52721
Tcerg1l	transcription elongation regulator 1-like	NM_183289	1.52632
Prdm1	PR domain containing 1, with ZNF domain	NM_007548	1.52515
Pak1	p21 protein (Cdc42/Rac)-activated kinase 1	NM_011035	1.52389
1190007F08Rik	RIKEN cDNA 1190007F08 gene	NM_001163721	1.5194
Soat1	sterol O-acyltransferase 1	NM_009230	1.51793
Tgfb3	transforming growth factor, beta 3	NM_009368	1.51763
Rnf180	ring finger protein 180	NM_027934	1.51676
Capsl	calcyphosine-like	NM_029341	1.51458
Ppp1r3c	protein phosphatase 1, regulatory (inhibitor) subunit 3C	NM_016854	1.5111
Arhgef4	Rho guanine nucleotide exchange factor (GEF) 4	NM_183019	1.51105
Spo11	sporulation protein, meiosis-specific, SPO11	NM_012046	1.51063



	homolog		
Chst11	carbohydrate sulfotransferase 11	NM_021439	1.51022
Myliip	myosin regulatory light chain interacting protein	NM_153789	1.50443
Lrrc56	leucine rich repeat containing 56	NM_001172064	1.50368
Serpinb6b	serine (or cysteine) peptidase inhibitor, clade B, member 6	NM_011454	1.5019
Myo1e	myosin IE	NM_181072	1.50175
Cav2	caveolin 2	NM_016900	1.50146
4831426I19Rik	RIKEN cDNA 4831426I19 gene	NM_001042699	1.50112
Naaladl2	N-acetylated alpha-linked acidic dipeptidase-like 2	XM_910834	1.50034

### **Genes enriched in the interfollicular epidermis (IFE) at E14.5:**

<b>Genes symbol</b>	<b>Description</b>	<b>Ref_Seq</b>	<b>Fold change</b>
Dct	dopachrome tautomerase	NM_010024	-13.3986
Fabp7	fatty acid binding protein 7, brain	NM_021272	-11.1386
Kit	kit oncogene	NM_001122733	-8.89564
Ednrb	endothelin receptor type B	NM_007904	-8.03849
Mcoln3	mucolipin 3	NM_134160	-7.67076
Hba-a1	hemoglobin alpha, adult chain 1	NM_008218	-7.59276
Hba-a2	hemoglobin alpha, adult chain 2	NM_001083955	-7.07394
Tyr	tyrosinase	NM_011661	-7.05902
Si	silver	NM_021882	-6.53347
Slc45a2	solute carrier family 45, member 2	NM_053077	-6.52809
Mitf	microphthalmia-associated transcription factor	NM_001113198	-6.29898
Hbb-b1	hemoglobin, beta adult major chain	NM_008220	-6.28766
Slc24a5	solute carrier family 24, member 5	NM_175034	-6.27844
Gpnmb	glycoprotein (transmembrane) nmb	NM_053110	-6.06478
Itga4	integrin alpha 4	NM_010576	-6.03604
Slc7a8	solute carrier family 7 (cationic amino acid transporter, light chain, L system) member 8	NM_016972	-5.91936
Gjc3	gap junction protein, gamma 3	NM_080450	-5.91203
Gabbr2	gamma-aminobutyric acid (GABA) A receptor, subunit beta 2	NM_008070	-5.76314
Cubn	cubilin (intrinsic factor-cobalamin receptor)	NM_001081084	-5.7264
Bace2	beta-site APP-cleaving enzyme 2	NM_019517	-5.30143
Pax3	paired box gene 3	NM_008781	-5.15059
Zeb2	zinc finger E-box binding homeobox 2	NM_015753	-5.10228

Slc7a11	solute carrier family 7 (cationic amino acid transporter, light chain, L system) member 11	NM_011990	-5.00851
Gucy1b3	guanylate cyclase 1, soluble, beta 3	NM_017469	-4.68383
Shc4	SHC (Src homology 2 domain containing) family, member 4	NM_199022	-4.51824
Dsc1	desmocollin 1	NM_013504	-4.29284
Cd97	CD97 antigen	NM_011925	-4.08062
Pde8a	phosphodiesterase 8A	NM_008803	-4.01469
Cpa3	carboxypeptidase A3, mast cell	NM_007753	-3.96657
Ptprj	protein tyrosine phosphatase, receptor type, J	NM_008982	-3.86641
Eya1	eyes absent 1 homolog (Drosophila)	NM_010164	-3.82696
Them5	thioesterase superfamily member 5	NM_025416	-3.79337
Tm4sf1	transmembrane 4 superfamily member 1	NM_008536	-3.7218
Serpib12	serine (or cysteine) peptidase inhibitor, clade B (ovalbumin) member 12	NM_027971	-3.55006
Abca12	ATP-binding cassette, sub-family A (ABC1), member 12	NM_175210	-3.54327
1700086L19Rik	RIKEN cDNA 1700086L19 gene	NR_030733	-3.53514
Ttyh2	tweety homolog 2 (Drosophila)	NM_053273	-3.48151
Sox10	SRY-box containing gene 10	NM_011437	-3.40337
Bhlhe41	basic helix-loop-helix family, member e41	NM_024469	-3.36134
Pmp22	peripheral myelin protein 22	NM_008885	-3.35803
Cdh19	cadherin 19, type 2	NM_001081386	-3.33919
Aadacl2	arylacetamide deacetylase-like 2	NM_001128091	-3.31869
Megf10	multiple EGF-like-domains 10	NM_001001979	-3.285
4833423E24Rik	RIKEN cDNA 4833423E24 gene	NM_001081664	-3.28403
Ddah1	dimethylarginine dimethylaminohydrolase 1	NM_026993	-3.27234
Serpib3a	serine (or cysteine) peptidase inhibitor, clade B (ovalbumin) member 3	NM_009126	-3.19283
Elovl4	elongation of very long chain fatty acids (FEN1/Elo2, SUR4/Elo3, Yeast)-Like 4	NM_148941	-3.17368
Iqgap2	IQ motif containing GTPase activating protein 2	NM_027711	-3.1546
Krt77	keratin 77	NM_001003667	-3.07428
Ace2	angiotensin I converting enzyme (peptidyl-dipeptidase A) 2	NM_027286	-3.06103
Serpib3c	serine (or cysteine) peptidase inhibitor, clade B, member 3	NM_201363	-2.99416
Mlana	melan-A	NM_029993	-2.96325
Npy	neuropeptide Y	NM_023456	-2.94426
Aff3	AF4/FMR2 family, member 3	NM_010678	-2.91408
Dbpht2	DNA binding protein with his-thr domain	NM_198866	-2.88289
Casp14	caspase 14	NM_009809	-2.86772
Plp1	Nproteolipid protein (myelin) 1	NM_011123	-2.85823
Rdh12	retinol dehydrogenase 12	NM_030017	-2.85649

Cdh2	cadherin 2	NM_007664	-2.84678
Foxd3	forkhead box D3	NM_010425	-2.80057
Ptgds	prostaglandin D2 synthase (brain)	NM_008963	-2.7837
Fap	fibroblast activation protein	NM_007986	-2.78074
Krtdap	keratinocyte differentiation associated protein	NM_001033131	-2.73273
Sdr16c6	short chain dehydrogenase/reductase family 16C, member 6	NM_001080710	-2.693
Car8	carbonic anhydrase 8	NM_007592	-2.68262
Cttnbp2	cortactin binding protein 2	NM_080285	-2.6631
Bpil2	bactericidal/permeability-increasing protein-like 2	NM_177772	-2.65552
Dmkn	dermokine	NM_001166173	-2.65336
Gabbr3	gamma-aminobutyric acid (GABA) A receptor, subunit beta 3	NM_008071	-2.62234
Muc15	mucin 15	NM_172979	-2.61603
Glcci1	glucocorticoid induced transcript 1	NM_133236	-2.59503
Dock5	dedicator of cytokinesis 5	NM_177780	-2.56376
Tgm3	transglutaminase 3, E polypeptide	NM_009374	-2.56111
Vim	vimentin	NM_011701	-2.55643
Ets1	E26 avian leukemia oncogene 1, 5' domain	NM_011808	-2.54204
Lix1l	Lix1-like	NM_001163170	-2.53879
Smpdl3a	sphingomyelin phosphodiesterase, acid-like 3A	NM_020561	-2.53731
Glrb	glycine receptor, beta subunit	NM_010298	-2.53534
Pnpla1	patatin-like phospholipase domain containing 1	NM_001034885	-2.52928
Rhoj	ras homolog gene family, member J	NM_023275	-2.52197
Lmo2	LIM domain only 2	NM_008505	-2.51665
Gpr124	G protein-coupled receptor 124	NM_054044	-2.51493
Eng	endoglin	NM_001146350	-2.51234
Cyp4f39	cytochrome P450, family 4, subfamily f, polypeptide 39	NM_177307	-2.47551
Hspb1	heat shock protein 1	NM_013560	-2.46524
Dsg1a	desmoglein 1 alpha	NM_010079	-2.4552
Gabra1	gamma-aminobutyric acid (GABA) A receptor, subunit alpha 1	NM_010250	-2.44598
Rassf2	Ras association (RalGDS/AF-6) domain family member 2	NM_175445	-2.40868
Fndc3c1	fibronectin type III domain containing 3C1	NM_001007580	-2.39585
Mef2c	myocyte enhancer factor 2C	NM_001170537	-2.39039
Pla2g2f	phospholipase A2, group IIF	NM_012045	-2.37833
Krt1	keratin 1	NM_008473	-2.37567
Cyp2j6	cytochrome P450, family 2, subfamily j, polypeptide 6	NM_010008	-2.36934
Gpm6a	glycoprotein m6a	NM_153581	-2.36615

Cd44	CD44 antigen	NM_009851	-2.36345
2610528A11Rik	RIKEN cDNA 2610528A11 gene	BC049685	-2.35047
Serpinb3b	serine (or cysteine) peptidase inhibitor, clade B (ovalbumin) member 3	NM_198680	-2.34213
Ly6g6c	lymphocyte antigen 6 complex, locus G6C	NM_023463	-2.33239
Syt4	synaptotagmin IV	NM_009308	-2.32023
Aox4	aldehyde oxidase 4	NM_023631	-2.29538
Dusp4	dual specificity phosphatase 4	NM_176933	-2.28567
Cyp2w1	cytochrome P450, family 2, subfamily w, polypeptide 1	NM_001160265	-2.28215
Tspan10	tetraspanin 10	NM_145363	-2.2754
Gpr111	G protein-coupled receptor 111	NM_001033493	-2.24943
Lgals9	lectin, galactose binding, soluble 9	NM_010708	-2.24754
Krt10	keratin 10	NM_010660	-2.24585
Acsl1	acyl-CoA synthetase long-chain family member 1	NM_007981	-2.24443
C130079G13Rik	RIKEN cDNA C130079G13 gene	NM_177661	-2.2349
Sdr16c5	short chain dehydrogenase/reductase family 16C, member 5	NM_181989	-2.23471
Dgat2	diacylglycerol O-acyltransferase 2	NM_026384	-2.22619
Tspan7	tetraspanin 7	NM_019634	-2.22509
Ceacam1	carcinoembryonic antigen-related cell adhesion molecule 1	NM_001039185	-2.21668
Plxna4	plexin A4	NM_175750	-2.21437
Mgst1	microsomal glutathione S-transferase 1	NM_019946	-2.21317
Tmem45a	transmembrane protein 45a	NM_019631	-2.21307
Ephx3	epoxide hydrolase 3	NM_001033163	-2.20599
Igf1	insulin-like growth factor 1	NM_010512	-2.19222
Nkd2	naked cuticle 2 homolog (Drosophila)	NM_028186	-2.18762
Gpr155	G protein-coupled receptor 155	NM_001080707	-2.17668
Mgl1	monoglyceride lipase	NM_001166251	-2.1652
Loxl3	lysyl oxidase-like 3	NM_013586	-2.16268
Lgals3	lectin, galactose binding, soluble 3	NM_001145953	-2.15513
Dhrs7	dehydrogenase/reductase (SDR family) member 7	NM_025522	-2.14505
Defb1	defensin beta 1	NM_007843	-2.13563
Igsf11	immunoglobulin superfamily, member 11	NM_170599	-2.13439
Apod	apolipoprotein D	NM_007470	-2.12285
Ano7	anoctamin 7	NM_207031	-2.11815
Msn	moesin	NM_010833	-2.11068
Gsta1	glutathione S-transferase, alpha 1 (Ya)	NM_008181	-2.10006
Alx1	ALX homeobox 1	NM_172553	-2.07513
Qpct	glutaminyl-peptide cyclotransferase (glutaminyl cyclase)	NM_027455	-2.05609

Pcsk2	proprotein convertase subtilisin/kexin type 2	NM_008792	-2.04744
Lox	lysyl oxidase	NM_010728	-2.04368
Tgm1	transglutaminase 1, K polypeptide	NM_001161715	-2.01038
Rxrg	retinoid X receptor gamma	NM_009107	-2.00772
Itga9	integrin alpha 9	NM_133721	-2.00334
Fam174b	family with sequence similarity 174, member B	NM_001162532	-1.99666
Trf	transferrin	NM_133977	-1.99192
St8sia6	ST8 alpha-N-acetyl-neuraminide alpha-2,8-sialyltransferase 6	NM_145838	-1.99135
Tmem26	transmembrane protein 26	NM_177794	-1.99127
Dpysl3	dihydropyrimidinase-like 3	NM_009468	-1.98497
Myo7a	myosin VIIA	NM_008663	-1.98315
Chsy3	chondroitin sulfate synthase 3	NM_001081328	-1.98098
Dsg1b	desmoglein 1 beta	NM_181682	-1.97908
Hsd17b11	hydroxysteroid (17-beta) dehydrogenase 11	NM_053262	-1.97763
Npbwr1	neuropeptides B/W receptor 1	NM_010342	-1.9776
Clvs1	clavesin 1	NM_028940	-1.97621
Gca	grancalcin	NM_145523	-1.97335
Mocos	molybdenum cofactor sulfurase	NM_026779	-1.9684
Gm10639	predicted gene 10639	NM_001122660	-1.96733
Mme	membrane metallo endopeptidase	NM_008604	-1.95696
Fmn1	formin 1	NM_010230	-1.95256
Gsta2	glutathione S-transferase, alpha 2 (Yc2)	NM_008182	-1.93678
Nipal1	NIPA-like domain containing 1	NM_001081205	-1.93147
Rab25	RAB25, member RAS oncogene family	NM_016899	-1.93048
Gldc	glycine decarboxylase	NM_138595	-1.92331
F3	coagulation factor III	NM_010171	-1.92279
Pde3a	phosphodiesterase 3A, cGMP inhibited	NM_018779	-1.92154
Slc6a15	solute carrier family 6 (neurotransmitter transporter), member 15	NM_175328	-1.92055
Scel	sciellin	NM_022886	-1.91843
Atg4a	autophagy-related 4A (yeast)	NM_174875	-1.91751
Nipal4	NIPA-like domain containing 4	NM_172524	-1.89996
St3gal5	ST3 beta-galactoside alpha-2,3-sialyltransferase 5	NM_011375	-1.89425
Tprg	transformation related protein 63 regulated	NM_175165	-1.89031
Plxnc1	plexin C1	NM_018797	-1.88757
Pcsk6	proprotein convertase subtilisin/kexin type 6	NM_011048	-1.88695
Vat1l	vesicle amine transport protein 1 homolog-like	NM_173016	-1.88139
Phyhipl	phytanoyl-CoA hydroxylase interacting protein-like	NM_178621	-1.88025
Hexa	hexosaminidase A	NM_010421	-1.87951
Fam13c	family with sequence similarity 13, member C	NM_024244	-1.87934

Acadl	acyl-Coenzyme A dehydrogenase, long-chain	NM_007381	-1.87602
Parvb	parvin, beta	NM_133167	-1.86923
Gabrp	gamma-aminobutyric acid (GABA) A receptor, pi	NM_146017	-1.86752
Smtnl2	smoothelin-like 2	NM_177776	-1.86721
Cpa6	carboxypeptidase A6	NM_177834	-1.8646
Lipm	lipase, family member M	NM_023903	-1.86238
Dpp4	dipeptidylpeptidase 4	NM_010074	-1.86079
Anxa1	annexin A1	NM_010730	-1.86048
Afap1l2	actin filament associated protein 1-like 2	NM_146102	-1.85728
Heyl	hairly/enhancer-of-split related with YRPW motif-like	NM_013905	-1.85722
Zfp185	zinc finger protein 185	NM_009549	-1.85238
Atg4a	autophagy-related 4A (yeast)	NM_174875	-1.85005
Ch25h	cholesterol 25-hydroxylase	NM_009890	-1.85
4931406C07Rik	RIKEN cDNA 4931406C07 gene	NM_133732	-1.848
Slc2a3	solute carrier family 2 (facilitated glucose transporter) member 3	NM_011401	-1.84559
Col12a1	collagen, type XII, alpha 1	NM_007730	-1.8431
Sgip1	SH3-domain GRB2-like (endophilin) interacting protein 1	NM_144906	-1.84309
Adam12	a disintegrin and metallopeptidase domain 12 (meltrin alpha)	NM_007400	-1.84139
Gulp1	GULP, engulfment adaptor PTB domain containing 1	NM_028450	-1.84102
Fam57a	family with sequence similarity 57, member A	NM_027773	-1.8401
Ccr4	chemokine (C-C motif) receptor 4	NM_009916	-1.83905
Plagl1	pleiomorphic adenoma gene-like 1	NM_009538	-1.83139
Tmem154	transmembrane protein 154	NM_177260	-1.83136
St3gal1	ST3 beta-galactoside alpha-2,3-sialyltransferase 1	NM_009177	-1.82318
Crmp1	collapsin response mediator protein 1	NM_007765	-1.81883
Il22ra1	interleukin 22 receptor, alpha 1	NM_178257	-1.81498
Cftr	cystic fibrosis transmembrane conductance regulator homolog	NM_021050	-1.81473
Ctsc	cathepsin C	NM_009982	-1.81255
Tnik	TRAF2 and NCK interacting kinase	NM_026910	-1.8114
Sbsn	suprabasin	NM_172205	-1.81113
Chl1	cell adhesion molecule with homology to L1CAM	NM_007697	-1.80492
Uap1l1	UDP-N-acetylglucosamine pyrophosphorylase 1-like 1	NM_001033293	-1.79965
Pcbd1	pterin 4 alpha carbinolamine dehydratase/dimerization cofactor of Hepatocyte Nuclear Factor 1 Alpha	NM_025273	-1.79887



Pde3b	phosphodiesterase 3B, cGMP-inhibited	NM_011055	-1.79598
Arhgap6	Rho GTPase activating protein 6	NM_009707	-1.79047
Ceacam19	carcinoembryonic antigen-related cell adhesion molecule 19	NM_177036	-1.78945
Adamts1	a disintegrin-like and metallopeptidase repro-lysin type with Thrombospondin Type 1 Motif, 1	NM_009621	-1.78818
Rab31	RAB31, member RAS oncogene family	NM_133685	-1.78794
Nppb	natriuretic peptide precursor type B	NM_008726	-1.78734
Cdh9	cadherin 9	NM_009869	-1.78631
Adssl1	adenylosuccinate synthetase like 1	NM_007421	-1.78417
Edn1	endothelin 1	NM_010104	-1.78375
Lypd3	Ly6/Plaur domain containing 3	NM_133743	-1.78152
Capns2	calpain, small subunit 2	NM_027112	-1.78084
2310007B03Rik	RIKEN cDNA 2310007B03 gene	NM_172411	-1.77783
Anxa8	annexin A8	NM_013473	-1.77481
Ppp1r16b	protein phosphatase 1, regulatory (inhibitor) subunit 16	NM_153089	-1.76265
Rin3	Ras and Rab interactor 3	NM_177620	-1.7594
Aim1	absent in melanoma 1	NM_172393	-1.75903
Gm5226	predicted pseudogene 5226	XM_914955	-1.75671
Ogn	osteoglycin	NM_008760	-1.75611
Manba	mannosidase, beta A, lysosomal	NM_027288	-1.75238
2210023G05Rik	RIKEN cDNA 2210023G05 gene	NM_197999	-1.7485
Slc26a7	solute carrier family 26, member 7	NM_145947	-1.7447
Cd200	CD200 antigen	NM_010818	-1.744
Rab3d	RAB3D, member RAS oncogene family	NM_031874	-1.7392
Leprel1	leprecan-like 1	NM_173379	-1.73852
AW551984	expressed sequence AW551984	NM_178737	-1.7381
C2	complement component 2 (within H-2S)	NM_013484	-1.73393
Scnn1a	sodium channel, nonvoltage-gated 1 alpha	NM_011324	-1.73157
Il15	interleukin 15	NM_008357	-1.73129
Sirpa	signal-regulatory protein alpha	NM_007547	-1.72769
Dlx5	distal-less homeobox 5	NM_010056	-1.727
Hist1h2bc	histone cluster 1, H2bc	NM_023422	-1.72637
Nkain4	Na <sup>+</sup> /K <sup>+</sup> transporting ATPase interacting 4	NM_021426	-1.72516
Dlc1	deleted in liver cancer 1	NM_015802	-1.71766
Alox12	arachidonate 12-lipoxygenase	NM_007440	-1.71714
Syng1	synaptogyrin 1	NM_207708	-1.71617
Ptprm	protein tyrosine phosphatase, receptor type, M	NM_008984	-1.71509
Cd109	CD109 antigen	NM_153098	-1.70606
Cpt1a	carnitine palmitoyltransferase 1a, liver	NM_013495	-1.70545
Igfbp3	insulin-like growth factor binding protein 3	NM_008343	-1.70523
Edil3	EGF-like repeats and discoidin I-like domains 3	NM_001037987	-1.7045

Prex1	phosphatidylinositol-3,4,5-trisphosphate-dependent Rac exchange factor 1	NM_177782	-1.70439
Aebp1	AE binding protein 1	NM_009636	-1.70392
Foxo1	forkhead box O1	NM_019739	-1.70091
Syde1	synapse defective 1, Rho GTPase, homolog 1 (C. elegans)	NM_027875	-1.69704
Ica1	islet cell autoantigen 1	NM_010492	-1.69649
Faah	fatty acid amide hydrolase	NM_010173	-1.69601
Gsta3	glutathione S-transferase, alpha 3	NM_001077353	-1.69572
Renbp	renin binding protein	NM_023132	-1.69342
Gpr143	G protein-coupled receptor 143	NM_010951	-1.6893
Rab27b	RAB27b, member RAS oncogene family	NM_001082553	-1.68653
Cot1	coactosin-like 1 (Dictyostelium)	NM_028071	-1.68495
Gpr115	G protein-coupled receptor 115	NM_030067	-1.68479
Pla2g4f	phospholipase A2, group IVF	NM_001024145	-1.6837
Creg1	cellular repressor of E1A-stimulated genes 1	NM_011804	-1.68105
Atp6v0a1	ATPase, H+ transporting, lysosomal V0 subunit A1	NM_016920	-1.68015
Fbn2	fibrillin 2	NM_010181	-1.67988
Cdkn1a	cyclin-dependent kinase inhibitor 1A (P21)	NM_007669	-1.67904
Abtb2	ankyrin repeat and BTB (POZ) domain containing 2	NM_178890	-1.67736
Vat1	vesicle amine transport protein 1 homolog (T californica)	NM_012037	-1.67695
Agtr1a	angiotensin II receptor, type 1a	NM_177322	-1.67621
Rarb	retinoic acid receptor, beta	NM_011243	-1.67254
Tmbim1	transmembrane BAX inhibitor motif containing 1	NM_027154	-1.66823
Myo5b	myosin VB	NM_201600	-1.6682
Sdc3	syndecan 3	NM_011520	-1.66804
Fam83a	family with sequence similarity 83, member A	NM_173862	-1.66613
Aldh1a7	aldehyde dehydrogenase family 1, subfamily A7	NM_011921	-1.65783
Npl	N-acetylneuraminase pyruvate lyase	NM_028749	-1.65692
Nkd1	naked cuticle 1 homolog (Drosophila)	NM_027280	-1.65403
Mall	mal, T-cell differentiation protein-like	NM_145532	-1.65312
Reln	reelin	NM_011261	-1.65289
Rhob	ras homolog gene family, member B	NM_007483	-1.6515
Gm2a	GM2 ganglioside activator protein	NM_010299	-1.64723
Plbd1	phospholipase B domain containing 1	NM_025806	-1.64712
Gm6181	predicted pseudogene 6181	XM_885168	-1.64469
Prkg2	protein kinase, cGMP-dependent, type II	NM_008926	-1.64465
Fez1	fasciculation and elongation protein zeta 1 (zygin I)	NM_183171	-1.64201
Ppfibp2	PTPRF interacting protein, binding protein 2	NM_008905	-1.64072

	(liprin beta 2)		
Masp1	mannan-binding lectin serine peptidase 1	NM_008555	-1.64019
Palld	palladin, cytoskeletal associated protein	NM_001081390	-1.63705
Liph	lipase, member H	NM_001083894	-1.6357
B4galt5	UDP-Gal:betaGlcNAc beta 1,4-galactosyltransferase, polypeptide 5	NM_019835	-1.63195
Id2	inhibitor of DNA binding 2	NM_010496	-1.63144
Mxra7	matrix-remodelling associated 7	NM_026280	-1.63076
Ap1s2	adaptor-related protein complex 1, sigma 2 subunit	NM_026887	-1.62928
Slc27a6	solute carrier family 27 (fatty acid transporter), member 6	NM_001081072	-1.62671
Gfra1	glial cell line derived neurotrophic factor family receptor alpha 1	NM_010279	-1.62607
Serpib7	serine (or cysteine) peptidase inhibitor, clade B, member 7	NM_027548	-1.62578
4930485B16Rik	RIKEN cDNA 4930485B16 gene	ENSMUST00000067705	-1.62514
Npr2	natriuretic peptide receptor 2	NM_173788	-1.62372
Fads3	fatty acid desaturase 3	NM_021890	-1.62337
Ankrd22	ankyrin repeat domain 22	NM_024204	-1.62334
Bend6	BEN domain containing 6	NM_177235	-1.6224
Cpeb4	cytoplasmic polyadenylation element binding protein 4	NM_026252	-1.62213
Nipal2	NIPA-like domain containing 2	NM_145469	-1.62162
Cpne4	copine IV	NM_028719	-1.62158
Serpina3b	serine (or cysteine) peptidase inhibitor, clade A, member 3	NM_173024	-1.62112
1700055N04Rik	RIKEN cDNA 1700055N04 gene	AK081788	-1.62076
Gm10786	predicted gene 10786	ENSMUST00000099550	-1.61909
Ppl	periplakin	NM_008909	-1.61745
Lta4h	leukotriene A4 hydrolase	NM_008517	-1.61696
Lpcat2	lysophosphatidylcholine acyltransferase 2	NM_173014	-1.61627
Tmem108	transmembrane protein 108	NM_178638	-1.61446
Ttc22	tetratricopeptide repeat domain 22	NM_177667	-1.6136
Fmod	fibromodulin	NM_021355	-1.6126
Sat1	spermidine/spermine N1-acetyl transferase 1	NM_009121	-1.61253
Lipk	lipase, family member K	NM_172837	-1.61147
Shc3	src homology 2 domain-containing transforming protein C3	NM_009167	-1.60699
Ahr	aryl-hydrocarbon receptor	NM_013464	-1.60638
Gucy1a3	guanylate cyclase 1, soluble, alpha 3	NM_021896	-1.60579
Dsg3	desmoglein 3	NM_030596	-1.6046
Tdrkh	tudor and KH domain containing protein	NM_028307	-1.60207

Tacstd2	tumor-associated calcium signal transducer 2	NM_020047	-1.60099
Tec	tec protein tyrosine kinase	NM_001113460	-1.60042
Scly	selenocysteine lyase	NM_016717	-1.59996
Mc1r	melanocortin 1 receptor	NM_008559	-1.59962
Gpr87	G protein-coupled receptor 87	NM_032399	-1.59921
Klhl30	kelch-like 30 (Drosophila)	NM_027551	-1.59911
Dact1	dapper homolog 1, antagonist of beta-catenin (xenopus)	NM_021532	-1.59768
Grhl1	grainyhead-like 1 (Drosophila)	NM_001161406	-1.59755
Thrb	thyroid hormone receptor beta	NM_009380	-1.59645
Ehd4	EH-domain containing 4	NM_133838	-1.5963
Klf3	Kruppel-like factor 3 (basic)	NM_008453	-1.5948
Col8a1	collagen, type VIII, alpha 1	NM_007739	-1.5946
Hoxc13	homeobox C13	NM_010464	-1.59267
Aqp3	aquaporin 3	NM_016689	-1.59194
Irak4	interleukin-1 receptor-associated kinase 4	NM_029926	-1.59068
Gm106	predicted gene 106	NM_001033288	-1.58707
Cbs	cystathionine beta-synthase	NM_144855	-1.58694
Dock10	dedicator of cytokinesis 10	NM_175291	-1.58613
I730030J21Rik	RIKEN cDNA I730030J21 gene	ENSMUST0000008925 2	-1.58459
Rnf128	ring finger protein 128	NM_023270	-1.58383
Mlph	melanophilin	NM_053015	-1.58285
Tacc1	transforming, acidic coiled-coil containing protein 1	NM_177089	-1.58058
Sult2b1	sulfotransferase family, cytosolic, 2B, member 1	NM_017465	-1.57843
Mrps21	mitochondrial ribosomal protein S21	NM_078479	-1.57721
Il1f5	interleukin 1 family, member 5 (delta)	NM_001146087	-1.57106
Pip5k1b	phosphatidylinositol-4-phosphate 5-kinase, type 1 beta	NM_008846	-1.5667
Cd63	CD63 antigen	NM_001042580	-1.56621
Egfl6	EGF-like-domain, multiple 6	NM_019397	-1.56356
Dnase1l3	deoxyribonuclease 1-like 3	NM_007870	-1.56243
Itm2a	integral membrane protein 2A	NM_008409	-1.56183
Susd2	sushi domain containing 2	NM_027890	-1.55929
D7Ertd443e	DNA segment, Chr 7, ERATO Doi 443, expressed	GQ499374	-1.55884
Maob	monoamine oxidase B	NM_172778	-1.5574
Cldn1	claudin 1	NM_016674	-1.55157
Nid1	nidogen 1	NM_010917	-1.5506
5430435G22Rik	RIKEN cDNA 5430435G22 gene	NM_145509	-1.55016
Nceh1	arylacetamide deacetylase-like 1	NM_178772	-1.5486
Eef2k	eukaryotic elongation factor-2 kinase	NM_007908	-1.54467
Ostf1	osteoclast stimulating factor 1	NM_017375	-1.54424

Serpinb3d	serine (or cysteine) peptidase inhibitor, clade B (ovalbumin) member 3	NM_201376	-1.54375
Trim71	tripartite motif-containing 71	NM_001042503	-1.54353
Lgals12	lectin, galactose binding, soluble 12	NM_019516	-1.5435
D030046N08Rik	RIKEN cDNA D030046N08 gene	AK141732	-1.54326
Cds1	CDP-diacylglycerol synthase 1	NM_173370	-1.54218
Lactb2	lactamase, beta 2	NM_145381	-1.5418
Runx3	runt related transcription factor 3	NM_019732	-1.54153
Abhd14b	abhydrolase domain containing 14b	NM_029631	-1.54123
Tinagl1	tubulointerstitial nephritis antigen-like 1	NM_023476	-1.53826
Aldh3b2	aldehyde dehydrogenase 3 family, member B2	NM_001177438	-1.53793
Sgpp1	sphingosine-1-phosphate phosphatase 1	NM_030750	-1.53666
Ndrp2	N-myc downstream regulated gene 2	NM_013864	-1.5341
Fam178b	family with sequence similarity 178, member B	NM_201365	-1.53347
9530008L14Rik	RIKEN cDNA 9530008L14 gene	NM_175417	-1.53333
Depdc6	DEP domain containing 6	NM_001037937	-1.53249
Elavl4	ELAV (embryonic lethal, abnormal vision, Drosophila)-like 4	NM_010488	-1.53164
Kcnk6	potassium inwardly-rectifying channel, subfamily K, member 6	NM_001033525	-1.53139
Trpc1	transient receptor potential cation channel, subfamily C, member 1	NM_011643	-1.53134
Pdzk1ip1	PDZK1 interacting protein 1	NM_001164557	-1.52907
Tubb3	tubulin, beta 3	NM_023279	-1.5283
Paqr5	progesterin and adipoQ receptor family member V	NM_028748	-1.52822
Vegfc	vascular endothelial growth factor C	NM_009506	-1.52594
Myc	myelocytomatosis oncogene	NM_010849	-1.52588
Trim2	tripartite motif-containing 2	NM_030706	-1.52511
Trpm1	transient receptor potential cation channel, subfamily M, member 1	NM_001039104	-1.52394
Gstm6	glutathione S-transferase, mu 6	NM_008184	-1.52352
Gsdmc	gasdermin C	NM_031378	-1.52268
Rapgef1	Rap guanine nucleotide exchange factor (GEF)-like 1	NM_001080925	-1.52242
Tmem184a	transmembrane protein 184a	NM_001161548	-1.52236
Car6	carbonic anhydrase 6	NM_009802	-1.52167
Krt15	keratin 15	NM_008469	-1.51893
Dsc2	desmocollin 2	NM_013505	-1.51662
Tcn2	transcobalamin 2	NM_015749	-1.51643
Gstp2	glutathione S-transferase, pi 2	NM_181796	-1.51642
Lce6a	late cornified envelope 6A	NM_001166172	-1.51564
Vcan	versican	NM_001081249	-1.5153

Ahnak2	AHNAK nucleoprotein 2	BC138468	-1.51427
Retsat	retinol saturase all trans retinol 13,14 reductase	NM_026159	-1.51347
Rapgef4	Rap guanine nucleotide exchange factor (GEF) 4	NM_019688	-1.51327
Gltp	glycolipid transfer protein	NM_019821	-1.51324
Mcam	melanoma cell adhesion molecule	NM_023061	-1.51124
Sdr42e1	short chain dehydrogenase/reductase family 42E, member 1	NM_028725	-1.51123
Mmp16	matrix metalloproteinase 16	NM_019724	-1.51108
Sec11c	SEC11 homolog C ( <i>S. cerevisiae</i> )	NM_025468	-1.51074
Ltbr	lymphotoxin B receptor	NM_010736	-1.50968
Sptlc3	serine palmitoyltransferase, long chain base subunit 3	NM_175467	-1.50781
Thbd	thrombomodulin	NM_009378	-1.50665
Il17rc	interleukin 17 receptor C	NM_134159	-1.50461
Prrg4	proline rich Gla (G-carboxyglutamic acid) 4 (transmembrane)	NM_178695	-1.50406
2210411K11Rik	RIKEN cDNA 2210411K11 gene	NM_029384	-1.50405
Il1rap	interleukin 1 receptor accessory protein	NM_008364	-1.50257
Maoa	monoamine oxidase A	NM_173740	-1.50129
Notch3	Notch gene homolog 3 ( <i>Drosophila</i> )	NM_008716	-1.50126
Lmo4	LIM domain only 4	NM_010723	-1.5007



**Supplementary Table S2.** Representative lists of differentially regulated genes in the **epidermis** of  $\Delta N$  embryos when compared to controls at E14.5 (**a**, downregulated and **b**, upregulated in  $\Delta N$  embryos vs. controls). Only mRNAs differentially up- or down-regulated  $\geq 1.5x$  are listed.

### Differentially expressed genes in $\Delta N$ embryos at E14.5

#### a) Downregulated in $\Delta N$ embryos:

Genes symbol	Description	Ref_Seq	Fold change
Frem1	Fras1 related extracellular matrix protein 1	NM_177863	5.3297
Tnc	tenascin C	NM_011607	4.18183
Cd74	CD74 Antigen	NM_001042605	3.83445
Prnd	prion protein dublet	NM_023043	3.69287
Socs2	suppressor of cytokine signaling 2	NM_007706	3.64399
Dkk4	dickkopf homolog 4 ( <i>Xenopus laevis</i> )	NM_145592	3.59292
Pla2g7	phospholipase A2, group VII (platelet-activating factor acetylhydrolase, plasma)	NM_013737	3.51707
Slc14a1	solute carrier family 14 (urea transporter), member 1	NM_001171010	3.42343
Ly6g6c	lymphocyte antigen 6 complex, locus G6C	NM_023463	3.03654
Foxi3	forkhead box I3	NM_001101464	2.90417
Serpnb3a	serine (or cysteine) peptidase inhibitor, clade B (ovalbumin) member 3	NM_009126	2.85518
Susd2	sushi domain containing 2	NM_027890	2.82966
Ptch1	patched homolog 1	NM_008957	2.82694
BC100530	cDNA sequence BC100530	NM_001082546	2.80312
Wif1	Wnt inhibitory factor 1	NM_011915	2.77261
Clca2	chloride channel calcium activated 2	NM_030601	2.69697
Nrp2	neuropilin 2	NM_001077403	2.64097
Necab1	N-terminal EF-hand calcium binding protein 1	NM_178617	2.63714
Lypd5	Ly6/Plaur domain containing 5	NM_029806	2.54125
Gli1	GLI-Kruppel family member GLI1	NM_010296	2.49257
Trps1	trichorhinophalangeal syndrome I (human)	NM_032000	2.47674
Dusp6	dual specificity phosphatase 6	NM_026268	2.46991
Il2rg	interleukin 2 receptor, gamma chain	NM_013563	2.4657
Tspan18	tetraspanin 18	NM_183180	2.4343
Serpnb2	serine (or cysteine) peptidase inhibitor, clade B, memebr 2	NM_001174170	2.39753
Tnf	tumor necrosis factor	NM_013693	2.38059
Acer1	alkaline ceramidase 1	NM_175731	2.37223

Adamts3	a disintegrin-like and metallopeptidase with thrombospondin motifs 3	NM_177872	2.21406
C1s	complement component 1, s subcomponent	NM_144938	2.21217
Rragd	Ras-related GTP binding D	NM_027491	2.20995
Ltb	lymphotoxin B	NM_008518	2.20462
Tprg	transformation related protein 63 regulated	NM_175165	2.17802
Sprr1b	small proline-rich protein 1B	NM_009265	2.16581
Stfa1	stefin A1	NM_001082543	2.16379
2610528A11Rik	RIKEN cDNA 2610528A11 gene	BC049685	2.13002
Sdr9c7	4short chain dehydrogenase/reductase family 9C, member 7	NM_027301	2.12331
Ptch2	patched homolog 2	NM_008958	2.11929
Ncam1	neural cell adhesion molecule 1	NM_001081445	2.11752
Sostdc1	sclerostin domain containing 1	NM_025312	2.10836
Krt77	keratin 77	NM_001003667	2.0926
Prss35	protease, serine, 35	NM_178738	2.05754
Srgap1	SLIT-ROBO Rho GTPase activating protein 1	NM_001081037	2.04739
Fndc1	fibronectin type III domain containing 1	NM_001081416	2.01216
D19Ertd652e	DNA segment, Chr 19, ERATO Doi 652, expressed	BC107403	1.98524
4833423E24Rik	RIKEN cDNA 4833423E24 gene	NM_001081664	1.98148
Aox4	aldehyde oxidase 4	NM_023631	1.97771
Tnfaip3	tumor necrosis factor, alpha-induced protein 3	NM_009397	1.94167
Galnt6	UDP-N-acetyl-alpha-D-galactosamine: polypeptide N-acetylgalactosaminyltransferase 6	NM_001161767	1.91422
2210023G05Rik	RIKEN cDNA 2210023G05 gene	NM_197999	1.90753
Fgd5	FYVE, RhoGEF and PH domain containing 5	NM_172731	1.90493
Eif4e3	eukaryotic translation initiation factor 4E member 3	NM_025829	1.89894
Cyfip2	cytoplasmic FMR1 interacting protein 2	NM_133769	1.89842
Ifitm1	interferon induced transmembrane protein 1	NM_026820	1.89673
Cntnap1	contactin associated protein-like 1	NM_016782	1.89603
Egln3	EGL nine homolog 3 (C. elegans)	NM_028133	1.88526
Bcar3	breast cancer anti-estrogen resistance 3	NM_013867	1.86971
Shh	sonic hedgehog	NM_009170	1.86585
Madcam1	mucosal vascular addressin cell adhesion molecule 1	NM_013591	1.86208
Mical2	microtubule associated monooxygenase, calponin and LIM domain containing 2	NM_177282	1.84081
Vldlr	very low density lipoprotein receptor	NM_013703	1.83891

Robo2	roundabout homolog 2 (Drosophila)	NM_175549	1.83432
Cyp17a1	cytochrome P450, family 17, subfamily a, polypeptide 1	NM_007809	1.83325
Lor	loricrin	NM_008508	1.83189
Stfa3	stefin A3	NM_025288	1.82883
Serpinb3b	serine (or cysteine) peptidase inhibitor, clade B (ovalbumin) member 3	NM_198680	1.82336
Clca1	chloride channel calcium activated 1	NM_009899	1.82303
Cnfn	cornifelin	NM_028219	1.81784
Serpinb3c	serine (or cysteine) peptidase inhibitor, clade B (ovalbumin) member 3	NM_201363	1.80208
Sdr16c5	short chain dehydrogenase/reductase family 16C, member 5	NM_181989	1.79991
Etv4	ets variant gene 4 (E1A enhancer binding protein, E1AF)	NM_008815	1.79859
Chl1	cell adhesion molecule with homology to L1CAM	NM_007697	1.78983
Mmp9	matrix metallopeptidase 9	NM_013599	1.78771
Moxd1	monooxygenase, DBH-like 1	NM_021509	1.78575
Etv5	ets variant gene 5	NM_023794	1.77897
1600029D21Rik	RIKEN cDNA 1600029D21 gene	NM_029639	1.7675
Alox12b	arachidonate 12-lipoxygenase, 12R type	NM_009659	1.7653
Tmem45a	transmembrane protein 45a	NM_019631	1.76028
Bcl3	B-cell leukemia/lymphoma 3	NM_033601	1.75433
Rgs5	regulator of G-protein signaling 5	NM_009063	1.72895
Astl	astacin-like metalloendopeptidase (M12 family)	NM_172539	1.72024
Lgals3	lectin, galactose binding, soluble 3	NM_001145953	1.71812
Ndufa4l2	NADH dehydrogenase (ubiquinone) 1 alpha subcomplex, 4-like 2	NM_001098789	1.71246
Prokr2	prokineticin receptor 2	NM_144944	1.7097
Csf1	colony stimulating factor 1 (macrophage)	NM_007778	1.70757
Mttr10	myotubularin related protein 10	NM_172742	1.68499
Relb	avian reticuloendotheliosis viral (v-rel) oncogene related homolog B	NM_009046	1.68204
Ifitm3	interferon induced transmembrane protein 3	NM_025378	1.67277
Npl	N-acetylneuraminic acid pyruvate lyase	NM_028749	1.67257
Ephx3	epoxide hydrolase 3	NM_001033163	1.67166
Tmem176a	transmembrane protein 176A	NM_025326	1.66412
Nrp1	neuropilin 1	NM_008737	1.6554
B2m	beta-2 microglobulin	NM_009735	1.65432
Aadacl2	arylacetamide deacetylase-like 2	NM_001128091	1.65394

Serpinb5	serine (or cysteine) peptidase inhibitor, clade B, member 5	NM_009257	1.65227
Serpinb6b	serine (or cysteine) peptidase inhibitor, clade B, member 6	NM_011454	1.6513
Me1	malic enzyme 1, NADP(+)-dependent, cytosolic	NM_008615	1.6483
Adamts15	a disintegrin-like and metallopeptidase with thrombospondin motifs 15	NM_001024139	1.64688
Sbsn	suprabasin	NM_172205	1.64486
Alox12e	arachidonate lipoxygenase, epidermal	NM_145684	1.64479
Tgfb1	transforming growth factor, beta 1	NM_011577	1.64403
Mest	mesoderm specific transcript	NM_008590	1.64183
Setbp1	SET binding protein 1	NM_053099	1.62694
Steap4	STEAP family member 4	NM_054098	1.62451
Serpinb3d	serine (or cysteine) peptidase inhibitor, clade B (ovalbumin) member 3	NM_201376	1.62108
Tmem176b	transmembrane protein 176B	NM_023056	1.6186
Ikbke	inhibitor of kappaB kinase epsilon	NM_019777	1.61781
Elovl7	ELOVL family member 7, elongation of long chain fatty acids	NM_029001	1.61718
Ankrd35	ankyrin repeat domain 35	NM_001081139	1.6135
Cxcl11	chemokine (C-X-C motif) ligand 11	NM_019494	1.60827
Ptges	prostaglandin E synthase	NM_022415	1.60778
Osmr	oncostatin M receptor	NM_011019	1.6042
Calml3	calmodulin-like 3	NM_027416	1.6038
Pthlh	parathyroid hormone-like peptide	NM_008970	1.60116
Lipm	lipase, family member M	NM_023903	1.60038
Orm1	orosomuroid 1	NM_008768	1.59549
Kcnp3	Kv channel interacting protein 3, calsenilin	NM_019789	1.58749
Phyhip	phytanoyl-CoA hydroxylase interacting protein	NM_145981	1.57769
Trim25	tripartite motif-containing 25	NM_009546	1.57537
Serpinb12	serine (or cysteine) peptidase inhibitor, clade B (ovalbumin) member 12	NM_027971	1.57423
Adra2b	adrenergic receptor, alpha 2b	NM_009633	1.57349
Pla2g2f	phospholipase A2, group IIF	NM_012045	1.56977
Mapk4	mitogen-activated protein kinase 4	NM_172632	1.56745
Them5	thioesterase superfamily member 5	NM_025416	1.56526
Glul	glutamate-ammonia ligase (glutamine synthetase)	NM_008131	1.56162
Cspg4	chondroitin sulfate proteoglycan 4	NM_139001	1.55824
Rasgrp1	RAS guanyl releasing protein 1	NM_011246	1.55786
F3	coagulation factor III	NM_010171	1.55233

Ttc39b	tetratricopeptide repeat domain 39B	NM_027238	1.54678
Stard5	StAR-related lipid transfer (START) domain containing 5	NM_023377	1.54597
Gsdmc	gasdermin C	NM_031378	1.54584
Trex2	three prime repair exonuclease 2	NM_011907	1.54408
Clca5	chloride channel calcium activated 5	NM_178697	1.54023
Arhgef3	Rho guanine nucleotide exchange factor (GEF) 3	NM_027871	1.53812
Rdh12	retinol dehydrogenase 12	NM_030017	1.53806
Dapl1	death associated protein-like 1	NM_029723	1.53781
Serpinb7	serine (or cysteine) peptidase inhibitor, clade B, member 7	NM_027548	1.53095
Parp12	poly (ADP-ribose) polymerase family, member 12	NM_172893	1.52898
Figf	c-fos induced growth factor	NM_010216	1.52603
Bnip3	BCL2/adenovirus E1B interacting protein 3	NM_009760	1.5244
Pdzk1ip1	PDZK1 interacting protein 1	NM_001164557	1.52419
Myb	myeloblastosis oncogene	NM_010848	1.52289
Lhx2	LIM homeobox protein 2	NM_010710	1.52144
Zdhhc2	zinc finger, DHHC domain containing 2	NM_178395	1.51928
Stra6	stimulated by retinoic acid gene 6	NM_009291	1.51604
Gsta1	glutathione S-transferase, alpha 1 (Ya)	NM_008181	1.5139
Acta2	actin, alpha 2, smooth muscle, aorta	NM_007392	1.51301
Car13	carbonic anhydrase 13	NM_024495	1.51048
Krt16	keratin 16	NM_008470	1.50953
Acsl1	acyl-CoA synthetase long-chain family member 1	NM_007981	1.50813
Gpm6b	glycoprotein m6b	NM_001177956	1.50714
Cxcl9	chemokine (C-X-C motif) ligand 9	NM_008599	1.5062
Tnip1	TNFAIP3 interacting protein 1	NM_021327	1.50449
Itpkb	inositol 1,4,5-trisphosphate 3-kinase B	NM_001081175	1.50267
Ptgs1	prostaglandin-endoperoxide synthase 1	NM_008969	1.50105
Sox9	SRY-box containing gene 9	NM_011448	1.50071
Acsl4	acyl-CoA synthetase long-chain family member 4	NM_207625	1.50053
Cald1	caldesmon 1	NM_145575	1.50041

**b) Upregulated in  $\Delta N$  embryos:**

Genes symbol	gene_assignment	Ref seq	Fold change
Gm10304	predicted gene 10304	ENSMUST0000094945	-3.26077

Mybpc1	myosin binding protein C, slow-type	NM_175418	-3.25459
Gm9911	predicted gene 9911	AK035883	-2.6811
Pcsk2	proprotein convertase subtilisin/kexin type 2	NM_008792	-2.5787
Igfbp3	insulin-like growth factor binding protein 3	NM_008343	-2.25564
Pisd-ps2	phosphatidylserine decarboxylase, pseudogene 2	NR_003519	-2.21286
St6galnac2	ST6 (Alpha-N-Acetyl-Neuraminyl-2,3-Beta-Galactosyl-1,3)-N-Acetylgalactosaminide Alpha-2,6-Sialyltransferase 2	NM_009180	-2.20545
Elmo1	engulfment and cell motility 1, ced-12 homolog (C. elegans)	NM_080288	-2.13654
Unc5d	unc-5 homolog D (C. elegans)	NM_153135	-2.13157
Lrrn1	leucine rich repeat protein 1, neuronal	NM_008516	-2.10864
Ano4	anoctamin 4	NM_178773	-2.05626
Jun	Jun oncogene	NM_010591	-2.03491
Kcnh7	potassium voltage-gated channel, subfamily H (eag-related) member 7	NM_133207	-1.98255
Cd68	CD68 antigen	NM_009853	-1.89433
Mir19b-1	microRNA 19b-1	NR_029815	-1.82456
Gria2	glutamate receptor, ionotropic, AMPA2 (alpha 2)	NM_013540	-1.78212
Lix1	limb expression 1 homolog (chicken)	NM_025681	-1.77782
Slc24a3	solute carrier family 24 (sodium/potassium/calcium exchanger) member 3	NM_053195	-1.76643
Spo11	sporulation protein, meiosis-specific, SPO11 homolog	NM_012046	-1.74945
Cygb	cytoglobin	NM_030206	-1.74346
Igf1	insulin-like growth factor 1	NM_010512	-1.74324
Npbwr1	neuropeptides B/W receptor 1	NM_010342	-1.73667
Scube1	signal peptide, CUB domain, EGF-like 1	NM_022723	-1.72514
Slc4a4	solute carrier family 4 (anion exchanger), member 4	NM_018760	-1.72296
1700001P01Rik	RIKEN cDNA 1700001P01 gene	NM_028156	-1.68043
Plcx2	phosphatidylinositol-specific phospholipase C, X domain containing 2	NM_001134480	-1.67512
Bmp2	bone morphogenetic protein 2	NM_007553	-1.66547
Lrch2	leucine-rich repeats and calponin homology (CH) domain containing 2	NM_001081173	-1.66022
B230325K18Rik	RIKEN cDNA B230325K18 gene	ENSMUST00000079045	-1.65577
AY512949	cDNA sequence AY512949	AY512949	-1.6508
Thsd7b	thrombospondin, type I, domain containing 7B	NM_172485	-1.64462
Lce6a	late cornified envelope 6A	NM_001166172	-1.63186
Pcdh10	protocadherin 10	NM_001098171	-1.63084



Sprr2a1	small proline-rich protein 2A1	AY158986	-1.61029
Fam38b	family with sequence similarity 38, member B	NM_001039485	-1.6021
Mirlet7c-1	microRNA let7c-1	NR_029728	-1.59206
Cd96	CD96 antigen	NM_032465	-1.58805
Snora75	small nucleolar RNA, H/ACA box 75	NR_028478	-1.56597
Pcdh17	protocadherin 17	NM_001013753	-1.56052
Ripply3	rippy3 homolog (zebrafish)	NM_133229	-1.55827
Cdh6	cadherin 6	NM_007666	-1.55706
Dusp1	dual specificity phosphatase 1	NM_013642	-1.55033
Tagln3	transgelin 3	NM_019754	-1.54993
Col19a1	collagen, type XIX, alpha 1	NM_007733	-1.54267
Nkain2	Na <sup>+</sup> /K <sup>+</sup> transporting ATPase interacting 2	NM_001013411	-1.52611
Gm12703	predicted gene 12703	ENSMUST00000064804	-1.526
Baalc	brain and acute leukemia, cytoplasmic	NM_080640	-1.51608
Ica1	islet cell autoantigen 1	NM_010492	-1.51287
Igfbp2	insulin-like growth factor binding protein 2	NM_008342	-1.51232
Snhg1	small nucleolar RNA host gene (non-protein coding) 1	AK051045	-1.51117
Gpx6	glutathione peroxidase 6	NM_145451	-1.51012
Taf1d	TATA box binding protein (Tbp)-associated factor, RNA polymerase I D	AK161656	-1.50123
Adam1a	a disintegrin and metallopeptidase domain 1a	NM_172126	-1.50059

**Supplementary Table S3. Upper table:** Number of NF- $\kappa$ B binding sites and cross-species conservation of all primary hair follicle placode-specific NF- $\kappa$ B target genes that have been analysed by qRT-PCR and ChIP (*Lhx2*, *Sox9*, *Mmp9*, *Trps1*) using an anti-p65 antibody. The right column indicates whether a particular gene was also bound by NF- $\kappa$ B subunits in Hodgkin's lymphoma cell lines (E. Kärigel and C. Scheidereit, unpublished). Previously unknown NF- $\kappa$ B targets are marked in green (see also <http://www.bu.edu/nf-kb/gene-resources/target-genes/>). **Lower table:** Cross-species conservation and number of LHX2 binding sites in NF- $\kappa$ B targets *Nrp2* and *Prokr2*.

Gene symbol	Number of potential NF- $\kappa$ B binding sites - JASPER (> 90%)	Cross species conservation - ECR browser Dcode	ChIP peak of NF- $\kappa$ B subunits in Hodgkin lymphoma
Adamts3	3	Binding sites are conserved in Muroidea	-
Adamts15	6	Binding sites are conserved in Muroidea	-
Ascl4	0	-	-
Bcl3	5	Binding sites are conserved up to Metatheria	Yes
Bmp2	2	Binding sites are conserved in Mammals	-
Cd74	4	Binding sites are conserved up to Metatheria	Yes
Cxcl9	8	Binding sites are conserved in Mammals	-
Cxcl11	7	Binding sites are conserved in Mammals	-
Dkk4	2	-	-
Dusp6	2	Binding sites are conserved in Vertebrata	Yes
Etv4	3	Binding sites are conserved up to Metatheria	Yes
Etv5	1	-	-
Fndc1	17	Binding sites are conserved in Muroidea	-
Foxi3	0	-	-
Frem1	10	Binding sites are conserved in Mammals	-
Galnt6	7	Binding sites are conserved in Mammals	Yes
Gli1	2	Binding sites are conserved in Mammals	Yes
Krt17	5	Binding sites are conserved in Muroidea	-
Lhx2	7	Binding sites are conserved in Mammals	Yes
Ltb	1	Binding site is conserved in Mammals	Yes
Madcam1	3	Binding sites are conserved in Muroidea	Yes
Mical2	18	Binding sites are conserved in Muroidea	Yes
Mmp9	3	Binding sites are conserved in Mammals	Yes
Ncam1	26	Binding sites are conserved in Mammals	Yes
Nrp2	16	Binding sites are conserved in Mammals	Yes
Prokr2	5	Binding sites are conserved in Muroidea	-
Prss35	3	-	-
Ptch1	2	Binding sites are conserved in Mammals	Yes
Ptch2	5	-	-
Pthlh	2	Binding sites are conserved in Mammals	Yes

Robo2	32	Binding sites are conserved in Muroidea	Yes
Scube1	20	Binding sites are conserved in Muroidea	Yes
Shh	4	Binding sites are conserved in Mammals	Yes
Socs2	3	Binding sites are conserved in Mammals	-
Sox9	2	Binding sites are conserved in Mammals	Yes
Sox21	2	Binding sites are conserved in Vertebrata	-
Srgap1	3	Binding sites are conserved in Mammals	Yes
Tgfb1	2	Binding sites are conserved in Muroidea	Yes
Tnc	3	Binding sites are conserved in Mammals	Yes
Tnf	3	Binding sites are conserved in Mammals	Yes
Tnfaip3	9	Binding sites are conserved up to Aves	Yes
Trps1	7	Binding sites are conserved up to Aves	Yes
Tsku	3	-	-
Tspan18	18	Binding sites are conserved in Mammals	Yes
Wif1	3	Binding sites are conserved in Muroidea	-
Wnt2b	1	Binding site is conserved in Mammals	-
<b>Total</b>	<b>44 of 46 ~ 96%</b>		<b>26 of 46 ~ 57%</b>

<b>Gene symbol</b>	<b>Number of potential LHX2 binding sites - JASPER (&gt; 90%)</b>	<b>Cross species conservation - ECR browser Dcode</b>
Nrp2	6	Binding sites are conserved in Muroidea
Prokr2	1	Binding sites are not conserved

**Supplementary Table S4.** List of genes specifically upregulated in the interfollicular epidermis (IFE), but down-regulated by NF- $\kappa$ B in hair follicle placodes at E14.5.

**Genes specifically upregulated in the interfollicular epidermis (IFE) and down-regulated by NF- $\kappa$ B in hair follicle placodes**

<b>Genes symbol</b>	<b>Description</b>	<b>Ref seq</b>	<b>Fold change (WT vs. <math>\Delta N</math>)</b>	<b>Fold change (HF vs IFE)</b>
Pcsk2	proprotein convertase subtilisin/kexin type 2	NM_008792	-2.5787	-2.04744
Igfbp3	insulin-like growth factor binding protein 3	NM_008343	-2.25564	-1.70523
Igf1	insulin-like growth factor 1	NM_010512	-1.74324	-2.19222
Npbwr1	neuropeptides B/W receptor 1	NM_010342	-1.73667	-1.9776
Lce6a	late cornified envelope 6A	NM_001166172	-1.63186	-1.51564
Ica1	islet cell autoantigen 1	NM_010492	-1.51287	-1.69649