FIG. 1

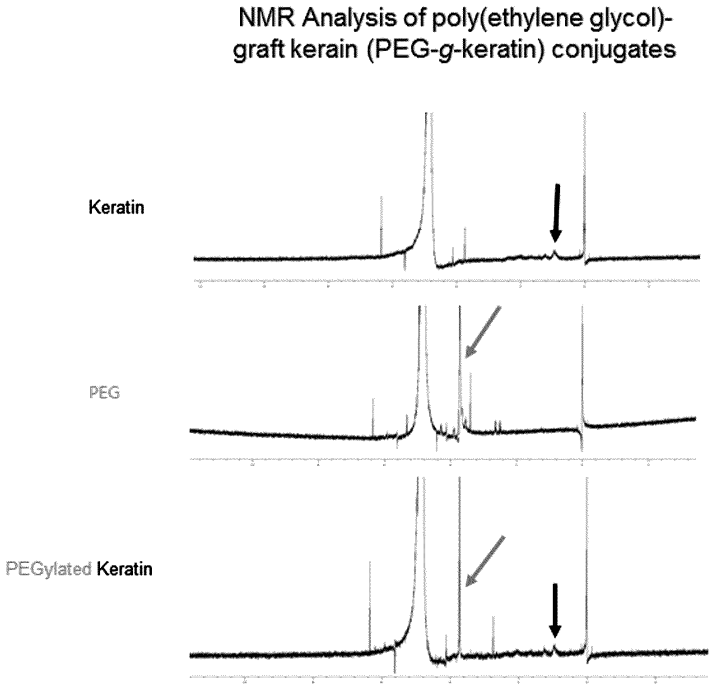

NMR Analysis of poly(ethylene glycol)-graft kerain (PEG-g-keratin) conjugates
Keratin
PEG
PEGylated Keratin

FIG. 2

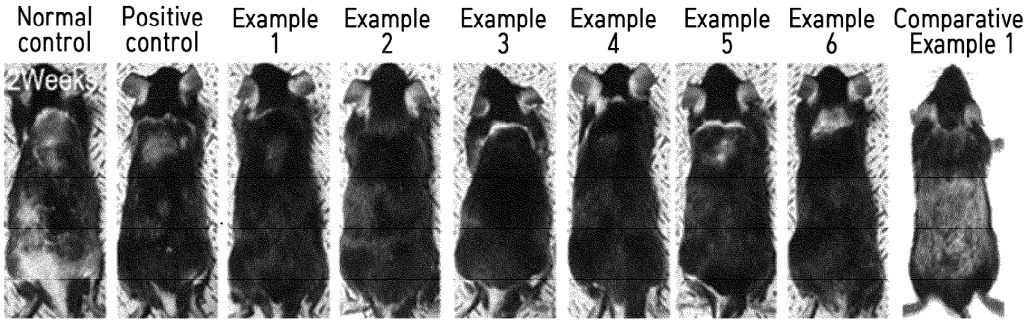

Normal control
Positive control
Example 1
Example 2
Example 3
Example 4
Example 5
Example 6
Comparative Example 1
2Weeks

FIG. 3

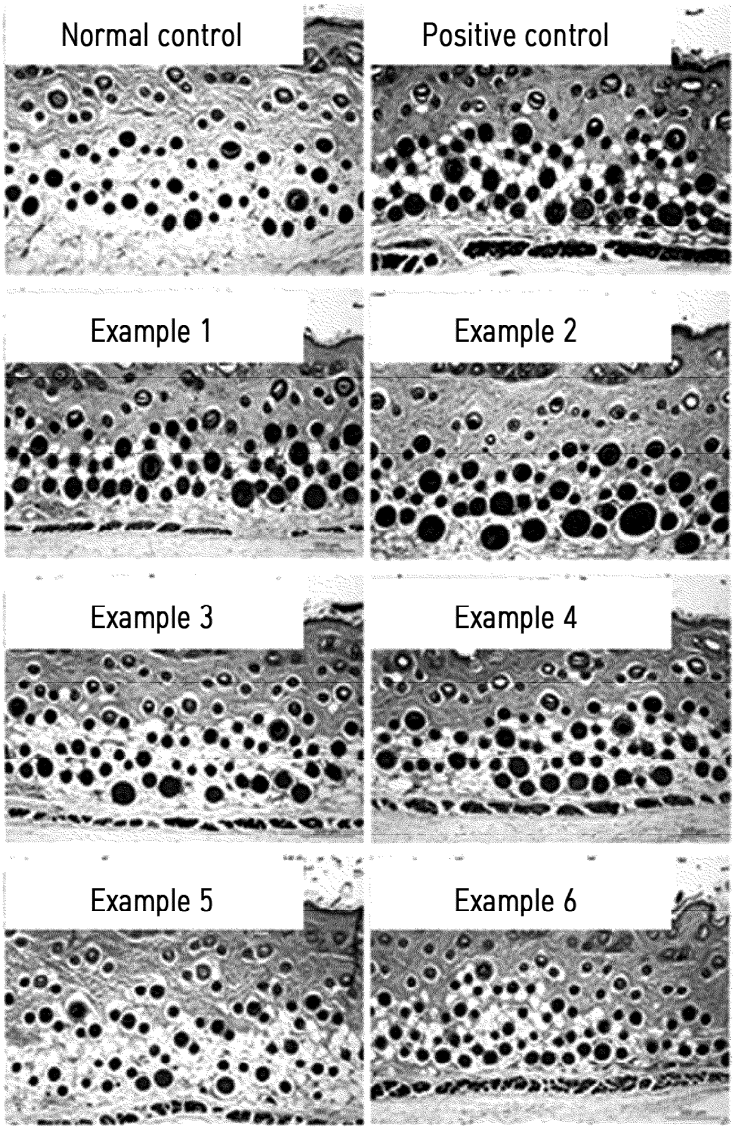

Normal control
Positive control
Example 1
Example 2
Example 3
Example 4
Example 5
Example 6

FIG. 4

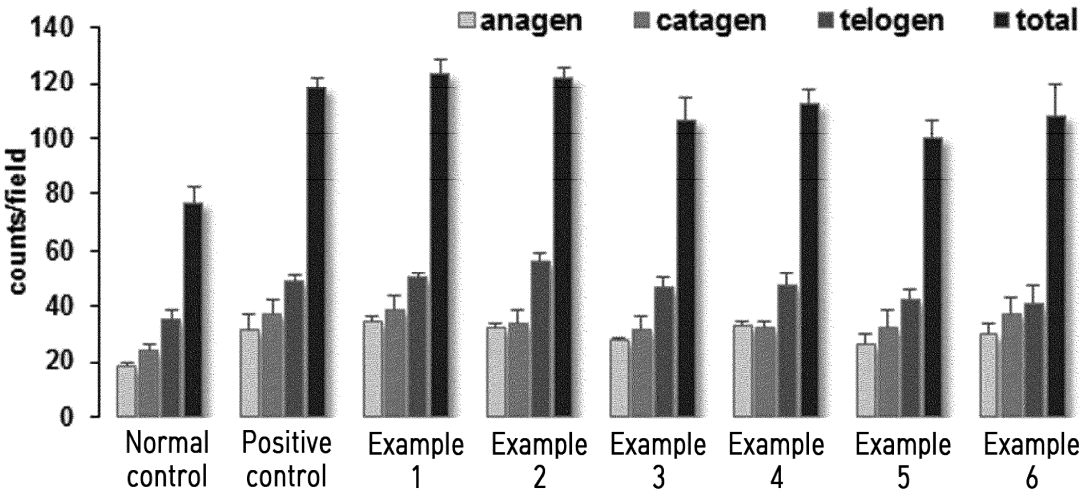

anagen
catagen
telogen
total
counts/field
140
120
100
80
60
40
20
0
Normal control
Positive control
Example 1
Example 2
Example 3
Example 4
Example 5
Example 6

FIG. 5

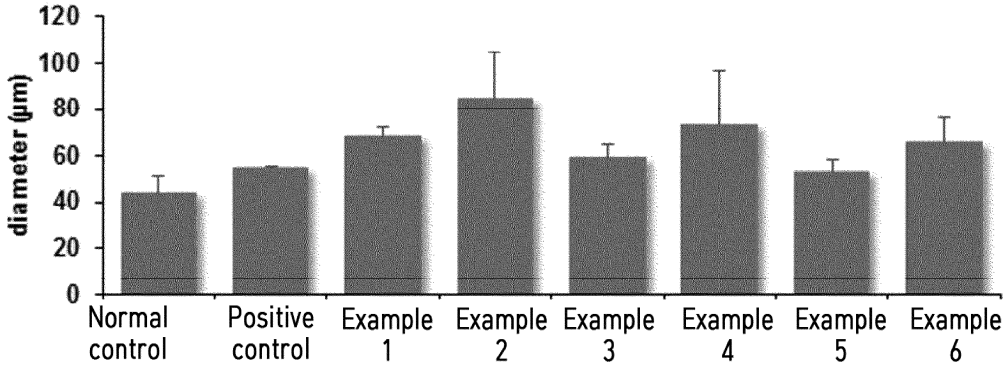

diameter (μm)
120
100
80
60
40
20
0
Normal control
Positive control
Example 1
Example 2
Example 3
Example 4
Example 5
Example 6

FIG. 6

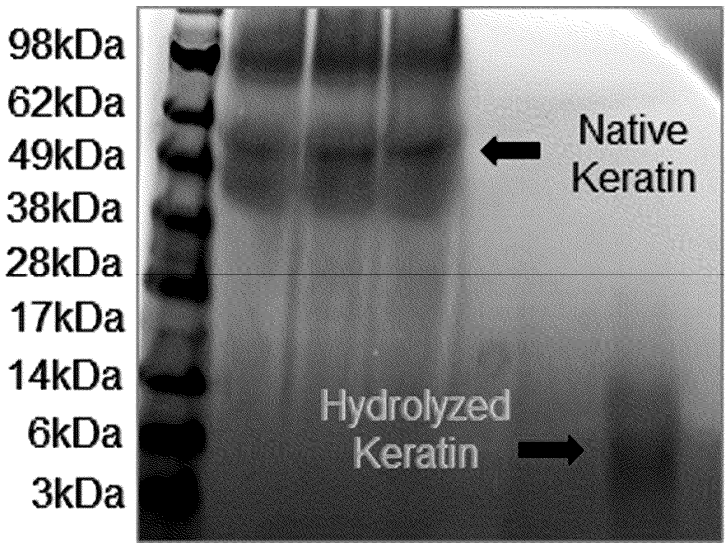

98kDa
62kDa
49kDa
38kDa
28kDa
17kDa
14kDa
6kDa
3kDa
Native Keratin
Hydrolyzed Keratin

FIG. 7

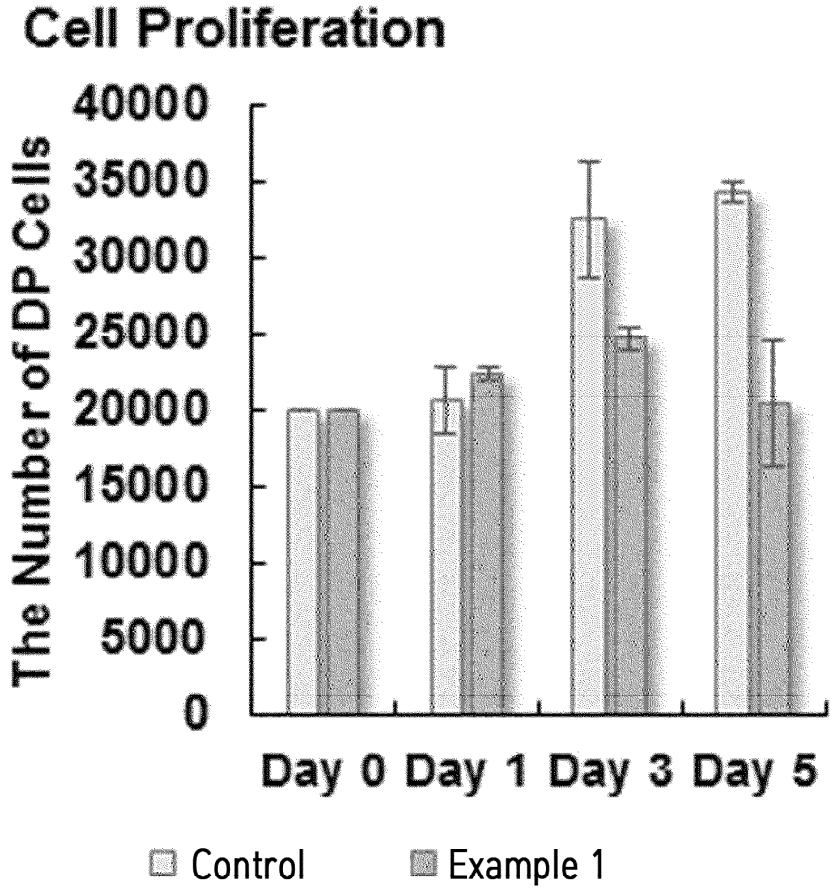

Cell Proliferation
The Number of DP Cells
40000
35000
30000
25000
20000
15000
10000
5000
0
Day 0
Day 1
Day 3
Day 5
Control
Example 1

FIG. 8

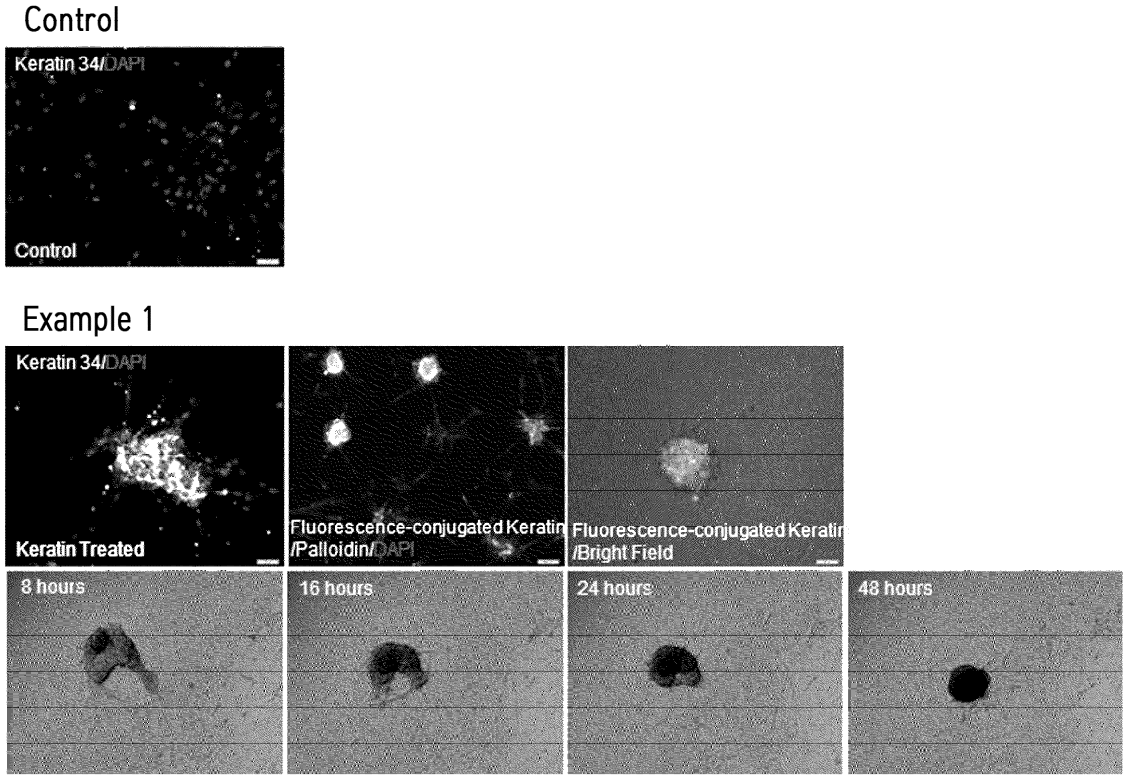

Control
Keratin 34/DAPI
Control
Example 1
Keratin 34/DAPI
Keratin Treated
Fluorescence-conjugated Keratin
/Palloidin/DAPI
Fluorescence-conjugated Keratin
/Bright Field
8 hours
16 hours
24 hours
48 hours

FIG. 9

RNA sequencing analysis

Upregulated Genes showing at least two fold Increase in Keratin Treated DP Cells

Gene name	term
C-C motif chemokine ligand 20(CCL20)	cell-cell signaling
hepatocyte growth factor(HGF)	positive regulation of cell migration
proprotein convertase subtilisin/kexin type 1(PCSK1)	cell-cell signaling
C-X-C motif chemokine ligand 5(CXCL5)	cell-cell signaling
TNF alpha induced protein 6(TNFAIP6)	cell-cell signaling
integrin subunit beta 8(ITGB8)	extracellular matrix organization
C-C motif chemokine ligand 7(CCL7)	cell-cell signaling
nicotinamide phosphoribosyl transferase(NAMPT)	cell-cell signaling
tachykinin precursor 1(TAC1)	cell-cell signaling
fibroblast growth factor 13(FGF13)	cell-cell signaling
C-C motif chemokine ligand 11(CCL11)	positive regulation of cell migration
interleukin 11(IL11)	cell-cell signaling
matrix metallopeptidase 9(MMP9)	Cell migration
C-X-C motif chemokine ligand 6(CXCL6)	cell-cell signaling
gap junction protein beta 2(GJB2)	cell-cell signaling
chondroitin sulfate N-acetylgalactosaminyltransferase 1(CSGALNACT1)	extracellular matrix organization
solute carrier family 7 member 11(SLC7A11)	Cell migration
angiopoietin 1(ANGPT1)	Cell migration
neuromedin B(NMB)	cell-cell signaling
laminin subunit gamma 3(LAMC3)	extracellular matrix organization
cell migration inducing hyaluronan binding protein(CEMIP)	positive regulation of cell migration
integrin subunit beta 3(ITGB3)	extracellular matrix organization
integrin subunit alpha V(ITGAV)	extracellular matrix organization
EGF like domain multiple 6(EGFL6)	extracellular matrix organization
Wnt family member 5A(WNT5A)	positive regulation of cell migration
neuropilin 2(NRP2)	positive regulation of cell migration
platelet derived growth factor D(PDGFD)	positive regulation of cell migration
integrin subunit alpha 2(ITGA2)	extracellular matrix organization
collagen type IV alpha 2 chain(COL4A2)	extracellular matrix organization
SAM and SH3 domain containing 1(SASH1)	positive regulation of cell migration
intercellular adhesion molecule 1(ICAM1)	extracellular matrix organization
copine 3(CPNE3)	positive regulation of cell migration
neuropilin 1(NRP1)	cell-cell signaling
endoplasmic reticulum oxidoreductase 1 beta(ERO1B)	extracellular matrix organization
integrin subunit alpha 8(ITGA8)	extracellular matrix organization
E74 like ETS transcription factor 3(ELF3)	extracellular matrix organization
matrix metallopeptidase 1(MMP1)	Cell migration
laeverin(LVRN)	cell-cell signaling
olfactomedin like 2A(OLFML2A)	extracellular matrix organization
integrin subunit alpha 4(ITGA4)	extracellular matrix organization
lumican(LUM)	extracellular matrix organization
collagen type IV alpha 1 chain(COL4A1)	extracellular matrix organization
C-C motif chemokine ligand 8(CCL8)	cell-cell signaling
WNT1 inducible signaling pathway protein 1(WISP1)	cell-cell signaling
semaphorin 6D(SEMA6D)	positive regulation of cell migration
collagen type IV alpha 4 chain(COL4A4)	extracellular matrix organization
ASH1 like histone lysine methyltransferase(ASH1L)	cell-cell signaling
semaphorin 5A(SEMA5A)	cell-cell signaling
sphingosine-1-phosphate receptor 1(S1PR1)	positive regulation of cell migration
fibroblast growth factor 2(FGF2)	extracellular matrix organization
vascular endothelial growth factor A(VEGFA)	positive regulation of cell migration
laminin subunit alpha 1(LAMA1)	extracellular matrix organization
ABI family member 3 binding protein(ABI3BP)	extracellular matrix organization
platelet derived growth factor receptor alpha(PDGFRA)	positive regulation of cell migration
nidogen 1(NID1)	extracellular matrix organization
ATPase copper transporting alpha(ATP7A)	extracellular matrix organization
nidogen 2(NID2)	extracellular matrix organization
insulin like growth factor 1(IGF1)	positive regulation of cell migration
neurofibromin 1(NF1)	extracellular matrix organization
transforming growth factor beta receptor 1(TGFBR1)	positive regulation of cell migration
TNF receptor superfamily member 11b(TNFRSF11B)	extracellular matrix organization
ADAM metallopeptidase domain 17(ADAM17)	positive regulation of cell migration
nephrocystin 3(NPHP3)	extracellular matrix organization
thrombospondin 1(THBS1)	extracellular matrix organization
integrin subunit beta 2(ITGB2)	extracellular matrix organization

Downregulated Genes showing at least two fold decrease in Keratin Treated DP Cells

Gene name	term
tubulin alpha 1b(TUBA1B)	cell division
cyclin B2(CCNB2)	regulation of cell cycle
tubulin alpha 1a(TUBA1A)	G1/M transition of mitotic cell cycle
TPX2, microtubule nucleation factor(TPX2)	mitotic nuclear division
inhibitor of DNA binding 3, HLH protein(ID3)	regulation of cell cycle
cyclin B1(CCNB1)	regulation of cell cycle
protein kinase, membrane associated tyrosine/threonine 1(PKMYT1)	regulation of cell cycle
forkhead box M1(FOXM1)	regulation of cell cycle
cell division cycle associated 3(CDCA3)	mitotic nuclear division
ubiquitin conjugating enzyme E2 C(UBE2C)	cell division
eukaryotic translation initiation factor 4E binding protein 1(EIF4EBP1)	positive regulation of mitotic cell cycle
aurora kinase B(AURKB)	mitotic nuclear division
SPC24, NDC80 kinetochore complex component(SPC24)	mitotic nuclear division
pituitary tumor-transforming 1(PTTG1)	mitotic nuclear division
asparagine synthetase (glutamine-hydrolyzing)(ASNS)	positive regulation of mitotic cell cycle
baculoviral IAP repeat containing 5(BIRC5)	mitotic nuclear division
polo like kinase 1(PLK1)	regulation of cell cycle
cell division cycle 20(CDC20)	mitotic nuclear division
growth arrest and DNA damage inducible beta(GADD45B)	regulation of cell cycle
TMF1-regulated nuclear protein 1(TRNP1)	regulation of cell cycle
tubulin beta 3 class III(TUBB3)	mitotic nuclear division
MX dynamin like GTPase 2(MX2)	regulation of cell cycle

FIG. 10

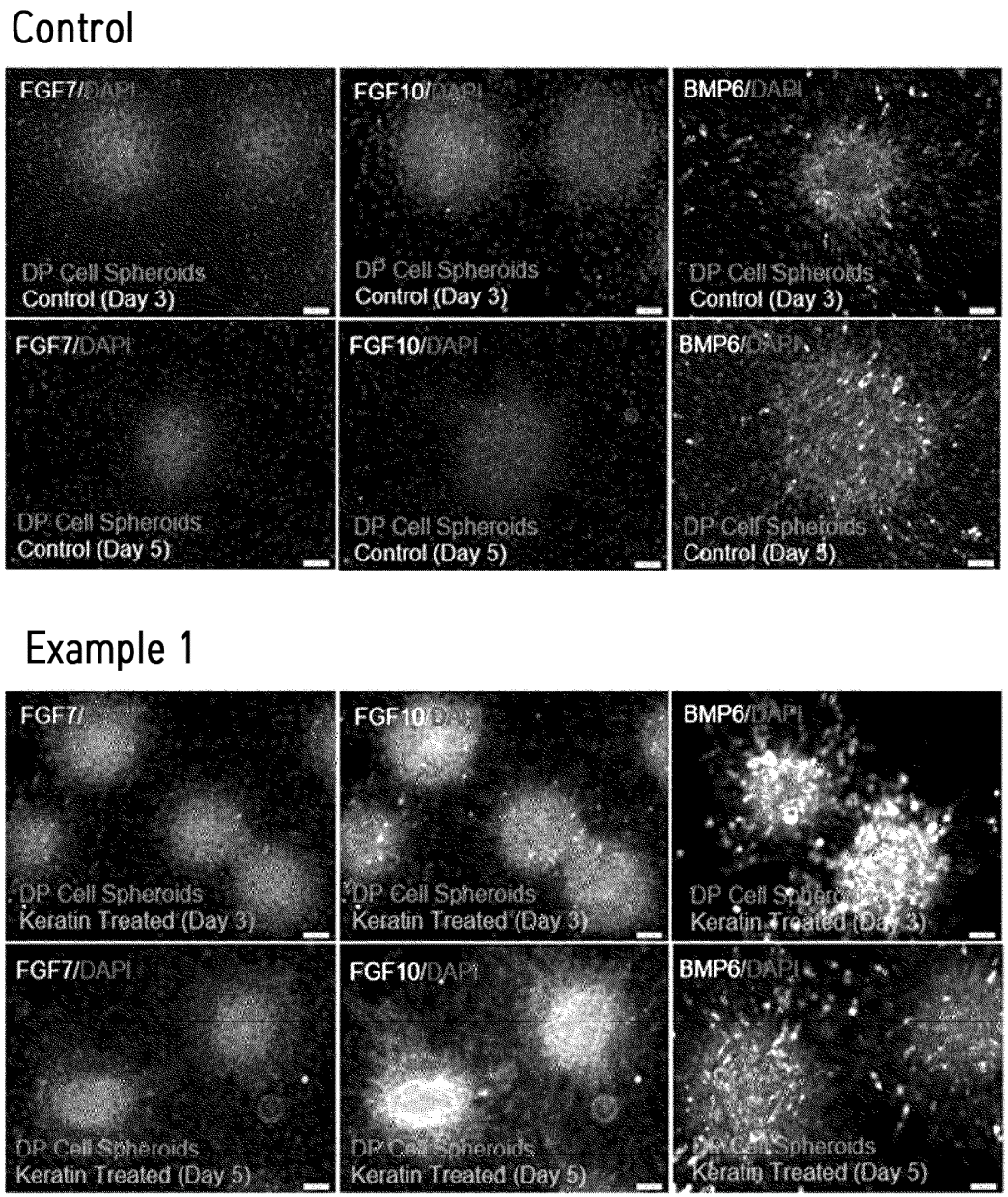

Control
FGF7/DAPI
DP Cell Spheroids
Control (Day 3)
FGF10/DAPI
DP Cell Spheroids
Control (Day 3)
BMP6/DAPI
DP Cell Spheroids
Control (Day 3)
FGF7/DAPI
DP Cell Spheroids
Control (Day 5)
FGF10/DAPI
DP Cell Spheroids
Control (Day 5)
BMP6/DAPI
DP Cell Spheroids
Control (Day 5)
Example 1
FGF7/
DP Cell Spheroids
Keratin Treated (Day 3)
FGF10/DAPI
DP Cell Spheroids
Keratin Treated (Day 3)
BMP6/DAPI
DP Cell Spheroids
Keratin Treated (Day 3)
FGF7/DAPI
DP Cell Spheroids
Keratin Treated (Day 5)
FGF10/DAPI
DP Cell Spheroids
Keratin Treated (Day 5)
BMP6/DAPI
DP Cell Spheroids
Keratin Treated (Day 5)

FIG. 11

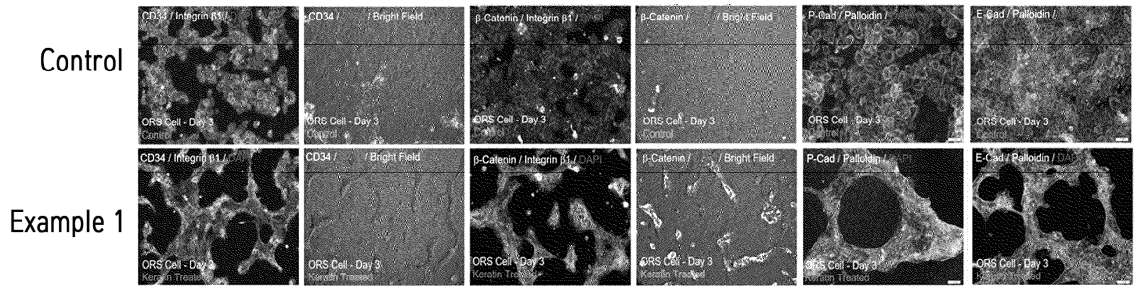

Control
Example 1
CD34 / Integrin β1 /
CD34 / / Bright Field
β-Catenin / Integrin β1 /
β-Catenin / / Bright Field
P-Cad / Palloidin /
E-Cad / Palloidin /
ORS Cell - Day 3
Control
Keratin Treated

FIG. 12

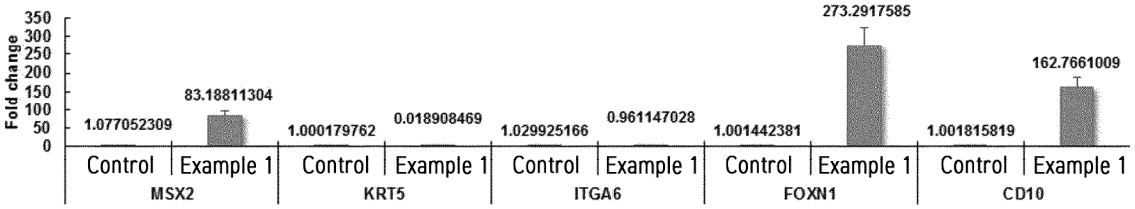

Fold change
350
300
250
200
150
100
50
0
1.077052309
83.18811304
1.000179762
0.018908469
1.029925166
0.961147028
1.001442381
273.2917585
1.001815819
162.7661009
Control
Example 1
MSX2
KRT5
ITGA6
FOXN1
CD10

FIG. 13

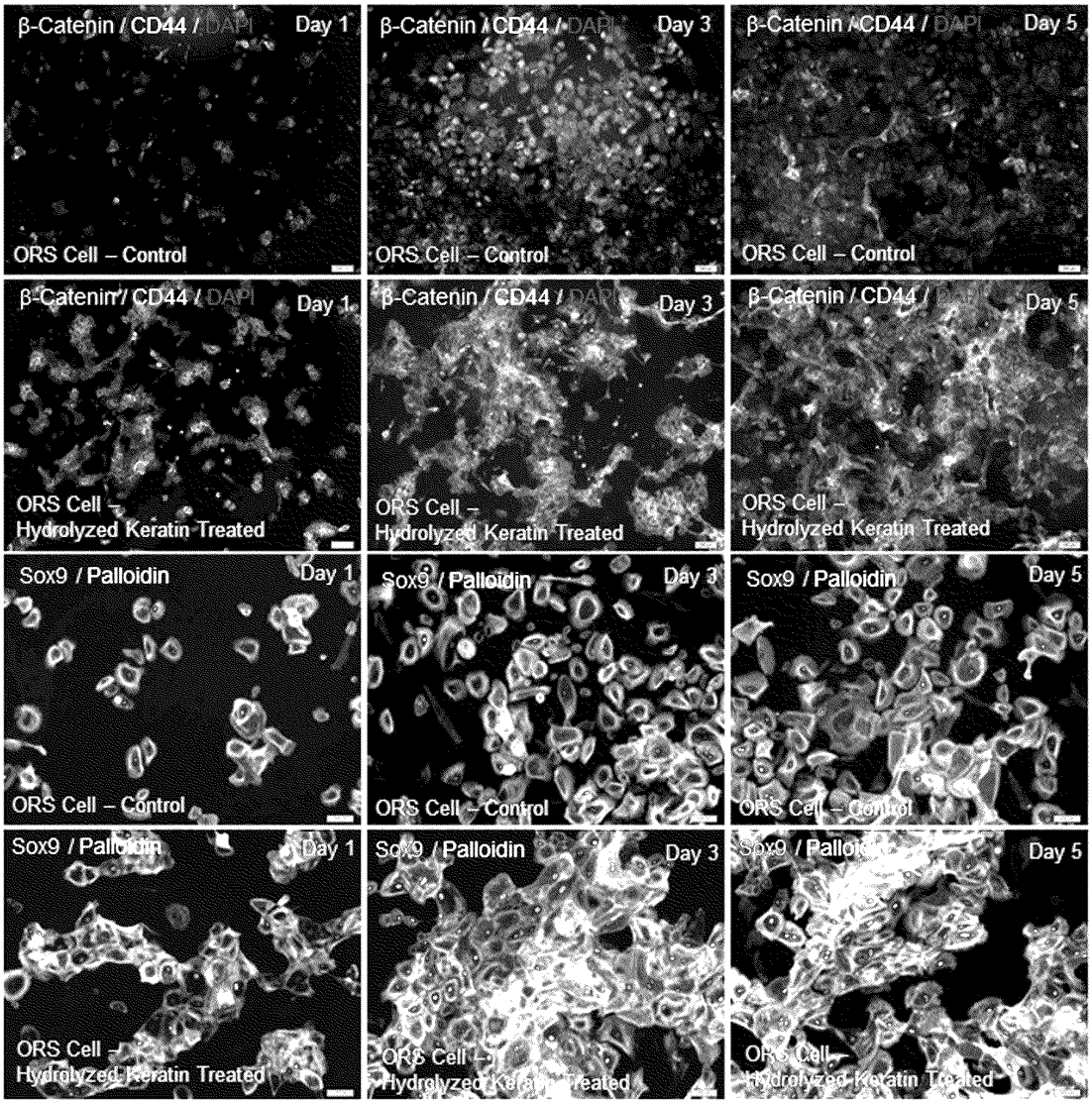

β-Catenin / CD44 / DAPI
Day 1
ORS Cell – Control
β-Catenin / CD44 / DAPI
Day 3
ORS Cell – Control
β-Catenin / CD44 / DAPI
Day 5
ORS Cell – Control
β-Catenin / CD44 / DAPI
Day 1
ORS Cell –
Hydrolyzed Keratin Treated
β-Catenin / CD44 / DAPI
Day 3
ORS Cell –
Hydrolyzed Keratin Treated
β-Catenin / CD44 / DAPI
Day 5
ORS Cell –
Hydrolyzed Keratin Treated
Sox9 / Palloidin
Day 1
ORS Cell – Control
Sox9 / Palloidin
Day 3
ORS Cell – Control
Sox9 / Palloidin
Day 5
ORS Cell – Control
Sox9 / Palloidin
Day 1
ORS Cell –
Hydrolyzed Keratin Treated
Sox9 / Palloidin
Day 3
ORS Cell –
Hydrolyzed Keratin Treated
Sox9 / Palloidin
Day 5
ORS Cell –
Hydrolyzed Keratin Treated

FIG. 14

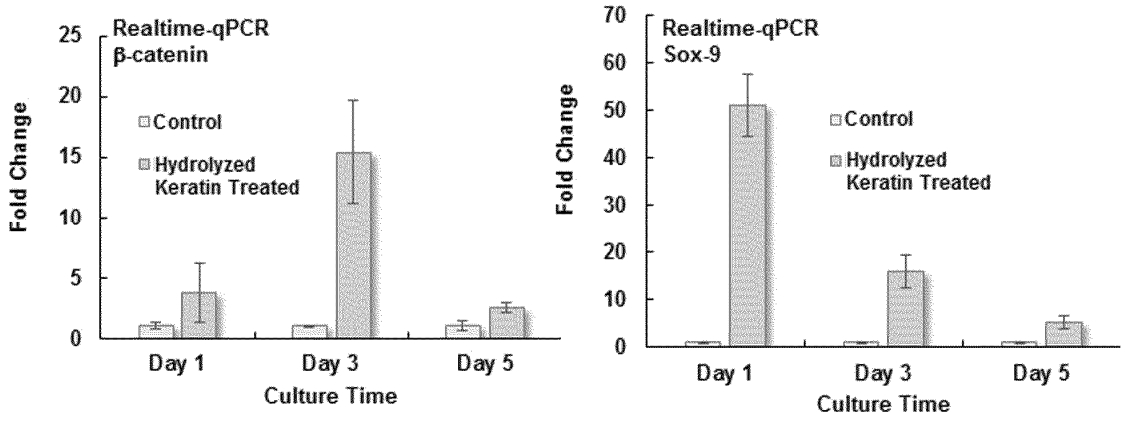

Realtime-qPCR
β-catenin
Fold Change
25
20
15
10
5
0
Control
Hydrolyzed
Keratin Treated
Day 1
Day 3
Day 5
Culture Time
Realtime-qPCR
Sox-9
Fold Change
70
60
50
40
30
20
10
0
Control
Hydrolyzed
Keratin Treated
Day 1
Day 3
Day 5
Culture Time

FIG. 15

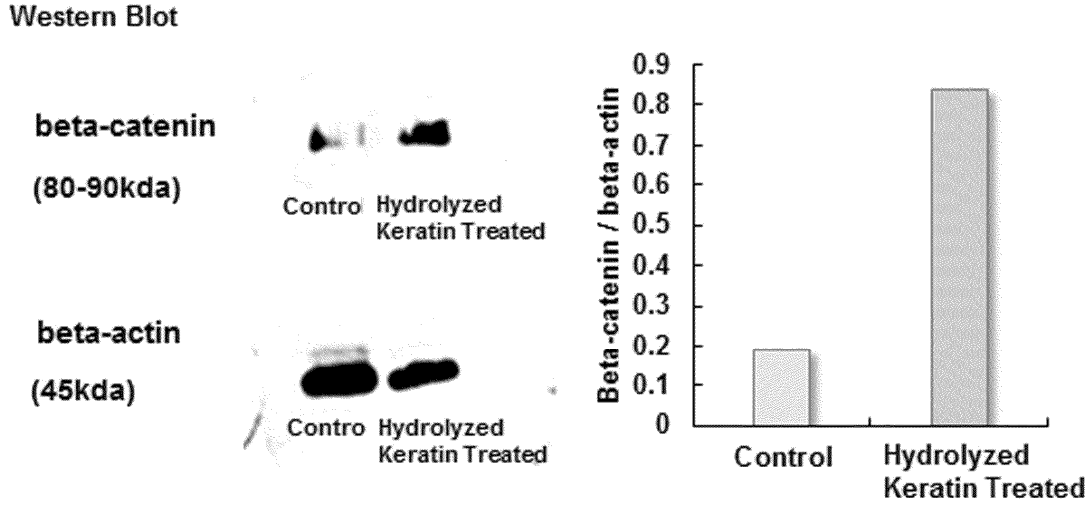

Western Blot
beta-catenin
(80-90kda)
Contro
Hydrolyzed
Keratin Treated
beta-actin
(45kda)
Contro
Hydrolyzed
Keratin Treated
Beta-catenin / beta-actin
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Control
Hydrolyzed
Keratin Treated

FIG. 16

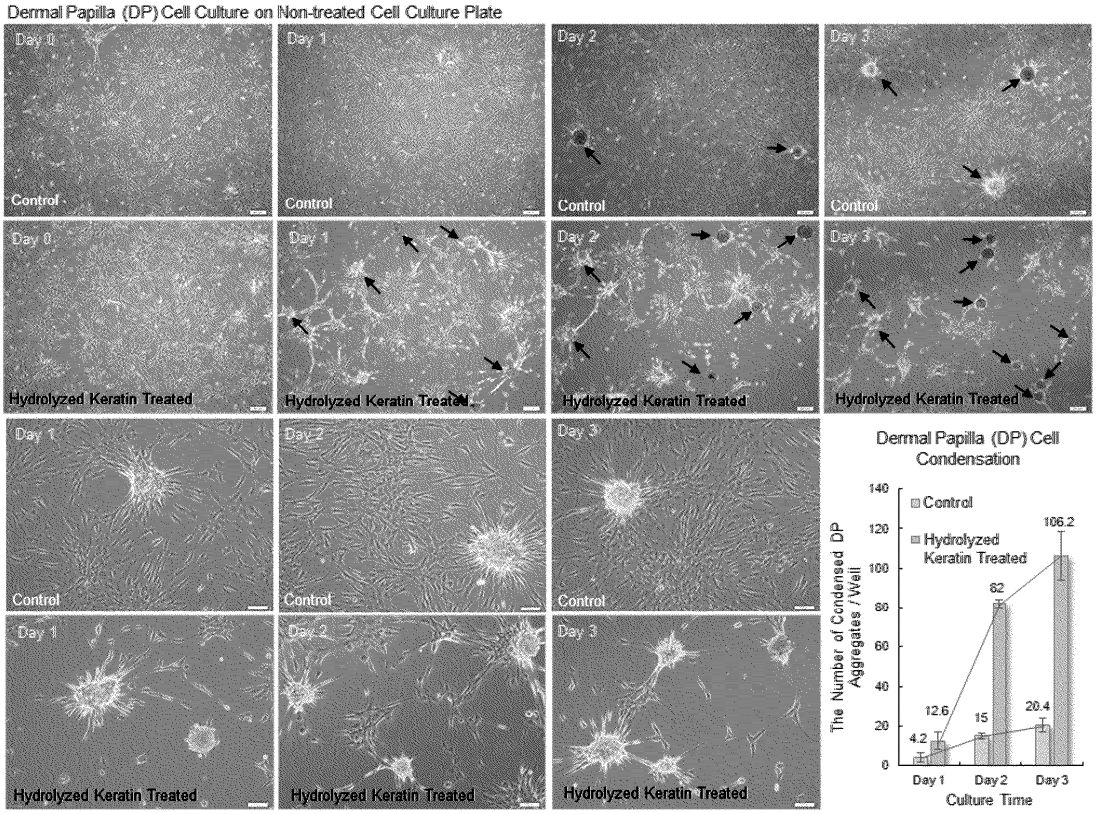

Dermal Papilla (DP) Cell Culture on Non-treated Cell Culture Plate
Day 0
Day 1
Day 2
Day 3
Control
Hydrolyzed Keratin Treated
Dermal Papilla (DP) Cell Condensation
The Number of Condensed DP Aggregates / Well
Control
Hydrolyzed Keratin Treated
4.2
12.6
15
82
20.4
106.2
Day 1
Day 2
Day 3
Culture Time

FIG. 17

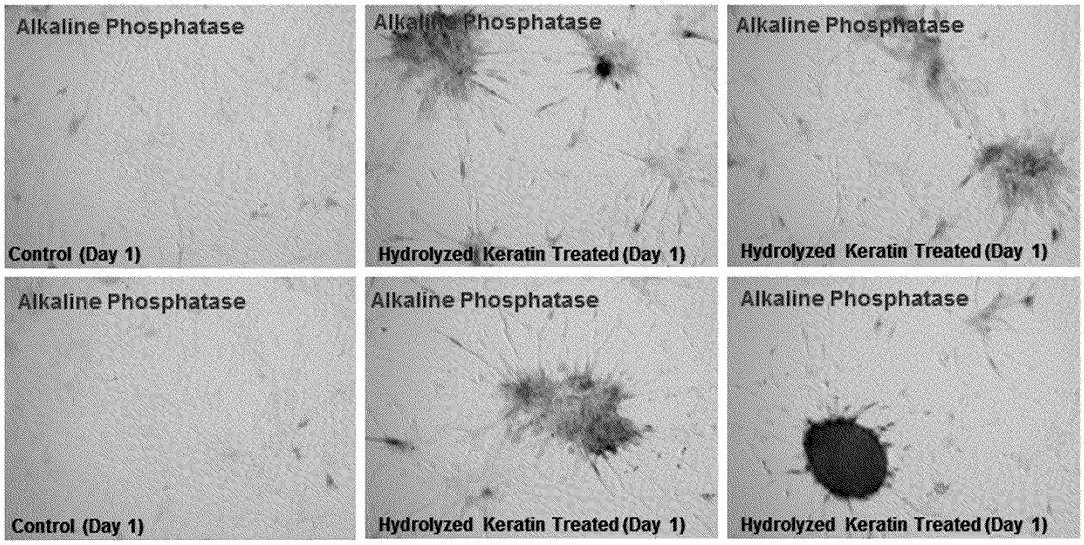
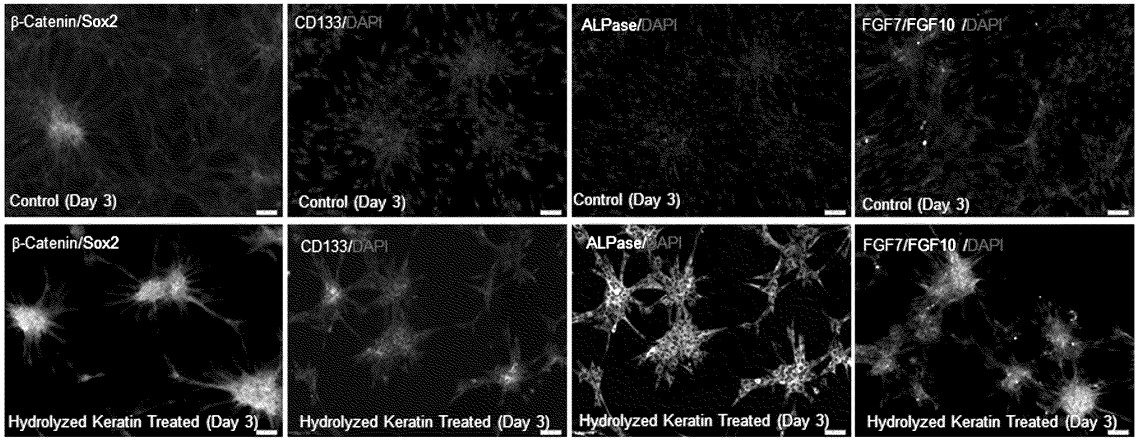

Alkaline Phosphatase
Control (Day 1)
Hydrolyzed Keratin Treated (Day 1)

FIG. 18


β-Catenin/Sox2
Control (Day 3)
CD133/DAPI
Control (Day 3)
ALPase/DAPI
Control (Day 3)
FGF7/FGF10 /DAPI
Control (Day 3)
β-Catenin/Sox2
Hydrolyzed Keratin Treated (Day 3)
CD133/DAPI
Hydrolyzed Keratin Treated (Day 3)
ALPase/DAPI
Hydrolyzed Keratin Treated (Day 3)
FGF7/FGF10 /DAPI
Hydrolyzed Keratin Treated (Day 3)