A	Allergy, 207–208
AAGAB, 38	ALLO-1, 378
AAV. See Adeno-associated virus	ALLO-2, 378
ABCA12, 47, 79–80, 436	Alopecia
ABCC1, 347	alopecia areata
ABCC11, 118	clinical presentation, 362-363
ABCG2, 347	management, 363
Acne vulgaris, microbiome, 249	pathogenesis, 363–364
Acomys, 188	anagen effluvium
ACTL6a, 293	clinical presentation, 364
AD. See Alzheimer's disease; Atopic dermatitis	management, 364–365
Adeno-associated virus (AAV), gene therapy, 430	pathogenesis, 365
Adenovirus (AdV), gene therapy, 430	androgenic alopecia
Adipocyte	clinical presentation, 360
adipokines, 153	management, 360
aging, 150–151	pathogenesis, 360, 362
defects and disease, 153–156	central centrifugal cicatricial alopecia
development, 145, 147, 149	clinical presentation, 368
dynamics, 146-147	management, 368-369
hair regeneration role, 149–150	pathogenesis, 369
hormone regulation, 151–152	chronic cutaneous lupus erythematosus
metabolism, 152–153	clinical presentation, 366
precursors, 155–156	management, 366
prospects for study, 156	pathogenesis, 366–367
wound healing, 147–148, 150	lichen planopilaris
Adiponectin, 153	clinical presentation, 367
AdV. See Adenovirus	management, 367–368
Aging	pathogenesis, 368
adipocytes, 150–151	loose anagen syndrome
overview, 257–258	clinical presentation, 365
skin effects	management, 364
barrier function, 258-259	pathogenesis, 365
dermal structure	overview, 359-362
collagen fibril degradation, 261–264	prospects for study, 369-370
extracellular matrix, 265-266	telogen effluvium
mechanical tension restoration of	clinical presentation, 364
extracellular matrix accumulation, 266	management, 364
overview, 261	pathogenesis, 364
fat, 261	traction alopecia, 366
immunity, 260	trichotillomania
innervation, 260	clinical presentation, 365
pigmentary system, 259-260	management, 365
regenerative capacity, 259	pathogenesis, 365-366
thermoregulation function, 258-259	ALOX12B, 80, 276
vasculature, 260-261	ALOXE3, 80, 276
AKT, 99, 418–419	Alzheimer's disease (AD), corneocyte gene
ALDH3A2, 436	mutations, 77

AMPK, 67	drug resistance, 377–378
Anagen effluvium. See Alopecia	prospects, 378–381
Anagen. See Hair follicle	SMO inhibitors, 375–377
ANCR, 275	traditional therapy, 374-375
Androgen receptor (AR), adipocytes, 152	Basal cell nevus syndrome (BCNS), 376
Androgenic alopecia. See Alopecia	Basophil, dermal immune function, 198
ANRIL, 276	B cell, dermal immune function, 199
Antigen-presenting cells (APCs), 194–195	BCC. See Basal cell carcinoma
Antimicrobial peptides	BCNS. See Basal cell nevus syndrome
barrier function, 83, 242	β-Catenin
fat layer immune function, 200	dermal papilla, 217, 222
AP-1, 149, 172, 263, 319, 322	desmosome protein interactions, 99
AP-3, 171	hair follicle neogenesis, 190
APCs. See Antigen-presenting cells	BLIMP1, 9, 25
APECED syndrome, 209	BLM, 174
Apocrine sweat gland. See Sweat gland	BLOC-1, 175
Apremilast, psoriasis management, 346	BMPs. See Bone morphogenetic proteins
AR. See Androgen receptor	BMT. See Bone marrow transplantation
Arsenic trioxide (ATO), basal cell carcinoma	Bone marrow transplantation (BMT)
management, 379	epithelial progenitors, 460-461
ARVC, 102, 104	indications, 461
Asymmetric cell division, 62–65	recessive dystrophic epidermolysis, 459-460
ATM, 309	skin repair mechanism, 460
ATO. See Arsenic trioxide	Bone morphogenetic proteins (BMPs)
Atopic dermatitis (AD), microbiome, 247-249	adipogenesis, 149-150
ATP2A2, Darier's disease mutations, 36, 38	hair follicle macroenvironment, 232, 236
ATP2C1, Hailey-Hailey disease mutations, 35, 38	sweat gland development signaling, 121
ATR, 309	BRAF, 276, 414-416, 418
Autoimmunity	Brg1, 292-293
antibacterial-like autoimmunity, 209	Brm, 292–293
antibody-mediated autoimmunity, 219-211	Bulge stem cell, markers, 5–8
antiviral-like autoimmunity, 209-210	
malignancy, 211	
overview, 208-209	С
	CARD14, 338, 347
D.	Cardiovascular disease (CVD), psoriasis
В	comorbidity, 333–334
BANCR, 276	Carney complex, 173
BAP1, 413	CCND1, 377, 421
Barrier function	CD200, bulge stem cell marker, 7
aging effects, 258–259	CD71, interfollicular stem cell expression, 9
assessment, 73–74	CDK4, 412–413
components	CDKN2A, 411–413
antimicrobial peptides, 82	CDSN. See Cornodesmosin
corneocytes and cornified envelope, 74, 76-78	CE. See Cornified envelope
junctional proteins, 78–79	C/EBP
lipids, 79–81	adipogenesis, 149
proteases and inhibitors, 81–82	epidermal barrier formation role, 83
transcription factors in development, 82–83	epidermal differentiation role, 287
desmosomes, 78–79, 99–100	Cell polarity
knockout mouse studies, 75–76	barrier formation role, 58, 60-61
prospects for study, 83–84	cell growth and metabolism studies, 66–67
tight junctions and cell polarity, 60–61	cilia formation, 61
Basal cell carcinoma (BCC). See also Skin cancer	epidermal cell fate regulation, 62–64
Hedgehog mutations, 373–374	epidermal regeneration and migration role, 64–65
treatment	immune signaling, 67

overview, 58–60	CSL, 314
prospects for study, 67–68	CTLA4, 45
signaling networks, 59	CVD. See Cardiovascular disease
skin cancer role, 65–66	Cyclooxygenase (COX), 399
Cell therapy. See also Induced pluripotent stem cell	Cystic fibrosis, 118
bone marrow stem cells	
mouse studies, 458	
overview, 457-458	D
bone marrow transplantation	Dandruff, microbiome, 249-250
epithelial progenitors, 460-461	Darier's disease, gene mutations, 35-38
indications, 461	Dasatinib, 420
skin repair mechanism, 460	DC. See Dendritic cell
challenges in inherited skin disease, 444	Dctn1, 63
epidermolysis bullosa	Dendritic cell (DC)
fibroblast cell therapy	dermal immune function, 197
overview, 444, 456	epidermal immune function, 195-196
recessive dystrophic epidermolysis bullosa,	immune response, 201–202
456-457	psoriasis
revertant cell therapy, 463	immunopathogenesis, 340-342
keratinocyte culture and skin grafting, 444	plaque-type psoriasis, 331
overview, 441–442, 445–455	Dermal papilla (DP)
prospects	cell types, 221–222
bone marrow cell protocol refinement, 463–464	hair follicle development and regeneration
cell targeting to damaged skin, 464	anagen phase
gene therapy combination, 464	functions, 218–219
protein and drug therapy combination, 464–465	initiation, 217–218
revertant mosaicism combination, 465	termination, 219–220
recessive dystrophic epidermolysis	cell number correlation with hair size and type, 216
bone marrow transplant, 459–460	genetic manipulation in mice, 216
mesenchymal stem cells, 458–459	hair pigmentation role, 219
revertant cell therapy, 463	overview, 213–215
umbilical cord blood, 461–462	prospects for study, 222–223
Central centrifugal cicatricial alopecia. See Alopecia	size maintenance, 220
Ceramide synthase, barrier function, 80	specification by placodal signals, 220-221
CGD. See Chronic granulomatous disease	Desmoplakin (Dp)
CGHT. See Generalized hypertrichosis terminalis	functional overview, 91–92
Chediak–Higashi syndrome, 174	transcriptional regulation, 98
CHIPS, 203	Desmosome
Chromatin remodeling. See Epigenetics	autoimmune disease, 101–102
Chronic cutaneous lupus erythematosus. See Alopecia	barrier function, 78–79, 99–100
Chronic granulomatous disease (CGD), 198	dynamics, remodeling, and turnover, 104–106
Cilia, formation, 61	gene mutations in skin disease, 38
ClfA, 203	morphogenesis and homeostasis of stratified
c-Myc, 475	tissues, 98–99
COL7A1,34,37,45,170,433–434,444,456–457,479,481	pathogenesis of inherited skin and heart
Collagen, fibril degradation in aging, 261–264	disease, 102–104
Complement	pharmacological targeting, 106
abnormalities, 200	prospects for study, 106–107
fat layer immune function, 199	skin cancer dysfunction, 100–101
Cornified envelope (CE), barrier function, 74, 76–78	structure and organization, 91–93
Cornodesmosin (CDSN), 99	toxin targeting, 102
COX. See Cyclooxygenase	transcriptional regulation of component
CPT-1, 153	expression, 93–98
CR3, 205	DICER, 173
Crb3, 61	Dimethylbenzanthracene (DMBA), squamous cell
CRISPR, 481	carcinoma induction, 386–390, 399–400
ONIOI IN TUI	Carcinoma muuchom, 300–330, 333–400

DKK1, 169, 232, 360	ultraviolet activation, 262
Dlg, 65	Epidermal stem cell
DLL1, 9, 318	bone marrow, 460–461
DMBA. See Dimethylbenzanthracene	hair follicle. See Hair follicle
DNA methylation. See Epigenetics	histone modification effects on activation and
DNA microarray, polygenic skin disease studies, 43-44	differentiation, 290–291
DNA-PK, 309	interfollicular epidermis, 9–10
DNMT1, 44, 286-287	lineage tracing
Dorfman-Chanarin syndrome, 81	glandular stem cells, 24-26
Dp. See Desmoplakin	hair follicles, 22–24
DP. See Dermal papilla	interfollicular epidermis
Dsc1, transcriptional regulation, 93, 96 Dsc2	maintenance and repair by stem cells, 18–21 mouse versus human, 21–22
therapeutic targeting, 106	principles, 4–5, 16–18
transcriptional regulation, 96–97	re-epithethelialization, 182–184
Dsc3, transcriptional regulation, 97	sebaceous gland, 8–9
Dsg1	sweat gland, 10
autoimmunity, 210	techniques for study
functional overview, 91–92	clonogenic assays, 4
striate palmoplantar keratoderma mutations, 36–38	label retention, 3–4
toxin targeting, 102	overview, 2–3
transcriptional regulation, 93, 95	skin reconstitution, 4lineage tracing, 4-5
transcriptional regulation, 95	Epidermolysis bullosa (EB)
Dsg2	gene therapy, 432–433
functional overview, 91–92	fibroblast cell therapy
skin cancer studies	overview, 444, 456
Dsg3	recessive dystrophic epidermolysis bullosa,
interfollicular stem cell expression, 9	456-457
therapeutic targeting, 106	revertant cell therapy, 463
transcriptional regulation, 95–96	Epidermolysis bullosa simplex (EBS)
Dsg4	gene therapy, 435
localized autosomal recessive hypotrichosus	keratin mutations, 33, 37, 45–46
mutations, 36	Epidermolytic hyperkeratosis (EH), keratin
transcriptional regulation, 96	mutations, 33
DSH, 176	Epidermolytic palmoplantar keratoderma (EPPK),
Dystrophic epidermolysis bullosa. See Recessive	KRT9 mutations, 34–35, 40
dystrophic epidermolysis bullosa	Epigenetics
7 1 1 7	chromatin remodeling
	histone modifications, 288–290
E	overview, 283
EB. See Epidermolysis bullosa	SWI/SNF, 292–293
Ebf1, 149	DNA methylation, 282, 286
EBS. See Epidermolysis bullosa simplex	epidermal differentiation regulation
Eccrine sweat gland. See Sweat gland	DNA methylation, 286–287
EDA, 46, 119-120	histone modification, 290-292
EGF. See Epidermal growth factor	knockout mouse studies, 284-285
EH. See Epidermolytic hyperkeratosis	nuclear dynamics, 294
Elovl proteins, barrier function, 80	prospects for study, 294–296
Embryonic stem cell (ESC), pluripotency, 474–475	H3K27me3 regulation, 289-290
Endothelial cell, dermal function, 197	overview, 281–282
Eosinophil, dermal immune function, 198	polygenic skin disease studies, 44–45, 49, 287–288
EphA2, 417	EPLIN, 106
Epidermal growth factor (EGF)	EPPK. See Epidermolytic palmoplantar keratoderma
gene therapy, 437	ERBB-2, sweat gland carcinoma expression, 127
receptor	ESC. See Embryonic stem cell
Notch interactions, 319–320	Estrogen, adipocyte regulation, 152
	- · · · · ·

F	prospects, 437
FALDH. See Fatty aldehyde dehydrogenase	revertant mosaicism, 432
FATP4, 79	virus vectors
Fatty aldehyde dehydrogenase (FALDH), 40, 436	adeno-associated virus, 430
FDH. See Focal dermal hypoplasia	adenovirus, 430
FGF. See Fibroblast growth factor	comparison of vectors, 429
Fibroblast	retrovirus, 428-429
dermal function, 197	Generalized hypertrichosis terminalis (CGHT), 48
epidermolysis bullosa cell therapy	Genome-wide association studies (GWAS), polygenic
overview, 444, 456	skin disease studies, 41-43
recessive dystrophic epidermolysis bullosa,	GH. See Growth hormone
456–457	GI-58, 81
Fibroblast growth factor (FGF)	GLI, 7, 9, 374, 377–380
dermal papilla, 217, 219–220	GNA11, 416, 419
FGF-9 in hair follicle neogenesis, 187–188	GNAQ, 416, 419
FGF-13 position effects, 48	GNAS, 277
hair follicle macroenvironment, 234-237	Grhl3, epidermal barrier formation role, 82–83
placode expression, 221	GRIN2A, 417
Filaggrin (FLG), 41, 77, 83, 196, 363	Griscelli syndrome, 174
Finasteride, 360	GRM3, 417-418
FL1, 44	Growth hormone (GH), adipocyte regulation, 151
FLG. See Filaggrin	GWAS. See Genome-wide association studies
Focal dermal hypoplasia (FDH), gene mutations, 47	
FoxO, 305	
FRMD4A, interfollicular stem cell expression, 10	Н
Functional cloning, inherited skin disease	H19, 277
studies, 33	Hailey-Hailey disease, gene mutations, 35
	Hair follicle (HF)
C	advantages in regeneration studies, 228-229
G	dermal papilla in development and regeneration
GANT58, 379	anagen phase
GANT61, 379	functions, 218–219
Gap junction, barrier function, 78	initiation, 217–218
Gata3, epidermal barrier formation role, 82	termination, 219–220
Gene therapy	cell number correlation with hair size and
cell therapy combination, 464	type, 216
indications	cell types, 221–222
epidermolysis bullosa, 432–433	genetic manipulation in mice, 216
epidermolysis bullosa simplex, 435	hair pigmentation role, 219
ichthyosis	overview, 213–215
harlequin ichthyosis, 436	papilla size maintenance, 220
lamellar ichthyosis, 435–436	prospects for study, 222–223
junctional epidermolysis bullosa, 434–435	specification by placodal signals, 220–221
melanoma, 435	embryogenesis, 2
Netherton syndrome, 437	innervation, 139–141
pachyonychia congenita, 435	macroenvironment regulation of hair cycling
recessive dystrophic epidermolysis bullosa,	overview, 227–229
433–434	prospects for study, 237-239
Sjögren–Larsson syndrome, 436	regenerative wave patterns and coordinated
wound healing, 435–437	stem cell activation, 232-236
xeroderma pigmentosum, 436	signaling
induced pluripotent stem cells, 480	complexity, 236–237
overview, 427-428	interplay with hair follicles, 230-232
plasmid DNA vectors	neogenesis, 186–188
administration, 431–432	Notch signaling, 314, 316
design, 430-431	p53/p63 in development and cycling, 306

Hair follicle (HF) (Continued)	inflammation termination and wound
stem cells	healing initiation, 202
bulge stem cell, 5–8	initiation and evolution, 200-202
hair germ, 7	malignancy, 211
lineage tracing, 22–24	overview, 194-195
upper hair follicle, 8–9	parasite, 206–207
Harlequin ichthyosis (HI), gene therapy, 436	virus, 204–205
HDAC1, 291-292, 305	Induced pluripotent stem cell (iPSC)
HDAC2, 291-292, 305	clinical applications in dermatology
HED. See Hypohidrotic/anhidrotic ectodermal dysplasia	challenges in research, 482-483
Hedgehog (HH), basal cell carcinoma	disease modeling, 482
mutations, 373–374	gene correction therapy, 490-491
therapeutic targeting, 375-376, 378-380	reprogramming cells in inherited skin
Hedgehog. See also Sonic Hedgehog	disease, 478–480
Hermansky-Pudlak syndrome, 174	revertant mosaicism, 481–482
Hes1, 319	skin cell differentiation, 490
HF. See Hair follicle	tissue rejuvenation, 481
HH. See Hedgehog	donor cell type for reprogramming, 477–478
HI. See Harlequin ichthyosis	generation, 475–477
Hippo, cell growth role, 68–69	overview, 473–474
Histone modification. See Epigenetics	pluripotency, 474–475
HLA-B13, 41	prospects for study, 483
HLA-C, 334–335, 338	Inflammation
HMGB1, 4641, 464	Notch signaling in skin, 320-321, 323
Hookworm, immune response, 206–207	squamous cell carcinoma, 399–401
HOTAIR, 273, 275	termination and wound healing initiation, 202
HOTTIP, 275	Inner root sheath (IRS), formation, 214–215
HOXA13, 169	Interferon, fat layer immune function, 200
HOXC, 273	Interfollicular epidermis (IFE)
HOXD, 273	epidermal stem cells
HPI-1, 379	maintenance and repair by stem cells, 18-2
HPV. See Human papilloma virus	mouse versus human, 21–22
Human papilloma virus (HPV), 204-205, 246	overview, 9-10
Human polyomavirus, 246	Notch signaling, 314, 317–318
Hygiene hypothesis, 207	Interleukin-6 (IL-6), 153
Hypersensitivity reactions, 208	Interleukin-17 (IL-17), psoriasis
Hypohidrotic/anhidrotic ectodermal dysplasia	immunopathogenesis, 340-342
(HED), 119–121, 126	therapeutic targeting, 346
	Interleukin-23 (IL-23), psoriasis
	immunopathogenesis, 340–342
Ī	Intermediate filaments, gene mutations in skin
Ichthyosis. See Harlequin ichthyosis; Lamellar ichthyosis	disease, 38-40
IFE. See Interfollicular epidermis	Involculin, 182
IGFBP7, 170	Involucrin, 390
IL-6. See Interleukin-6	IPEX syndrome, 199
IL-17. See Interleukin-17	iPSC. See Induced pluripotent stem cell
IL-23. See Interleukin-23	IRS. See Inner root sheath
Immune response, skin	
aging effects, 260	
allergy, 207–208	J
autoimmunity, 208–211	JEB. See Junctional epidermolysis bullosa
bacteria, 202–204	Junctional epidermolysis bullosa (JEB)
dermis, 197–199	gene therapy, 434-435
epidermis, 195–197	induced pluripotent stem cell therapy, 478, 480
fat layer, 199-200	LAMA5 mutations, 33-34
fungus, 205–206	mosaicism, 45

K	LI. See Lamellar ichthyosis
KCNQ1OT1, 277	Lichen planopilaris. See Alopecia
Keratin	Lineage tracing. See Epidermal stem cell
barrier function, 77–78	Linkage analysis, polygenic skin disease studies, 40-41
K14	LKB1, 65, 67, 173
epidermolysis bullosa simplex gene	LMNA, 154
therapy, 435	lncRNA. See Long noncoding RNA
interfollicular stem cell expression, 9	Localized autosomal recessive hypotrichosus (LAH),
K15	DSG4 mutations, 36
bulge stem cell expression, 7-8	Long noncoding RNA (lncRNA)
targeting of bulge stem cells, 5–6	overview, 271–273
skin disease mutations	prospects for study, 278
Darier's disease mutations, 35	skin function
epidermolysis bullosa simplex, 33, 37, 45-46	ANCR, 275
epidermolytic hyperkeratosis, 33	genetic syndromes with cutaneous
KRT9 mutations in epidermolytic palmoplantar	manifestations, 276-278
keratoderma, 34–35, 40	HOTAIR, 273, 275
sweat gland	HOTTIP, 275
expression in development, 118–119	overview, 274
stem cell expression, 10	skin cancer, 275–276
Keratinocyte	SPRY4-IT1, 276
culture and skin grafting, 444	TINCR, 276
epidermal function, 195	Loose anagen syndrome. See Alopecia
gene therapy. See Gene therapy	LRIG1, epidermal stem cell expression, 8, 10, 26
induced pluripotent stem cell differentiation, 480	Lrig1, 183
psoriasis	
activation, 339–340	
generalized pustular psoriasis, 332	M
immunopathogenesis, 340-342	Macrophage, dermal immune function, 197-198
plaque-type psoriasis, 331	Malassezia, dandruff role, 249
Keratinocyte growth factor (KGF), 155	Mannose binding lectin (MBL), 199
KGF. See Keratinocyte growth factor	MAPK. See Mitogen-activated protein kinase
KIF13A, 172	MART-1, 171–172, 210, 435
KIT, 419-420	Mast cell, dermal immune function, 198
KLF, adipogenesis, 149	MBL. See Mannose binding lectin
KLF4, 82, 293, 475	MC1R, 411, 413–414
	MCC. See Merkel cell carcinoma
L	McSC. See Melanocyte stem cell
	MCSP, interfollicular stem cell expression, 9
LAH. See Localized autosomal recessive hypotrichosus	Mek1, 399
LAMA5, junctional epidermolysis bullosa mutations,	Melanocyte
33–34	development, 164
LAMB3, 45, 434–435, 464, 478	epidermal function, 195–196
Lamellar ichthyosis (LI), gene therapy, 435–436	heterogeneity, 164, 169–170
Langerhans cell (LHC), 196, 201, 205	melanin synthesis regulation
LECTI, 81	enzymes in synthesis, 172
LEKT1, 102, 107, 437	melanosome structural proteins, 171–172
LEOPARD syndrome, 165, 173, 177	overview, 170–171
Leptin, 153, 155	trafficking proteins, 172
LFA-1, 197	transcription factors, 172–173
Lgl, 65–66	melanoma, 177
LGN, 63	overview, 163–164
LGR-5, bulge stem cell marker, 6	pigmentary disorders
LGR-6, 8–9, 24, 183–184	hyperpigmentation disorders
LHC. See Langerhans cell	acquired, 173–174
LHX2, bulge stem cell marker, 6	congenital, 173

Melanocyte (Continued)	techniques for study, 242-244
hypopigmentation disorders	viruses, 246–247
acquired, 175–176	Microneedle, plasmid DNA gene therapy
congenital, 174–175	administration, 431–432
mixed disorders, 176	MicroRNA (miRNA)
table, 165-169	p63 effects, 305
vitiligo, 176–177	skin disease studies, 44
prospects for study, 177-178	Minoxidil, 360
senescence, 170	miRNA. See MicroRNA
stem cells, 170	MITF, 170, 172-173, 176, 413-414
Melanocyte stem cell (McSC), hair follicle	Mitogen-activated protein kinase (MAPK), ultraviolet
neogenesis, 188	activation, 263
Melanoma. See also Skin cancer	MLL1 complex, 275
acral melanoma gene mutations, 419-420	Mosaicism, skin disease studies, 45-47
aggressive disease genomic expression patterns,	MRM, 309
420-421	MRP6, 38, 40
BRAF mutations, 414–416, 418	MRSA. See Methicillin-resistant Staphylococcus aureus
clinical phenotypes, 409-410	MSC. See Mesenchymal stem cell
epidemiology, 410-411	mTOR, 418
gene therapy, 435	
hereditary loci, 411-413	
MC1R variants, 411, 413-414	N
melanomagenesis, 411	Natural killer (NK) cell, dermal immune function, 198
mucosal melanoma gene mutations, 419-420	NEMO, 47, 176
NRAS mutations, 416–417	Netherton syndrome, gene therapy, 437
PI3K/AKT/mTOR mutations, 418	Neutrophil, dermal immune function, 198
prospects for study, 421	NF-κB. See Nuclear factor-κB
RAC1 mutations, 417	NFATC1, bulge stem cell marker, 6
receptor tyrosine kinase mutations, 417-418	Nickel allergy, 208
regulatory protein mutations, 418-419	NIF, 207
susceptibility genes, 177	NK cell. See Natural killer cell
ultraviolet mutagenesis, 414-415	NLRs. See NOD-like receptors
uveal melanoma gene mutations, 419	NOD-like receptors (NLRs), 200
Menkes disease, 174	Noonan syndrome, 173
Merkel cell	Notch
epidermal function, 195	cross talk, 318-320
neurite complexes in touch domes, 135–139	functional analysis of cutaneous signaling, 317-318
Merkel cell carcinoma (MCC)	hair follicles, 314, 316
microbiome, 250	inflammation regulation in skin, 320-321, 323
overview, 138–139	interfollicular epidermis, 314, 317–318
Mesenchymal stem cell (MSC), dystrophic epidermolysis	prospects for study, 324–325
bullosa cell therapy, 458-459	receptors, 315–316
Mesenchymal-to-epithelial transition (MET), 477–478	signaling overview, 313–314
MET. See Mesenchymal-to-epithelial transition	skin cancer tumor suppressor, 321-323
Methicillin-resistant Staphylococcus aureus (MRSA), 202	squamous cell carcinoma signaling, 397-399
Microbiome, skin	NRAS, melanoma mutations, 416–417
bacteria, 244–246	NUAK2, 170
diagnostic and therapeutic potential, 250-251	Nuclear factor-κB (NF-κB), sweat gland development
diseases	signaling, 119–120
acne vulgaris, 249	Numa1, 63
atopic dermatitis, 247–249	NURF, 293
dandruff, 249–250	
Merkel cell carcinoma, 250	0
psoriasis, 249	0
fungi, 246	Oct-4, 475
prospects for study, 251–252	Oculocutaneous albinism, 174

P	adipogenesis, 149
p16, 418	lichen planopilaris pathogenesis, 368
p21, 318–319, 322, 397	mutations, 154–155
p53, 126–127, 291	PRINS, 274
family and isoforms, 302–303	Propionibacterium acnes, 249, 251
hair follicle development and cycling role, 306	Protein A, 203
overview, 301–302	Protein kinase C (PKC)
prospects for study, 309–310	basal cell carcinoma therapeutic targeting, 379-380
skin cancer mutations, 308	desmosome regulation, 94, 105
skin response to chemotherapy, 309	polarity signaling by aPKC, 58, 61-67
squamous cell carcinoma	Psoriasis
knockout mice, 396–397	biomarker discovery, 347-349
mutations, 386	classification and histology
p63	erythrodermic psoriasis, 332
epidermal development role, 303–305	generalized pustular psoriasis, 332
hair follicle development and cycling role, 306	guttate psoriasis, 332
isoforms, 302–303	plaque-type psoriasis, 330–331
Notch interactions, 319	comorbidity, 333-334
skin cancer role, 308	environmental triggers, 339
wound healing role, 306-308	epidemiology, 330
p73	etiopathogenesis, 334
isoforms, 302–303	genetics
skin cancer role, 308-309	genome-wide association studies, 335, 338-339
Pachyonychia congenita, gene therapy, 435	overview, 334–335
Par proteins. See Cell polarity	PSORS1, 335
PARP1, 418	susceptibility genes, 335-337
PDGF. See Platelet-derived growth factor	immunopathogenesis
PEKAR1A, 173	established disease, 341-342
Perp, 101	initiation, 340–341
Peutz-Jegher syndrome (PJS), LKB1	overview, 339-340
mutations, 65, 165	microbiome, 249
Pg. See Plakoglobin	prospects for study, 349
Phototherapy, psoriasis, 342	psoriatic arthritis, 332-333
PI3K, 378, 380, 392, 418	treatment, 342–347
PJS. See Peutz–Jegher syndrome	PSORS1, 335
PKC. See Protein kinase C	PTCH1, 374-376
Pkp. See Plakophilin	PTEN, 305, 397, 418
PKP1, 38	
Plakoglobin (Pg)	D.
functional overview, 91-92	R
transcriptional regulation, 97–98	RA. See Retinoic acid
Plakophilin (Pkp)	Rac, 65,393
functional overview, 91–92	RAC1, melanoma mutations, 417
transcriptional regulation, 98	Raf-1, 392, 395
Platelet-derived growth factor (PDGF)	RalGDS, 395
adipogenesis, 150	RAS, squamous cell carcinoma
gene therapy, 437	effectors, 392–396
hair regeneration, 150	mutations, 386–388, 391
PLC-ε, 392–393	RBP-J, 317, 320, 323
PLET1, 8	RDEB. See Recessive dystrophic epidermolysis bullosa
PMEL17, 171–172	Recessive dystrophic epidermolysis bullosa (RDEB)
POEMS syndrome, 174	cell therapy
Polarity. See Cell polarity	bone marrow stem cells, 458-460
PORCN, 47	bone marrow transplant, 459-460
Position effects, skin disease studies, 47-48	fibroblasts, 456-457
PPARγ	induced pluripotent stem cells, 478-480

Recessive dystrophic epidermolysis bullosa (RDEB) (Continued)	SMO, 374–378 Somatic cell nuclear transfer (SCNT), 474
mesenchymal stem cells, 458–459	Sonic Hedgehog (SHH)
revertant cell therapy, 463	bulge stem cell marker, 6
COL7A1 mutations, 34, 37	
	sweat gland development signaling, 121
gene therapy, 433–434	Sorafenib, 420
Regeneration	Sox-2, 475
adipocyte in hair regeneration, 149–150	SOX-9, bulge stem cell marker, 6
aging effects on skin regenerative capacity, 259	SPINK5, 81, 437
cell polarity role, 64–65	SPPK. See Striate palmoplantar keratoderma
hair follicle neogenesis, 186–188	SPRY4-IT1, 276
prospects for study, 188–190	Squamous cell carcinoma (SCC). See also
sweat glands, 124–126	Skin cancer
Retinoic acid (RA), Notch interactions, 319	gene mutations, 380–381
Retrovirus, gene therapy, 428–429	inflammation, 399–401
Revertant mosaicism	mouse models
cell therapy combination, 465	chemical induction, 386–388
gene therapy, 432, 462–463	initiation target cell identification, 388–390
induced pluripotent stem cells, 481–482	knockout mice, 396–397
RhoA, 101–102, 105	Notch signaling, 397–399
RILP, 172	Ras effectors, 392–396
RNA sequencing, polygenic skin disease studies, 43–44	transgenic mice, 390–382
	ultraviolet radiation carcinogenesis, 386
S	prospects for study, 401
S6 kinase, 380	ST14, 81
Satb1, 294	Staphylococcal scalded skin syndrome, 102
SCC. See Squamous cell carcinoma	Staphylococcus aureus
SCD. See Symmetric cell division	atopic dermatitis role, 247
Schwann cell, type II terminal cells, 140	immune response, 202–204
SCIN, 203	STAT3, 101
SCNT. See Somatic cell nuclear transfer	Streptococcus, psoriasis role, 249
Scribble, 65	Striate palmoplantar keratoderma (SPPK),
Sebaceous gland, epidermal stem cells	DSG1 mutations, 36–38
lineage tracing, 25–26	SUFU, 374, 378
markers, 8–9	Sweat gland
Sept4/ARTS, 184	development
SHH. See Sonic Hedgehog	apocrine sweat glands, 118
SHOC2, 99, 102, 365	eccrine sweat glands, 116–119
SHP-1, 44	signaling, 119–121 disorders, 126–127
Sjögren–Larsson syndrome (SLS), gene therapy, 436	
SKH-1, 386	epidermal stem cells
Skin cancer	lineage tracing, 25–26, 119
cell polarity role, 65–66	markers, 10 homeostasis, 121–123
DNA methylation alterations, 287–288	regeneration, 124–126
long noncoding RNAs, 275–276	types and functions, 115–116
Notch as tumor suppressor, 321–323	wound repair
p53 mutations, 308	epidermal injury, 123
p63 role, 308	glandular injury, 123–124
p73 role, 308–309	SWI/SNF, 292–293
Skin cancer. See also specific cancers	Symmetric cell division (SCD), 62–63, 65
desmosome dysfunction, 100–101	57 minetile cell division (5CD), 02-03, 03
sweat glands, 126–127	
SLC45A2, 172	T
SLS. See Sjögren–Larsson syndrome	Taf10, epidermal barrier formation role, 82
Slug, 94	Tamoxifen, epidermal stem cell lineage tracing, 4

TAT, 477	knockout mice, 399
TBX1, bulge stem cell marker, 6	psoriasis
T cell	immunopathogenesis, 340, 342
autoimmunity, 209-211	therapeutic targeting, 343, 347
bacteria immune response, 203-204	Twin studies, polygenic skin disease
dermal immune function, 198-199	studies, 40-41
fungus immune response, 205-206	TYRP1, 172
helper cells, 201, 205-206	
memory T cell epidermal immune function,	
196-197	U
parasite immune response, 206–207	ULPB3, 43
psoriasis	Ultraviolet radiation (UV)
immunopathogenesis, 340-342	collagen fibril degradation, 261-264
plaque-type psoriasis, 331	dermal structure effects, 262-264
therapeutic targeting, 343	DNA methylation effects, 288
virus immune response, 204-205	melanoma mutagenesis, 414-415
TCF-3, bulge stem cell marker, 6	photoaging, 257
Telogen effluvium. See Alopecia	pigmentary system effects, 259-260
Telomerase reverse transcriptase	psoriasis phototherapy, 342
(TERT), 419, 481	squamous cell carcinogenesis, 386
TERT. See Telomerase reverse transcriptase	Umbilical cord blood, cell therapy, 461-462
TEWL. See Transepidermal water loss	Uniparental disomy (UPD), skin disease
TGF-β. See Transforming growth factor-β	studies, 47
TGM1, 39-40, 76-77	UPD. See Uniparental disomy
Thyroid hormone, adipocyte regulation, 152	UV. See Ultraviolet radiation
Tiam1, 393	
Tight junction (TJ)	
barrier function, 78	V
cell polarity, 60–61	Vascular endothelial growth factor (VEGF), gene
TINCR, 276	therapy, 436-437
TJ. See Tight junction	VEGF. See Vascular endothelial growth factor
TLRs. See Toll-like receptors	Vinculin, 106
TNF. See Tumor necrosis factor	Vismodegib, basal cell carcinoma management,
Tofacitinib, psoriasis management, 346	375-376
Toll-like receptors (TLRs), 200, 205	Vitiligo, 176–177, 209–210
Touch receptors	
hair follicle innervation, 139–141	***
Merkel cell-neurite complexes in touch domes,	W
135-139	Warts, 203
overview, 133–134	WIF-1, 174
prospects for study, 141	Wilson disease, 174
sensory neurons, 134	Wnt
TPA, squamous cell carcinoma induction, 386–390,	hair follicle
399-400	macroenvironment, 232, 234-237
Traction alopecia. See Alopecia	neogenesis, 187
Transepidermal water loss (TEWL), 74,	sweat gland development signaling, 120-121
78–79, 82	Wound healing
Transforming growth factor-β (TGF-β)	adipocyte, 147-148, 150
hair follicle macroenvironment, 236-237	dystrophic epidermolysis bullosa fibroblast cell
ultraviolet effects, 264	therapy, 457
wound healing, 186, 202	gene therapy, 435-437
Trichotillomania. See Alopecia	inflammation termination and wound healing
TRPS1, 48	initiation, 202
TSLP, 323, 400-401	overview, 181–182
TSST-1, 204	p63 role, 306-308
Tumor necrosis factor (TNF)	prospects for study, 188-190

Wound healing (Continued)
re-epithethelialization and epithelial stem cells,
182–184
scarless wound healing in mammals,
184–186
sweat glands
epidermal injury, 123
glandular injury, 123–124

X

Xeroderma pigmentosum (XP), gene therapy, 436 XP. See Xeroderma pigmentosum

Z

Zeb, 94 ZO-1, 100