The Integumentary System

Skin Development

Overview

- Largest organ of the body
- Dual origin:

Component	Origin
Epidermis	Surface ectoderm
Dermis	Mesenchyme (mesoderm + neural crest)

Epidermis Development

Early Stage

- Initially single-layered ectoderm

2nd Month

- Ectoderm divides → forms:
  - Periderm (epitrichium) → superficial flattened layer
  - Basal layer → proliferative layer
- Further proliferation → intermediate layer

By 4th Month → Definitive Layers

Layer	Features
Basal (stratum germinativum)	Stem cells; forms epidermal ridges → fingerprints
Spinous (stratum spinosum)	Polyhedral cells with tonofibrils
Granular (stratum granulosum)	Keratohyalin granules
Horny (stratum corneum)	Dead keratinized cells → protective barrier

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Periderm Fate

- Shed in 2nd half of intrauterine life
- Cells present in amniotic fluid

Melanocytes

- Origin
  - Neural crest cells
- Timeline
  - Migrate into epidermis by 3rd month
- Function
  - Produce melanin in melanosomes
  - Transfer pigment to keratinocytes

→ Responsible for skin & hair color

Dermis Development

- Origin (Mesenchyme from 3 sources)

Source	Region
Paraxial mesoderm	Dermis of back
Lateral plate mesoderm	Dermis of limbs & body wall
Neural crest	Dermis of face & neck

- 3rd–4th Month Changes
  - Formation of dermal papillae:
    - Project into epidermis
    - Contain:
      - Capillary loops
      - Sensory nerve endings

- Deep Layer
  - Subcorium (hypodermis) → rich in fat

Special Feature at Birth

- Vernix Caseosa
- Composition
  - Sebaceous gland secretions
  - Degenerated epidermal cells
  - Fine hair (lanugo)

- Function
  - Protects skin from amniotic fluid maceration

Clinical Correlates

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1. Pigmentary Disorders

- Piebaldism
  - Patchy absence of melanocytes
    → localized depigmented skin & hair

- Waardenburg Syndrome
  - Cause → defective neural crest migration
- Features
  - White forelock
  - Heterochromia iridis
  - Depigmented patches
  - Deafness

- Gene
  - PAX3 mutation (WS1 & WS3)

- Albinism (OCA)
  - Defect in melanin synthesis/processing
    → ↓/absent pigmentation (skin, hair, eyes)

- Vitiligo
  - Autoimmune destruction of melanocytes
    → patchy depigmentation
- Associations
  - Autoimmune diseases (especially thyroid disorders)

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2. Fingerprints (Dermatoglyphics)

- Origin
  - From epidermal ridges (basal layer)

- Sites
  - Fingertips, palms, soles
- Features
  - Genetically determined
  - Unique to each individual

- Clinical Importance
  - Forensics
  - Genetic studies
  - Abnormal in chromosomal disorders (e.g., Down syndrome)

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3. Keratinization Disorders

- Ichthyosis
  - Excess keratinization → dry, scaly skin
  - Mostly:
    - Autosomal recessive
    - Some X-linked forms

🔹 Harlequin Fetus (Severe Form)

- Thick, fissured, armor-like skin
- Often fatal shortly after birth

🔑 High Yield Summary

- Epidermis → ectoderm
- Dermis → mesoderm + neural crest
- Melanocytes → neural crest (3rd month)
- Periderm sheds → amniotic fluid
- Fingerprints → basal layer ridges
- Vernix → protection in utero

🔹 Hair Development

🔸 Origin

- From epidermis (surface ectoderm)

- Arises as solid proliferations from the basal (germinative) layer
- Grows downward into the dermis

🔸 Stages of Development

1. Hair Bud Formation

- Solid epidermal outgrowth penetrates dermis

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2. Hair Papilla Formation

- Terminal end invaginates → hair papilla
- Contains mesenchyme with:
  - Blood vessels
  - Nerve endings

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3. Differentiation

Component	Derivative
Central cells	Elongate → keratinize → hair shaft
Peripheral cells	Cuboidal → epithelial root sheath

4. Surrounding Mesenchyme

- Forms:
  - Dermal root sheath
  - Arrector pili muscle (smooth muscle)

🔸 Growth

- Continuous mitosis at base → pushes hair upward

🔹 Timeline

- End of 3rd month → first hairs appear
  - Eyebrows
  - Upper lip
- First hair = Lanugo
  - Fine, soft, unpigmented
  - Shed before/around birth
  - Replaced by terminal hair

🔹 Associated Structures

- Sebaceous Glands
- Development
  - Buds from hair follicle epithelium
- Mechanism
  - Central cells degenerate → form sebum
- Function
  - Sebum enters hair follicle → reaches skin surface → lubricates skin & hair

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Clinical Correlates (Hair)

- Hypertrichosis
  - Excessive hair growth
  - Cause → ↑ number of hair follicles
- Types

- Localized → e.g., lumbosacral region (spina bifida occulta marker)
- Generalized → whole body

- Atrichia
  - Congenital absence of hair
  - Often associated with:
    - Tooth abnormalities
    - Nail defects
      → (ectodermal dysplasia spectrum)

Sweat Glands Development

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1. Eccrine Sweat Glands

- Origin
  - Buds from epidermal germinative layer
- Development

- Extend into dermis → coil → form secretory portion

- Features
  - Mode: Merocrine (exocytosis)
  - Function: Thermoregulation
  - Distribution: Whole body (except lips, parts of genitalia)

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2. Apocrine Sweat Glands

- Origin
  - From epidermal buds associated with hair follicles
- Location
  - Axilla
  - Pubic region
  - Areola
  - Perianal region
  - Face
- Features
  - Start functioning at puberty (hormonal)

- Open into hair follicles
- Secretion contains:
  - Lipids
  - Proteins
  - Pheromones
- Odor → bacterial breakdown
- Mode: Apocrine (part of cytoplasm lost)

Clinical Correlates

- No major embryological anomalies
- Important clinically for:
  - Type of secretion
  - Function

Mammary Glands

Nature

- Modified sweat glands

🔸 Early Development

- Form as mammary lines (milk lines):
  - Extend from axilla → inguinal region
- Most regress
  → only thoracic region persists

🔸 Stages

1. Sprouting Stage

- 16–24 epithelial sprouts form
- Later canalize → lactiferous ducts

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2. Nipple Formation

- Initially:
  - Ducts open into epithelial pit
- After birth:
  - Mesenchymal proliferation → eversion → nipple formation

At Birth

- Only duct system present
- No alveoli

At Puberty (Female)

- Under estrogen & progesterone:
  - Duct branching
  - Formation of alveoli & secretory units

Clinical Correlates

Polythelia (Most Common)

- Accessory nipples
- Due to persistence of mammary line fragments
- Usually along milk line (often axilla)

- 🔹 Polymastia
  - Accessory breast tissue along mammary line

- 🔹 Inverted Nipple
  - Failure of epithelial pit to evert
  - Clinical relevance:
    - May mimic pathological inversion

🔑 Summary and High Yield Points

- Hair → ectodermal origin + mesenchymal papilla
- Lanugo → first fetal hair
- Sebaceous glands → from hair follicle epithelium
- Eccrine → merocrine, thermoregulation, all over body
- Apocrine → puberty, hair follicle, odor-producing
- Mammary gland → milk line origin
- Ducts → prenatal | Alveoli → puberty
- Lanugo = first fetal hair
- Apocrine glands → start at puberty
- Polythelia = most common mammary anomaly

- Milk line extends axilla → groin

-> The End <-