Development of the skin and its derivatives

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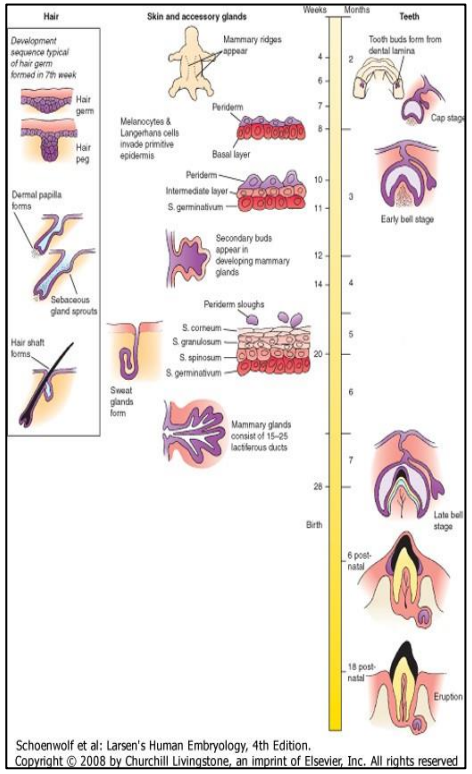
สาขาวิชากายวิภาคศาสตร์


MISS UNIVERSE THAILAND

Learning objectives

To understand



Skin function and anatomy

Skin origins

Development of the overlying epidermis

Development of epidermal appendages:

- ***Hair follicles***
- ***Glands***
- ***Nails***
- ***Teeth***

Development of melanocytes

Development of Langerhans cells

Development of the Dermis

Skin Function and Anatomy

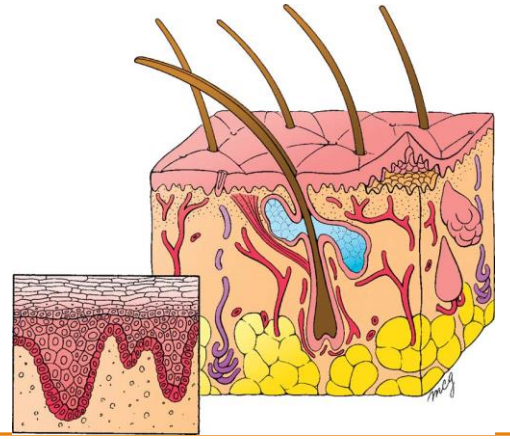
Largest organ of our body (20%)

- Protects inner body from outside world (pathogens, water, sun)
-Thermoregulation

Diverse: thick **vs** thin skin, scalp skin **vs** face skin, etc

Consists of:

- Overlying epidermis
- Epidermal appendages:-
  - Hair follicles,
  - Glands: sebaceous, sweat, apocrine, mammary
  - Nails
  - Teeth
- Melanocytes
- Langerhans cells
- (Merkel Cells)
- Dermis
- Hypodermis



Derivatives of the three Germ Layers

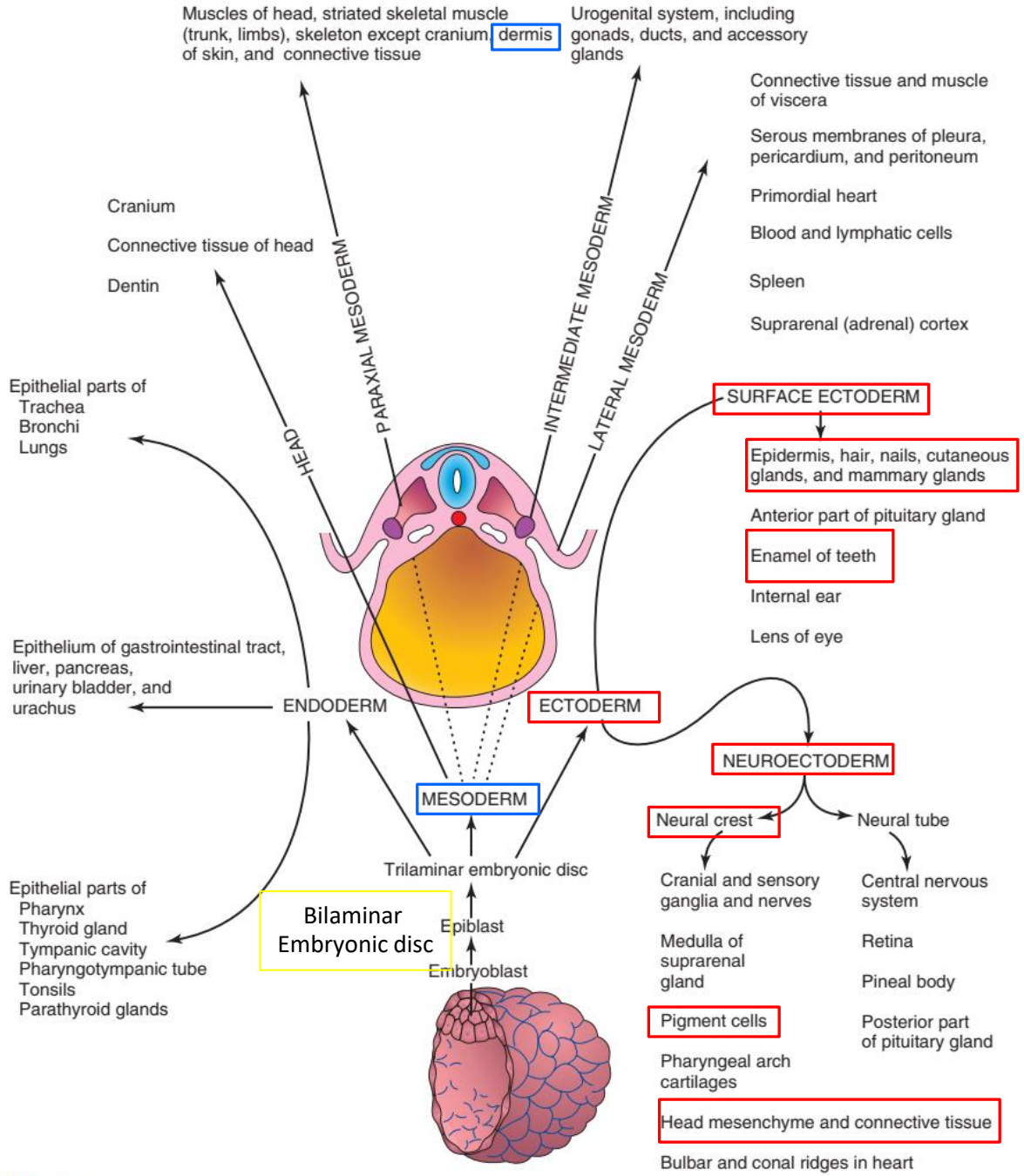
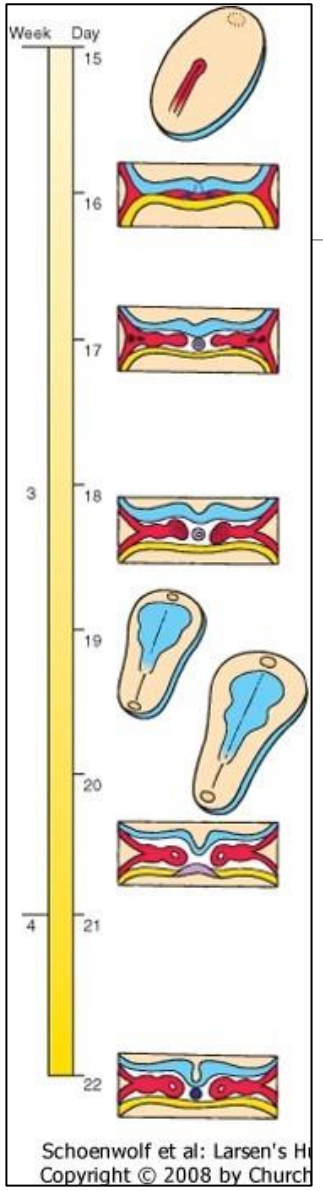


FIGURE 5–5 Schematic drawing of derivatives of the three germ layers, ectoderm, endoderm, and mesoderm. Cells from these layers contribute to the formation of different tissues and organs.

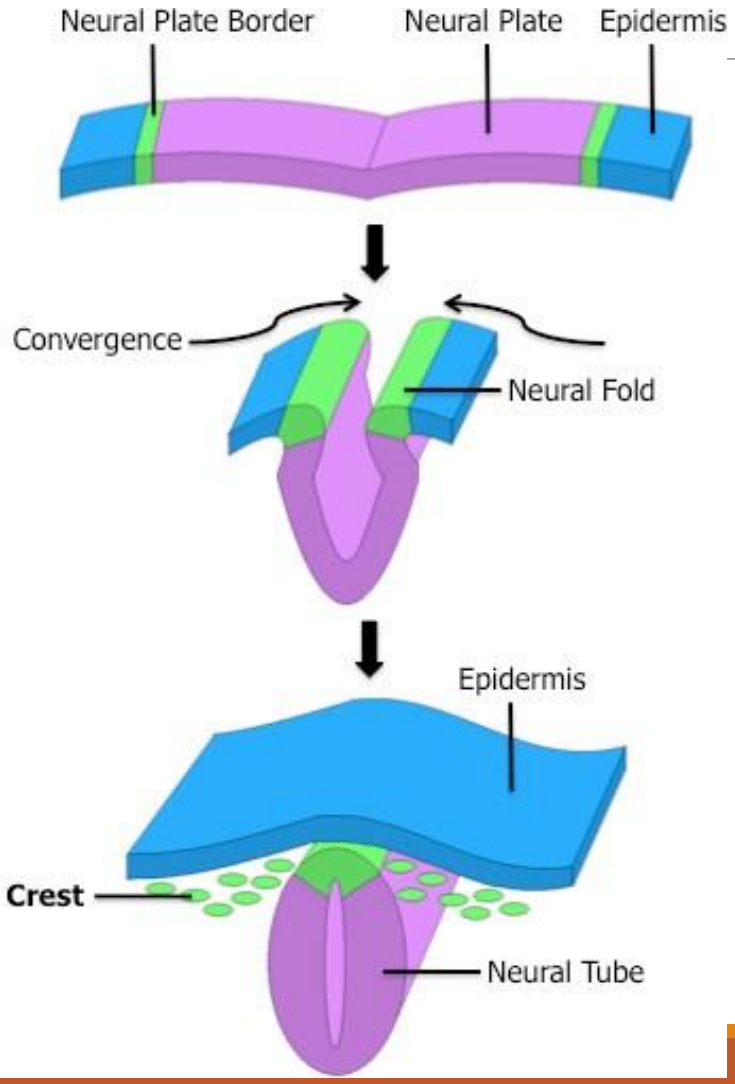
Ectoderm

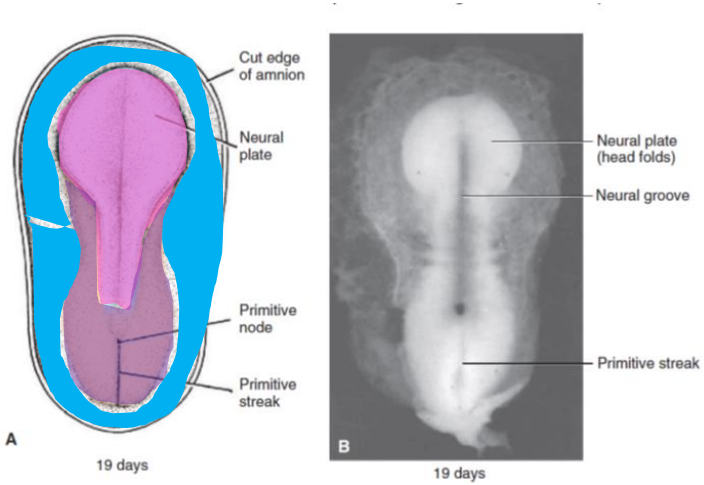
Overlying epidermis, epidermal appendages, nerve endings



Neural Crest

Melanocytes + Cranial Connective Tissue





Melanocytes

Cranial Connective Tissue

Weeks 3-4

Dermis

Connective tissue with:

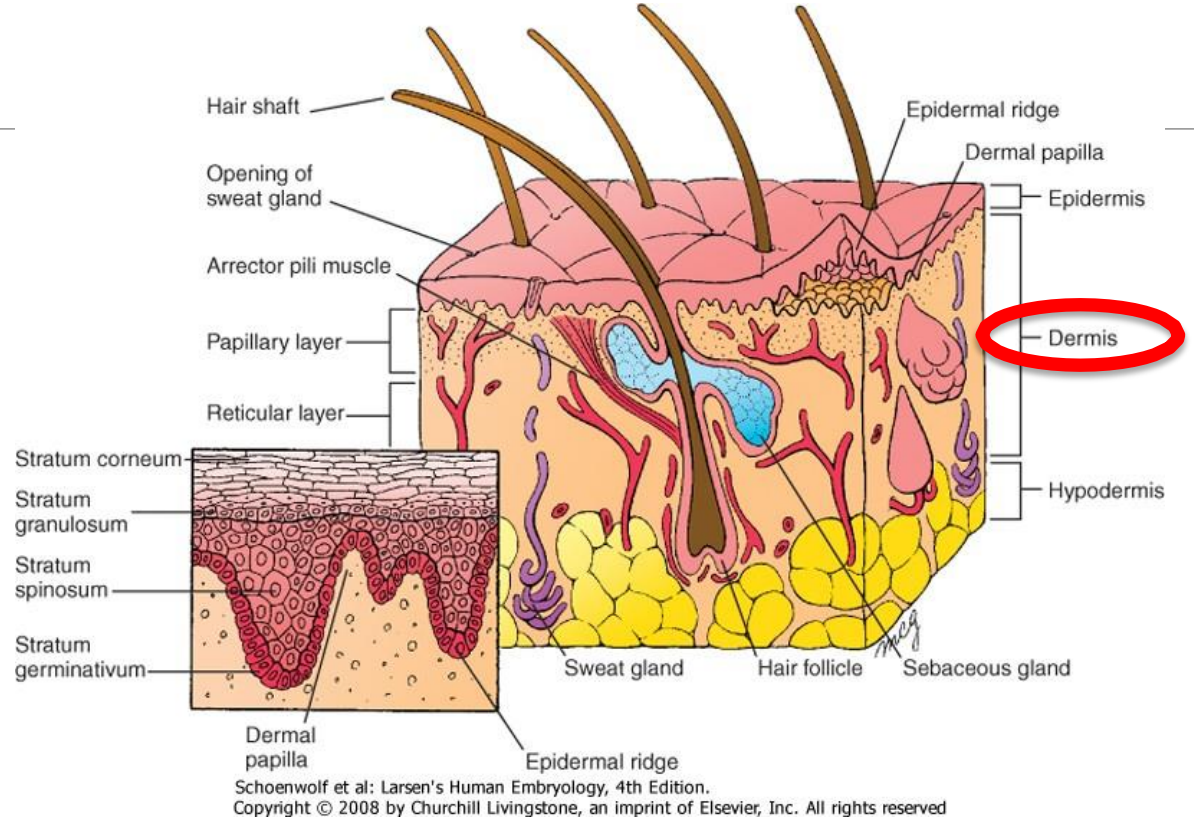
Fibroblasts

Blood vessels

Nerve endings

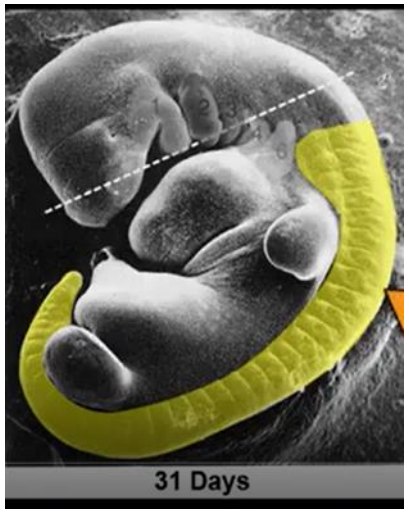
Sensory receptors

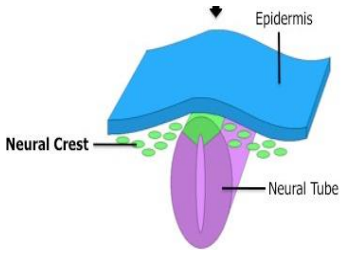
Muscle bundles

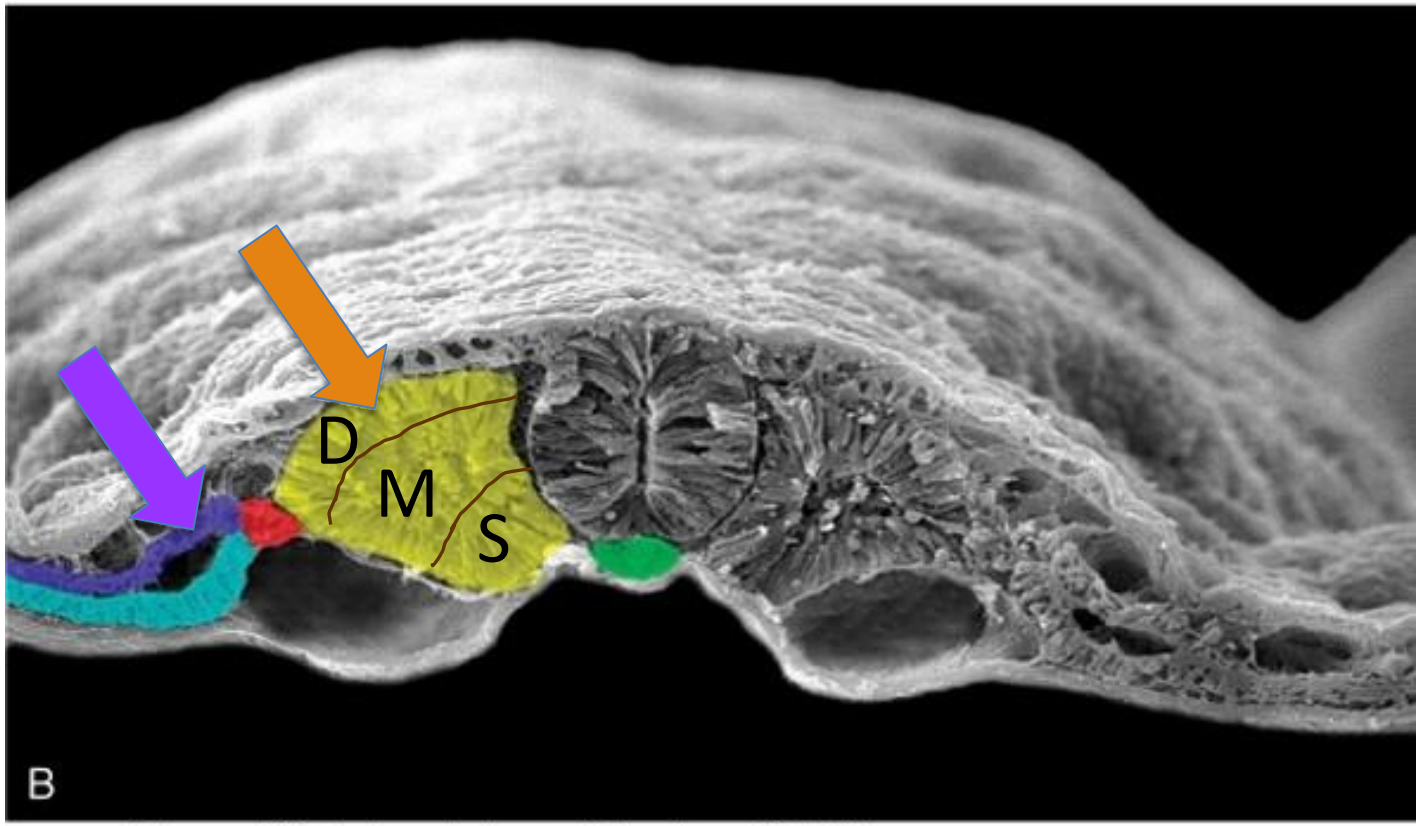


Dermis development

- Somitic mesoderm -> trunk (back)
- Somatic lateral plate mesoderm -> trunk (anterior), limbs
- Cranial neural crest derived mesenchyme -> cranial region





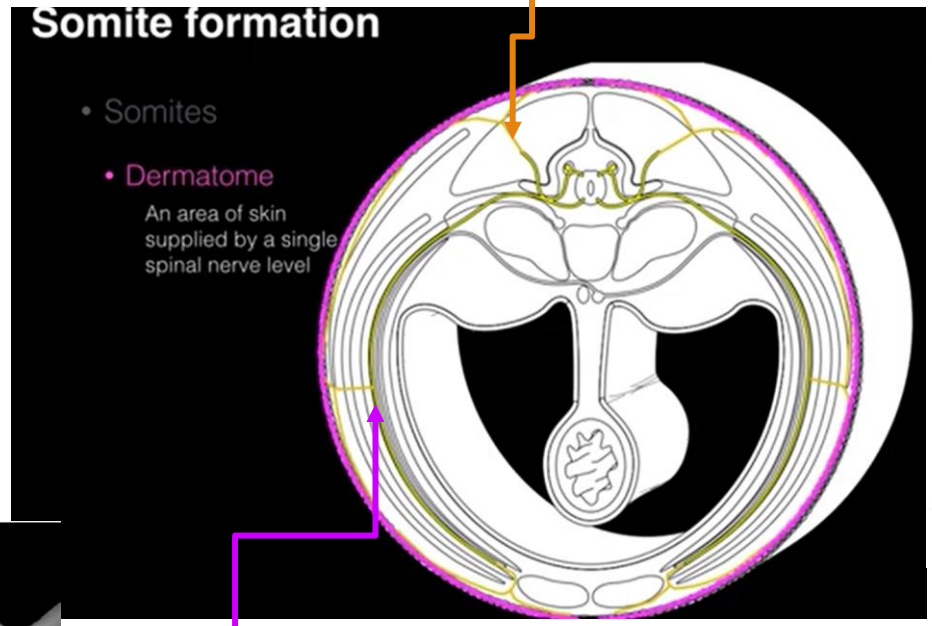


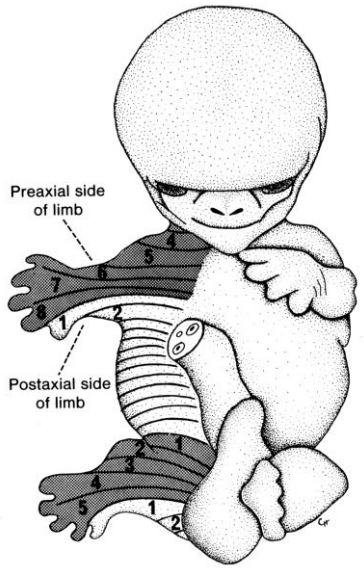
Schoenwolf et al: Larsen's Human Embryology, 4th Edition.

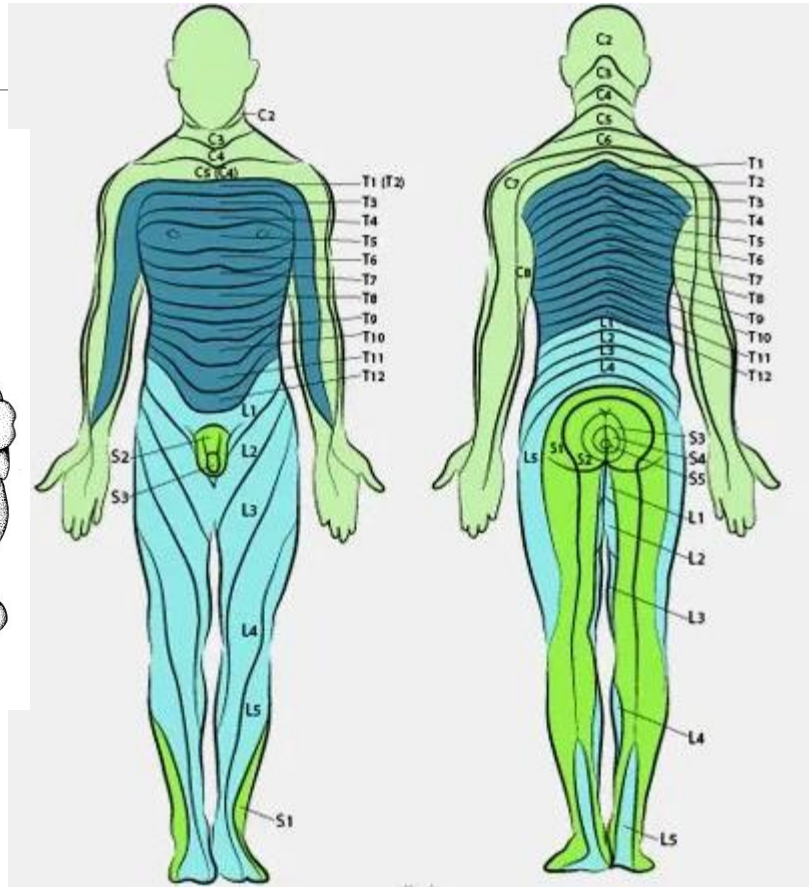
Dermatome : area of skin supplied by a single spinal nerve level

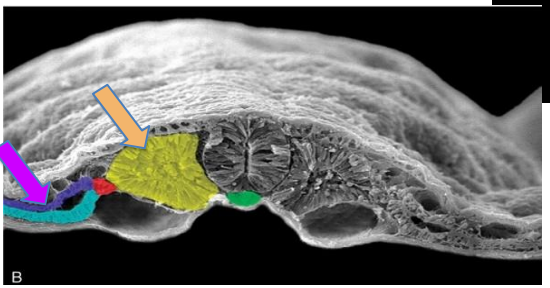
Dorsal ramus

(Somitic mesoderm -> trunk (back)



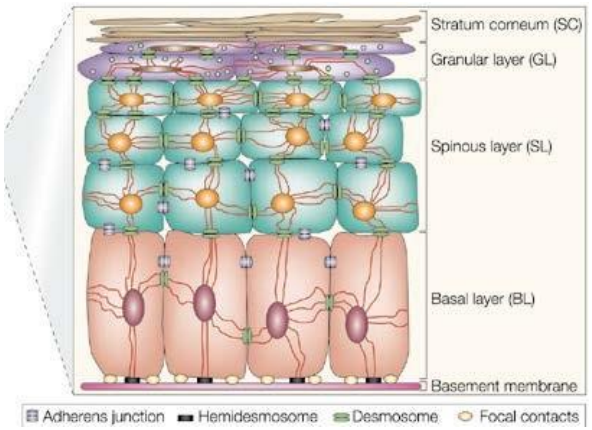


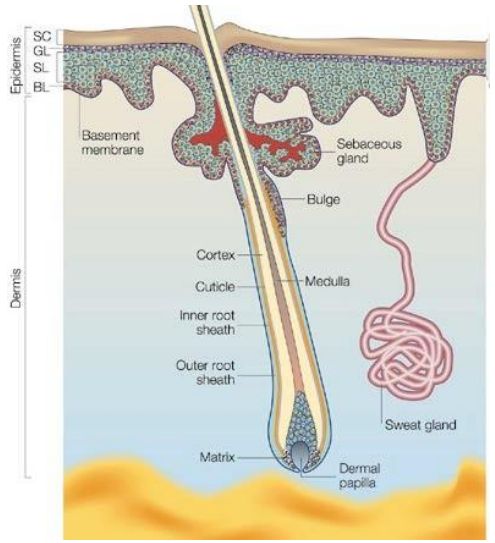




Ventral ramus

Somatic lateral plate mesoderm -> trunk (anterior), limbs





Epidermal development

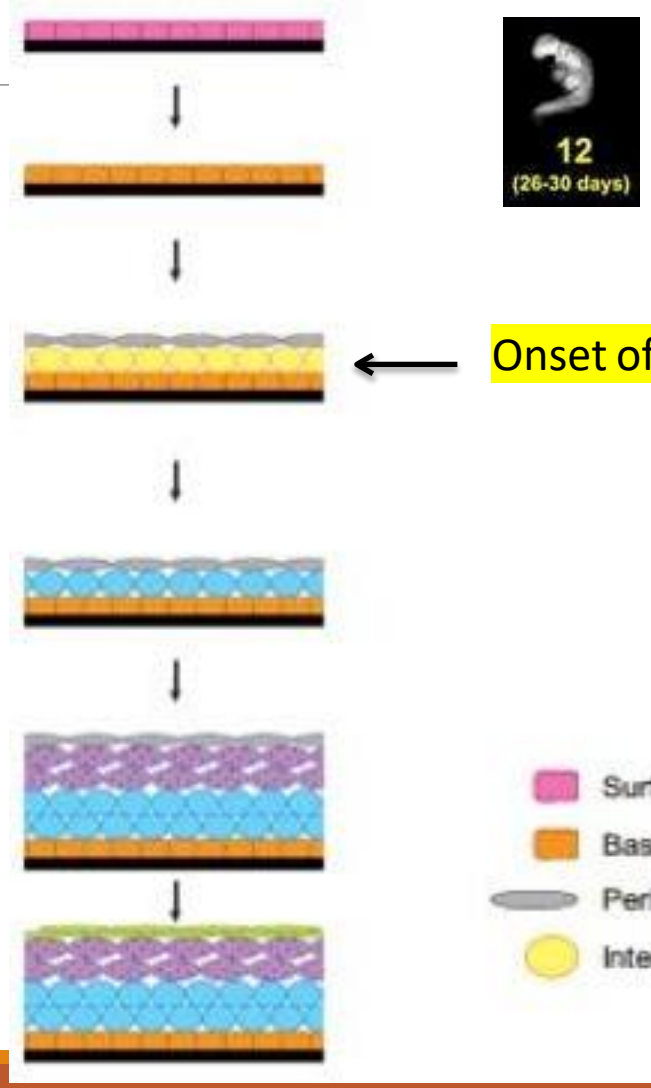
Surface ectoderm

Epidermis: stratified squamous epithelium

Appendages:

- Hair follicles
- Glands (sebaceous, sweat, apocrine, mammary, lacrimal, salivary)
- Nails
- Teeth

Development of Skin/interfollicular epidermis (IFE)

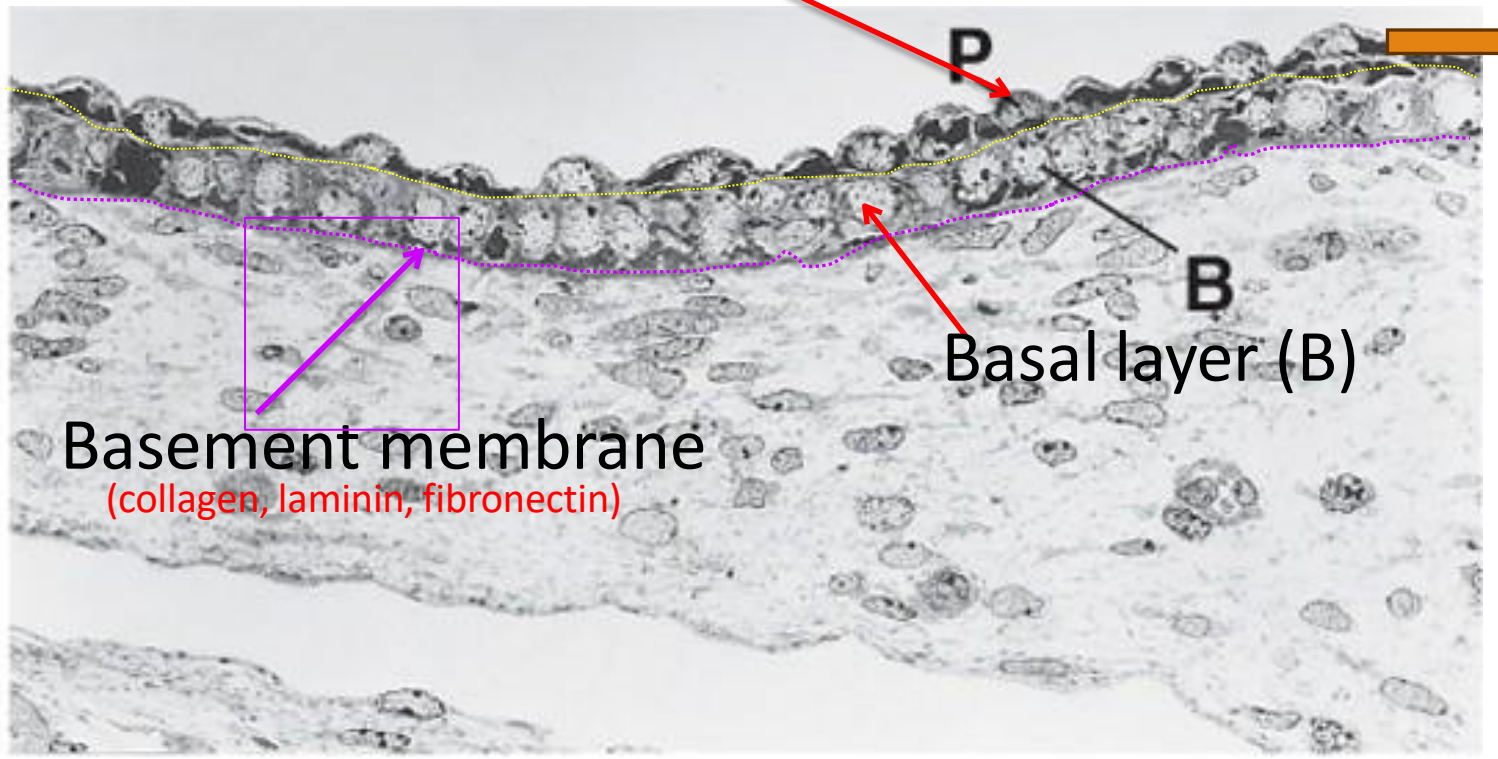


Onset of stratification

Development of Skin

Periderm formation: **4 weeks**

Periderm (P)



1. แลกเปลี่ยนน้ำและสารละลายระหว่างตัวอ่อนกับน้ำคร่ำ
2. ป้องกันเซลล์ชั้นล่าง

Development of Skin/Stratification

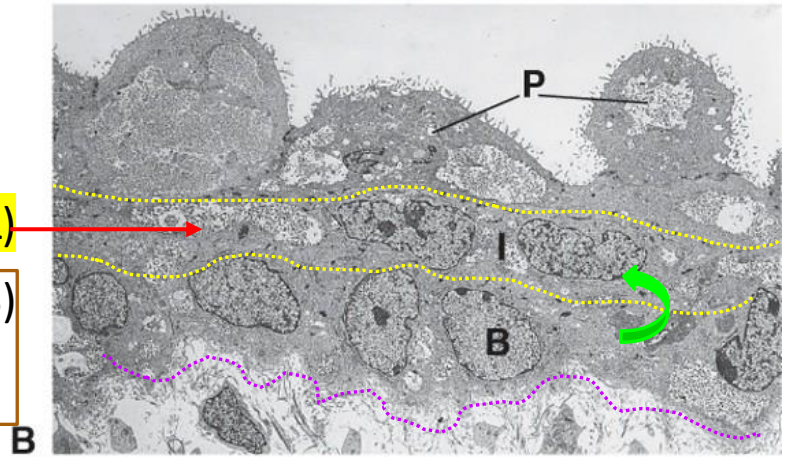
Onset of stratification

11 weeks (3 Mo): intermediate layer

Periderm (P)

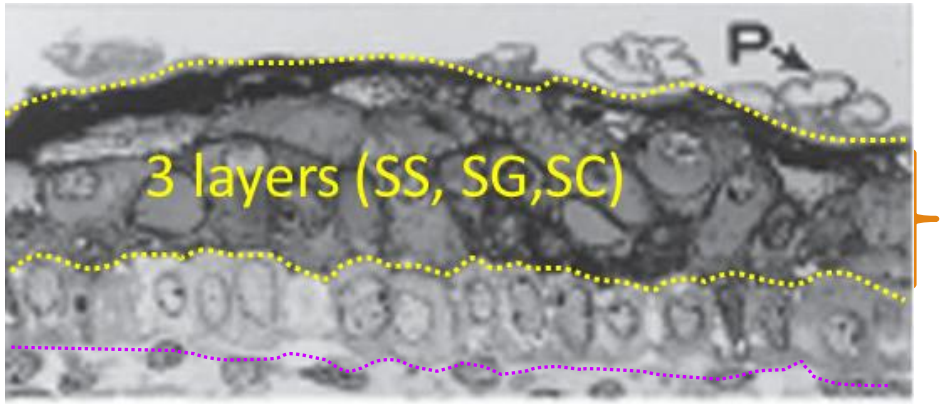
Intermediate layer (IL)

Germinative layer (B)
(Stratum germinativum: SG)
Layer of **stem cells**



11 weeks

5 months Periderm (P) is shed

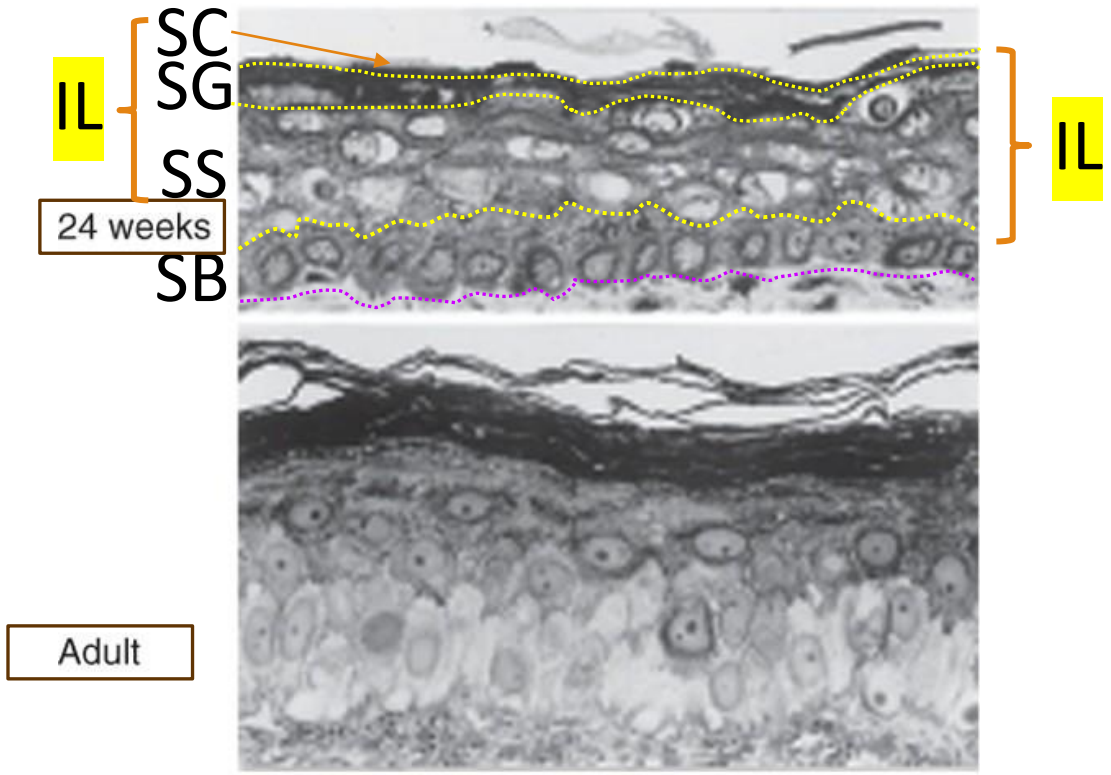


17 weeks

The basal layer later forms ridges and hollows, which are reflected on the surface of the skin in the fingerprint.

Development of Skin/Stratification

6 Months: Full thickness



Development of Skin/Stratification

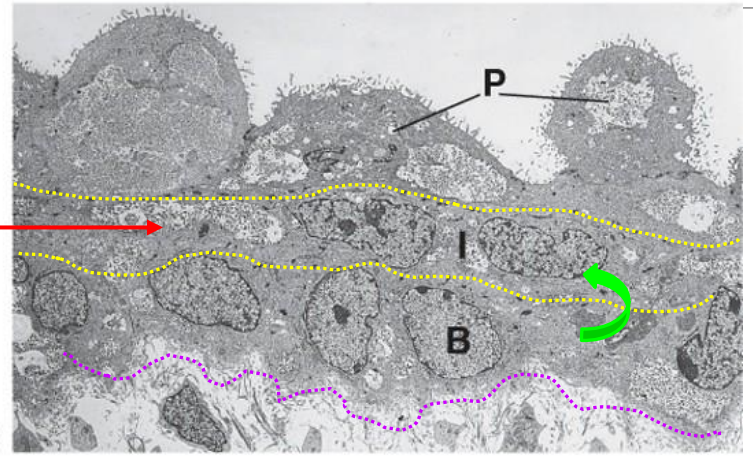
Onset of stratification

11 weeks: intermediate layer

Periderm (P)

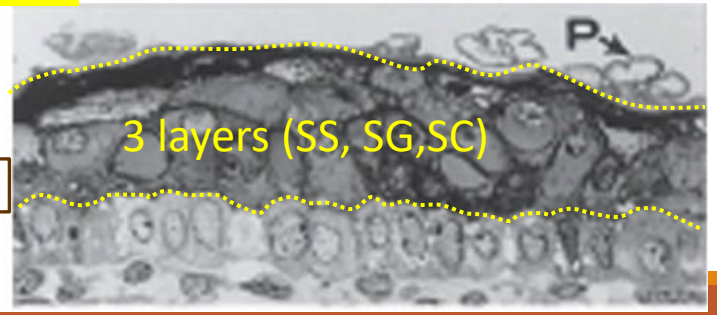
Intermediate layer (IL)

Germinative layer (B)
(Stratum germinativum: SG)
Layer of **stem cells**



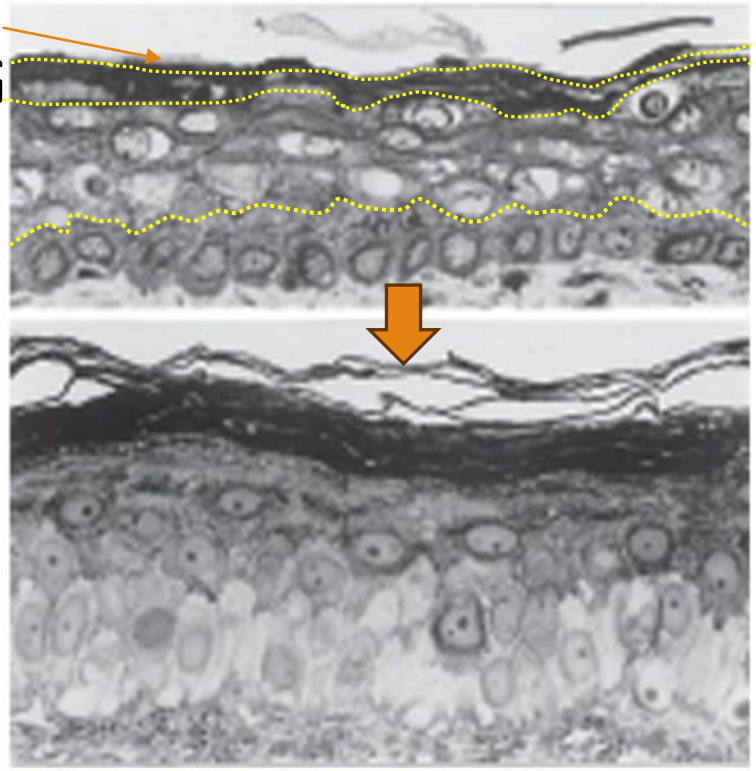
11 weeks

5 months Periderm (P) is shed



17 weeks

IL



24 weeks

Adult

Stratified epidermis

Filaggrin: flatten cell

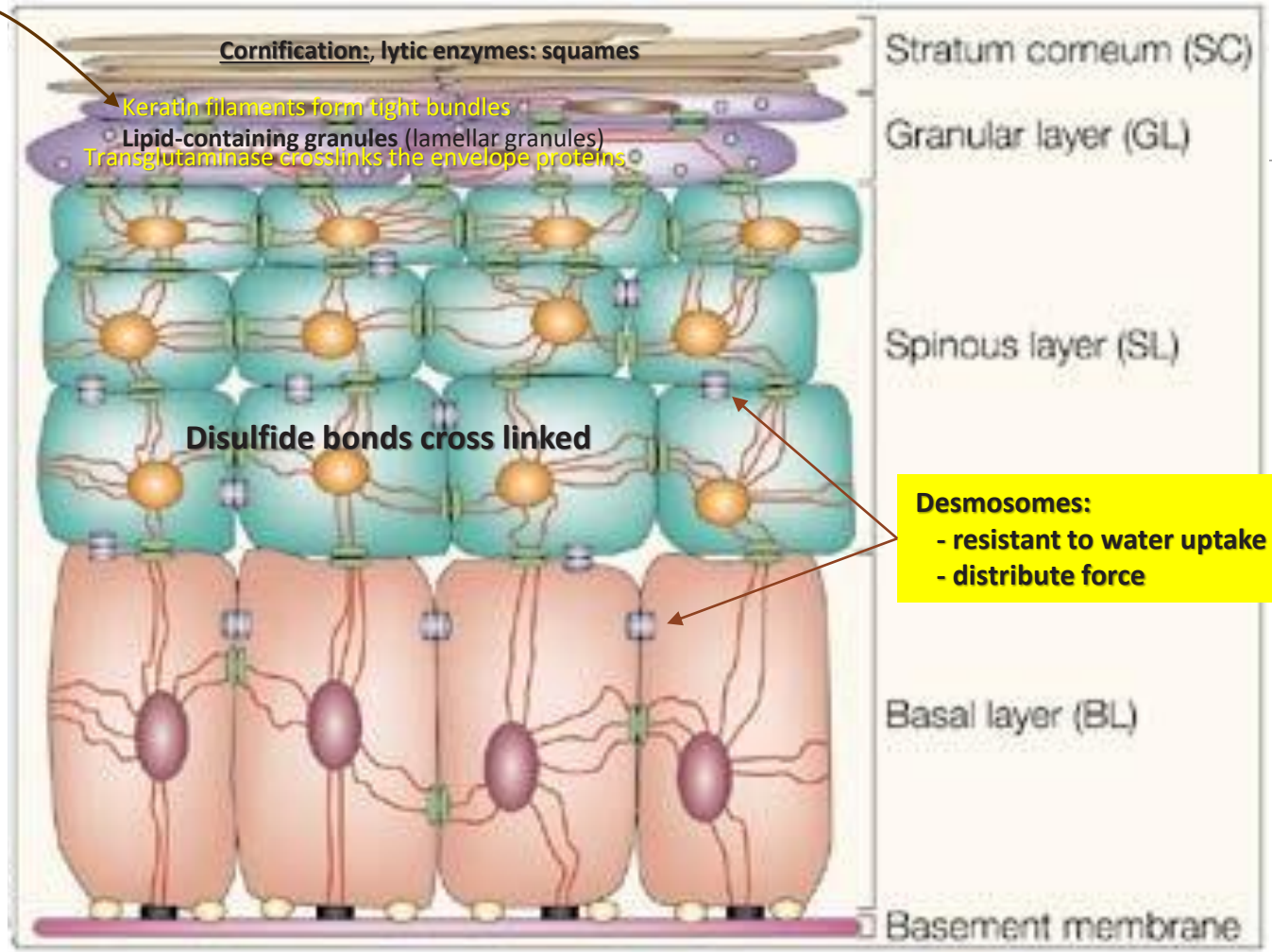
Envelope proteins
- Loricrin
- Involucrin
- Envoplakin

Secondary Keratin proteins

Keratin 1/10

Primary Keratin filaments

Keratin 5/14



Desmosomes:
- **resistant to water uptake or loss and infection**
- **distribute force**

Junctions: Adherens junction | Hemidesmosome | Desmosome | Focal contacts

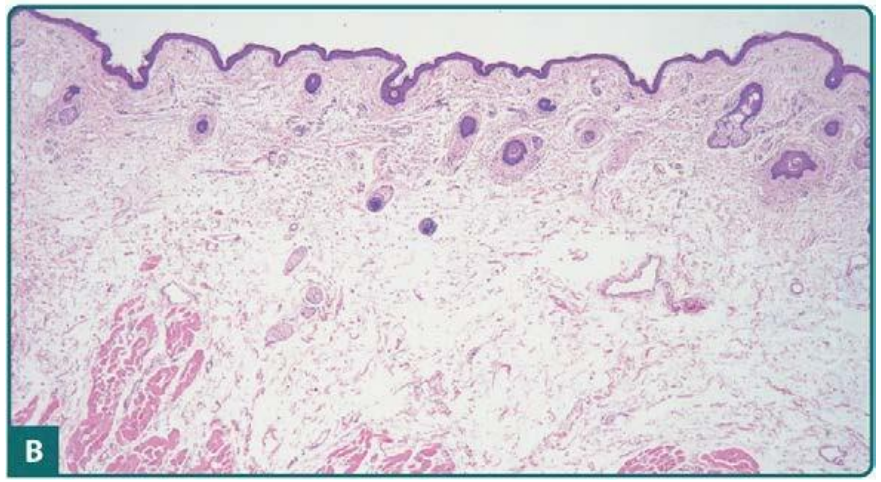
(integrins)

essential for cell survival and determines the orientation of cell divisions

Stratified skin

Thick skin

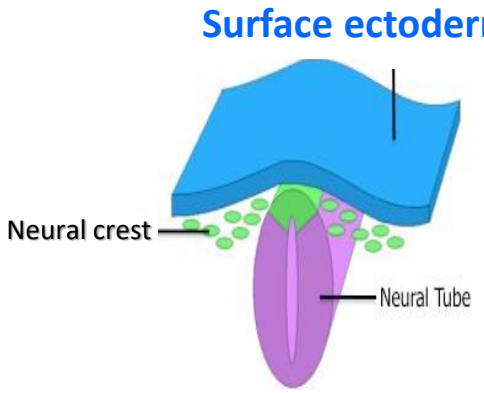
Thin skin



Keratinization of the Skin

Ichthyosis, excessive keratinization of the skin, is characteristic of a group of hereditary disorders that are usually inherited as an autosomal recessive trait but may also be X-linked. In severe cases, ichthyosis may result in a grotesque appearance, as in the case of a **harlequin fetus** (Fig. 21.2).

Figure 21.2 Ichthyosis in a harlequin fetus with massive thickening of the keratin layer, which cracks to form fissures between thickened plaques.

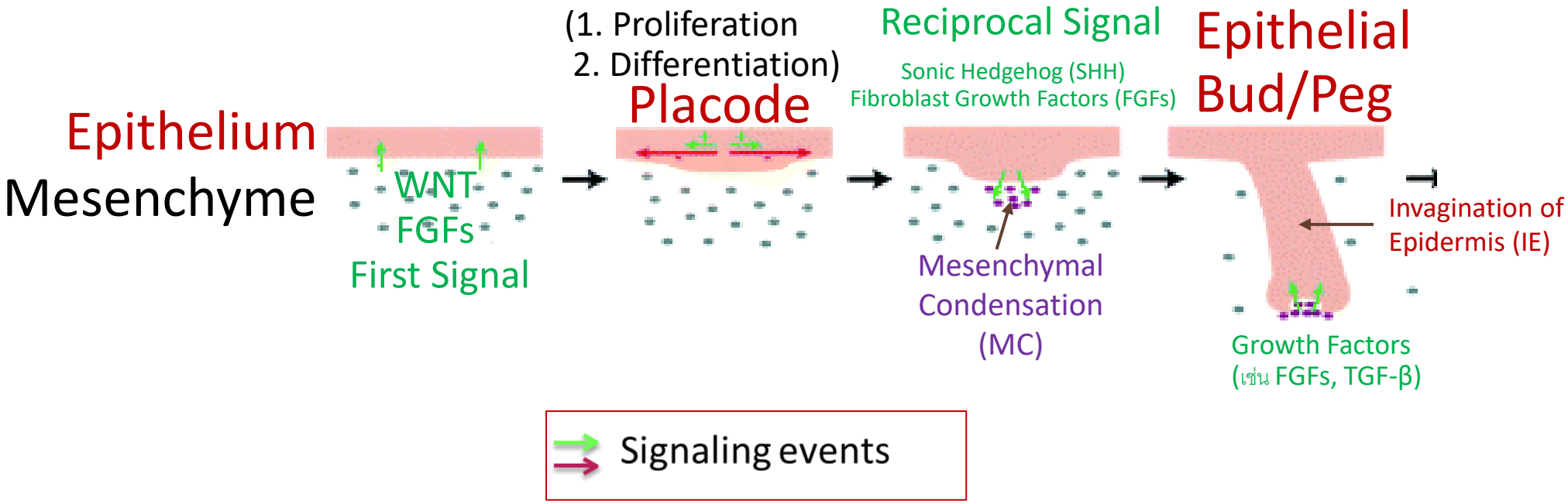


Epidermal Appendages

Surface ectoderm

- Hair follicles,
- Glands: **sebaceous, sweat, apocrine**, mammary, salivary, lacrimal
- Nails
- Teeth

Share common developmental mechanisms:

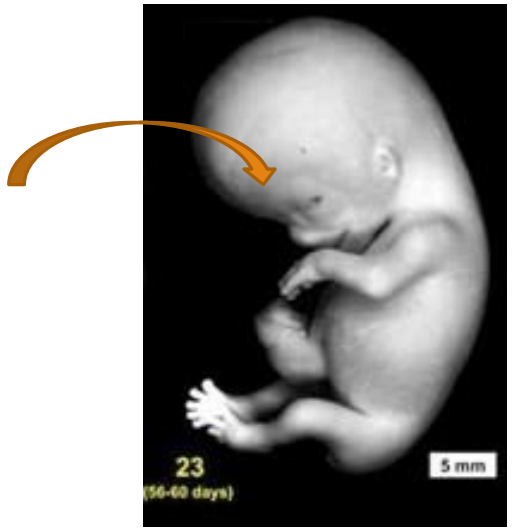


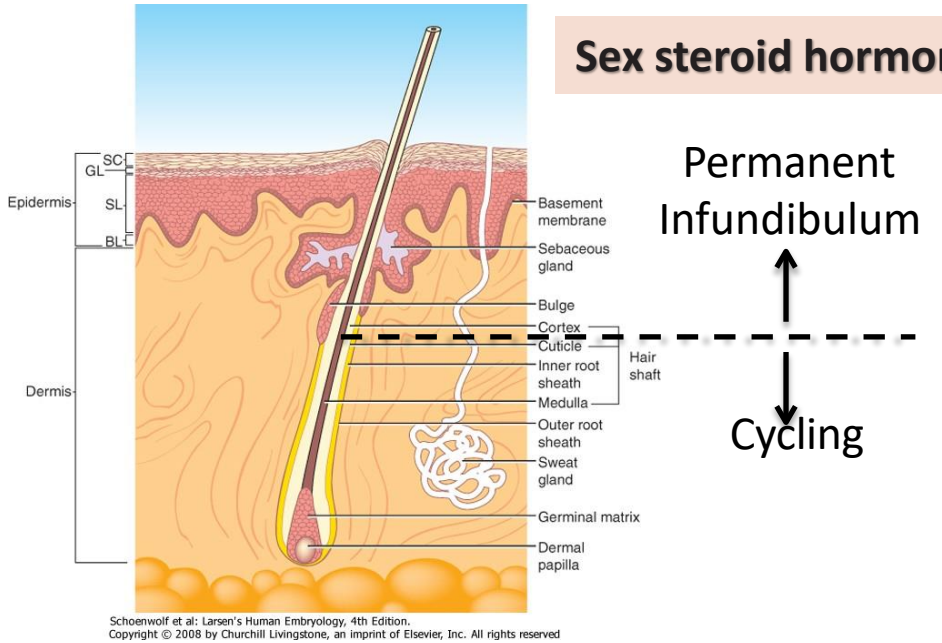
Epithelial-mesenchymal interaction induces the formation of the placode (P), followed by mesenchymal condensation (MC) and the invagination of the epidermis (IE) into the dermis.

Hair follicle development and cycling

Epidermal appendage
Involved in thermoregulation/sun protection

eyebrows,
eyelids,
upper
lip,
chin.





Sex steroid hormones dependent

Months 2-4: Onset hair follicle development

Hair follicles develop **first in cranial region**

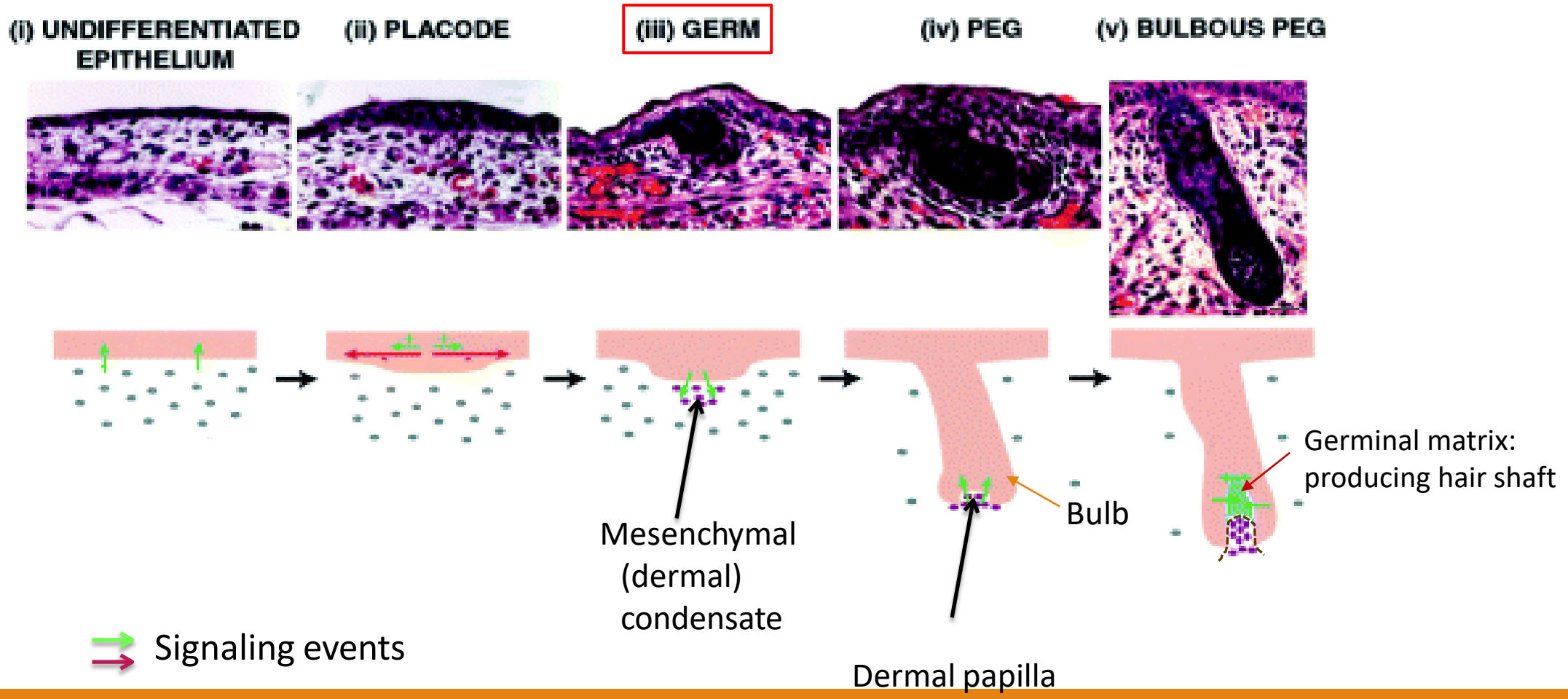
Month 5: most hair follicles present ≈ **5,000,000** hair follicles.

it is believed that novel hair follicles do not form after birth

Hair follicle development

(= 3 months = 12 weeks)

Month 2 → + 1 Month → Birth: 5,000,000



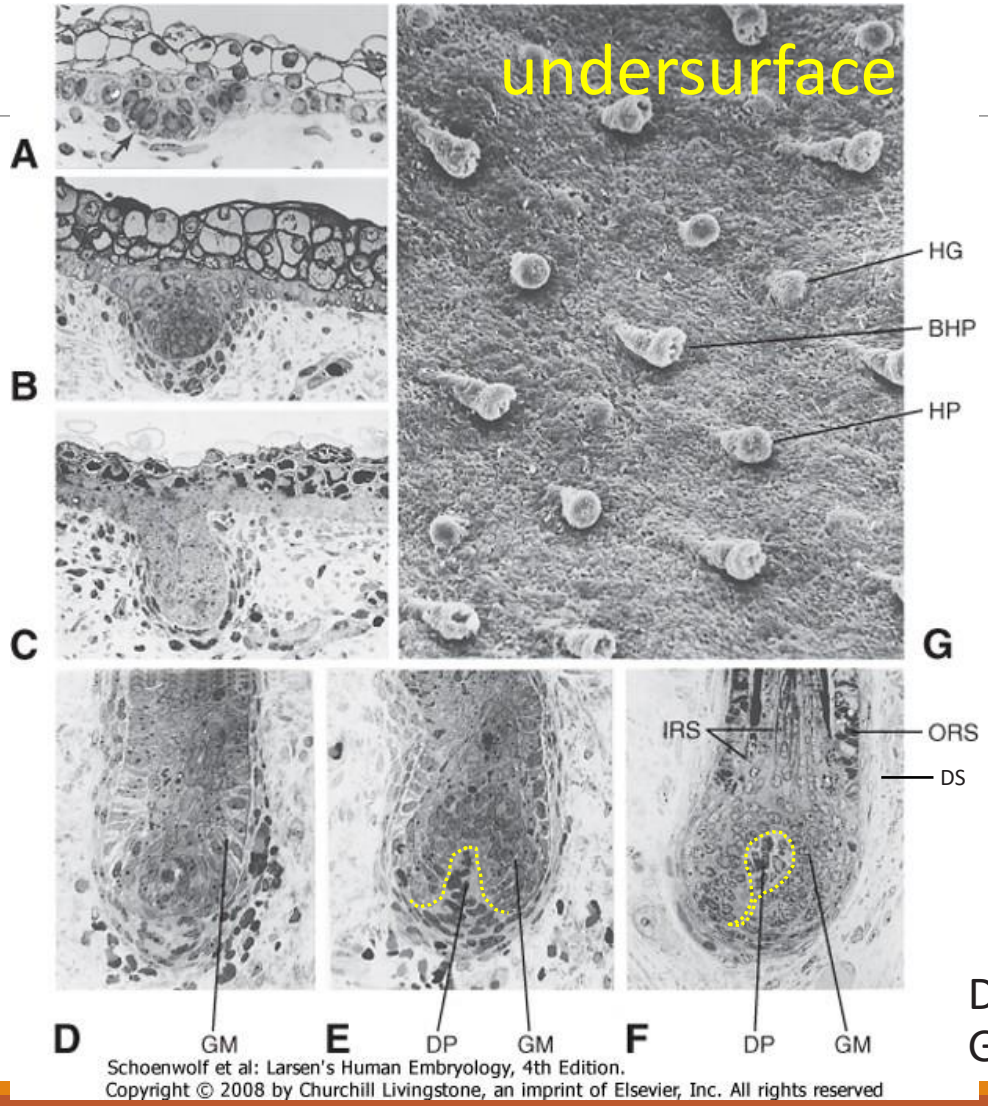
Hair follicle development

Hair germ (HG)

Hair peg (HP)

Bulbous hair peg (BHP)

Invasion of dermal cells



Epidermal cells lining the follicular canal

- Inner root sheath (IRS)
- Outer root sheath (ORS)

Dermal root sheath (DS)

⇩ associated with the hair follicle

Arrector pili muscle

- ⊘ eyebrows
- ⊘ eyelashes

DP: Dermal papilla
GM: Germinal matrix: producing the hair shaft

Hair follicle development

Formation of:

Arrector pili muscle (APM)

Stem cells= hair follicle bulge ★★
Germinal matrix
Inner and outer root sheaths

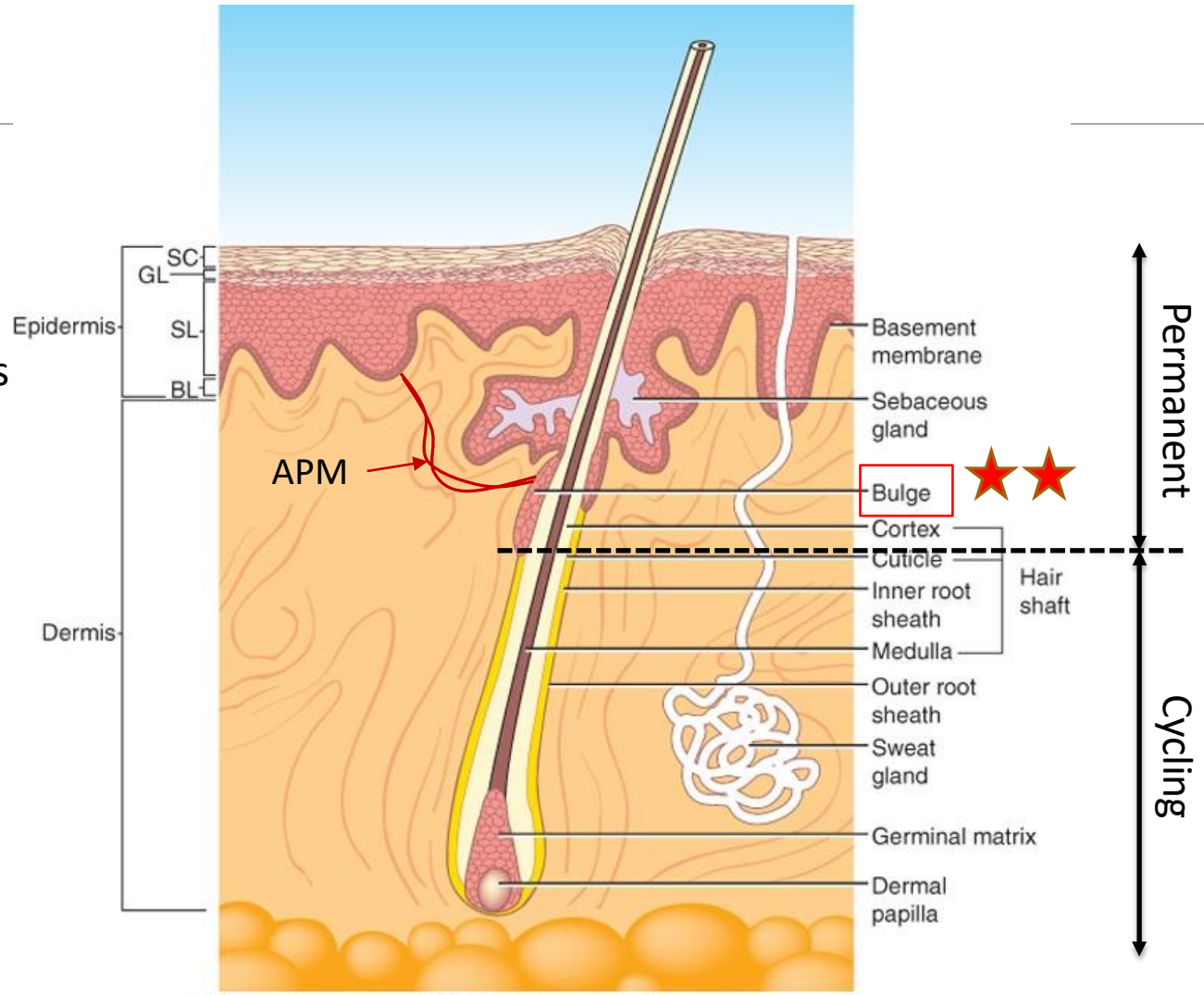
12th week

Babies are born with first generation of fine un-pigmented hairs:

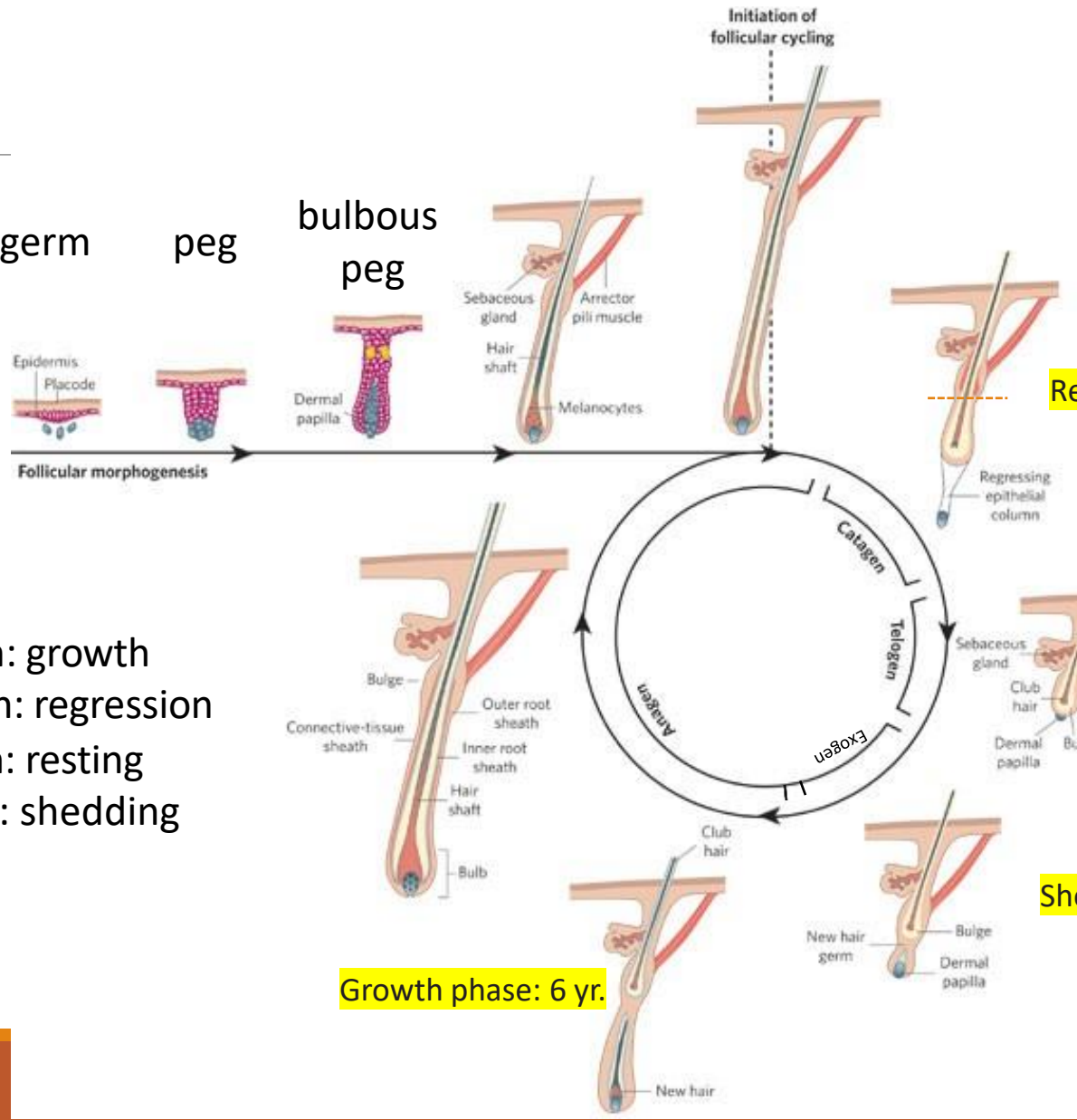
lanugo ★

Postnatal regeneration:
Hair follicle cycling

Vellus & terminal hairs



Postnatal hair follicle cycling



Anagen: growth
Catagen: regression
Telogen: resting
Exogen: shedding

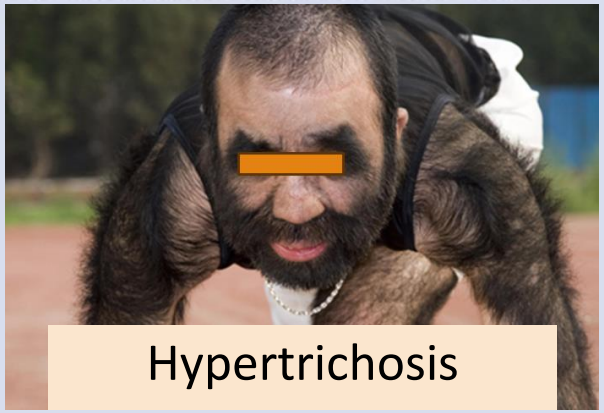
Platelet-Rich Plasma (PRP)

https://www.youtube.com/watch?v=gVSgDG8mDGk

Abnormalities of Hair Distribution

Hypertrichosis (excessive hairiness) is caused by an unusual abundance of hair follicles. It may be localized to certain areas of the body, especially the lower lumbar region covering a spina bifida occulta defect or may cover the entire body (Fig. 21.4).

Atrichia, the congenital absence of hair, is usually associated with abnormalities of other ectodermal derivatives, such as teeth and nails.



Hypertrichosis

Hypotrichosis or Alopecia or Atrichia

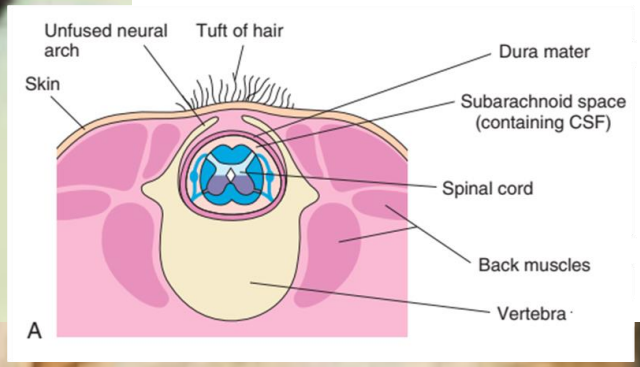
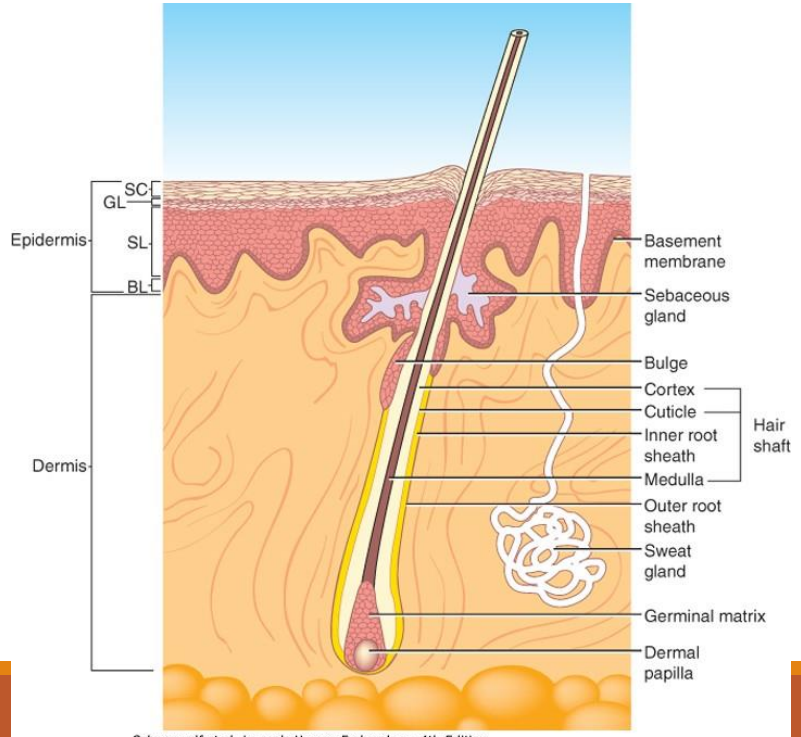


Figure 21.4 Child with hypertrichosis.

Epidermal gland development

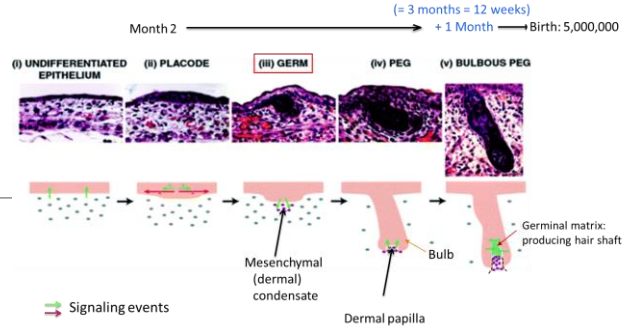
Epidermal appendages: outgrowths from E or HF

- **Sebaceous glands: sebum/vernix**
- **Sweat glands**
- **Apocrine glands (pheromones)**
- **Mammary glands**
- Salivary glands
- Lacrimal glands

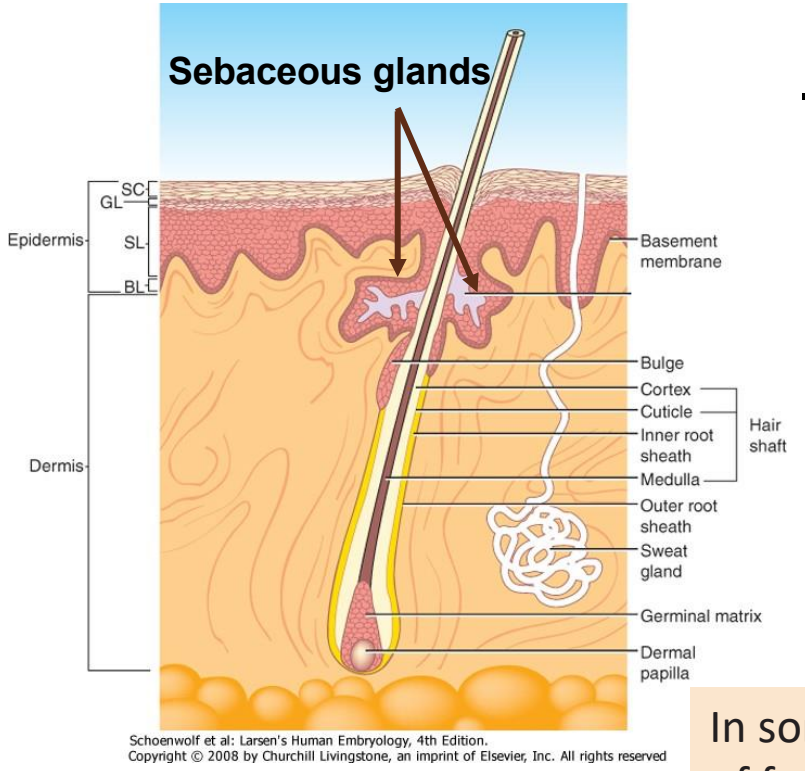


Epidermal gland development

Epidermal appendages



Sebaceous glands



Schoenwolf et al: Larsen's Human Embryology, 4th Edition.

- Develop from hair follicle (+4 weeks):
- Mature by 6 months: face
- Highly active in the fetus

(waterproof protective coating)

★**vernix caseosa =** sebum + desquamating epidermal cells + remnants of the periderm

In some areas of hairless skin—such as the glans penis of males and the labia minora of females—sebaceous glands develop as independent down growths of epidermis.

★**vernix caseosa =** sebum + desquamating epidermal cells + remnants of the periderm

After **birth**, the sebaceous glands become relatively **inactive**,
but at **puberty** they again begin to secrete **large quantities** of sebum in response to the **surge** in circulating **sex steroids**.

Milia (baby acne) are common in all ages and both sexes. They most often arise on the face, and are particularly prominent on the eyelids and cheeks, but they may occur elsewhere.

Epidermal gland development

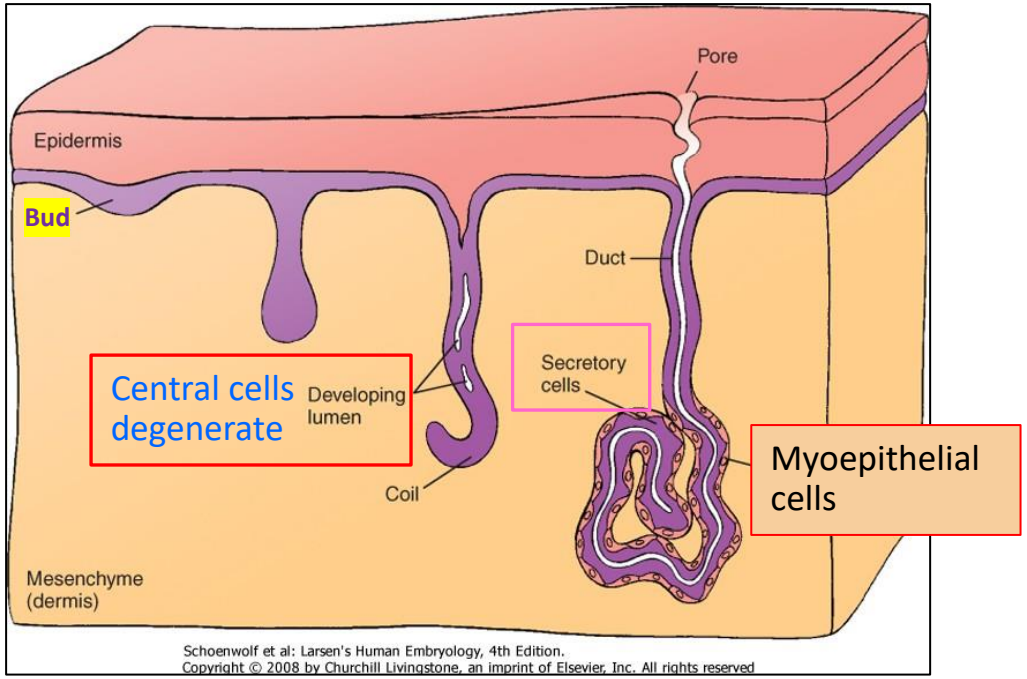
Epidermal appendages

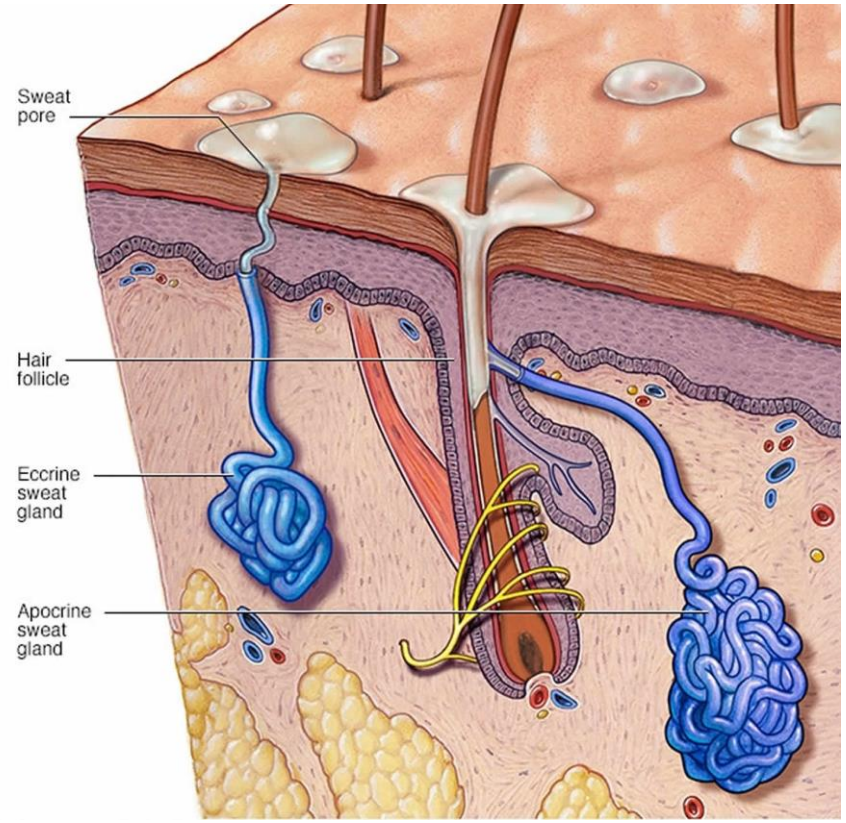
Sweat glands (eccrine): develop from **stratum germinativum (20 weeks+)**

Apocrine sweat glands: develop in association with HFs, most lost late in fetal development

except the axillae, mons pubis, prepuce, scrotum, and labia minora

Stratum germinativum



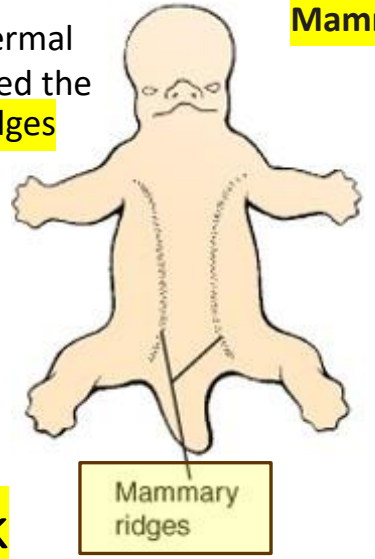


Epidermal gland development

Epidermal appendages

Mammary gland

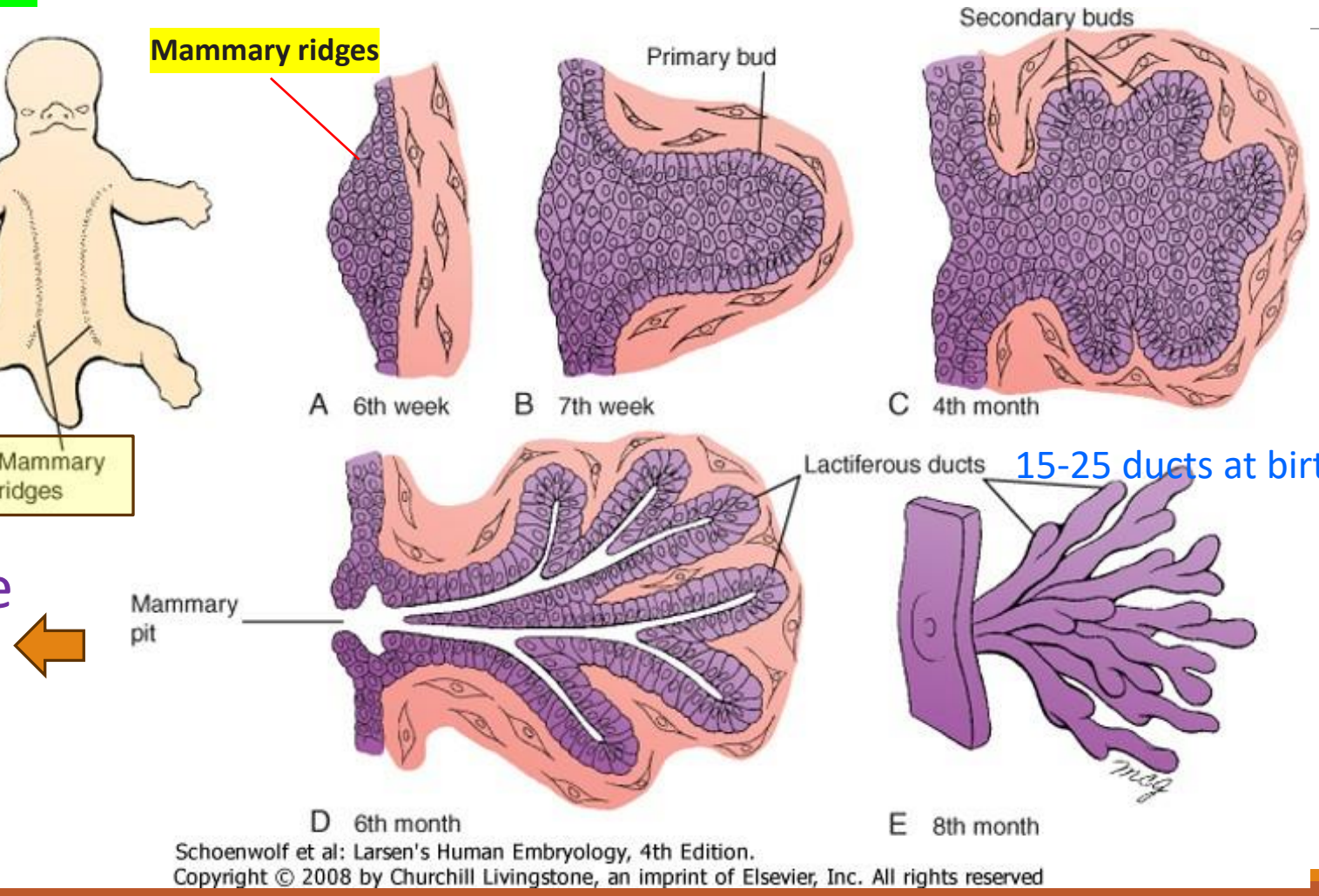
A pair of epidermal thickenings called the mammary ridges



4th week

inverted nipple

หัวนมบอด



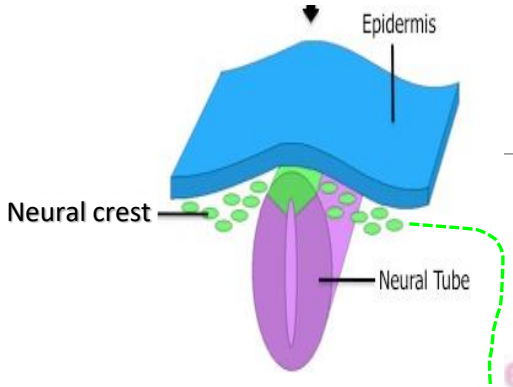
Polymastia:
supernumerary breasts

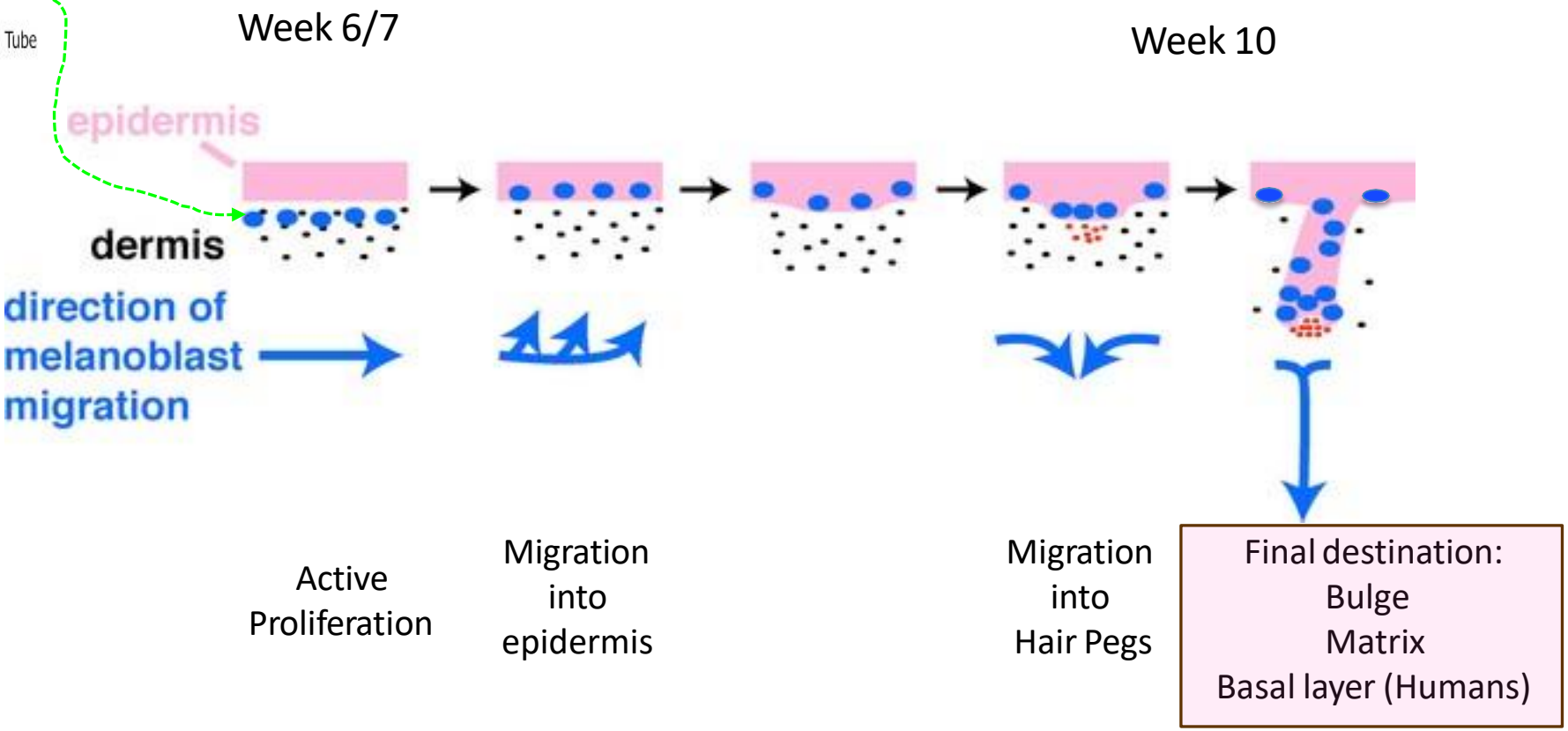
Polythelia:
supernumerary nipples

Melanocytes

Melanocyte development

Neural crest





Millar, Plos Biology 2005

Melanocyte development

Neural crest

Before stratification

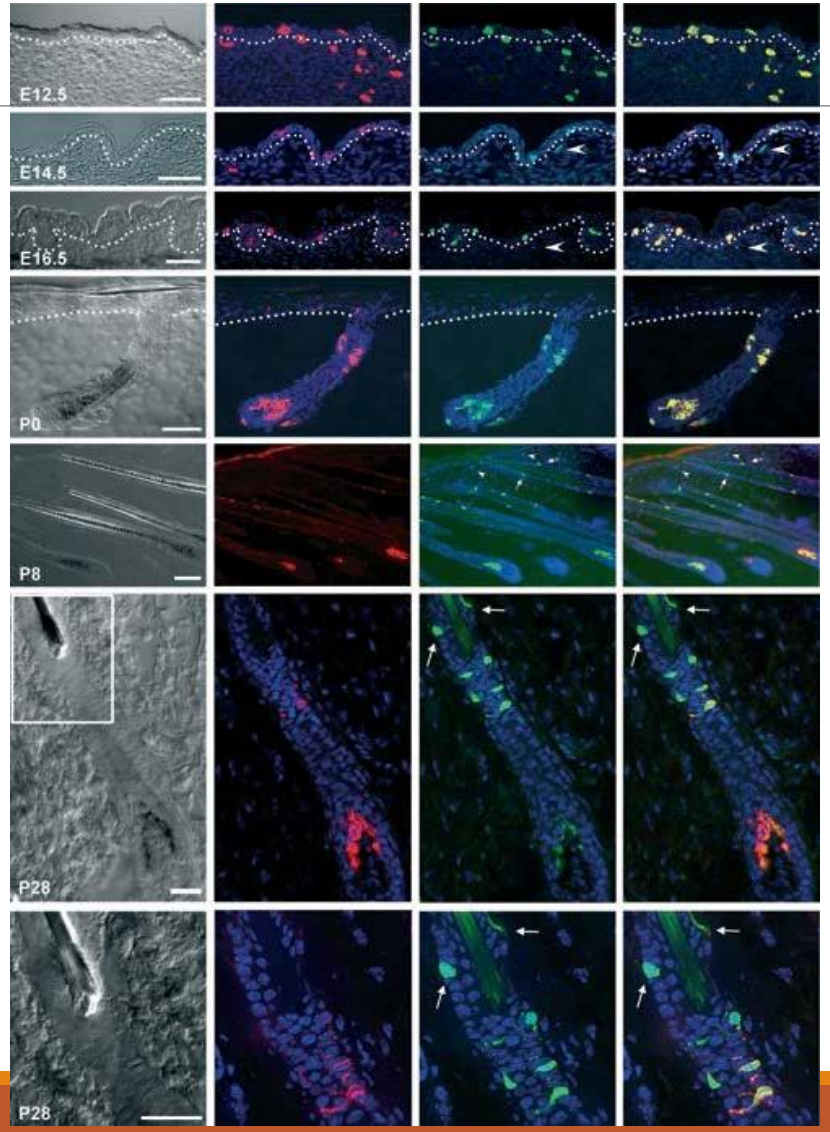
Onset stratification

Bulbous hair pegs

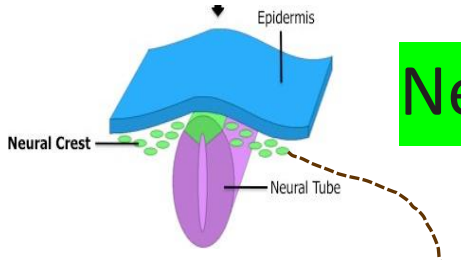
Anagen

Matrix

Hair follicle Bulge

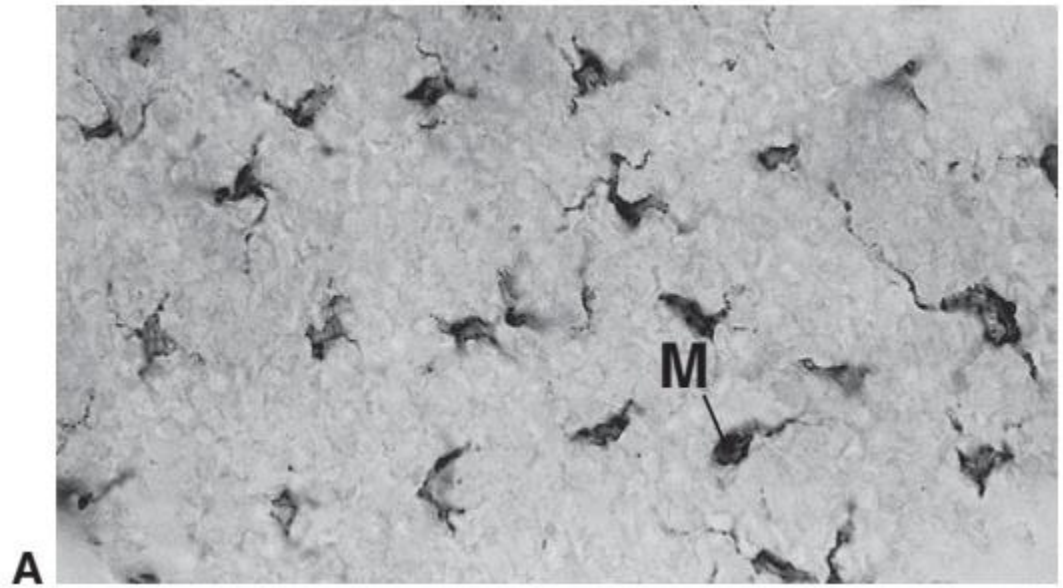


Djian-Zaouche,
Pigment Cell Melanoma Res 2012



Neural crest cells

Melanocytes



6^{th} to 7^{th} weeks

(studies using monoclonal antibodies directed against antigens characteristic of **melanocyte precursors**)

Melanocytes represent between 5% and 10% of the cells of the epidermis in the adult.

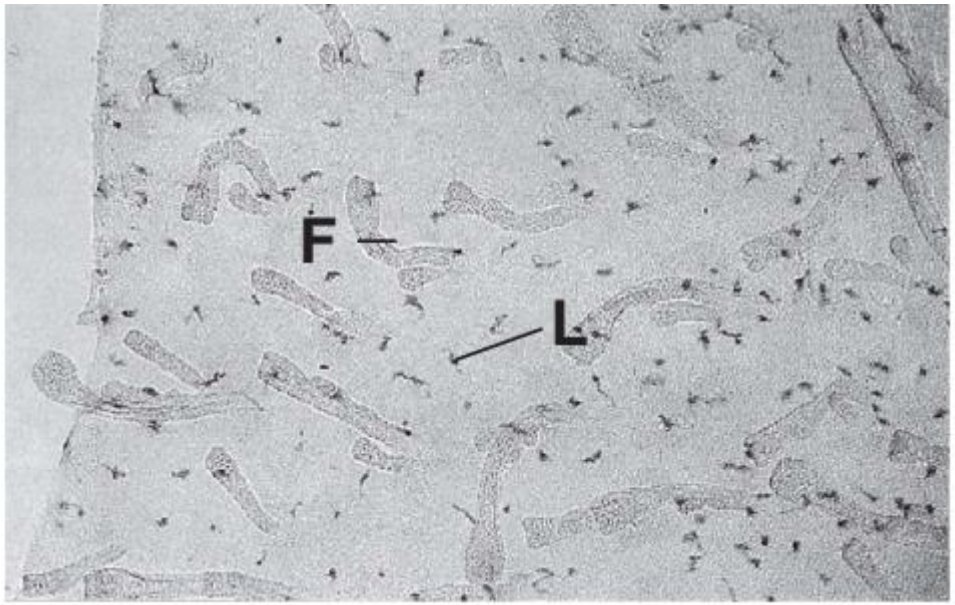
Melanocytes function as a sunscreen

- Sunburn
- Cancer

Melanoma

Bone marrow

Langerhans cells (macrophage)



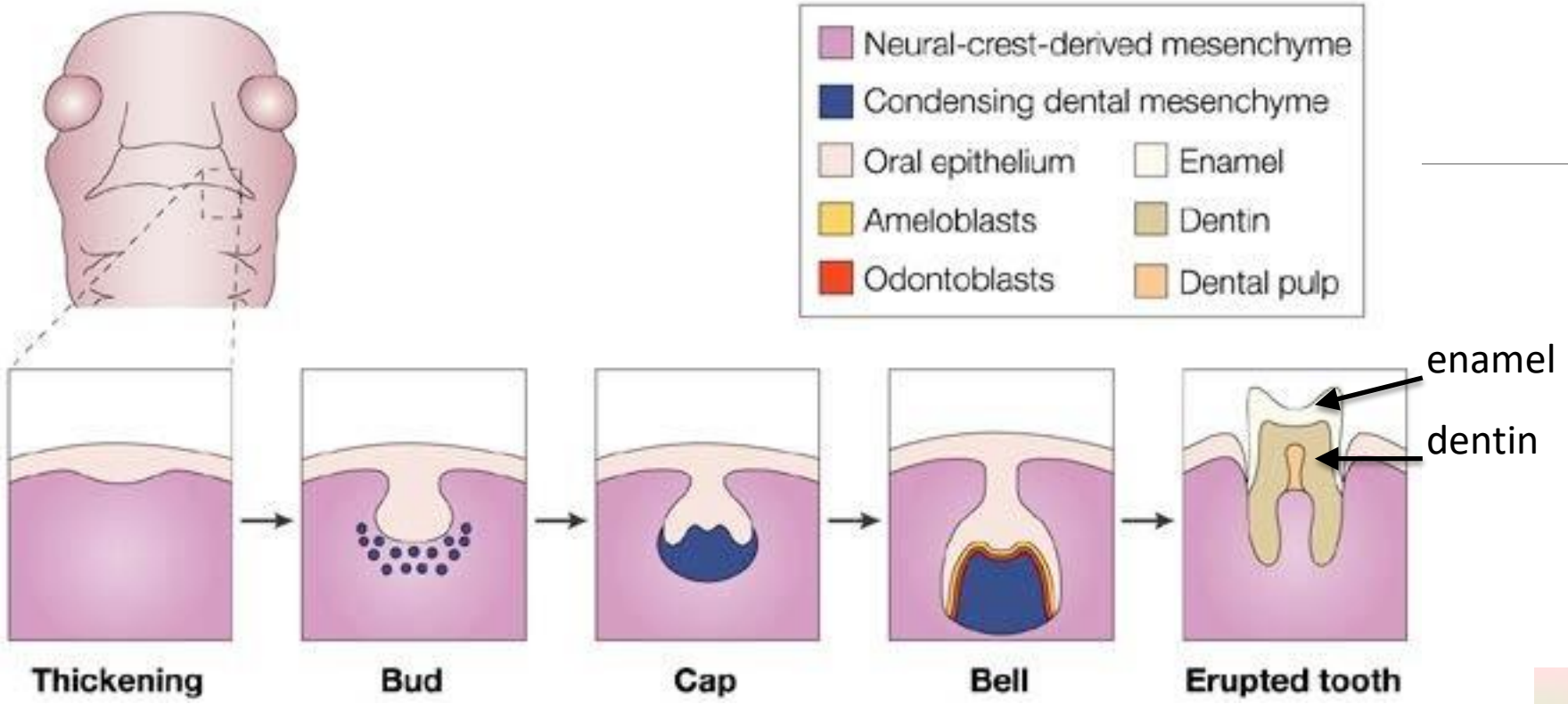
7th week → throughout life

Langerhans cells function as the **immune cells** of the skin

- contact sensitivity (allergic skin reactions)
- in immune surveillance against invading microorganisms

Teeth

Tooth development



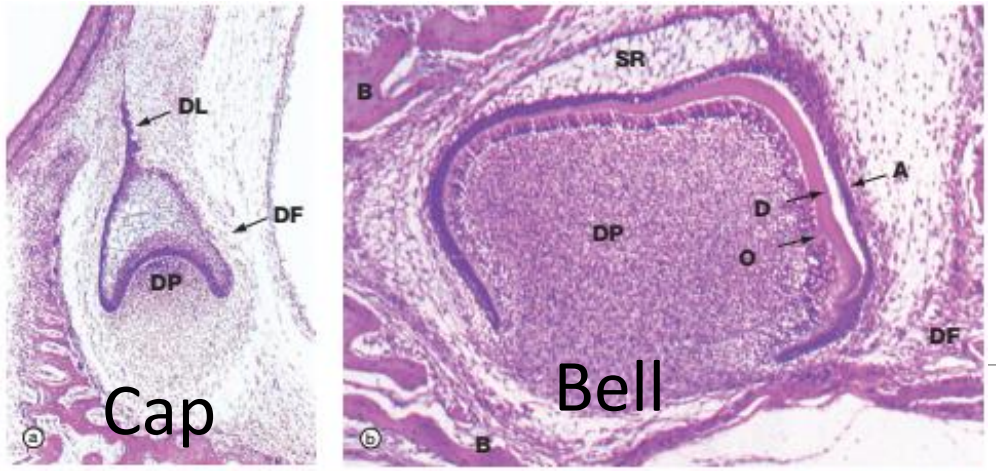
Week 6:
dental lamina
U-shaped ridge
of epidermis

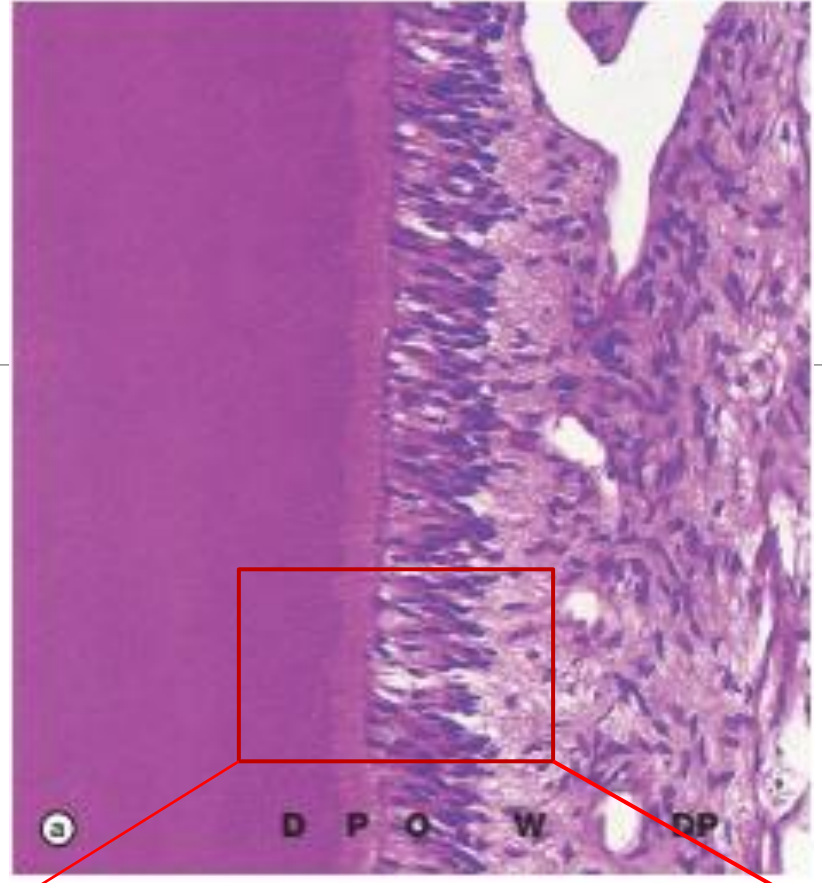
Week 7:
Mesenchyme condensation (20)

Week 8:
Mesenchyme invades base tooth bud:
Dental papilla

Week 14:
- Epithelial cells: Ameloblasts: enamel
- Neural crest cells=Ectomesenchymal cells = Odontoblasts: dentin

Tucker and Sharpe, Nature Genetics 2004





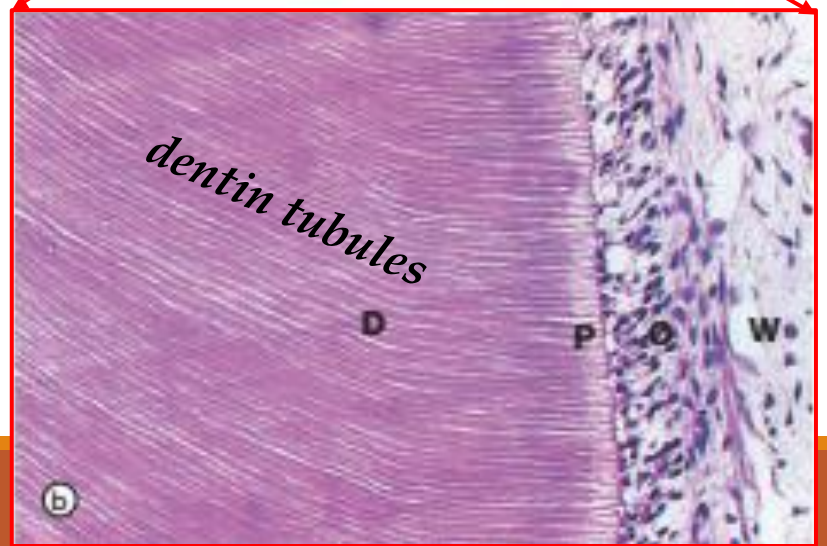
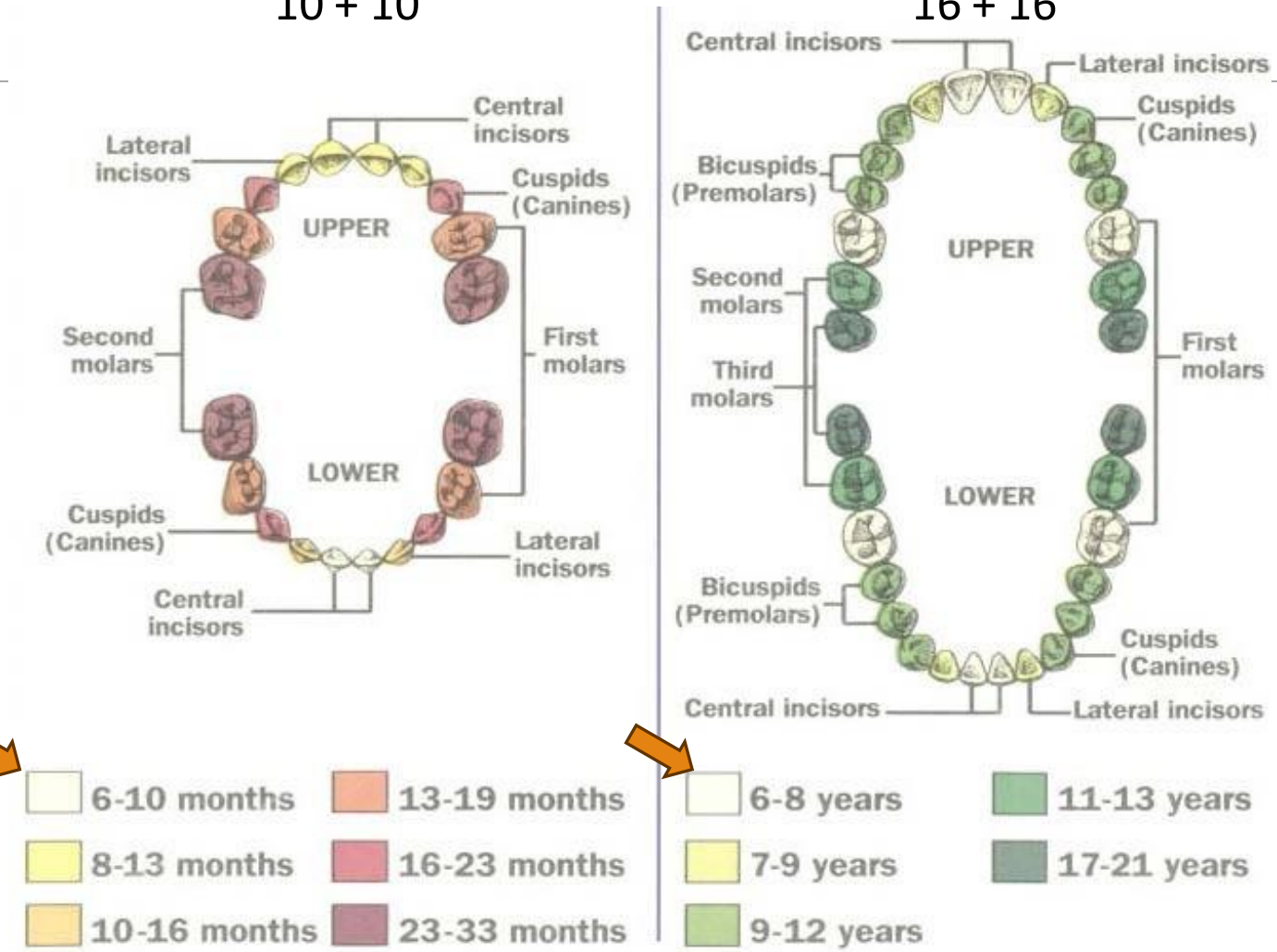


FIG. 13.5 Tooth development *(caption opposite)*
(a) H&E, cap stage (LP) (b) H&E, bell stage (MP) (c) H&E, onset of root development (LP) (d) H&E, ameloblasts (HP)

Tooth development

Primary teeth
10 + 10

Adult teeth
16 + 16



Nails

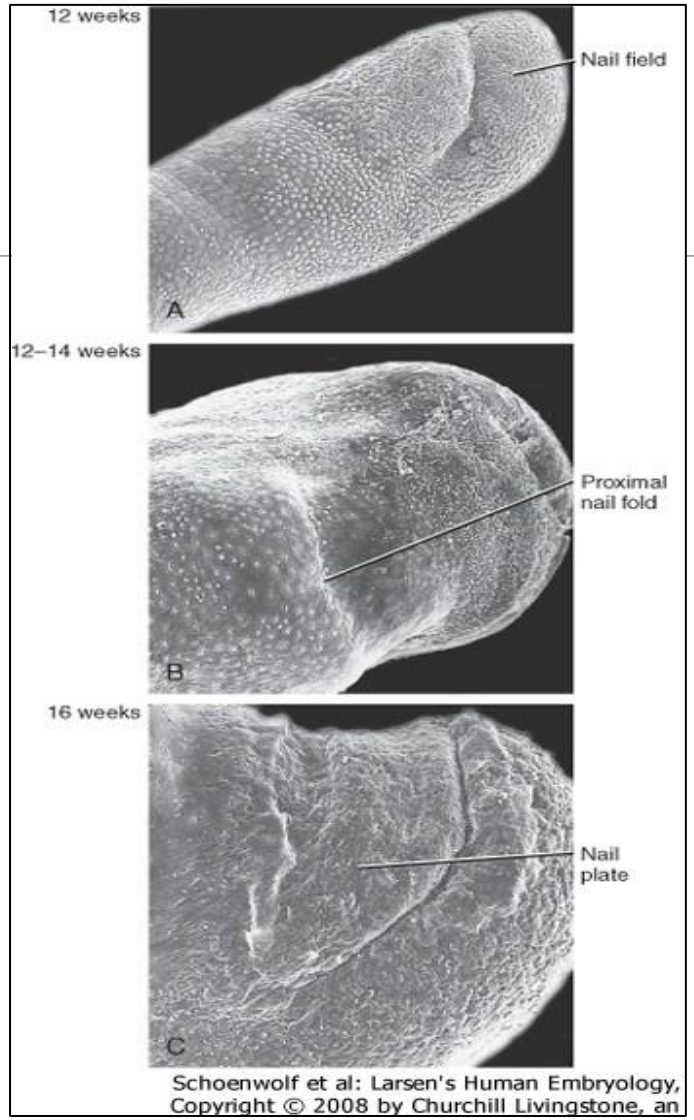
Nail development

Ectoderm

Week 10: epidermal thickening, **nail field**

Week 11: nail field **moves proximally,** nail folds, proximal nail fold: formation of formative zone

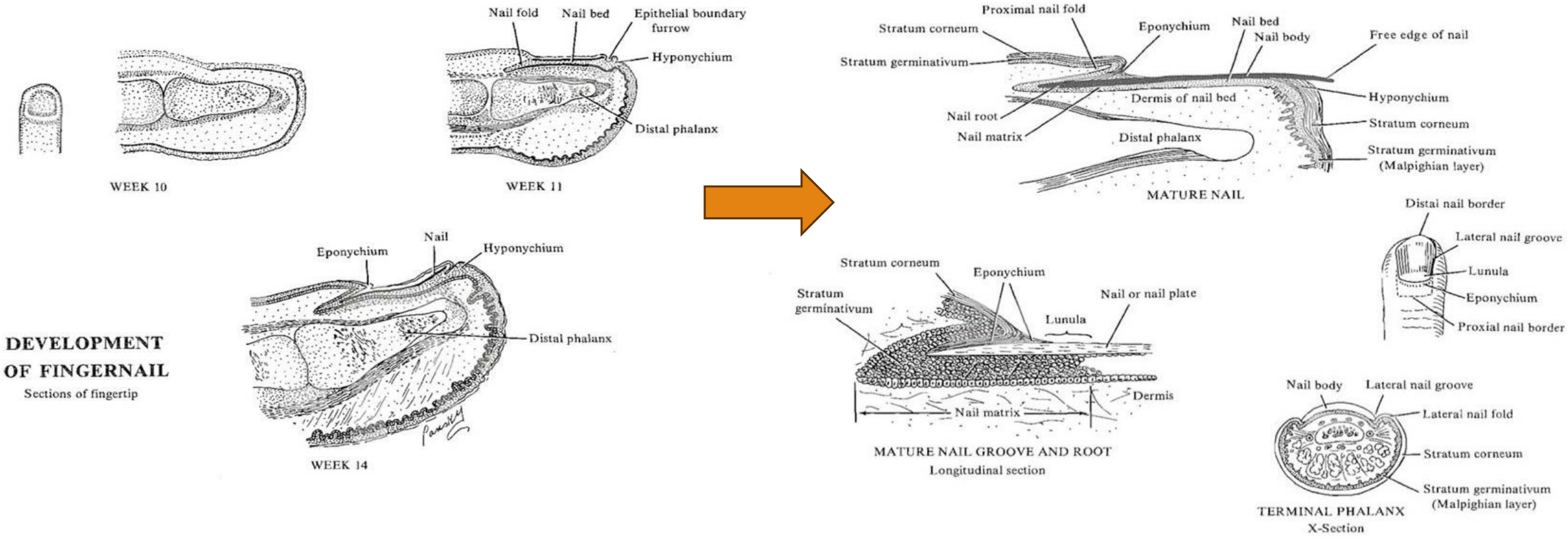
3rd – 9th months



http://discovery.lifemapsc.com/library/review-of-medical-embryology/chapter-75-development-of-the-nails

Nail development

Ectoderm



http://discovery.lifemapsc.com/library/review-of-medical-embryology/chapter-75-development-of-the-nails

X-linked genetic disorder

Ectodermal Dysplasia

- **Skin**: dry, thin, or prone to infections due to abnormalities in sweat glands.
- **Hair**: sparse, brittle, or absent (hypotrichosis or alopecia).
- **Nails**: thin, brittle, or misshapen.
- **Teeth**: hypodontia (fewer teeth) or anodontia (absence of teeth). Teeth may also be small, pointed, or misshapen.
- **Sweat Glands**: Reduction or absence of sweat glands can lead to heat intolerance and difficulty regulating body temperature.

Lecture conclusion

Skin

Skin origins

Development of the overlying epidermis

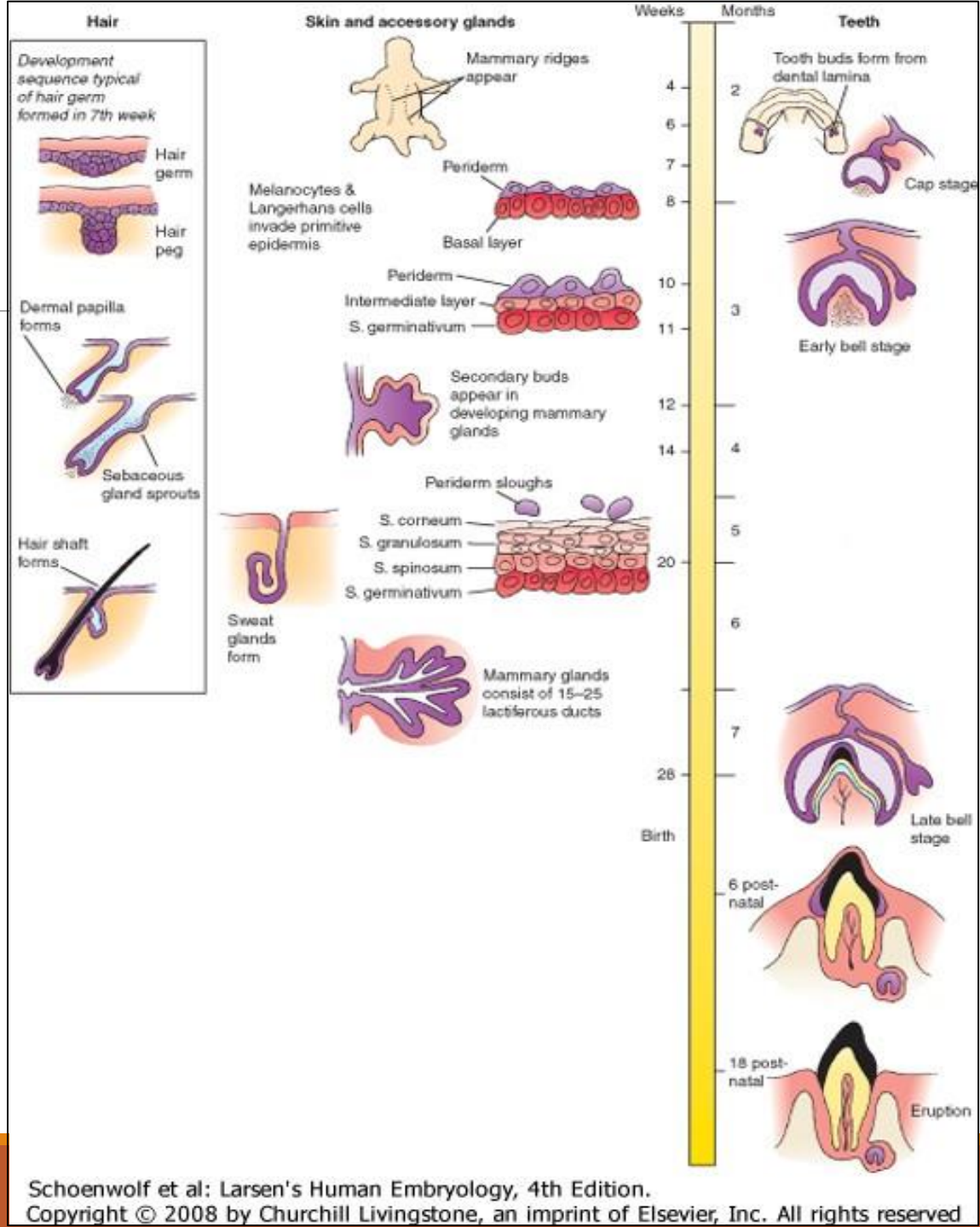
Development of epidermal appendages:

Hair follicles Glands
Mammary glands Nails
Teeth

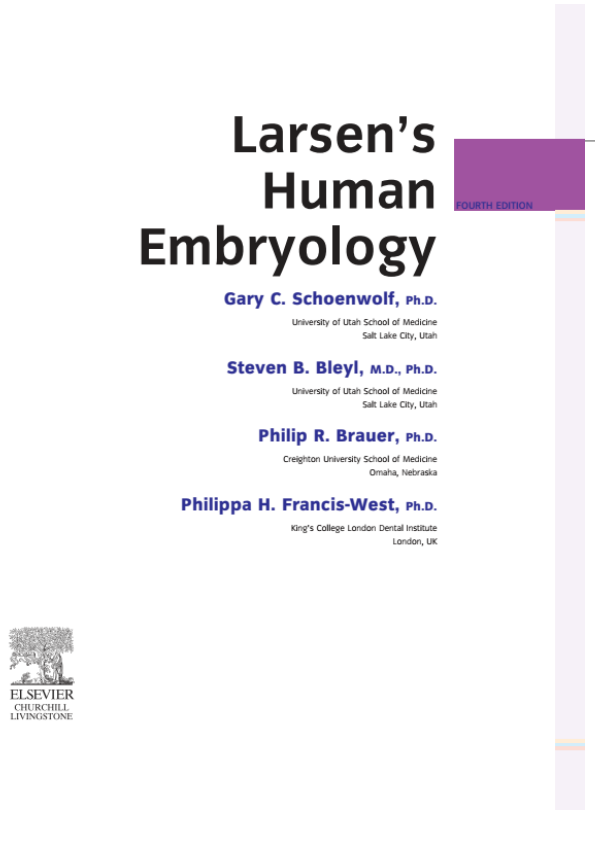
Development of Melanocytes

Development of Langerhans cells

Development of the Dermis



Schoenwolf et al: Larsen's Human Embryology, 4th Edition.


Larsen's
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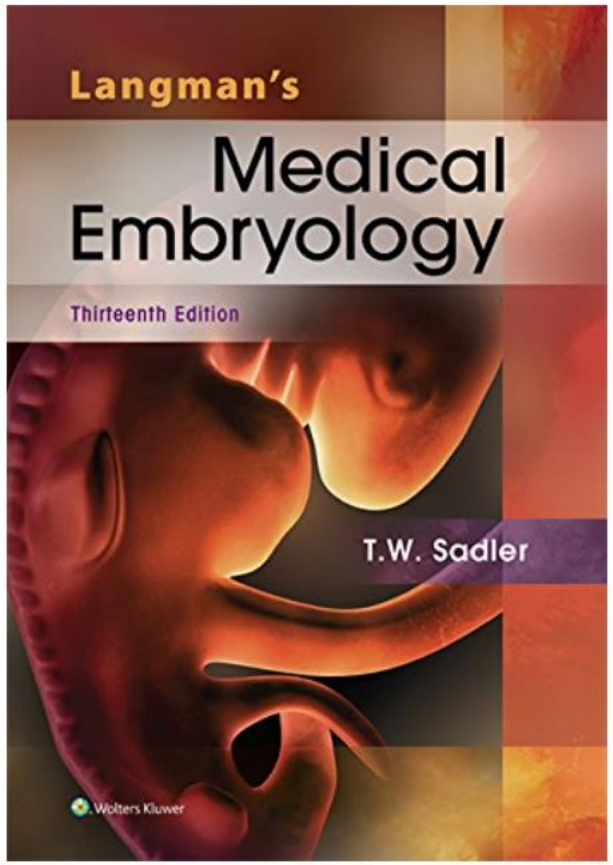
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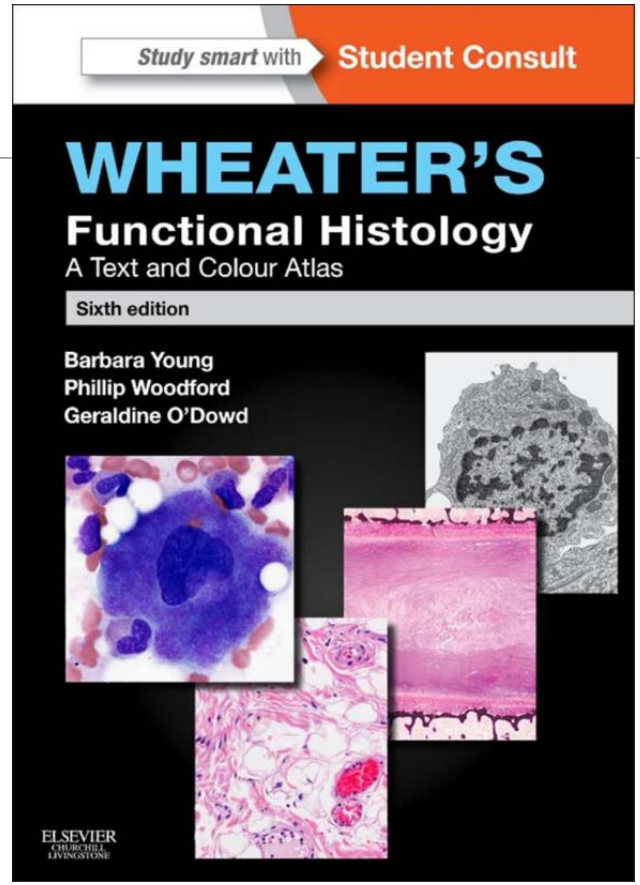
Wolters Kluwer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