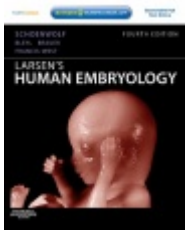
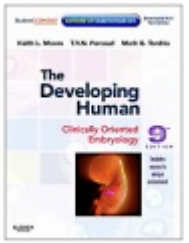
Development of the skin and its derivatives



Resources:
http://php.med.unsw.edu.au/embryology/
Larsen's Human Embryology – Chapter 7
The Developing Human: Clinically Oriented Embryology



Dr Annemiek Beverdam – School of Medical Sciences, UNSW
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Lecture overview

Skin function and anatomy

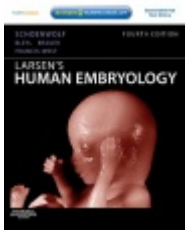
Skin origins

Development of the overlying epidermis

Development of epidermal appendages:
Hair follicles
Glands
Nails
Teeth

Development of melanocytes

Development of the Dermis



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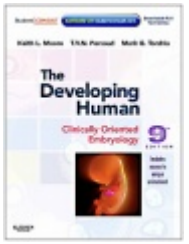

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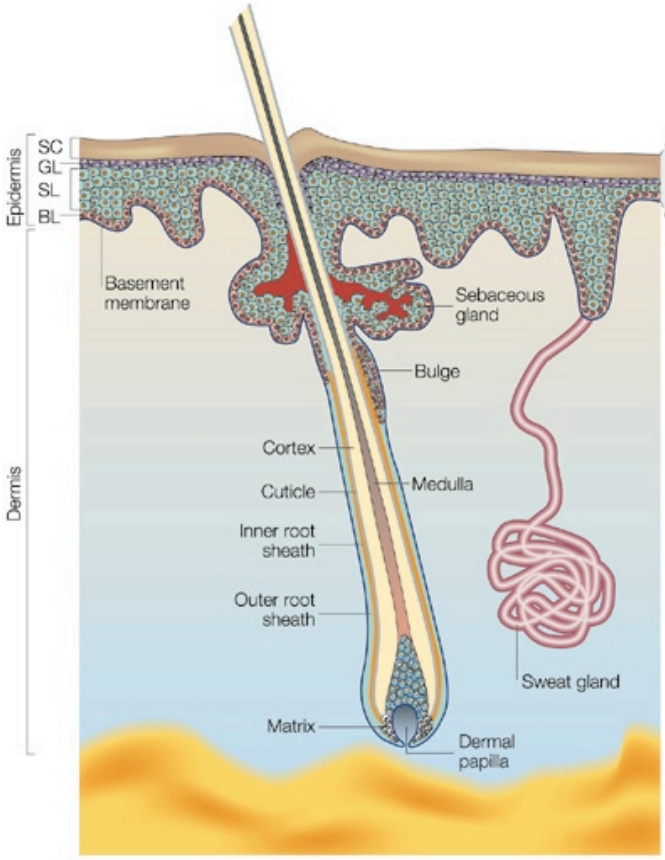
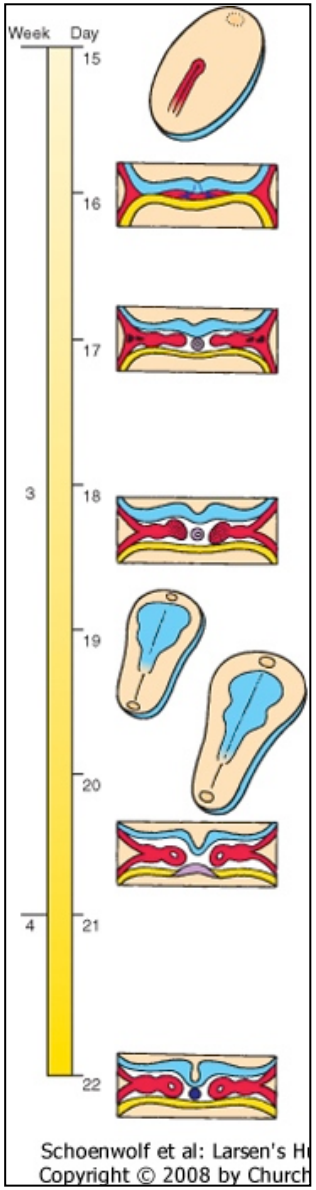
Skin Function and Anatomy

<u>Largest organ of our body</u>
Protects inner body from outside world (pathogens, water, sun)
Thermoregulation
Diverse: thick vs thin skin, scalp skin vs face skin, etc

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



Skin origins



Trilaminar embryo

Ectoderm *(Neural crest)*
brain, spinal cord, eyes, *peripheral nervous system*
epidermis of skin and associated structures,
melanocytes, cranial connective tissues (dermis)

Mesoderm
musculo-skeletal system, limbs
connective tissue of skin and organs
urogenital system, heart, blood cells

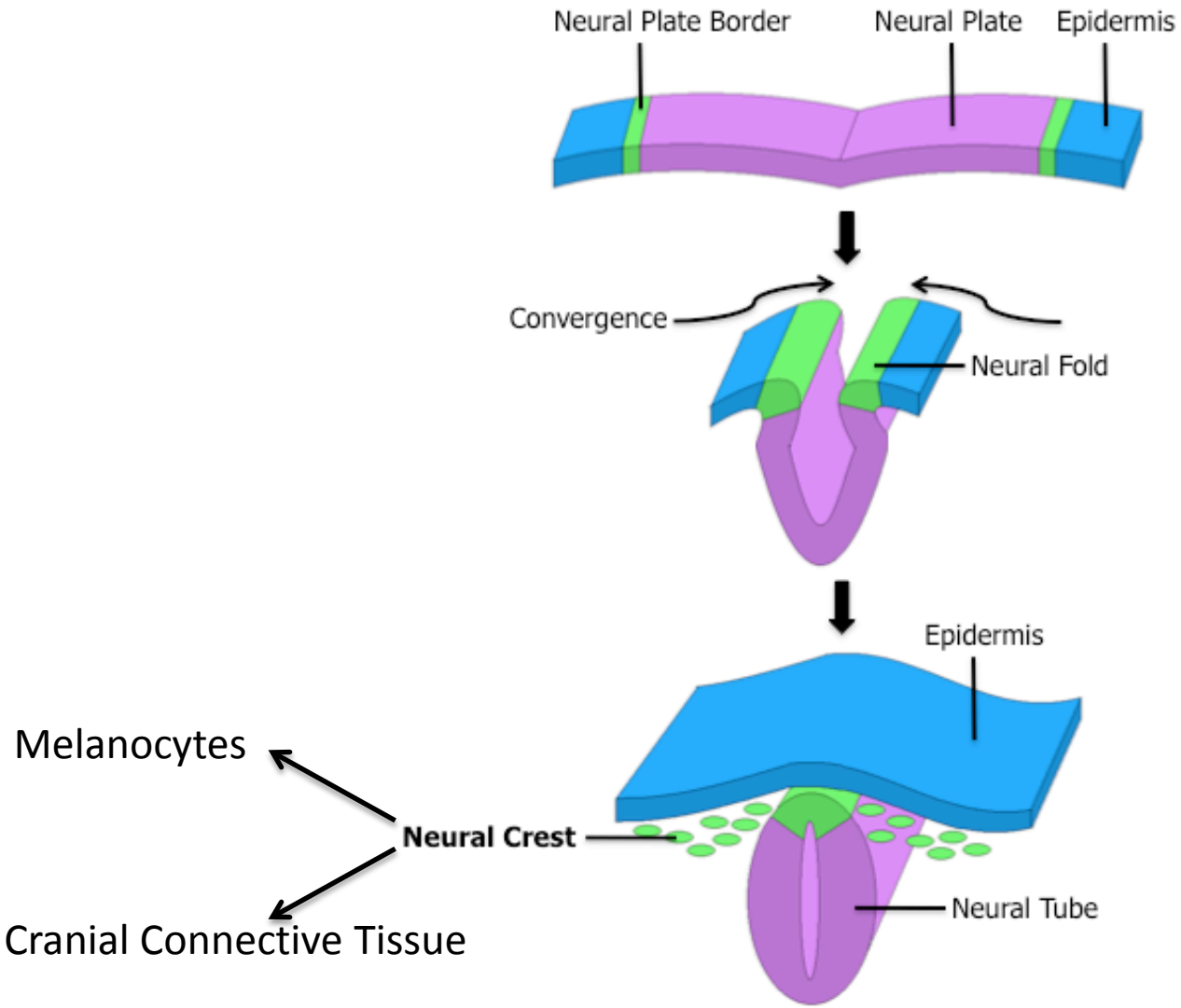
Endoderm
epithelial linings of gastrointestinal and respiratory tracts

Ectoderm

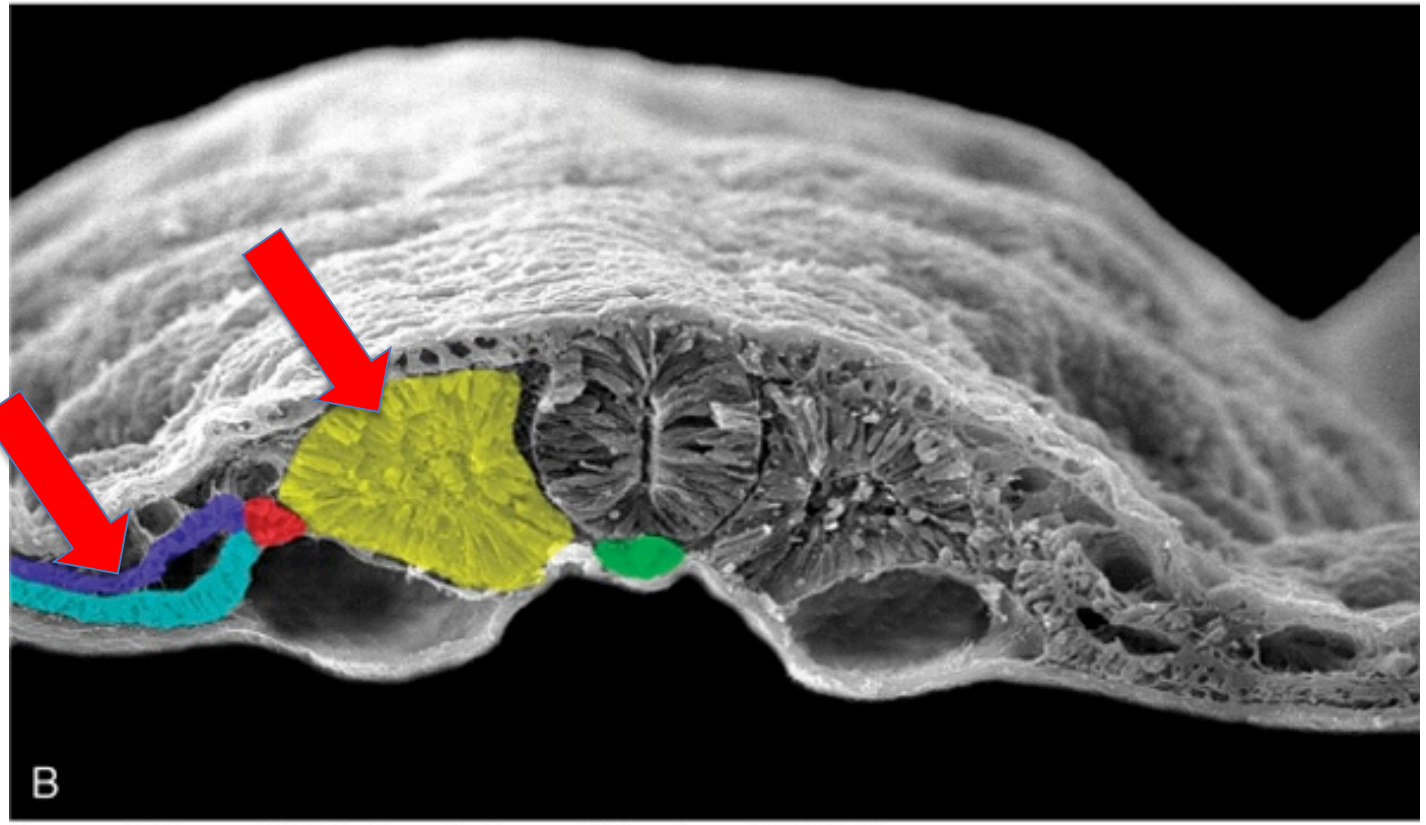
Overlying epidermis, epidermal appendages, nerve endings

Neural Crest

Melanocytes + Cranial Connective Tissue

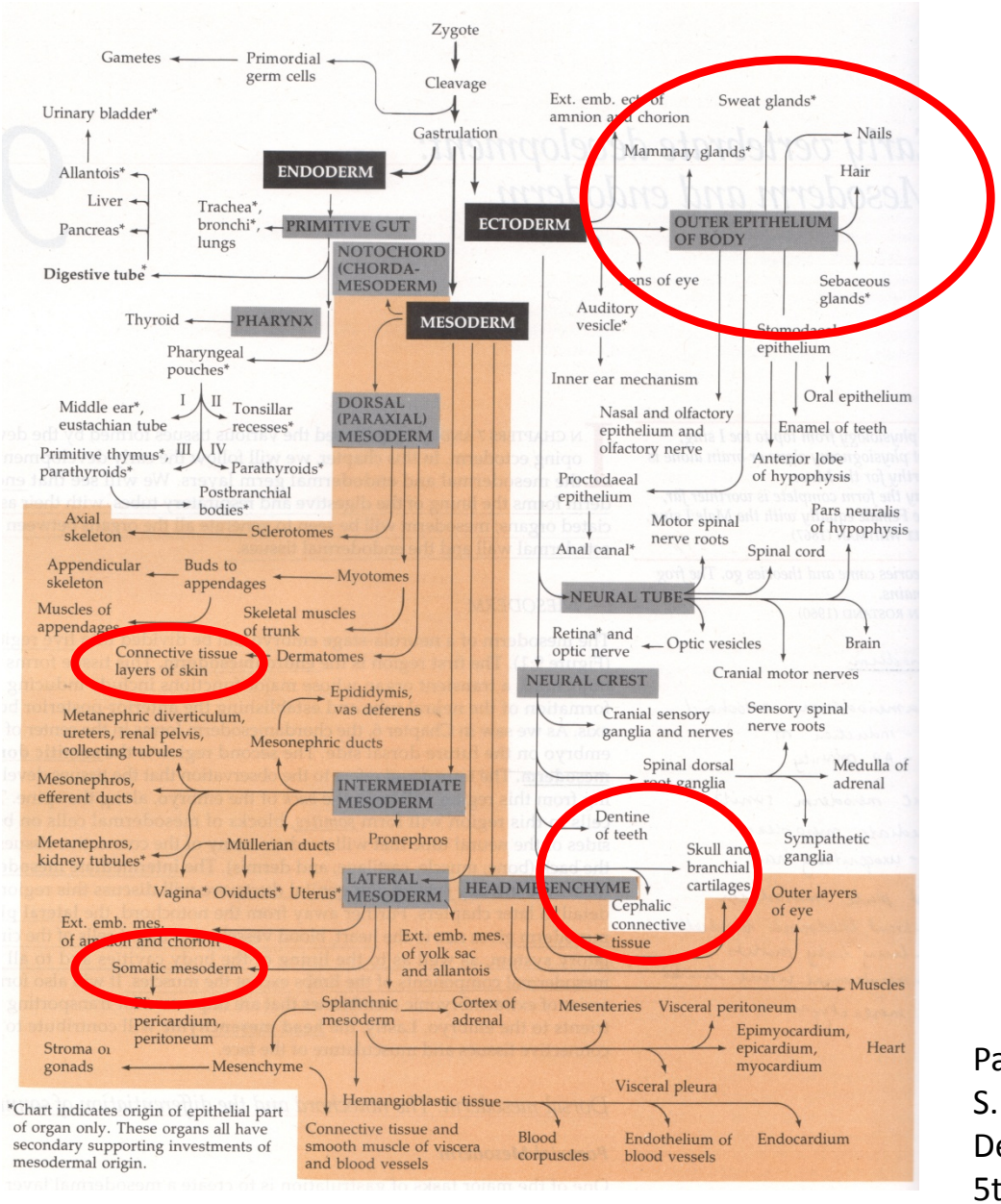


Mesoderm
Dermis, Hypodermis



Somitic mesoderm (yellow): dermomyotome -> dorsal dermis
Somatic lateral plate mesoderm (purple) -> ventral dermis

Embryonic development:



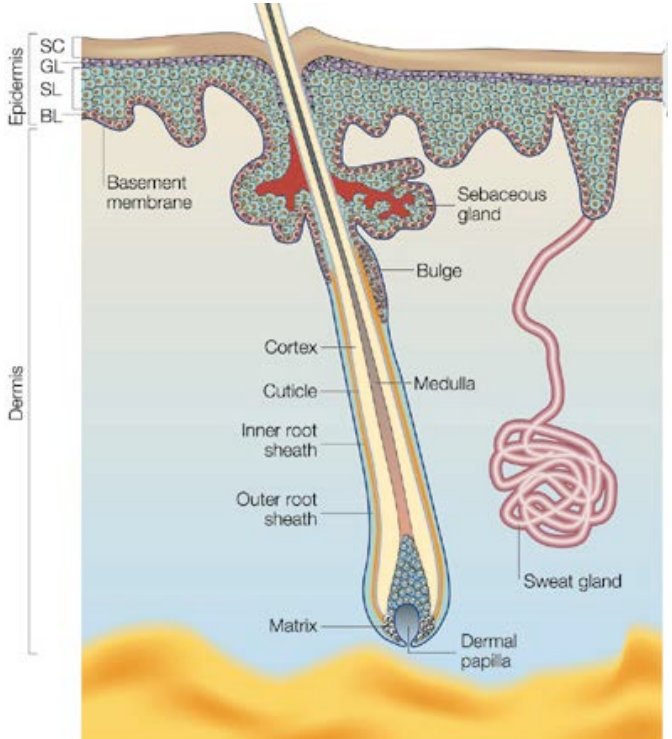
Page 342
S.F. Gilbert
Developmental Biology
5th edition

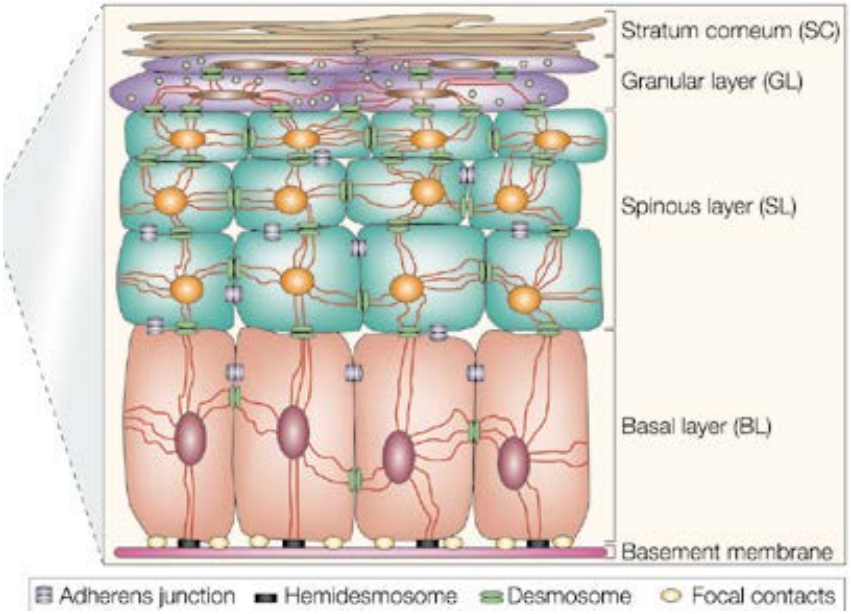
Epidermal development
Surface ectoderm

Skin/Interfollicular epidermis: stratified squamous epithelium

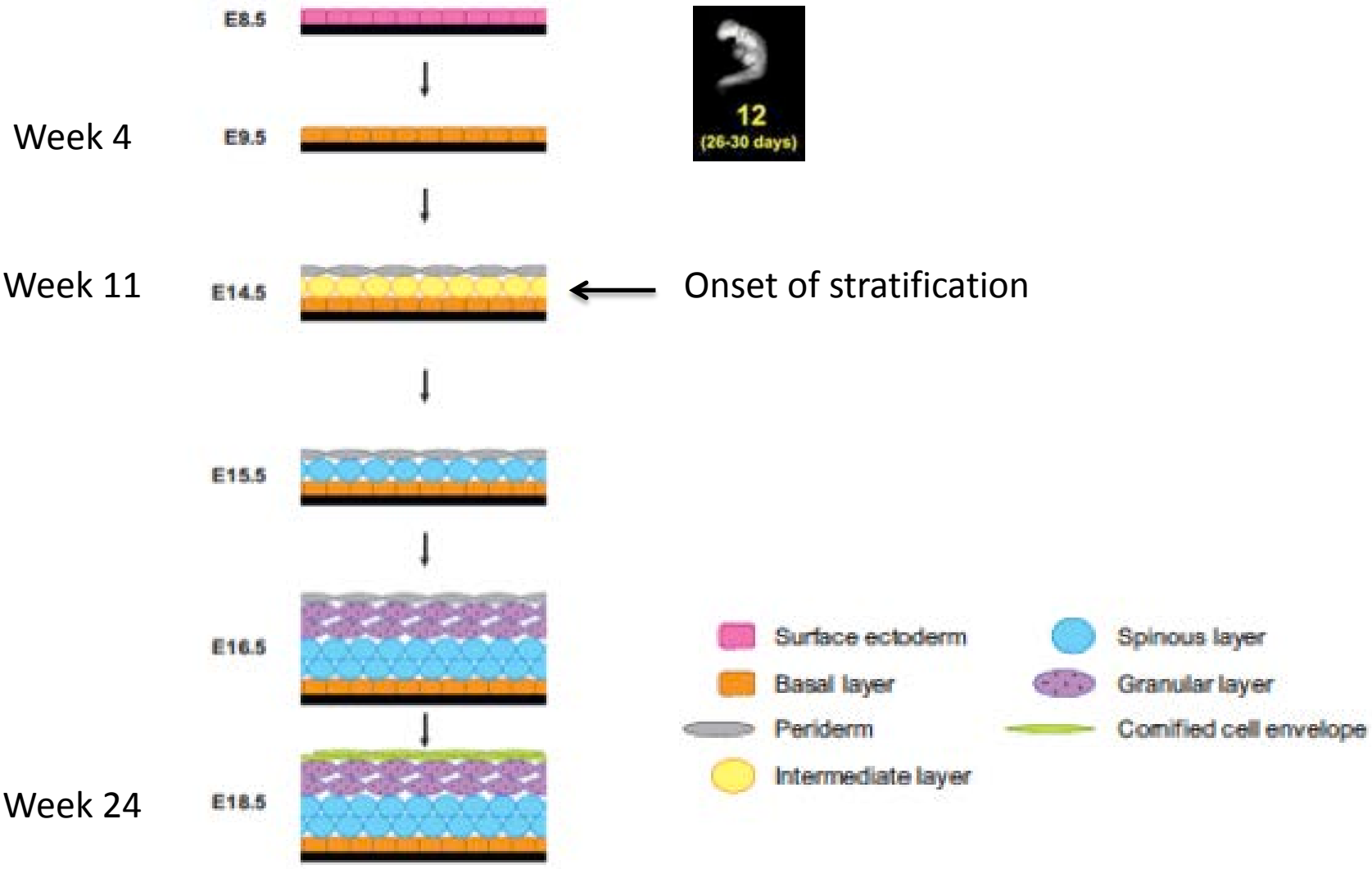
Appendages:

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



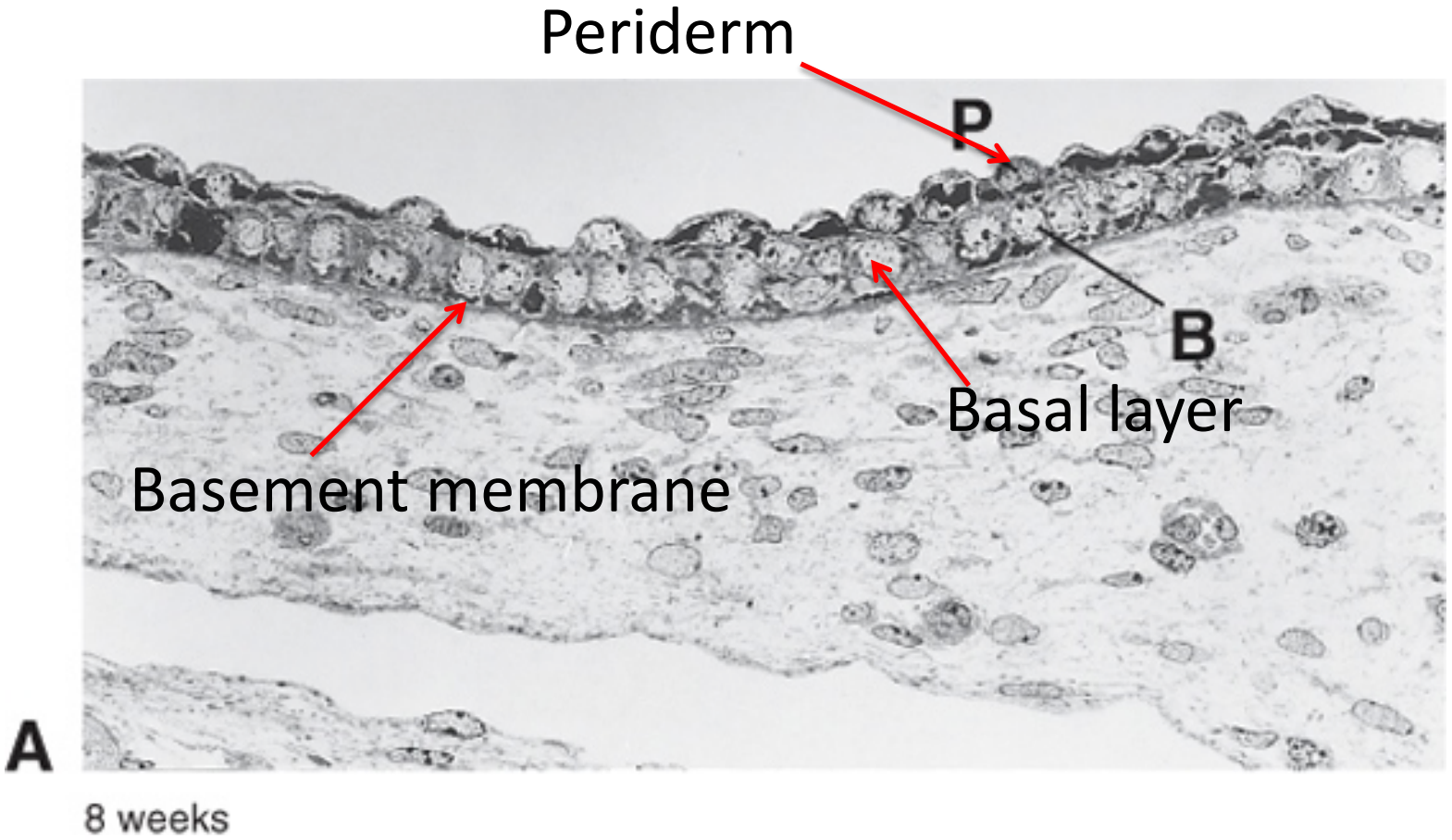


Development of Skin/interfollicular epidermis (IFE)



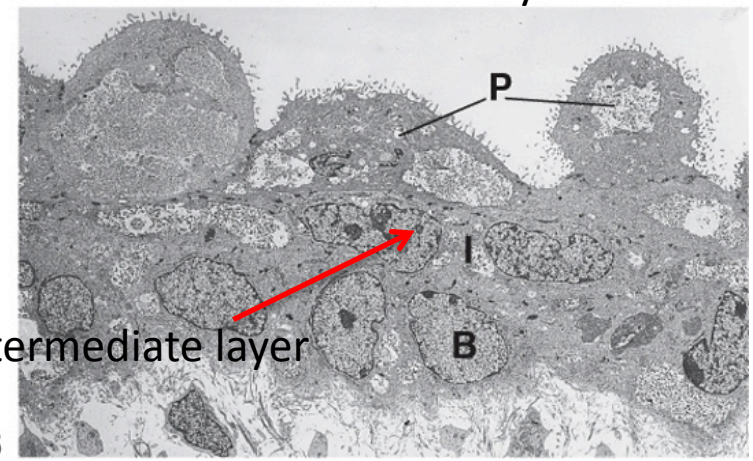
Development of Skin/interfollicular epidermis (IFE)

Periderm formation: 4 weeks



Development of Skin/interfollicular epidermis (IFE) Stratification

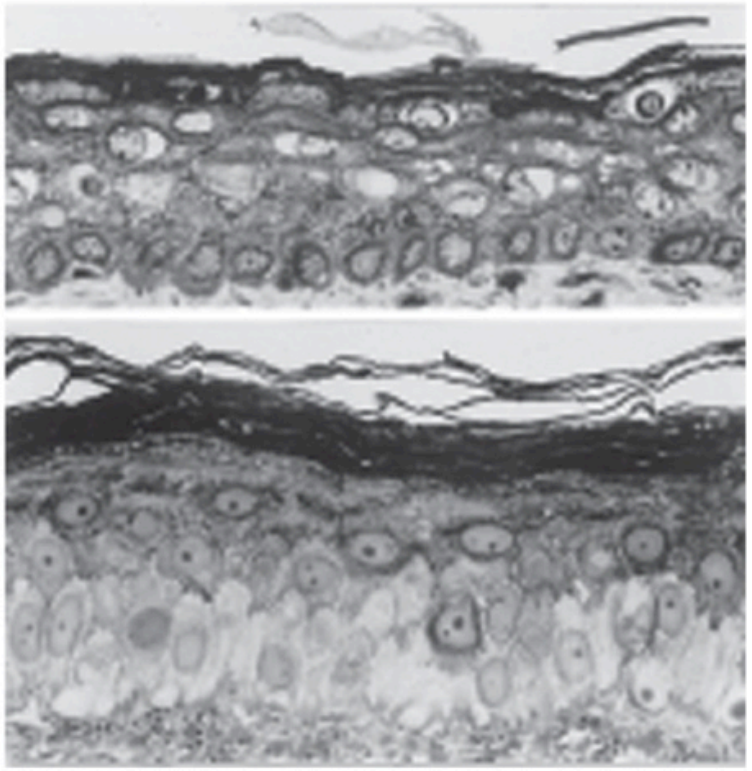
Week 11: intermediate layer



Intermediate layer

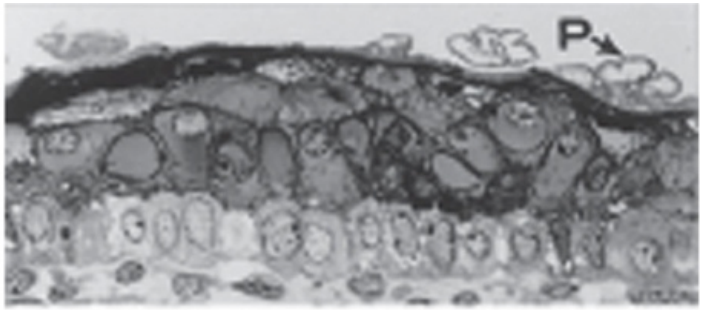
11 weeks

24 weeks



Adult

17 weeks

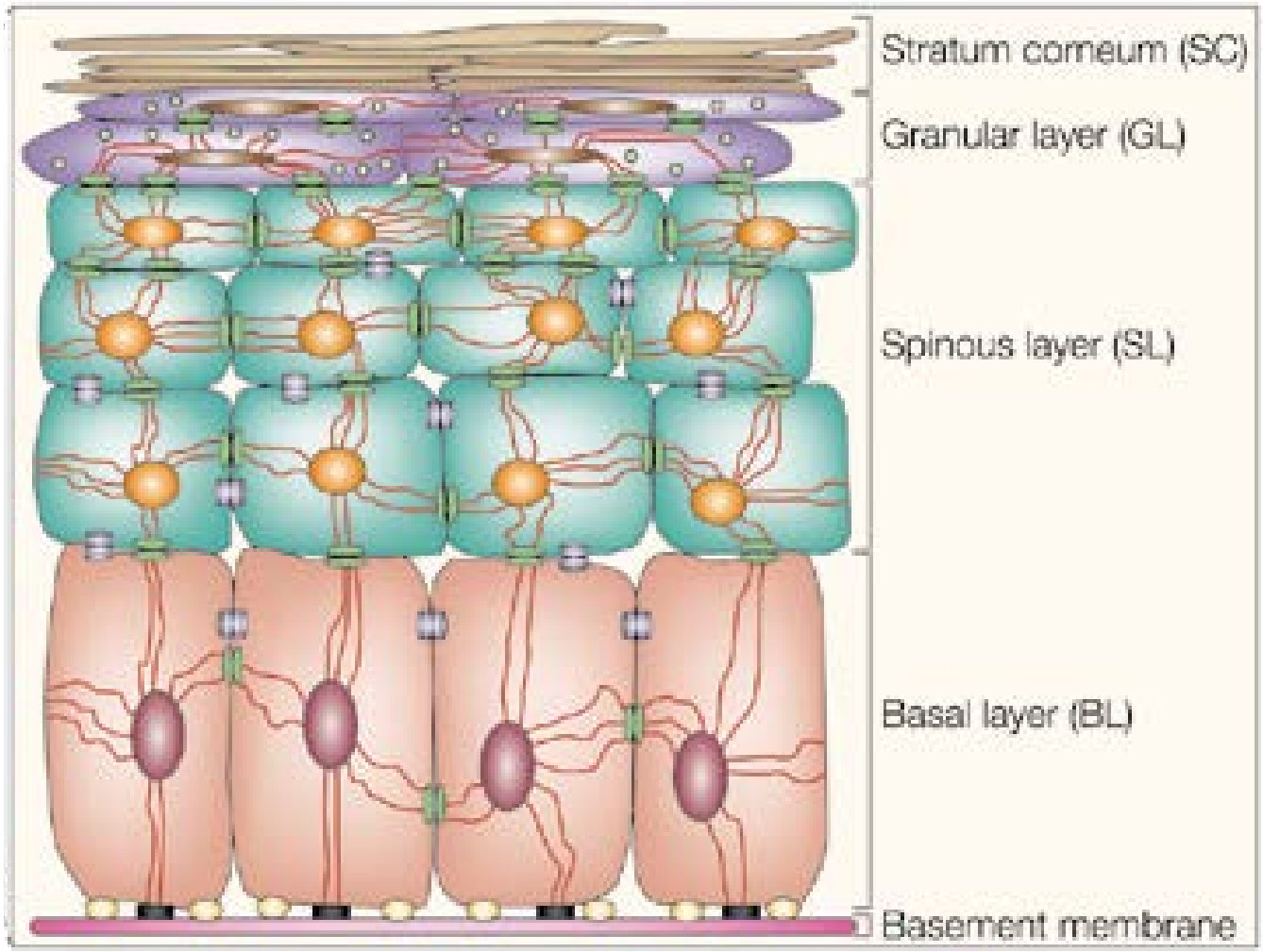


Stratified skin/IFE

Envelope proteins
- Loricrin
- Involucrin
- Fillagrin

Keratin 1/10

Keratin 5/14



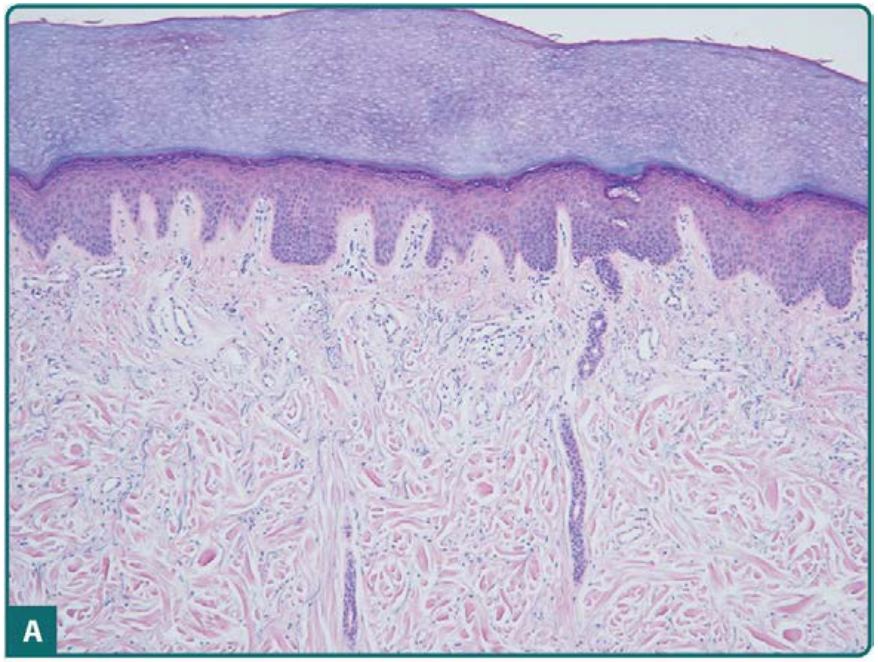
Junctions: Adherens junction | Hemidesmosome | Desmosome | Focal contacts

integrins

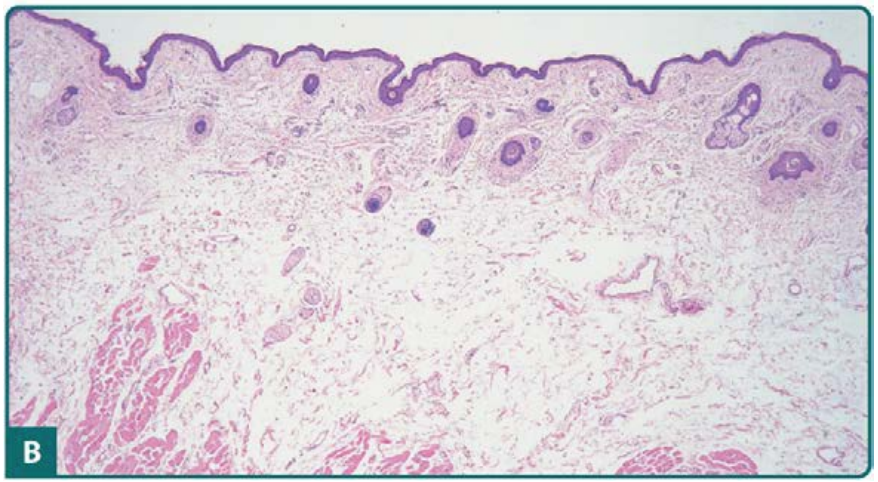
Regeneration, skin types

Stratified skin/IFE

Thick skin



Thin skin



Epidermal Appendages
Surface ectoderm

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

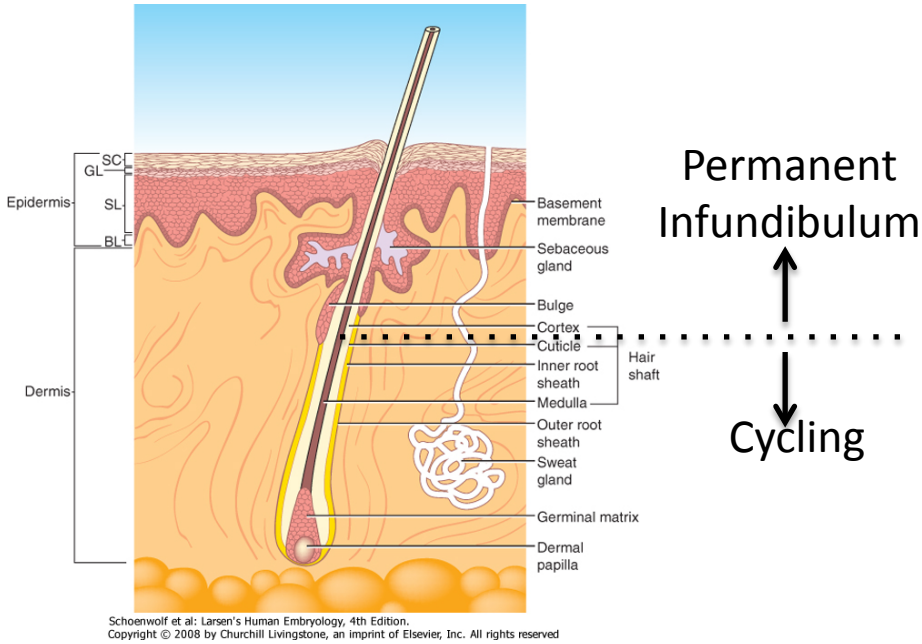
Share common developmental mechanisms:

Epithelial to mesenchymal signaling inducing formation of placode and mesenchymal condensations, invagination of epidermis into dermis.

Hair follicle development and cycling

Epidermal appendage

Involved in thermoregulation/sun protection



Month 2-4: Onset hair follicle development

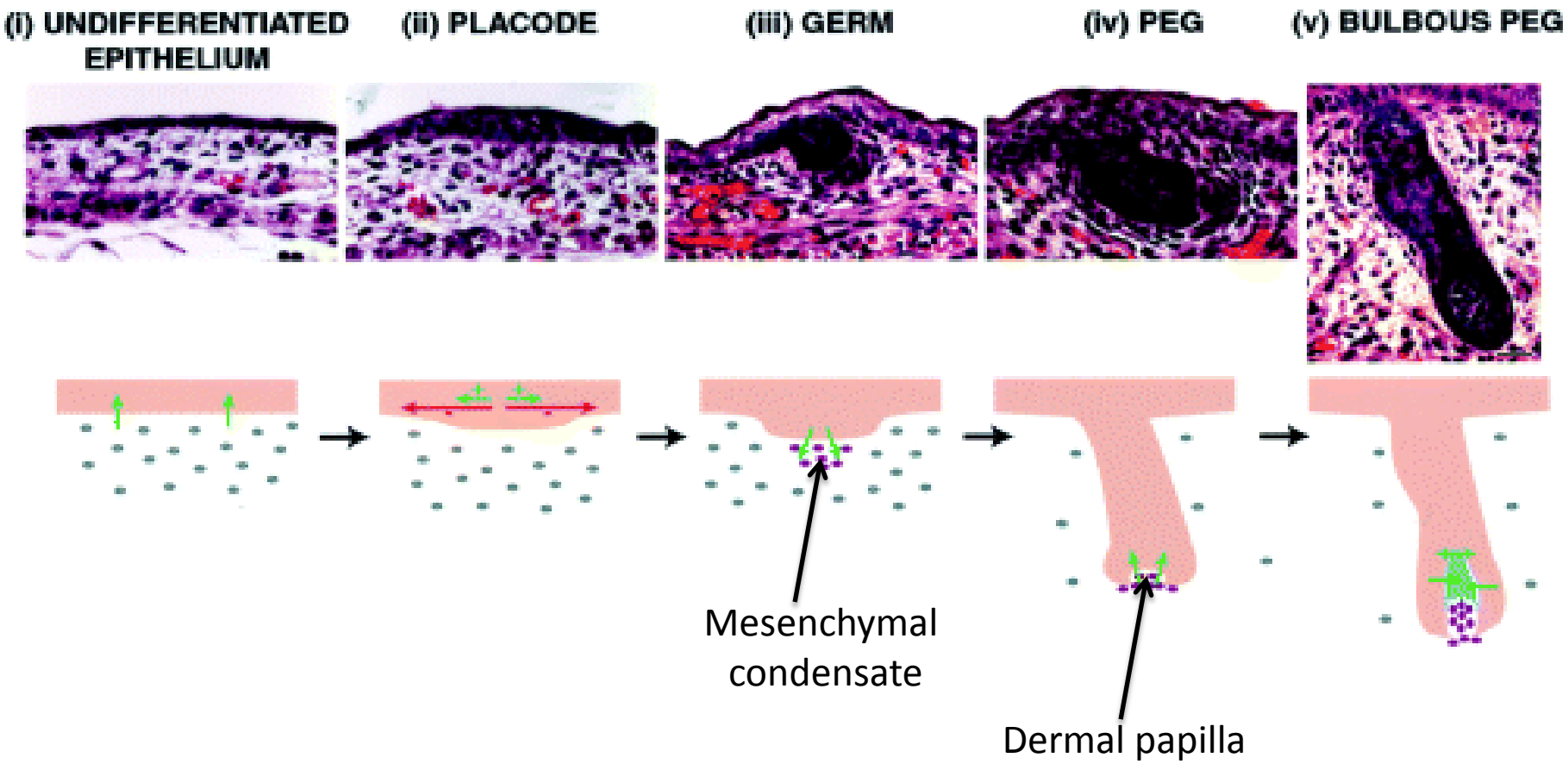
Hair follicles develop first in cranial region

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

Anatomy

Hair follicle development

Month 2 → Birth: 5000,000



Signaling events

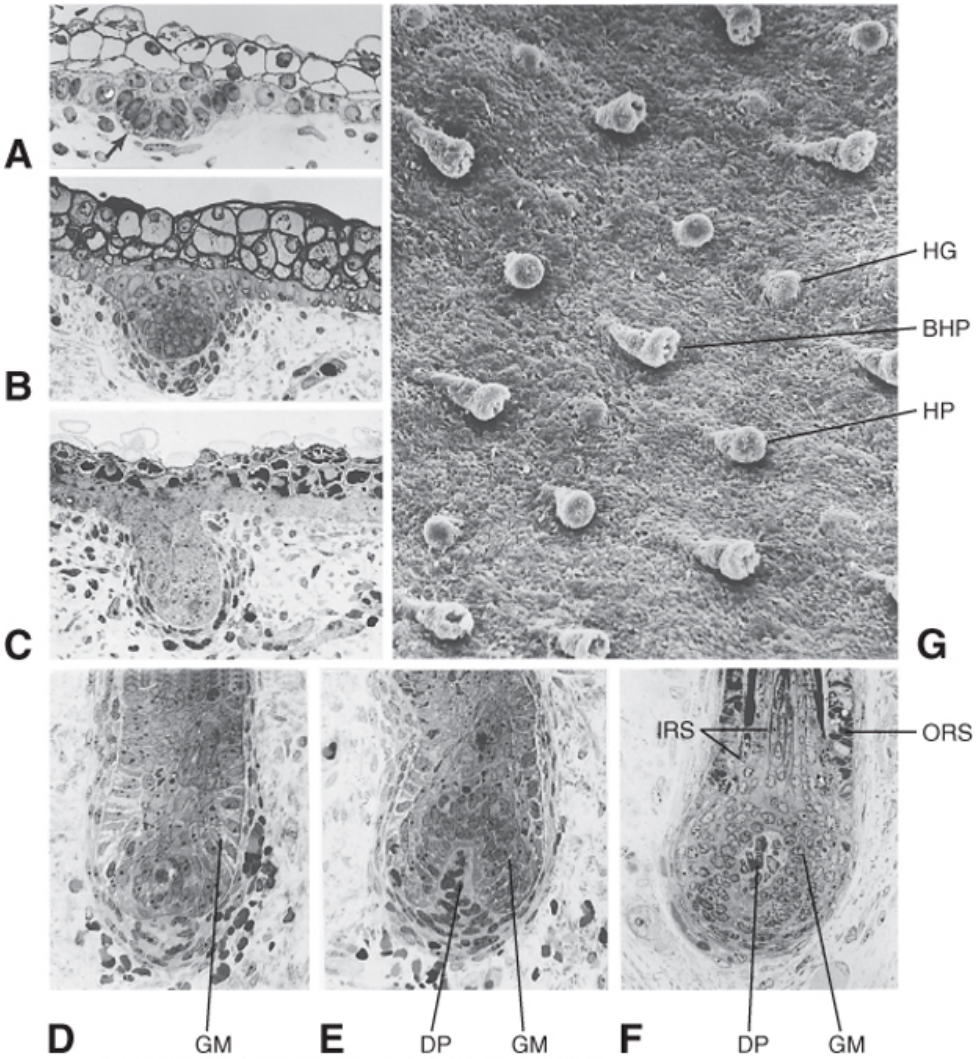
Hair follicle development

Hair germ

Hair peg

Bulbous hair peg

Invasion of dermal cells

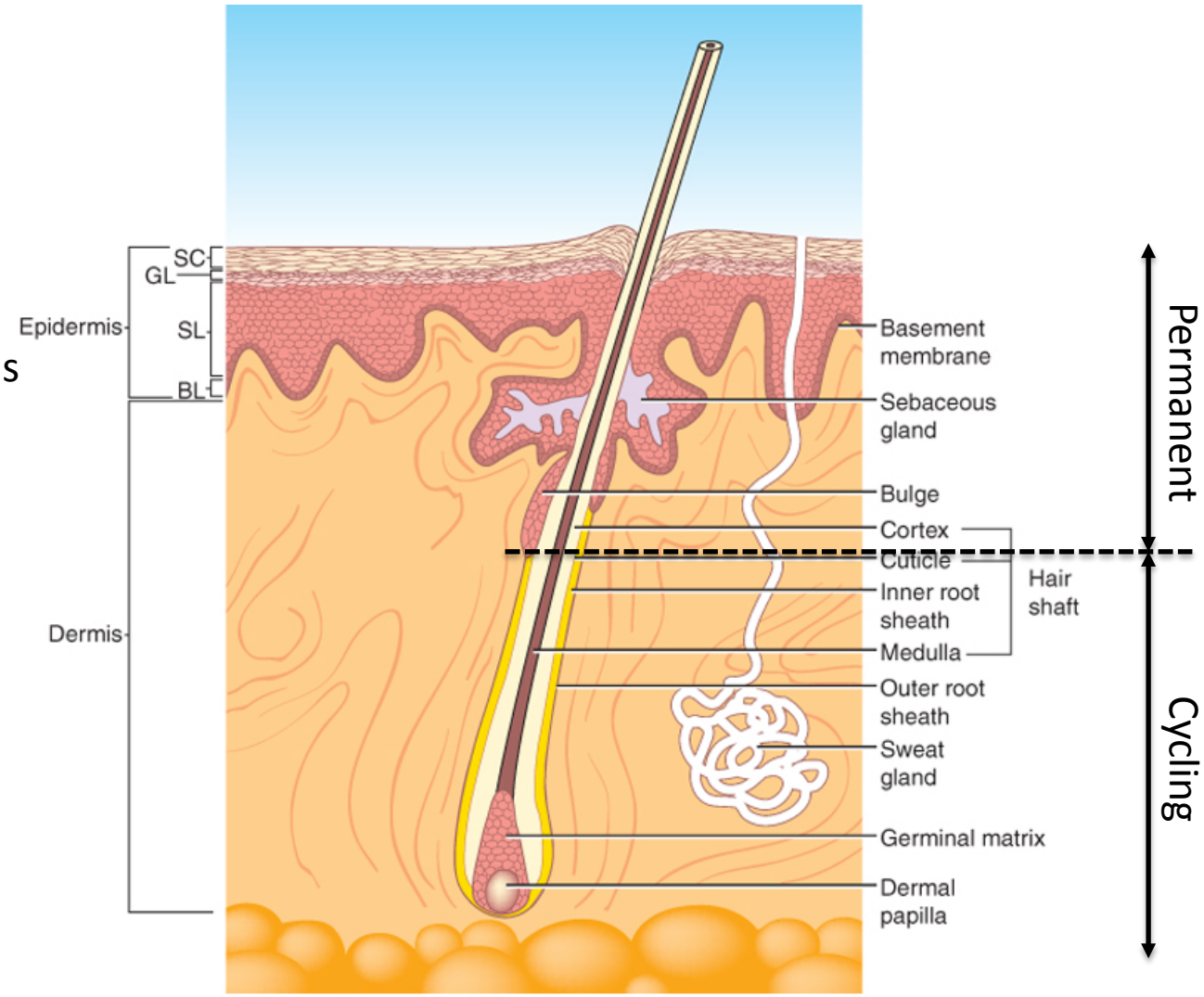


Hair follicle development

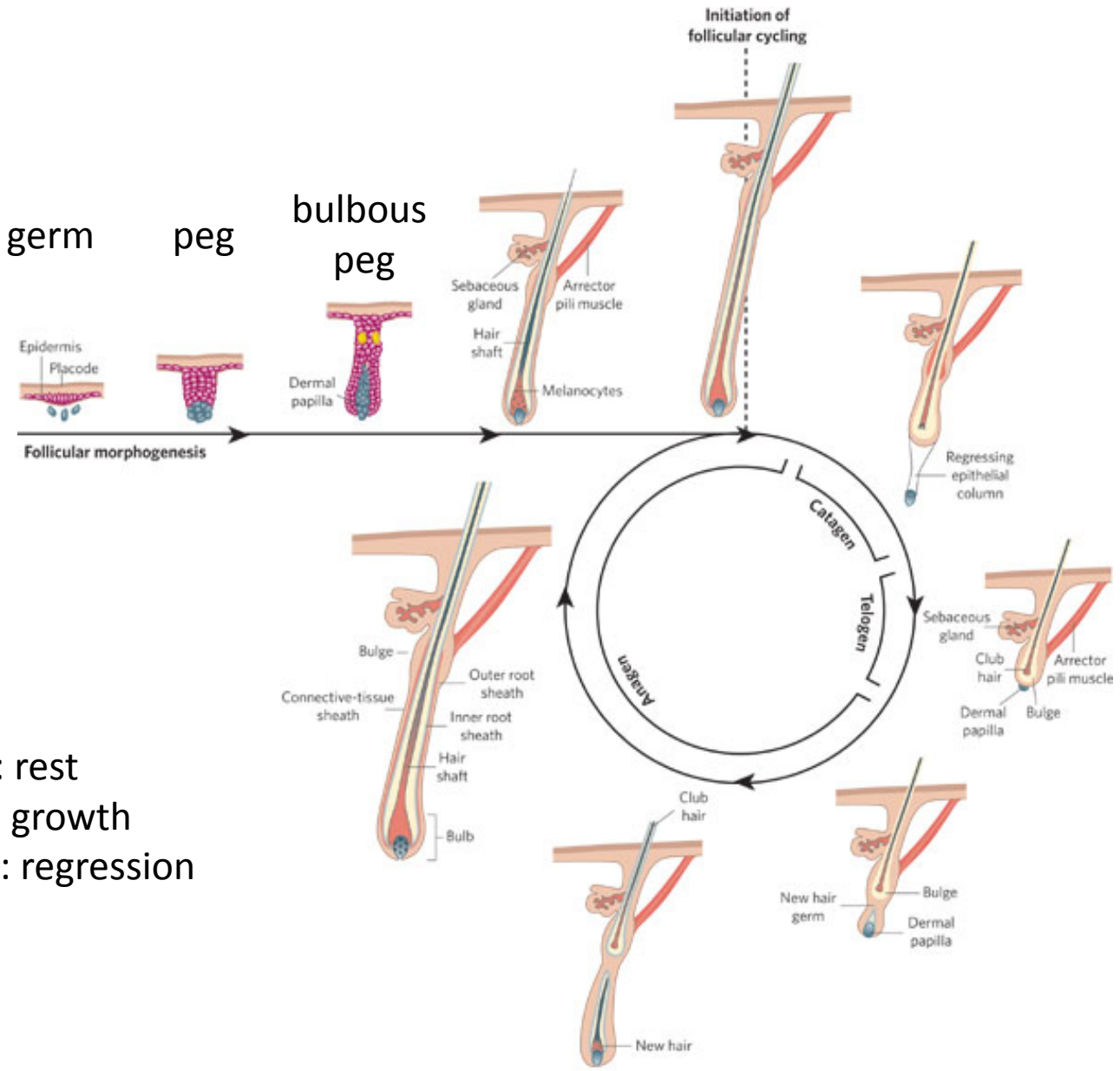
Formation of:
Arrector pili muscle
Hair follicle bulge
Germinal matrix
Inner and outer root sheaths

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

Postnatal regeneration:
Hair follicle cycling



Postnatal hair follicle cycling



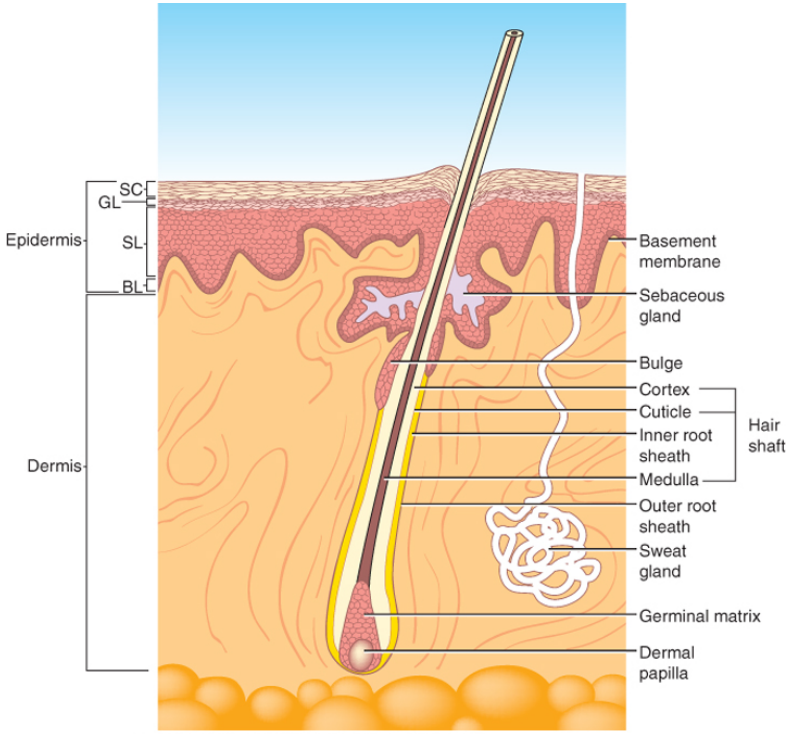
Telogen: rest
Anagen: growth
Catagen: regression

Ageing

Epidermal gland development

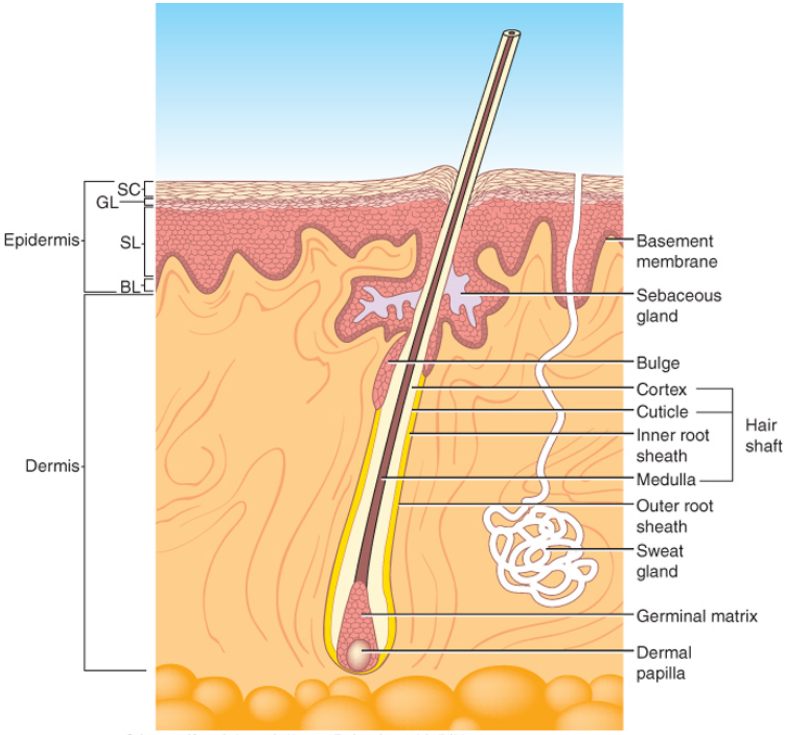
Epidermal appendages: outgrowths from IFE or HF

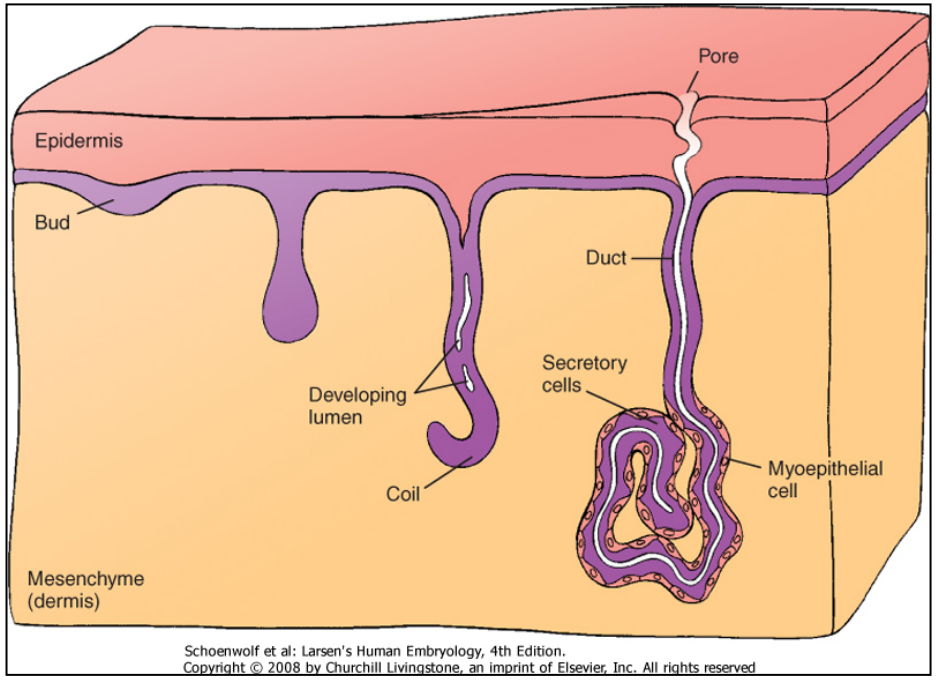
Sebaceous glands: sebrum/vernix
Sweat glands
Apocrine glands (pheromones)
Mammary glands
Salivary glands
Lacrimal glands



Epidermal gland development
Epidermal appendages

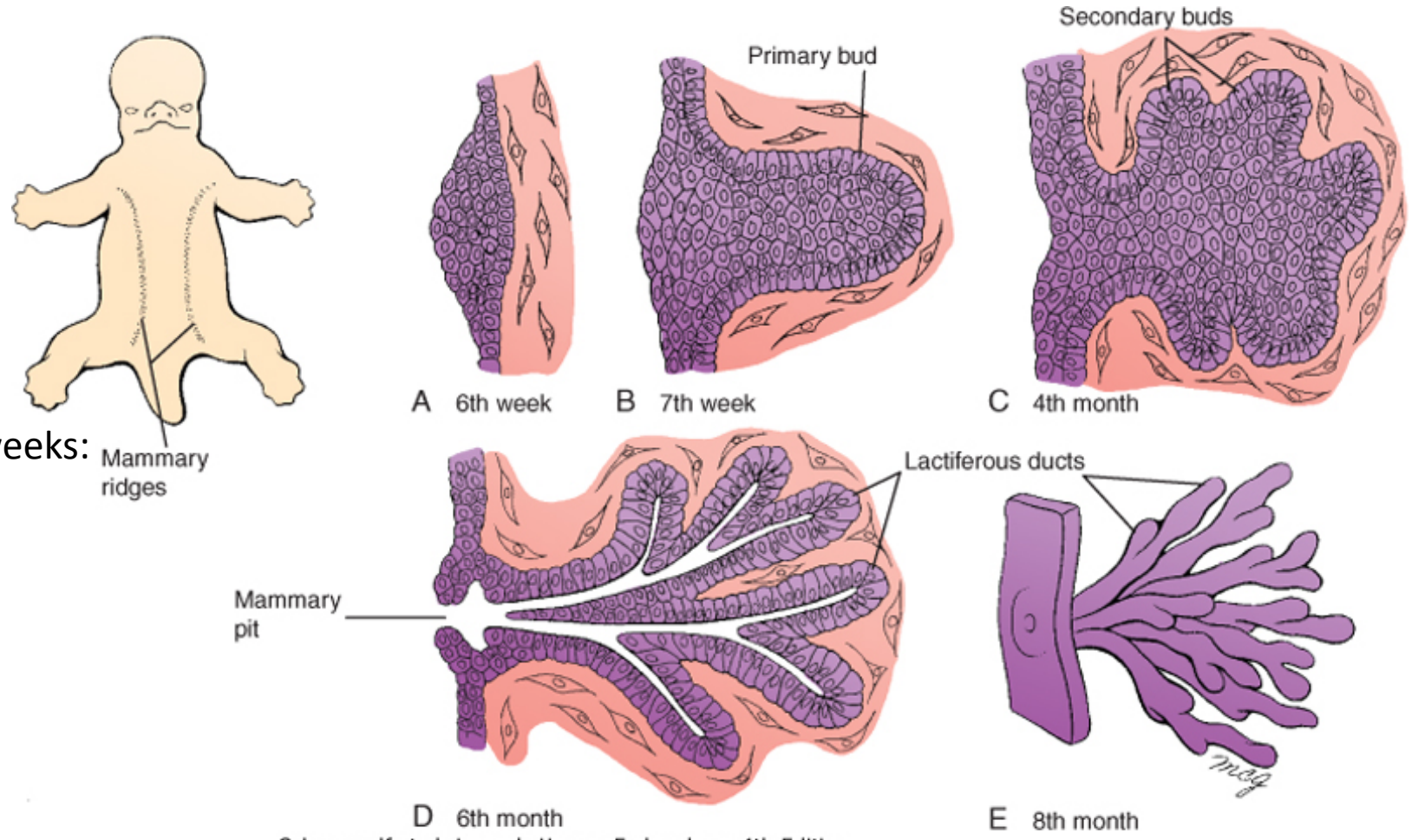
Sebaceous glands: develop from hair follicle (4 weeks +)
Sweat glands: develop from basal layer IFE (20 weeks+)
Apocrine glands: develop in association with HFs, most lost late in fetal dev.





Mammary gland development

Epidermal appendage

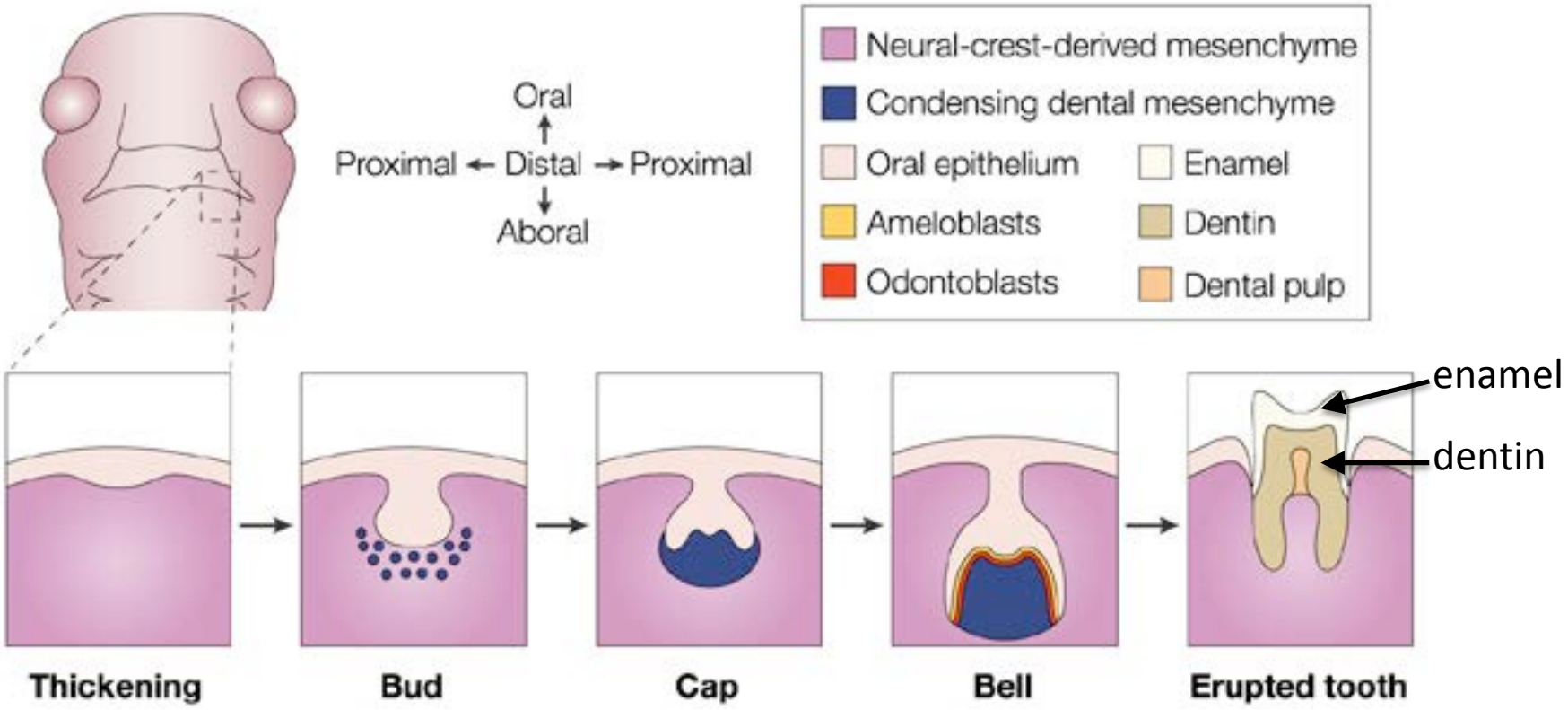


Postnatal regenerative growth

Teeth

Tooth development

Ectoderm/cranial neural crest derived mesenchyme



Week 6:
dental lamina
U-shaped ridge

Week 7:
Mesenchyme condensation

Week 8:
Mesenchyme invades base tooth bud:
Dental papilla

Week 14:
Epithelial cells:
Ameloblasts: enamel

Mesenchymal cells:
Odontoblasts: dentin

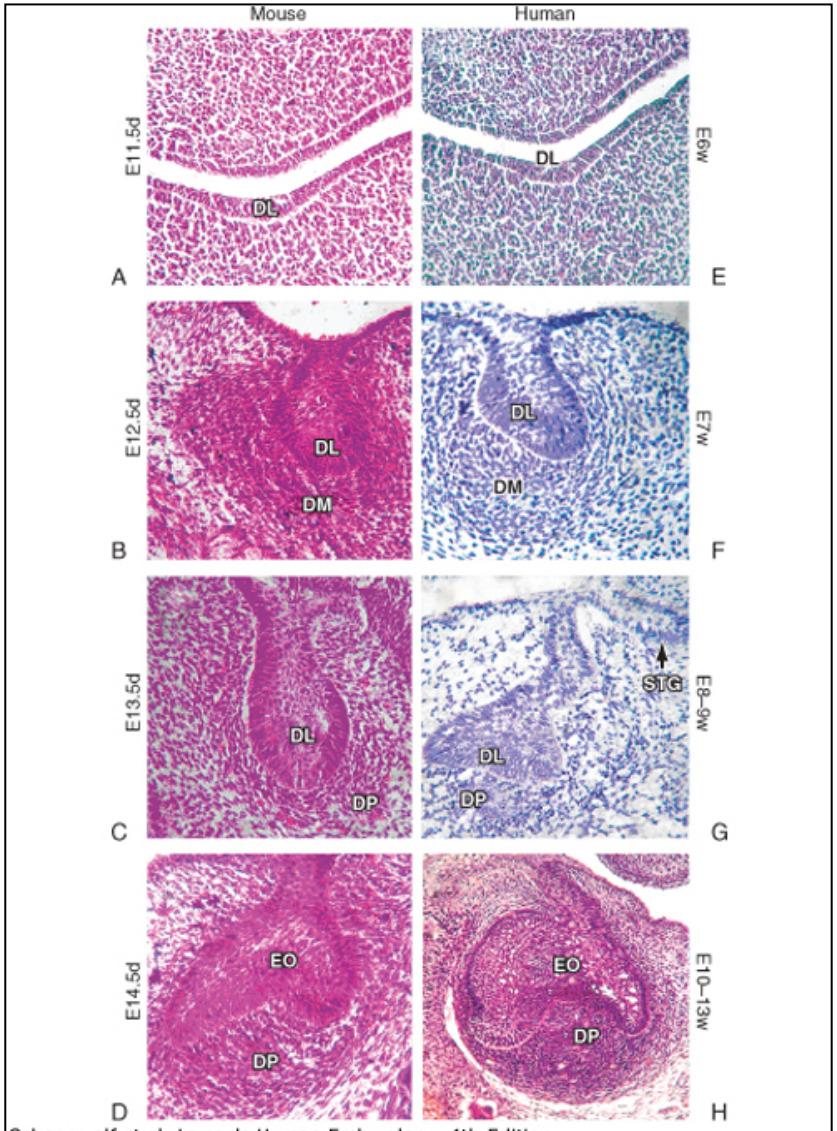
Tucker and Sharpe, Nature Genetics 2004

Tooth development

Week 6: dental lamina forms

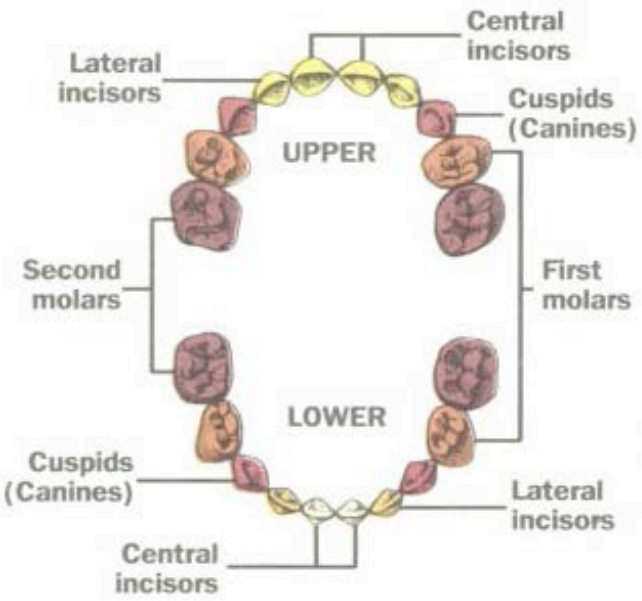
Week 7-8: formation of tooth buds: Bud stage

Week 8: formation of dental papilla: Cap and Bell Stage

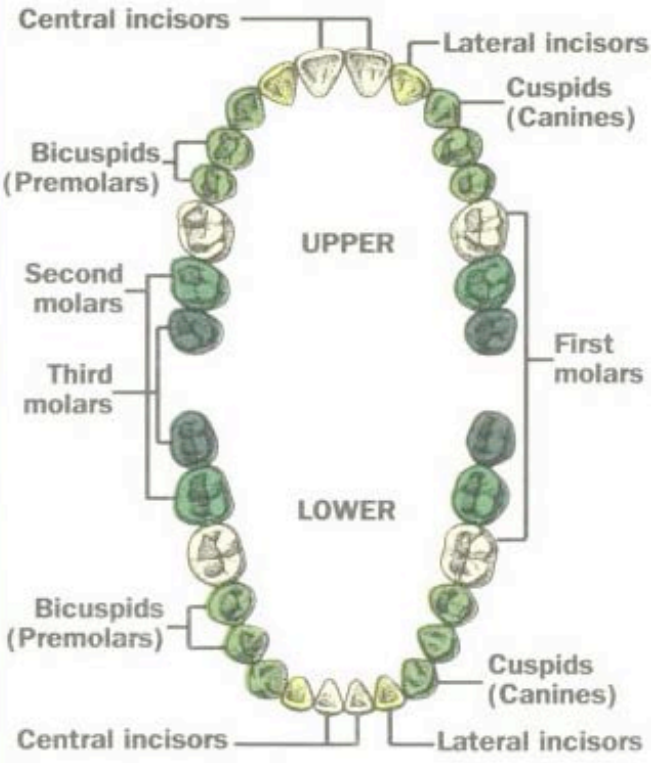


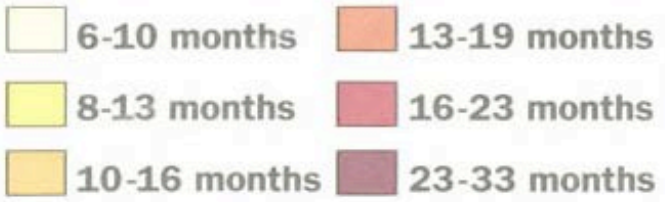
Tooth development

Primary teeth
10 + 10



Adult teeth
16 + 16



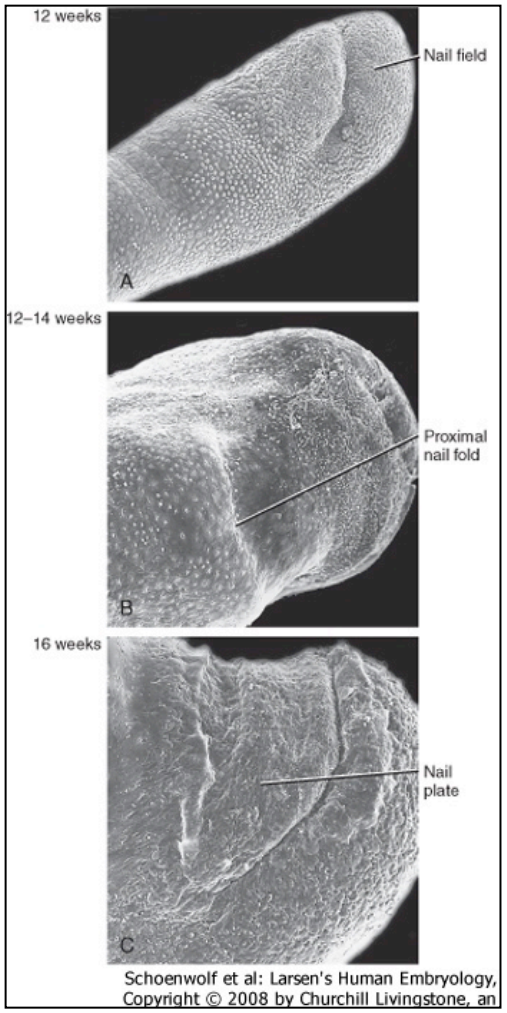


Nails

Nail development
Ectoderm

Week 10: epidermal thickening, nail field

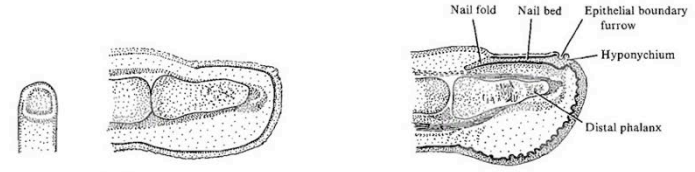
Week 11: nail anlagen moves proximally, nail folds, proximal hair fold: formation of formative zone

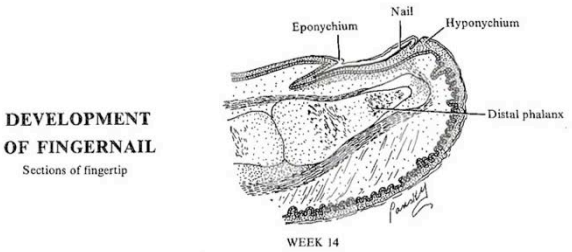


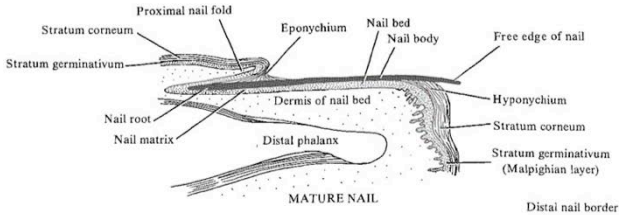
http://discovery.lifemapsc.com/library/review-of-medical-embryology/chapter-75-development-of-the-nails

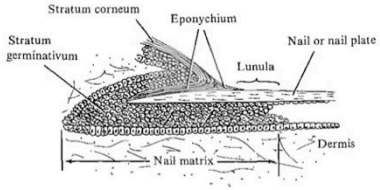
Nail development

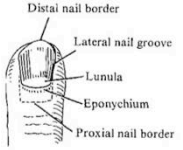
Ectoderm

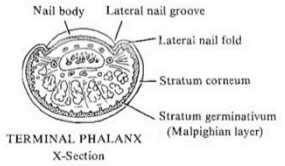












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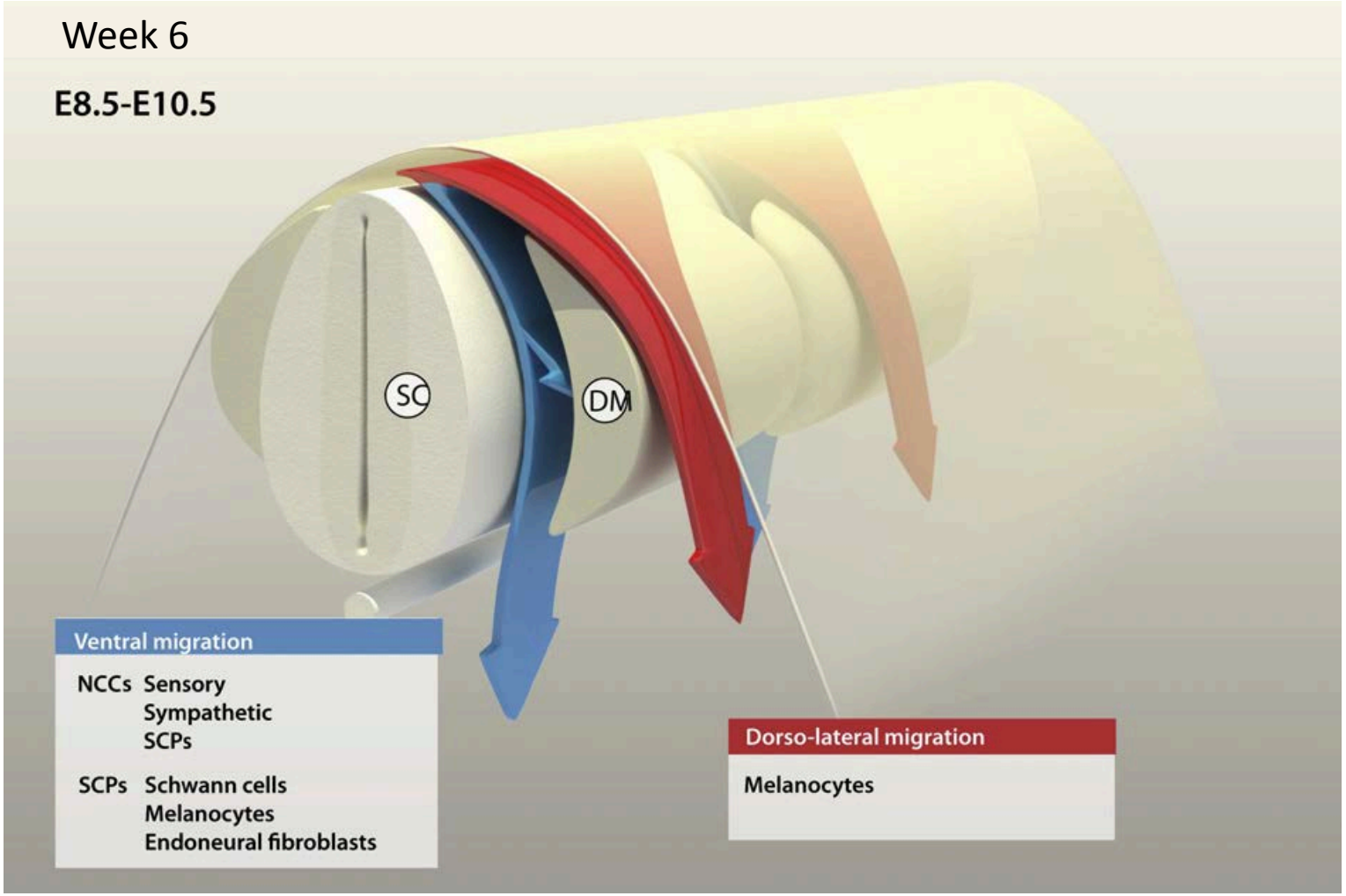
Melanocytes

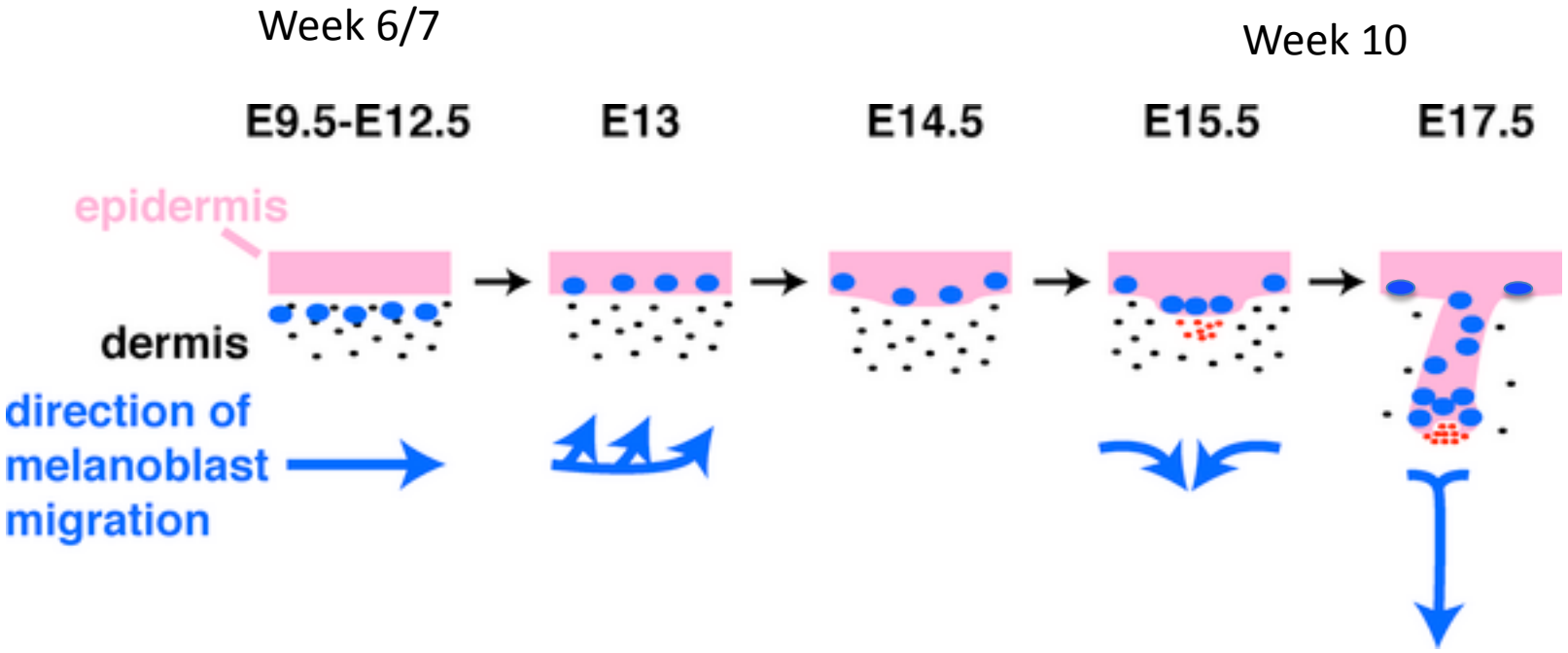
Melanocyte development
Neural crest



Ernfors, Exp Cell Res 2010

Melanocyte development

Neural crest



Millar, Plos Biology 2005

Melanocyte development

Neural crest

Before stratification

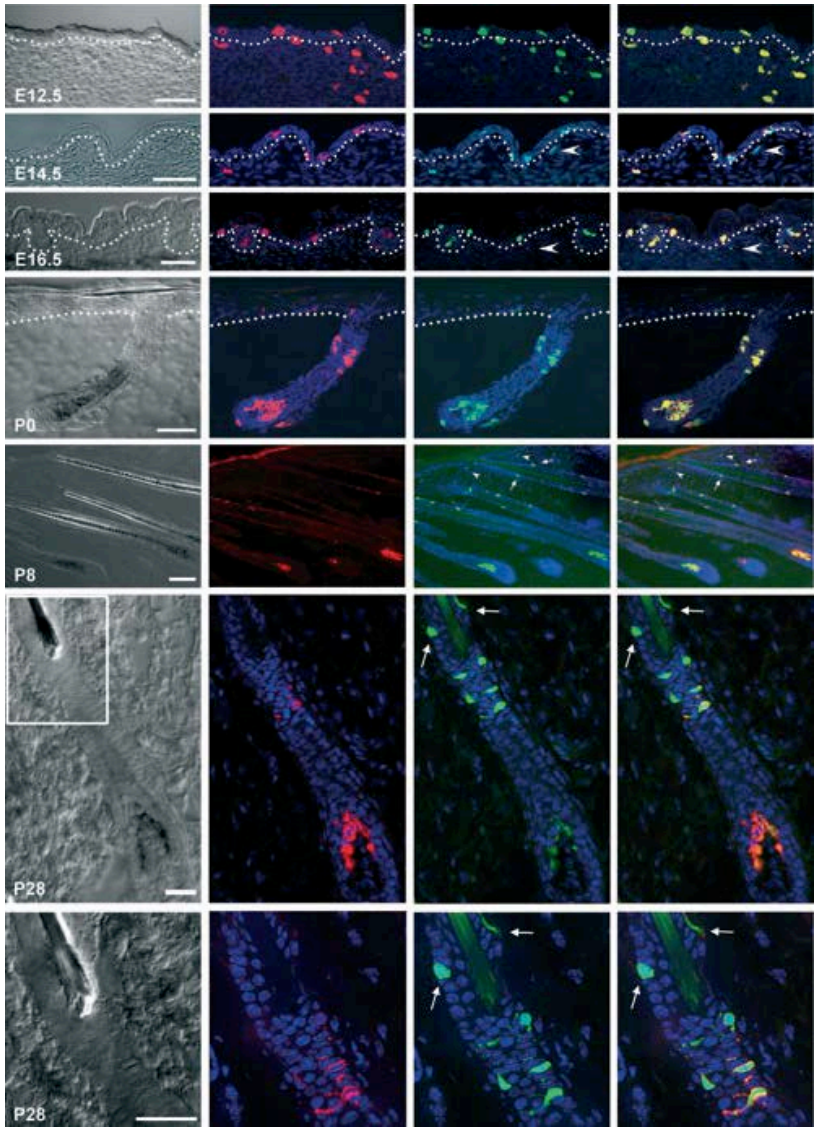
Onset stratification

Bulbous hair pegs

Anagen

Matrix

Hair follicle Bulge



Djian-Zaouche,
Pigment Cell Melanoma Res 2012

Dermis

Connective tissue with:

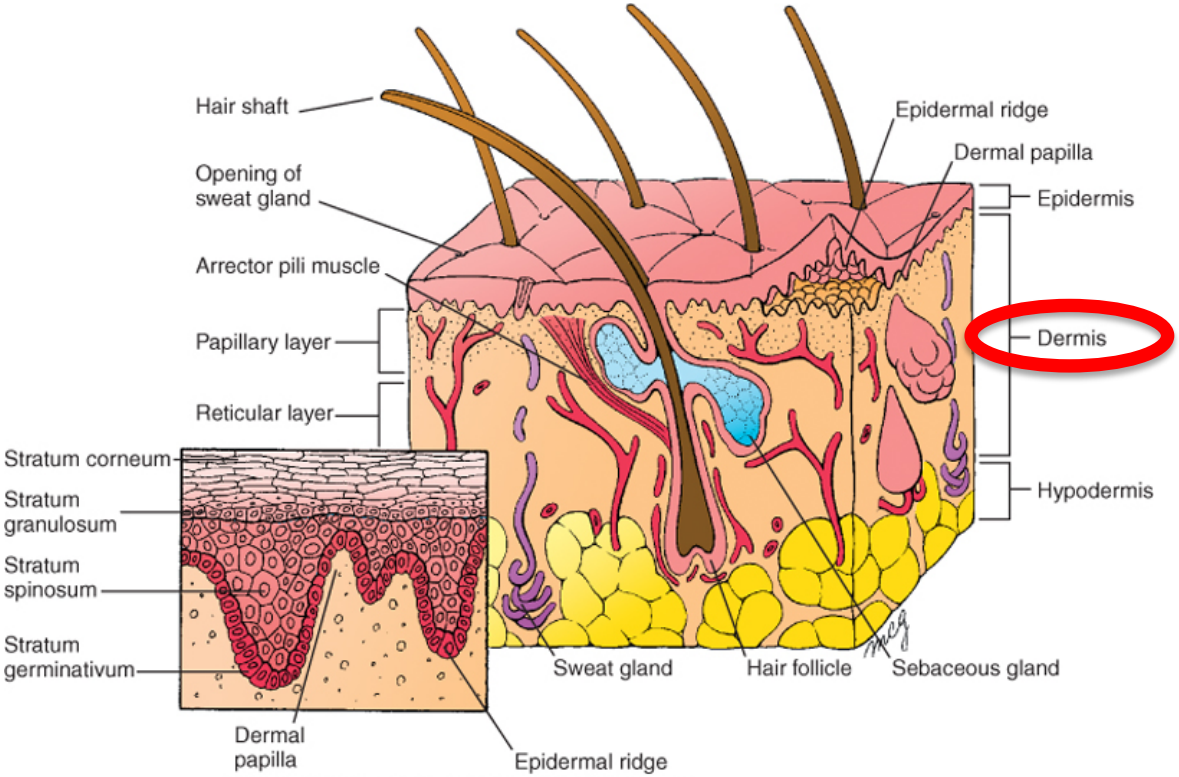
Fibroblasts

Blood vessels

Nerve endings

Sensory receptors

Muscle bundles

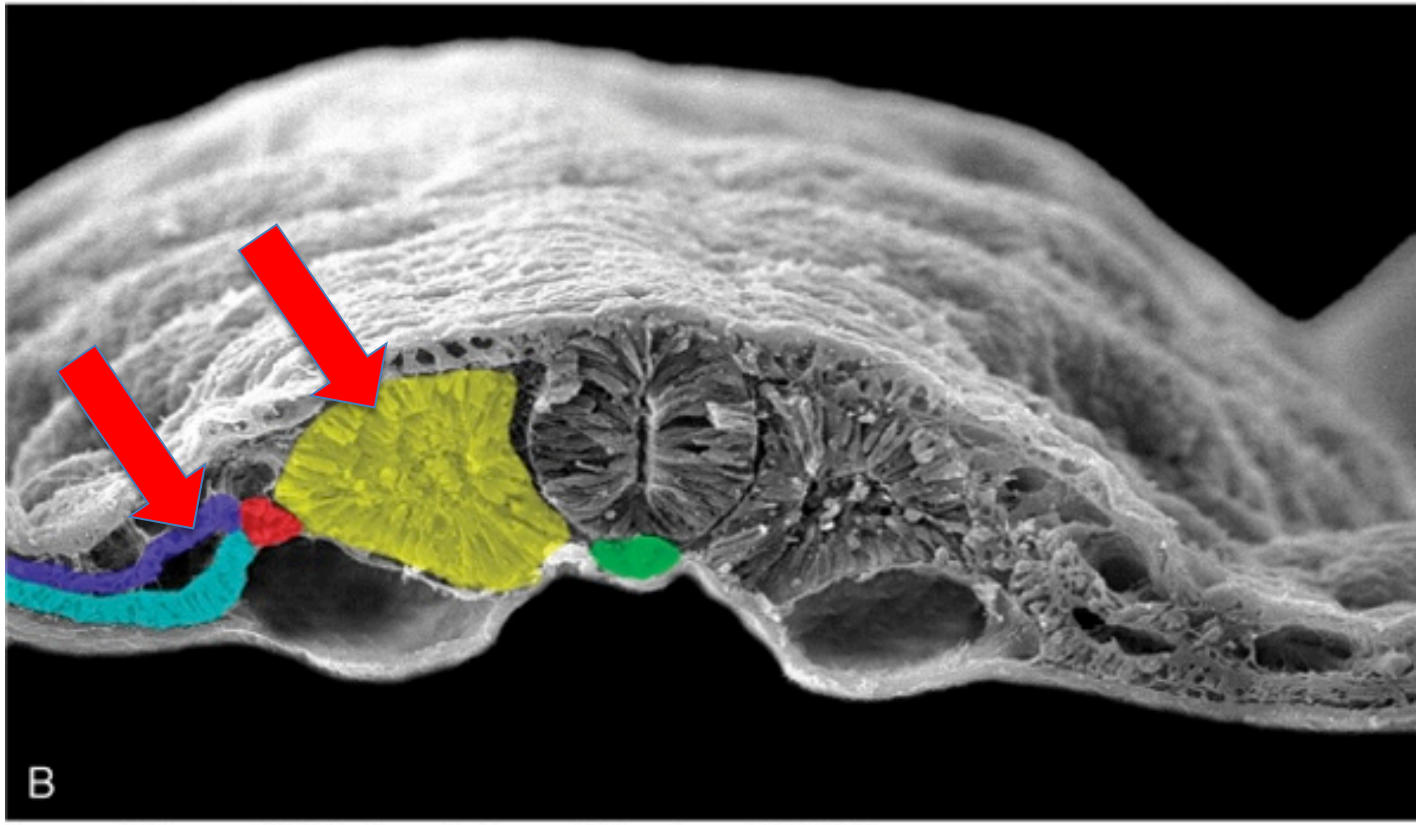


Dermis development

Somitic mesoderm -> trunk

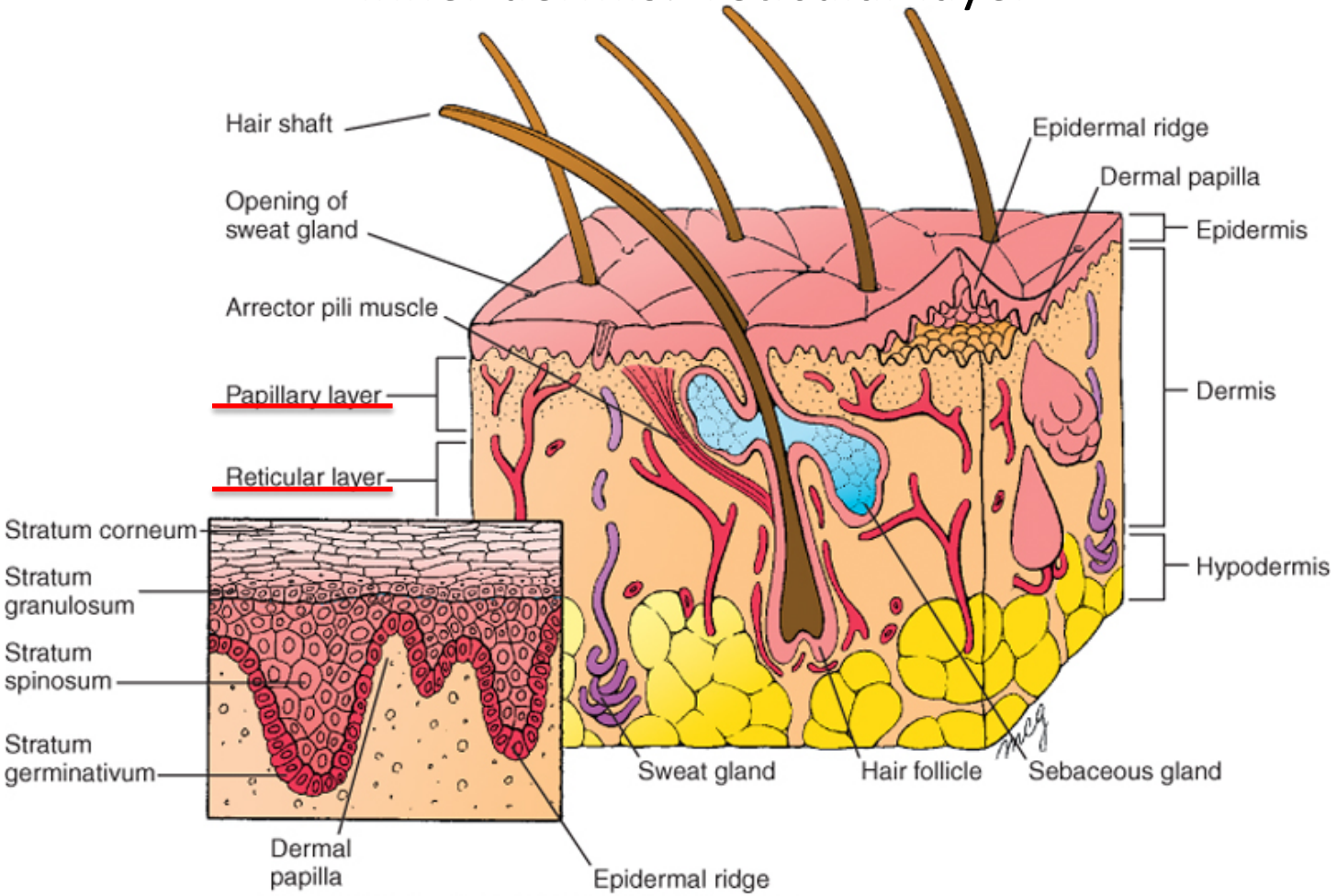
Somatic lateral plate mesoderm -> trunk, limbs

Cranial neural crest derived mesenchyme -> cranial region



Dermis development

3 Months: formation of papillary layer
(dermal papillae and epidermal ridges)
Inner dermis: reticular layer



Lecture overview

Skin

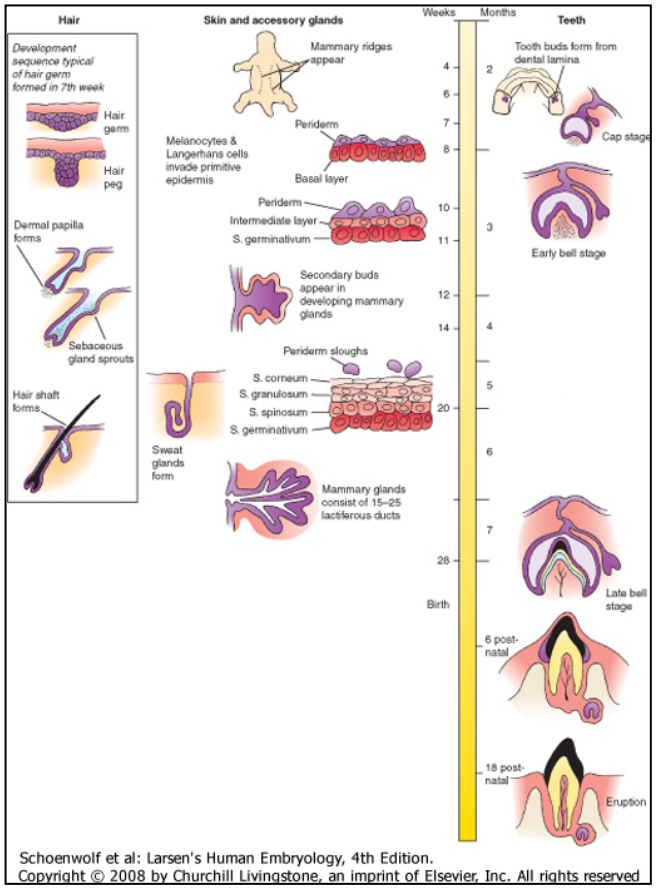
Skin origins

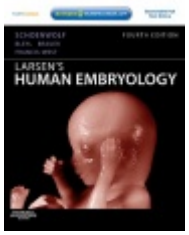
Development of the overlying epidermis

Development of epidermal appendages:
Hair follicles
Glands
Mammary glands
Nails
Teeth

Development of Melanocytes

Development of the Dermis





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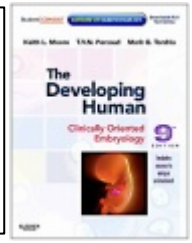
Larsen's Human Embryology – Chapter 7
The Developing Human: Clinically Oriented Embryology



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QUIZ

1. Hair follicles develop from:

A – the epidermis
B – the dermis
C – the hypodermis
D – the melanocytes

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C – is controlled by signaling from mesenchyme and surface ectoderm
D – is controlled by signaling from the melanocyte stem cells

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C – neurectoderm
D – endoderm

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