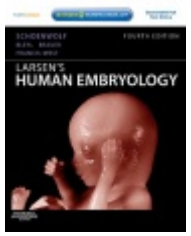
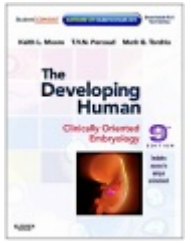
Development of the skin and its derivatives



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

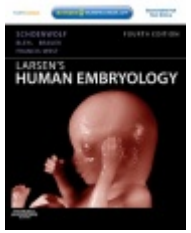
Skin origins

Development of the epidermis

Development of epidermal appendages:
Hair follicles
Glands
Nails
Teeth

Development of melanocytes

Development of the Dermis



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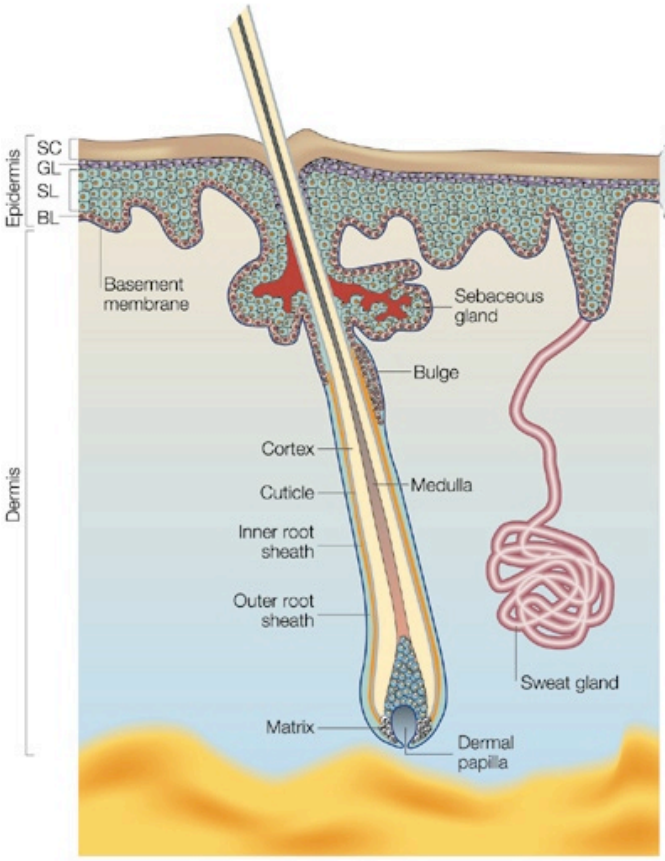
Skin Function and Anatomy

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



End Product Gastrulation

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

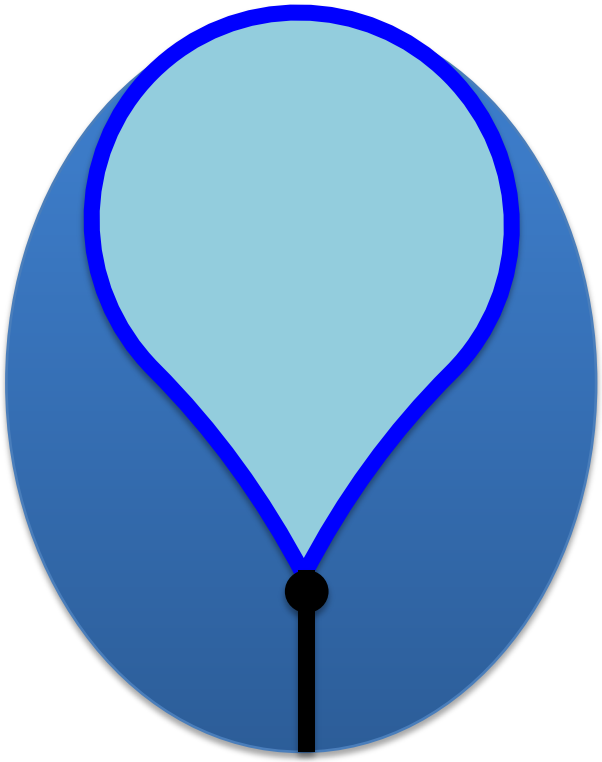
Embryonic tissues contributing to skin development

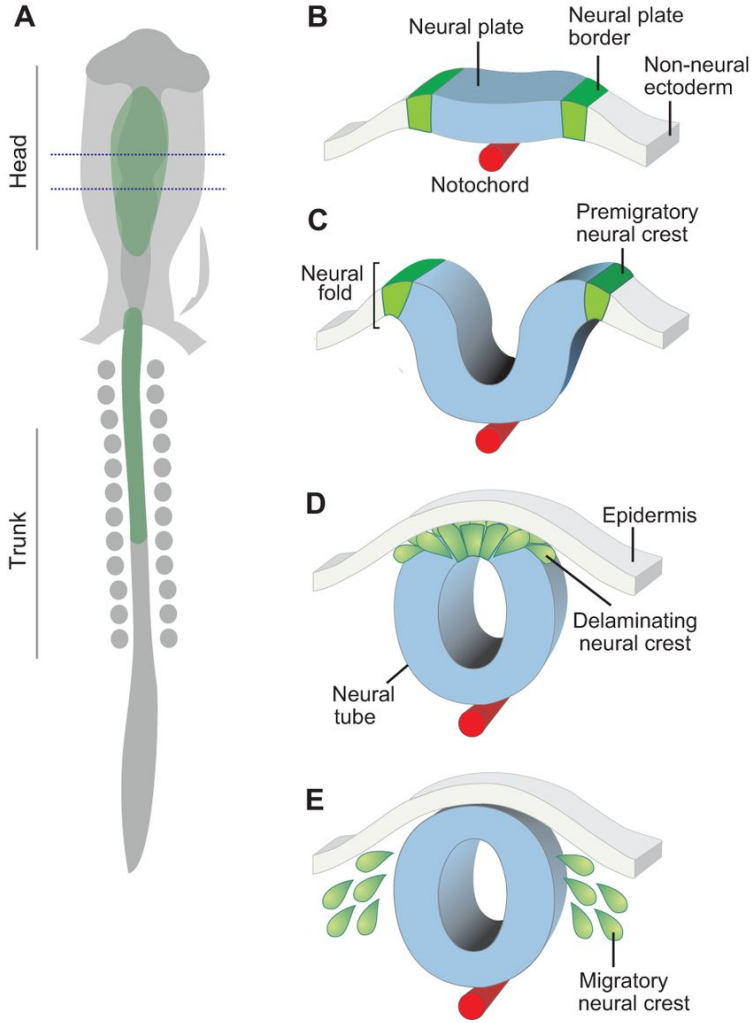
Lateral Ectoderm
Neural Crest
Somitic and Lateral Plate Mesoderm

Week 4 embryo

Lateral Ectoderm

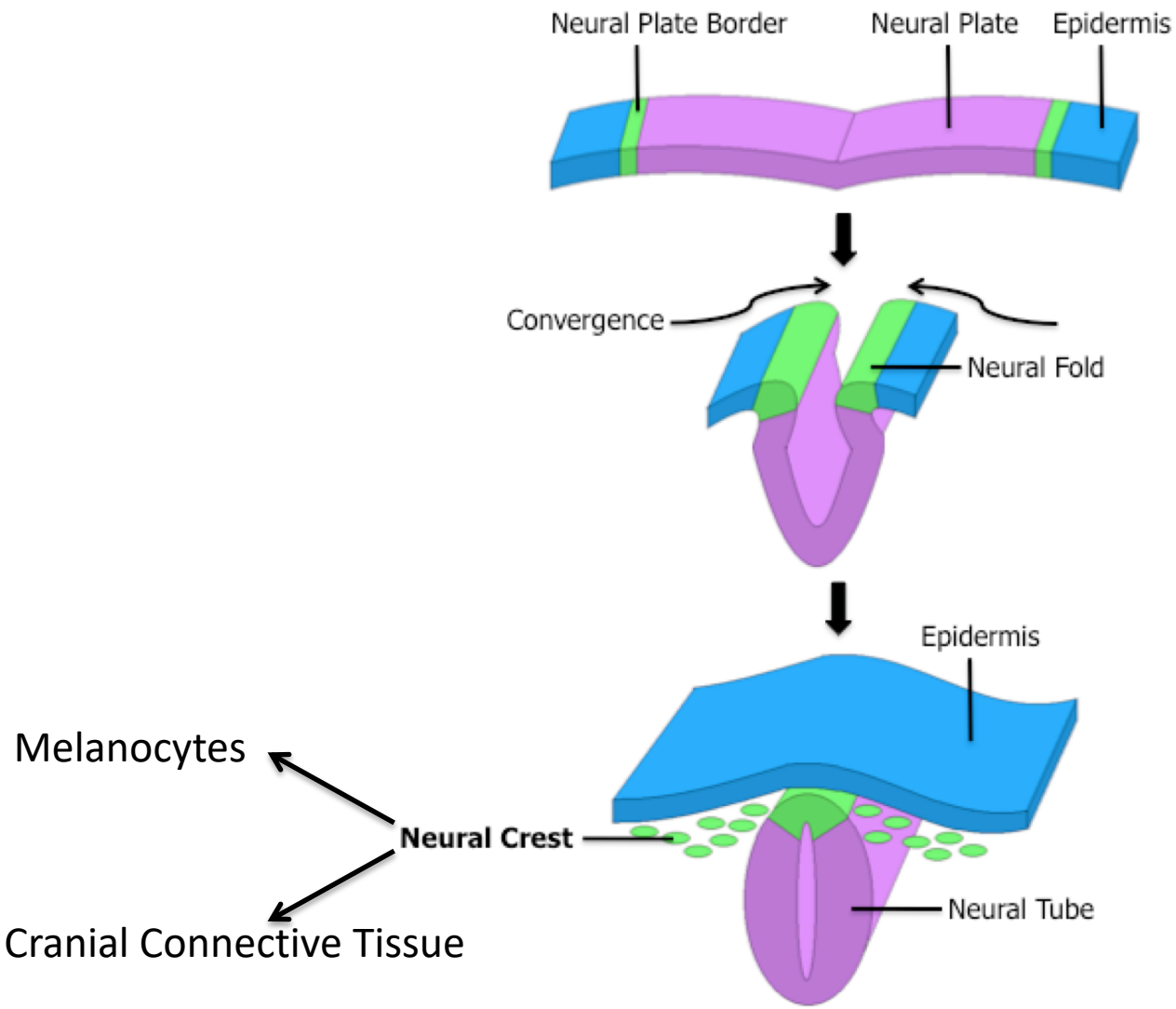
Overlying epidermis, epidermal appendages, nerve endings



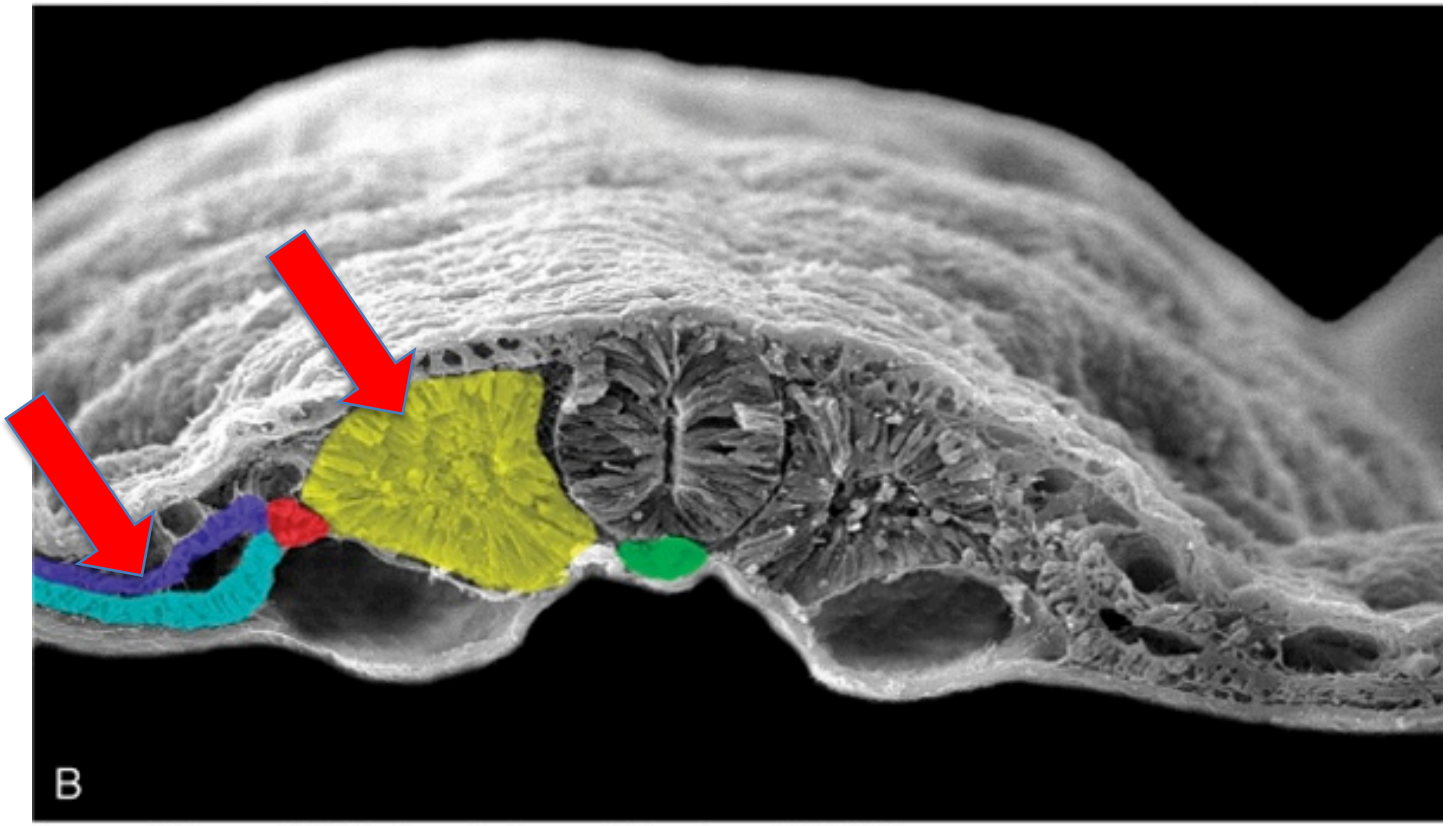


Neural Crest

Melanocytes + Cranial Connective Tissue



Mesoderm
Dermis, Hypodermis



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

Embryonic tissues contributing to skin development

Lateral Ectoderm

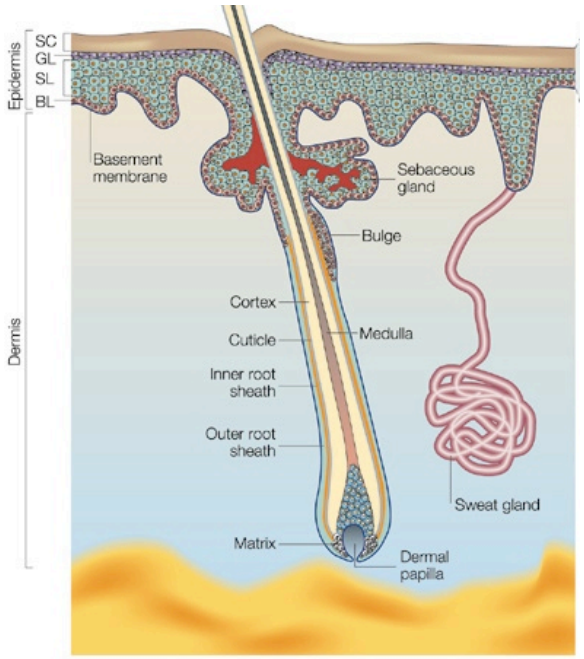
Neural Crest

Somitic and Lateral Plate Mesoderm

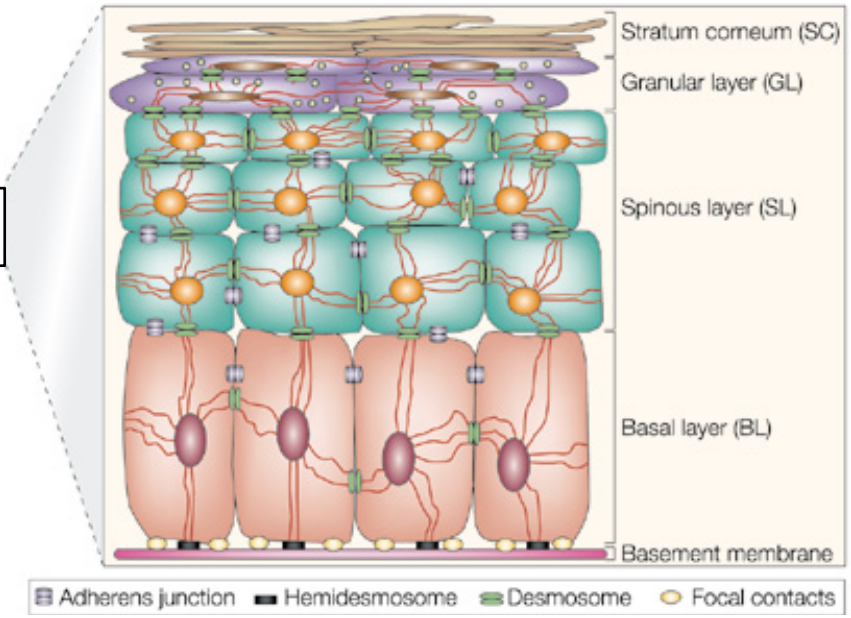
Week 4 embryo

Development of the Epidermis

Lateral ectoderm
Interfollicular epidermis: stratified squamous epithelium
Appendages:
- Hair follicles
- Glands (sebaceous, sweat, apocrine, mammary, lacrimal, salivary)
- Nails
- Teeth



Epidermis



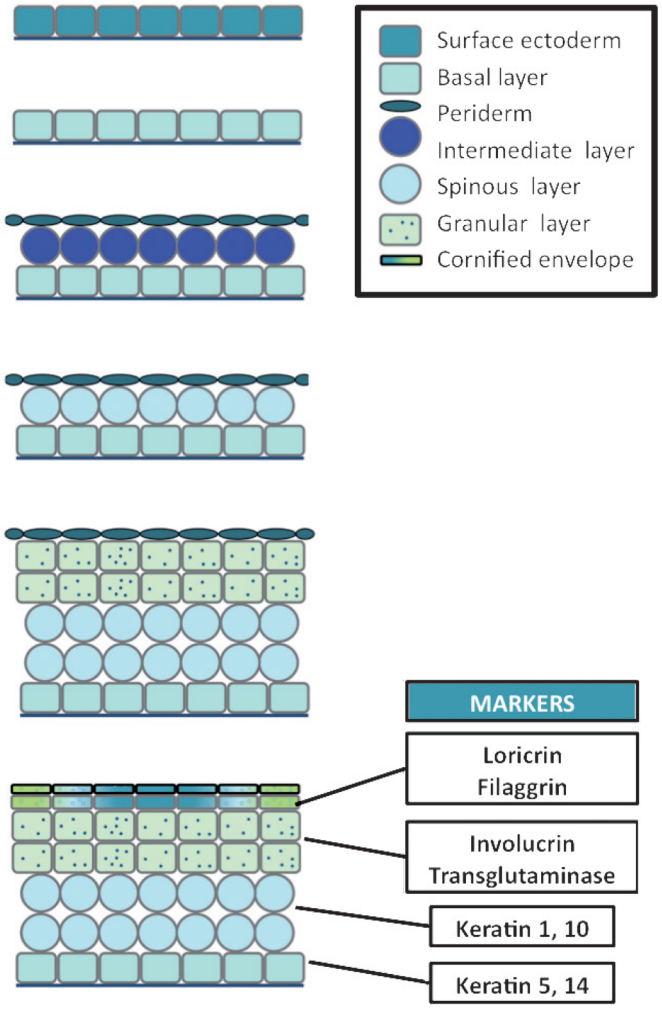
Development of the Interfollicular Epidermis (IFE)

Week 4

Onset of stratification → Week 11

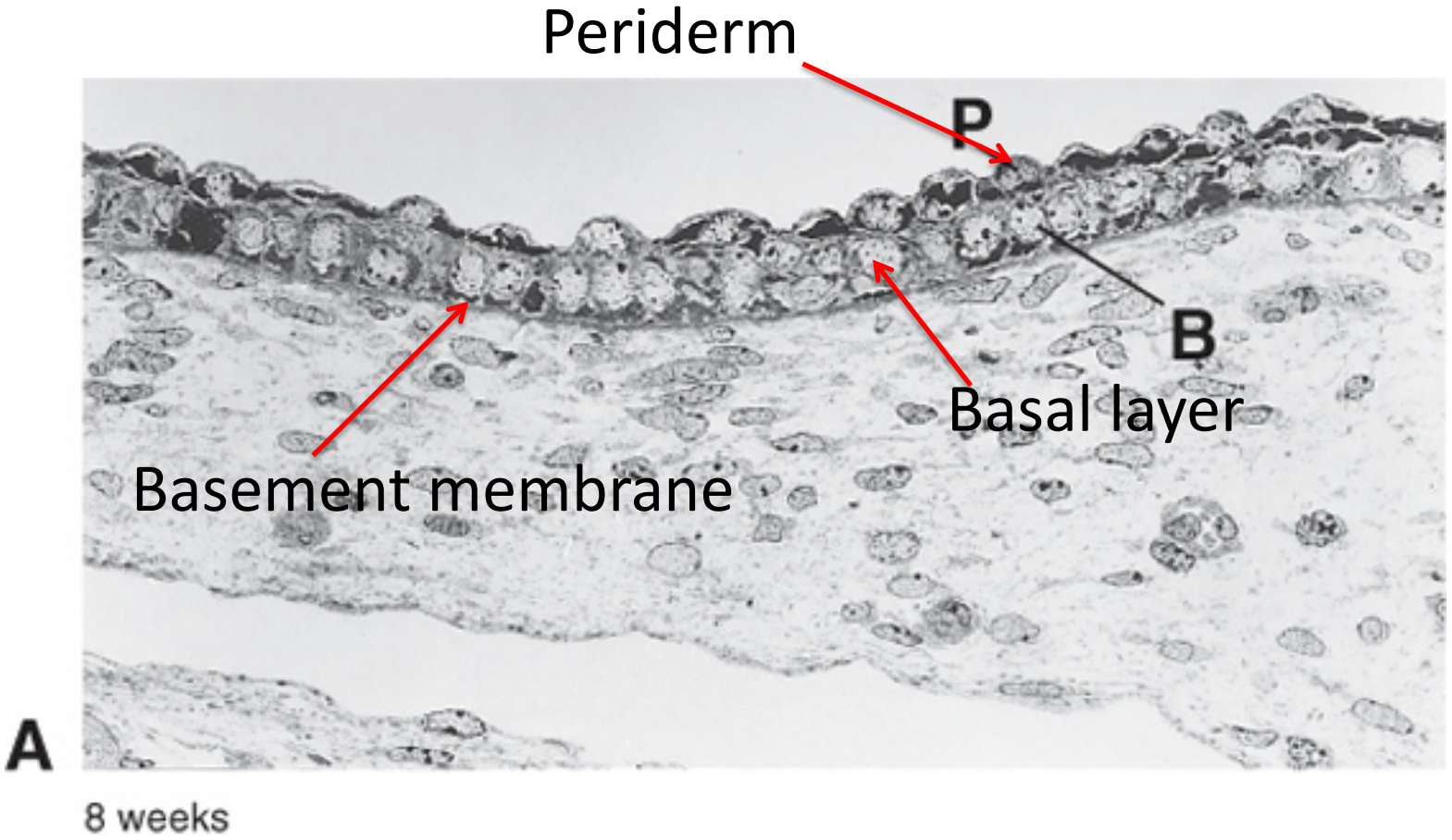
Periderm is transient
May persist until birth

Week 24



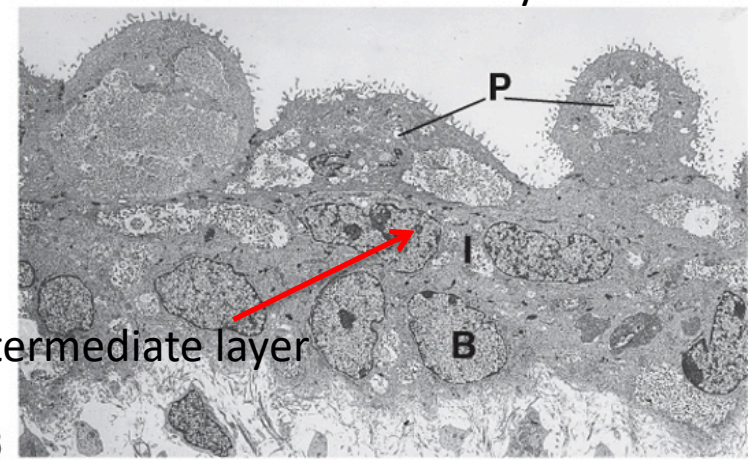
Development of Interfollicular Epidermis (IFE)

Periderm formation: 4 weeks



Development of Interfollicular Epidermis (IFE) Stratification

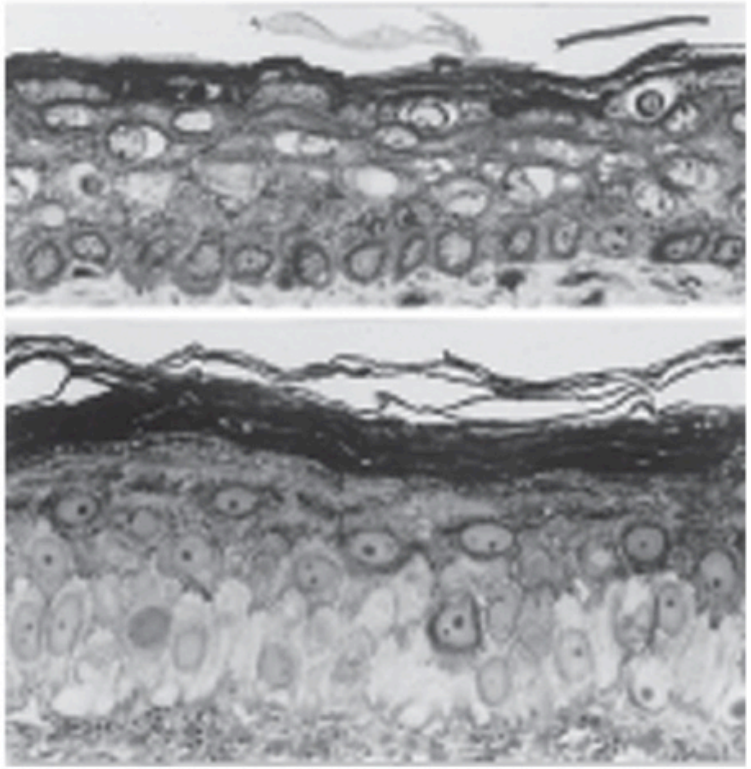
Week 11: intermediate layer



Intermediate layer

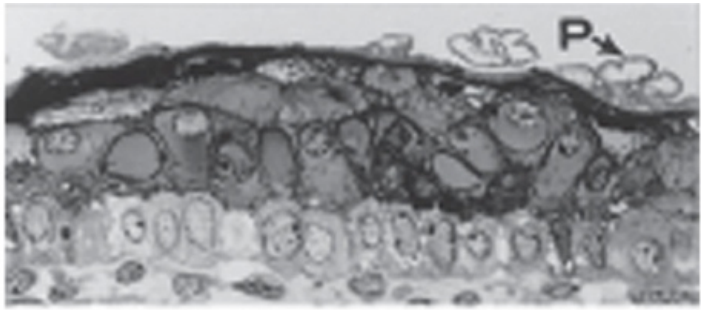
11 weeks

24 weeks



Adult

17 weeks

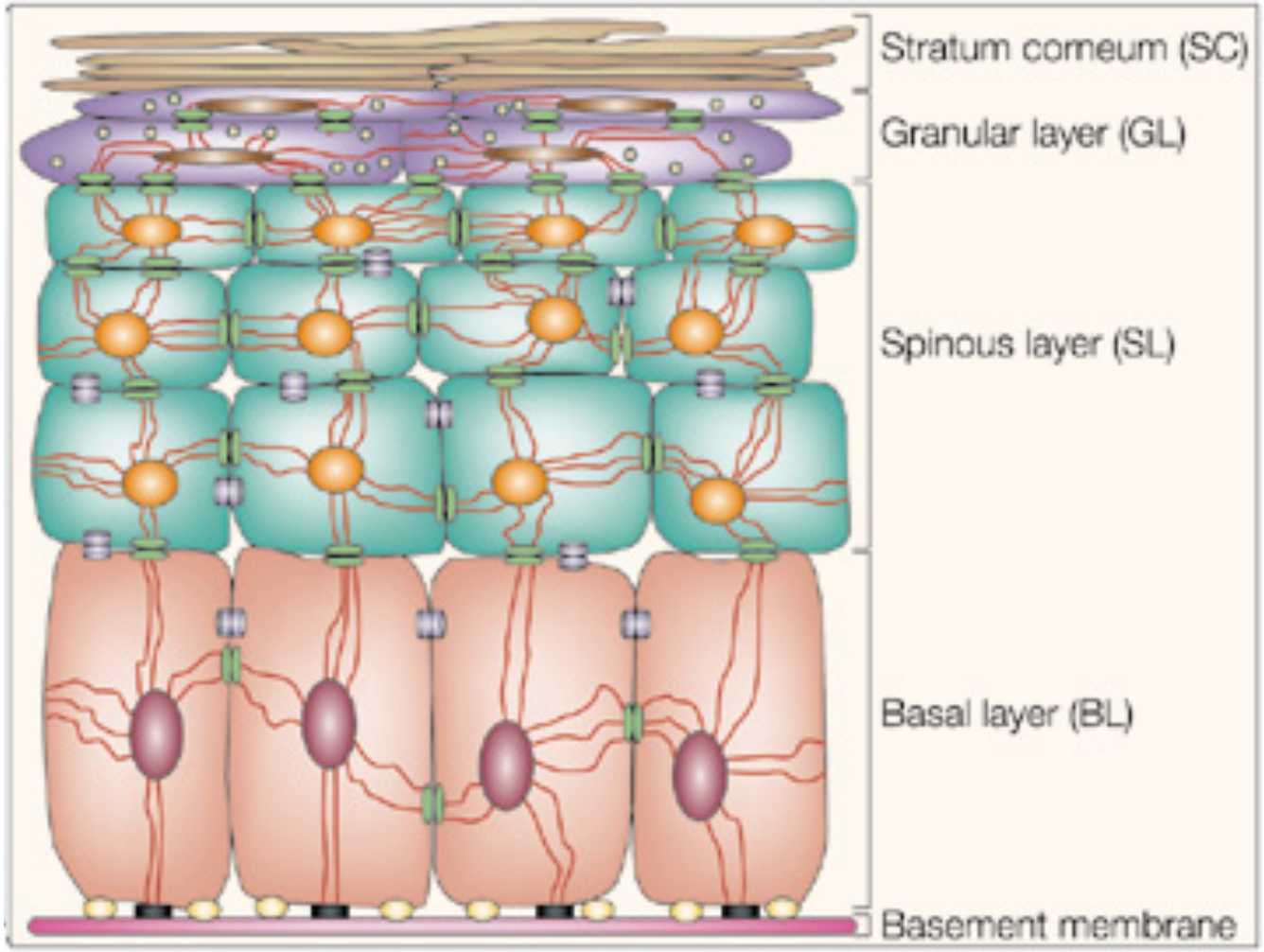


Stratified skin/IFE

Envelope proteins
- Loricrin
- Involucrin
- Fillagrin

Keratin 1/10

Keratin 5/14



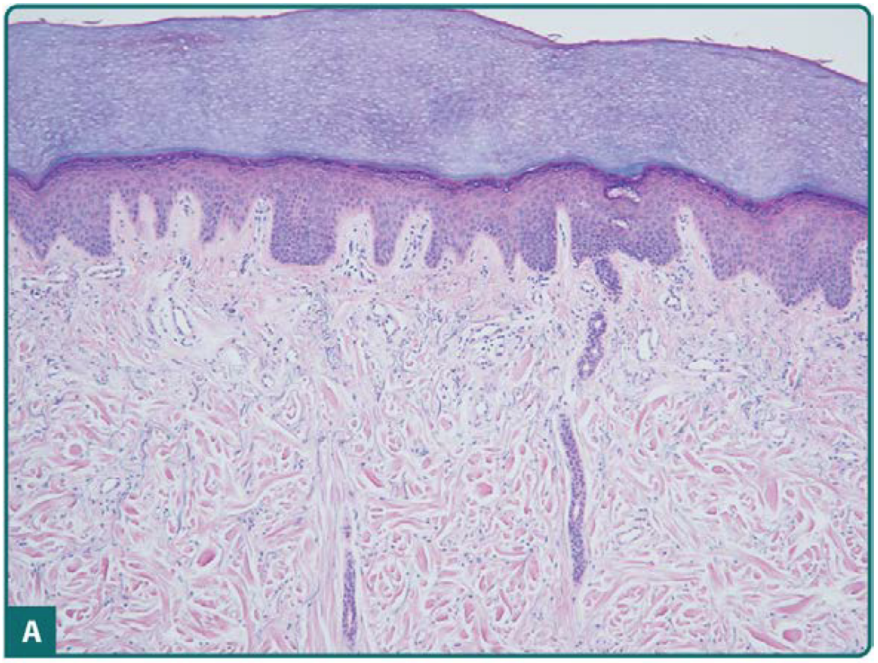
Junctions: Adherens junction — Hemidesmosome — Desmosome — Focal contacts

integrins

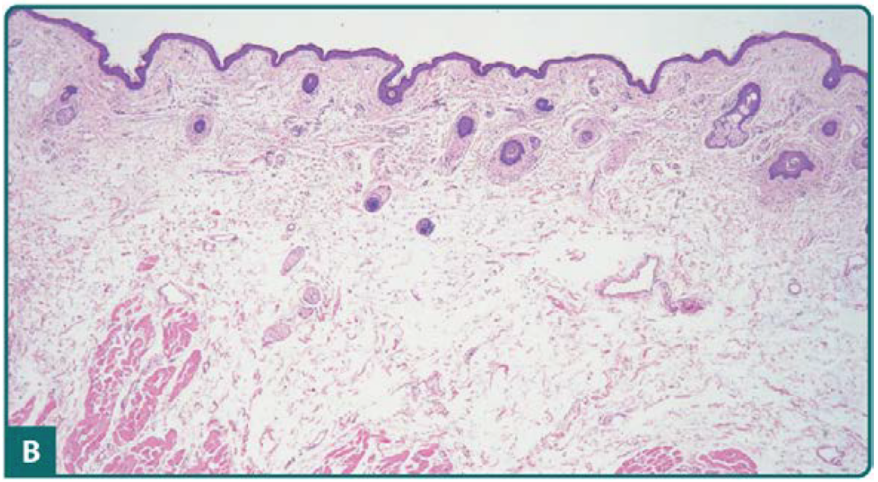
Regeneration, skin types

Stratified skin/IFE

Thick skin



Thin skin



Development of the Epidermal Appendages

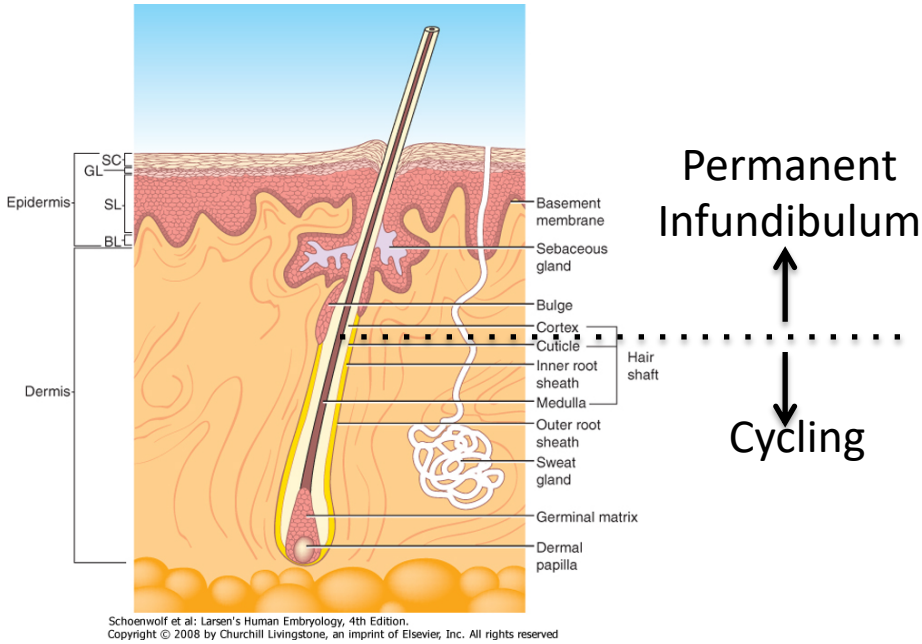
- Hair follicles,
- Glands: sebaceous, sweat, apocrine, mammary, salivary, lacrimal
- Nails
- Teeth

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

Involved in thermoregulation/sun protection



Month 2-4: Onset hair follicle development

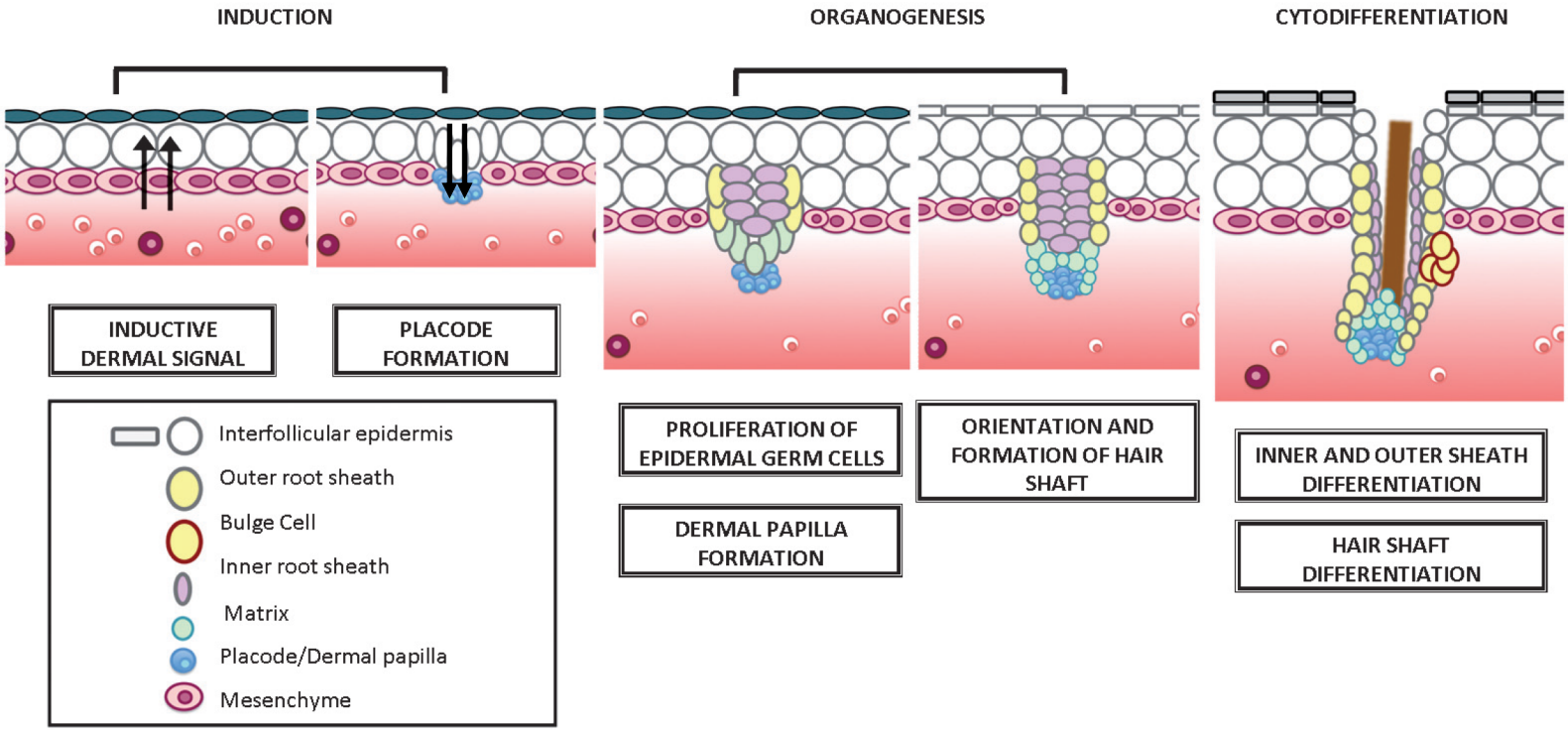
Hair follicles develop first in cranial region

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

Anatomy

Hair follicle development

Month 2 → Birth: 5000,000



Hair placode → Hair germ → Hair peg → Bulbous hair peg

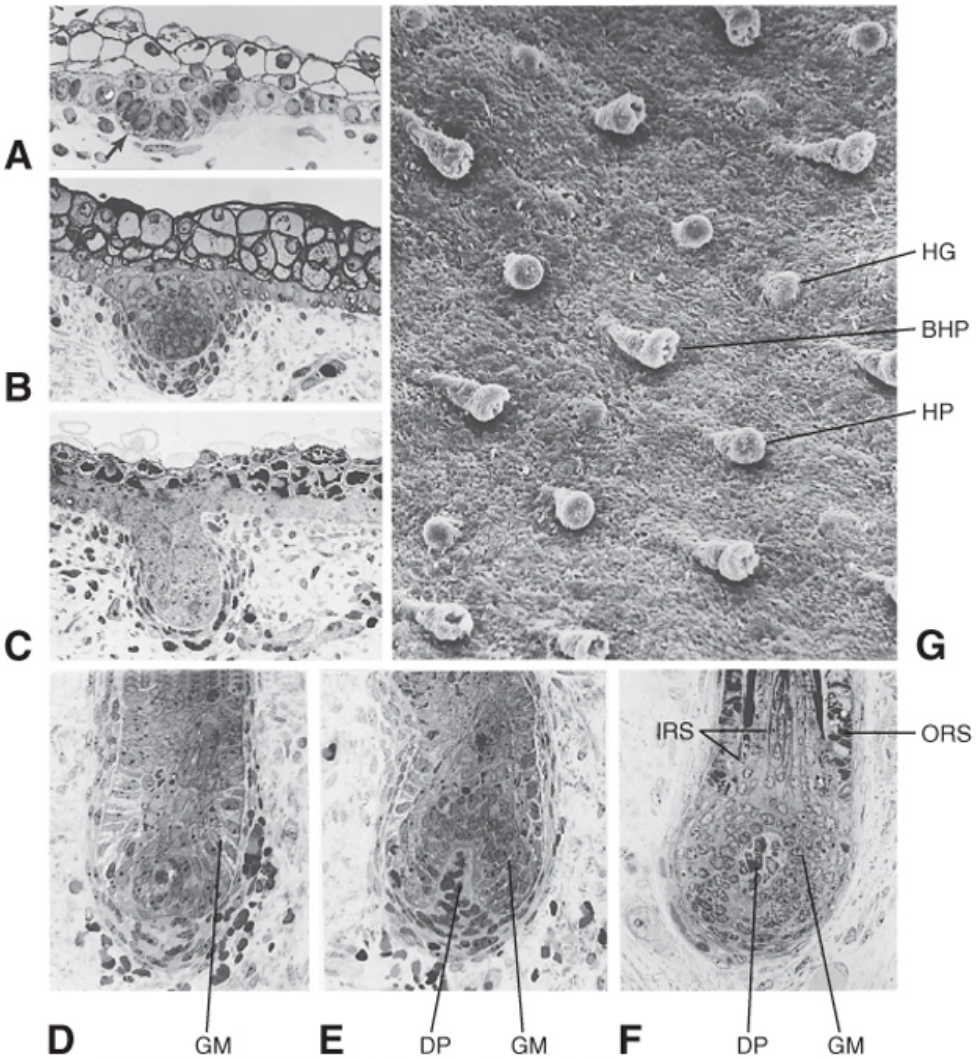
Hair follicle development

Hair germ

Hair peg

Bulbous hair peg

Invasion of dermal cells

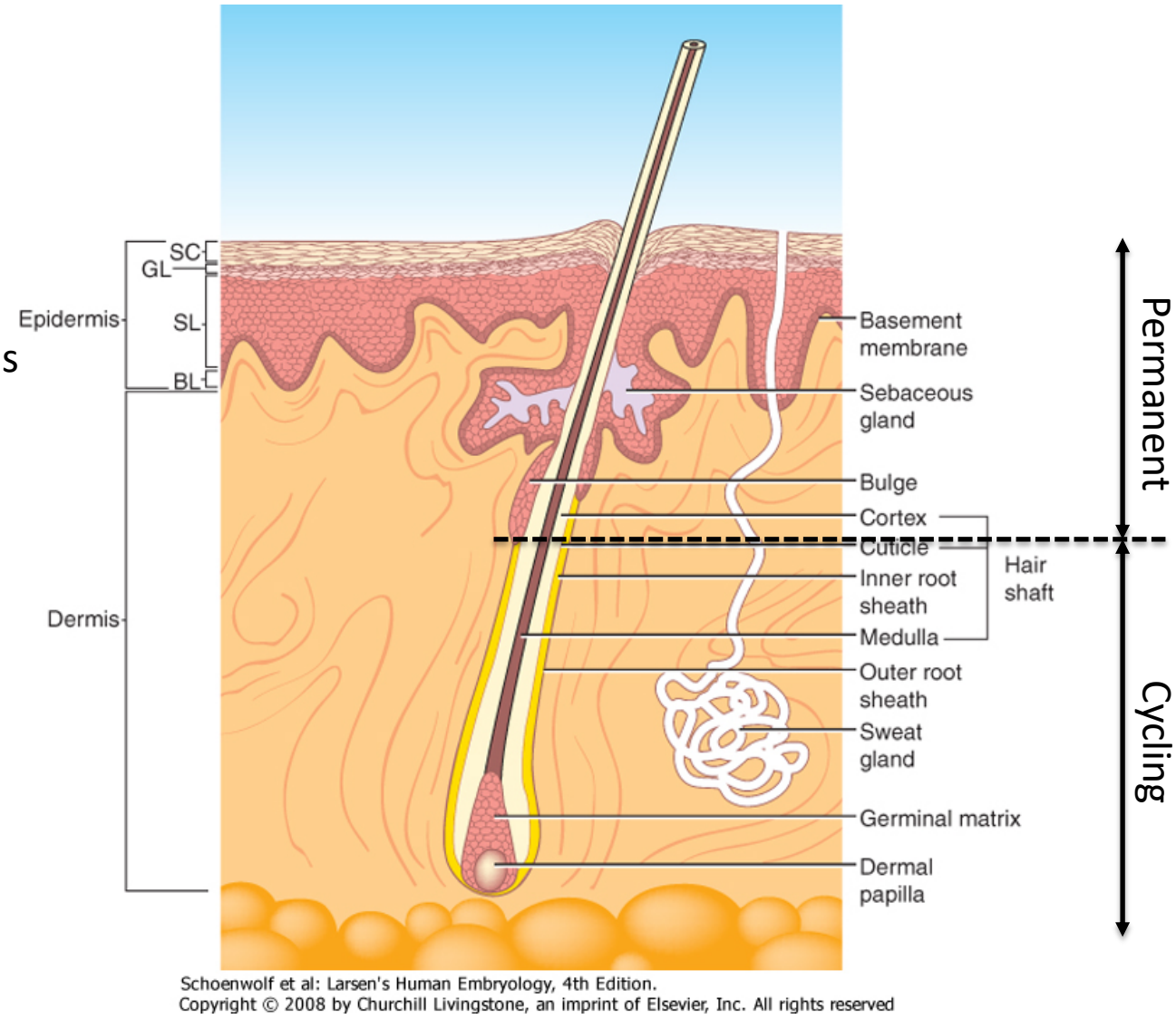


Hair follicle development

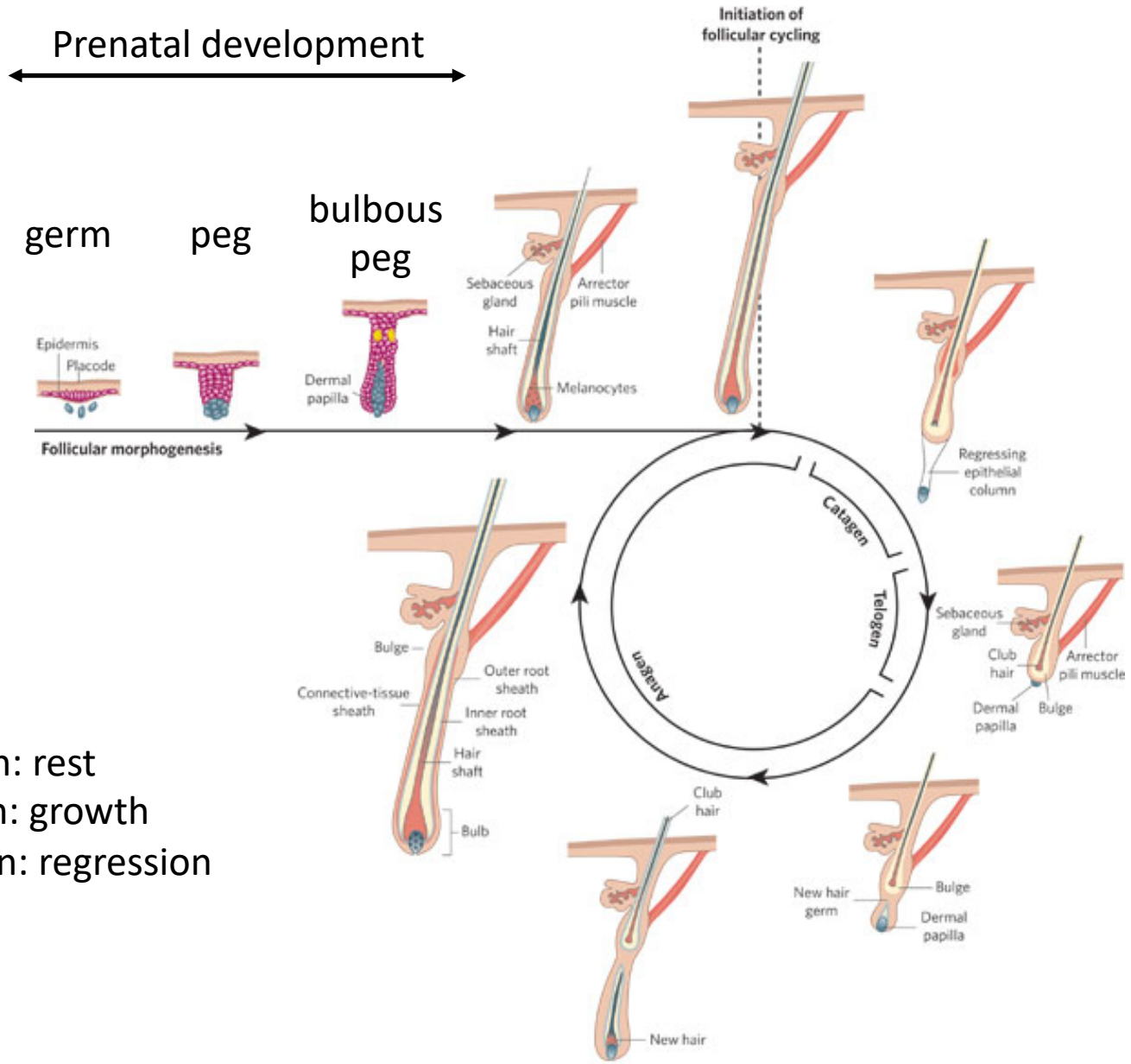
Formation of:
Arrector pili muscle
Hair follicle bulge
Germinal matrix
Inner and outer root sheaths

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

Postnatal regeneration:
Hair follicle cycling



Postnatal hair follicle cycling

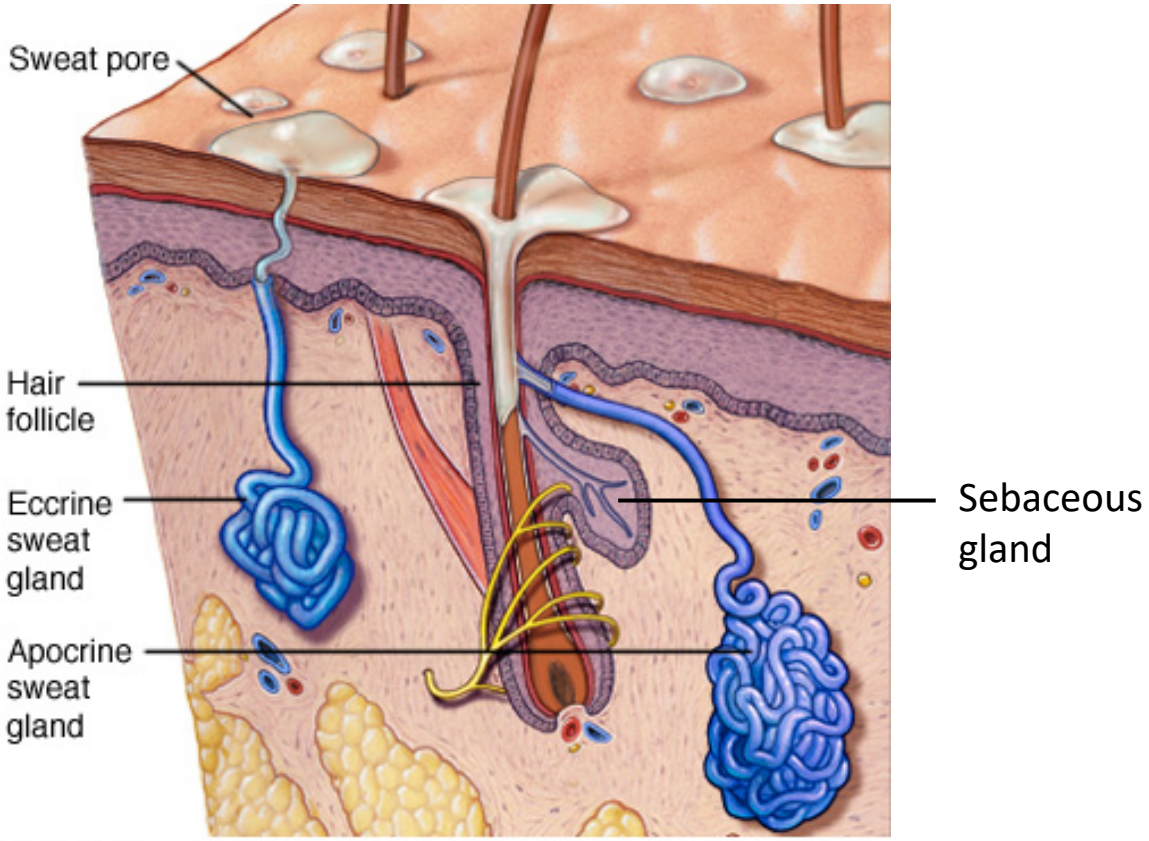


Telogen: rest
Anagen: growth
Catagen: regression

Ageing

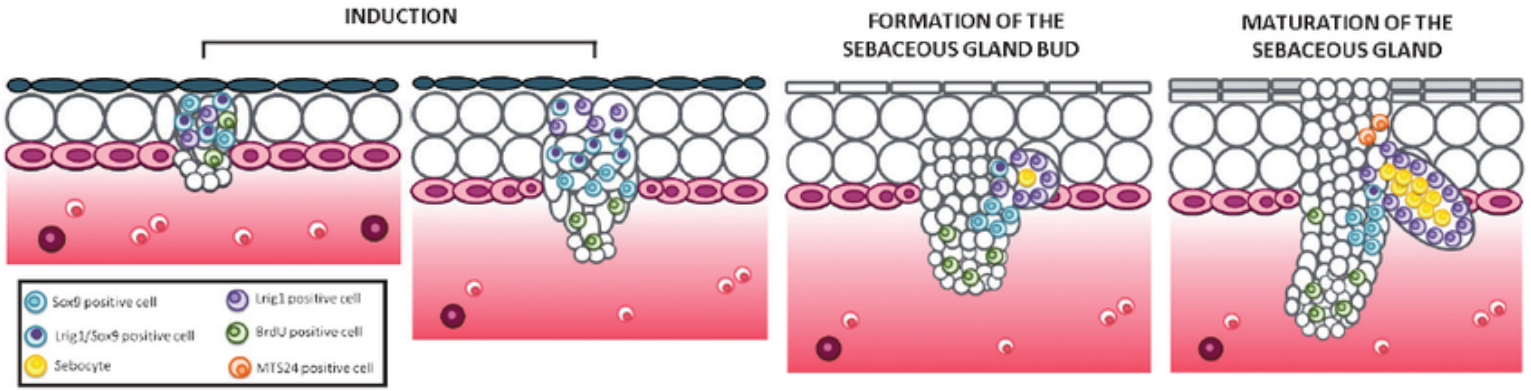
Epidermal Gland Anatomy

Sebaceous glands (Sebum): develop from hair follicle (4 weeks +)
Sweat/eccrine glands: develop from basal layer IFE (20 weeks+)
Apocrine glands (pheromones): develop in association with HFs

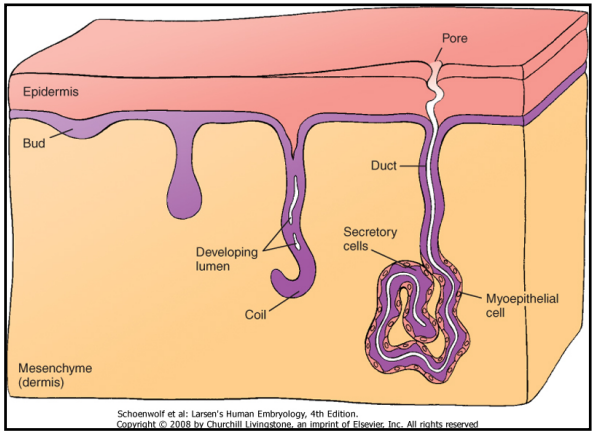


Epidermal Gland Development

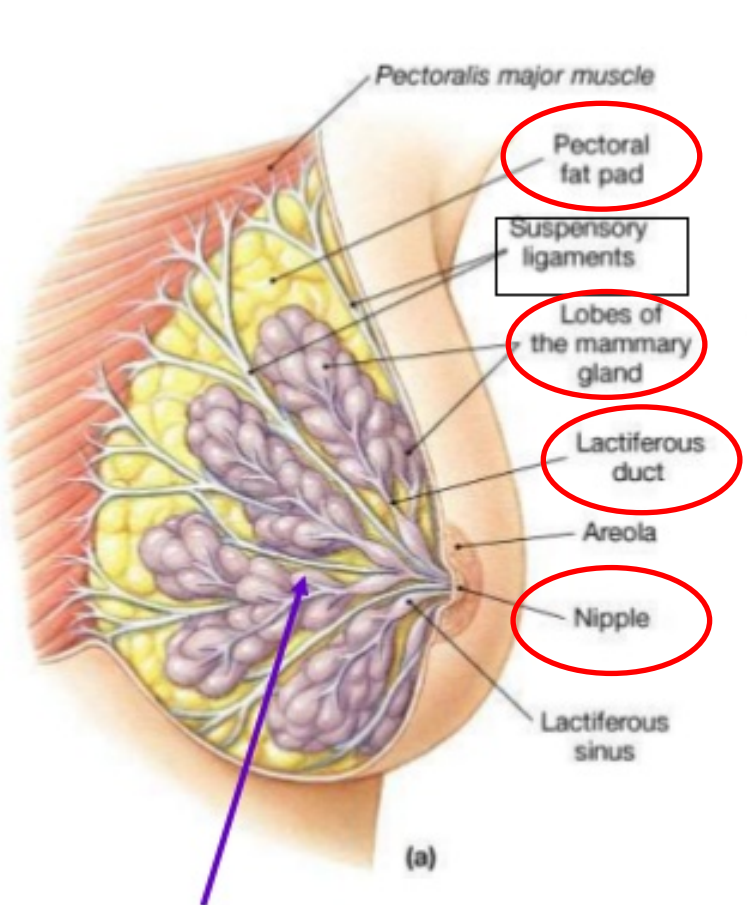
Sebaceous glands: develop from hair follicle (4 weeks +)
Sweat glands: develop from basal layer IFE (20 weeks+)
Apocrine glands: develop in association with HFs, most lost late in fetal dev.

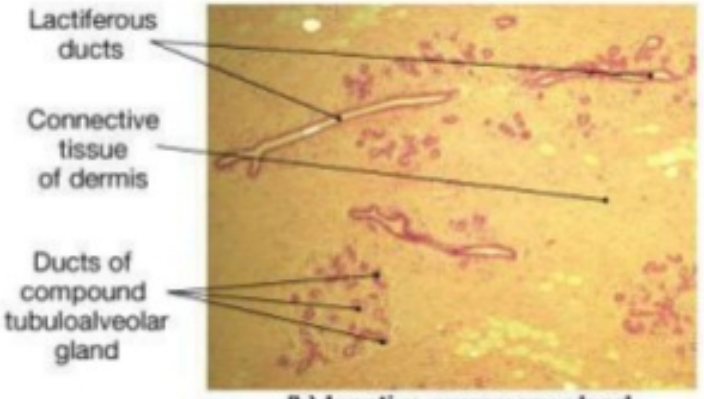


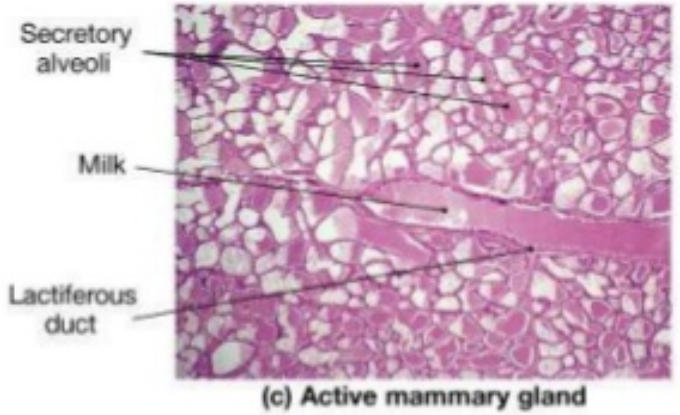
Eccrine gland Development:



Mammary Gland
Anatomy



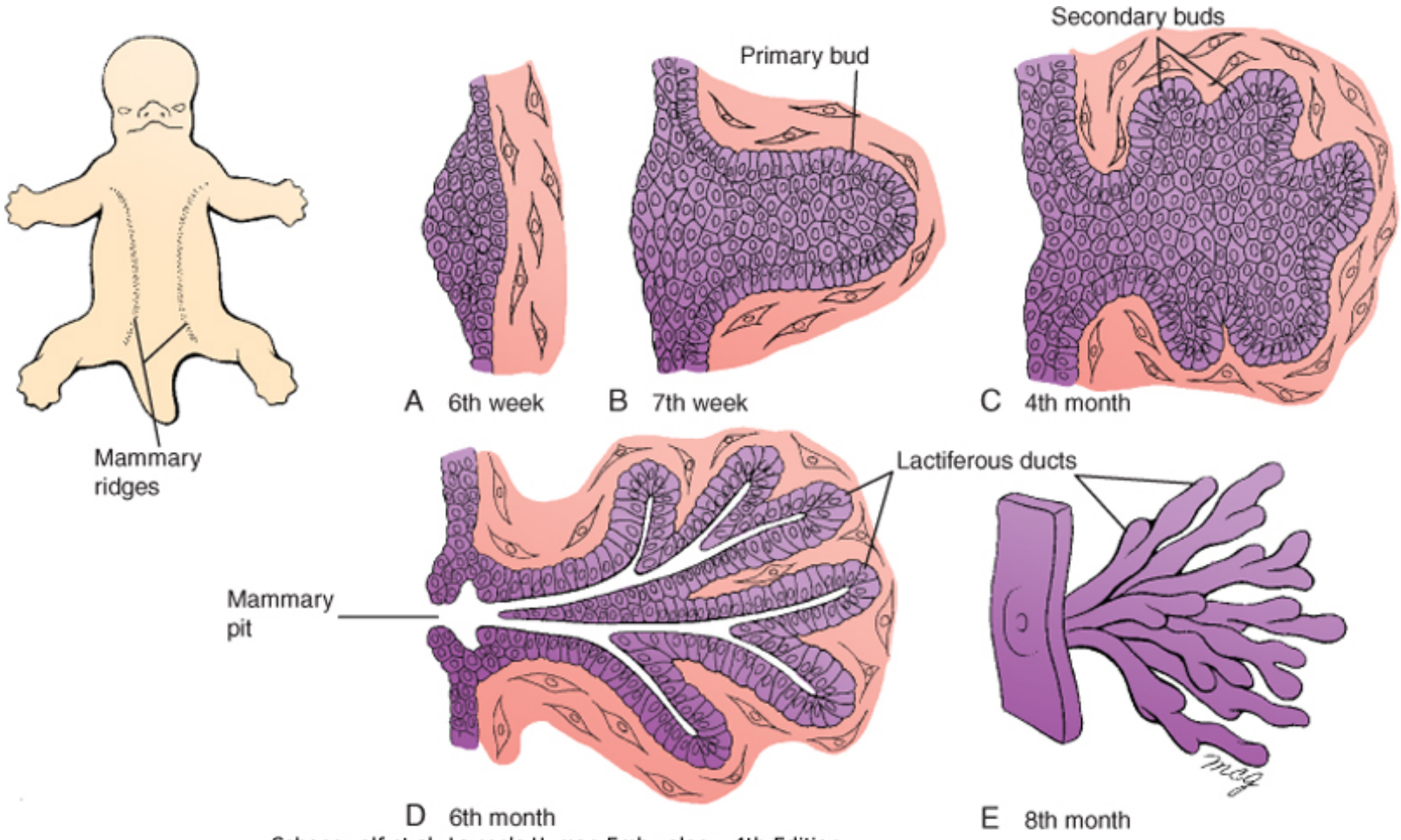




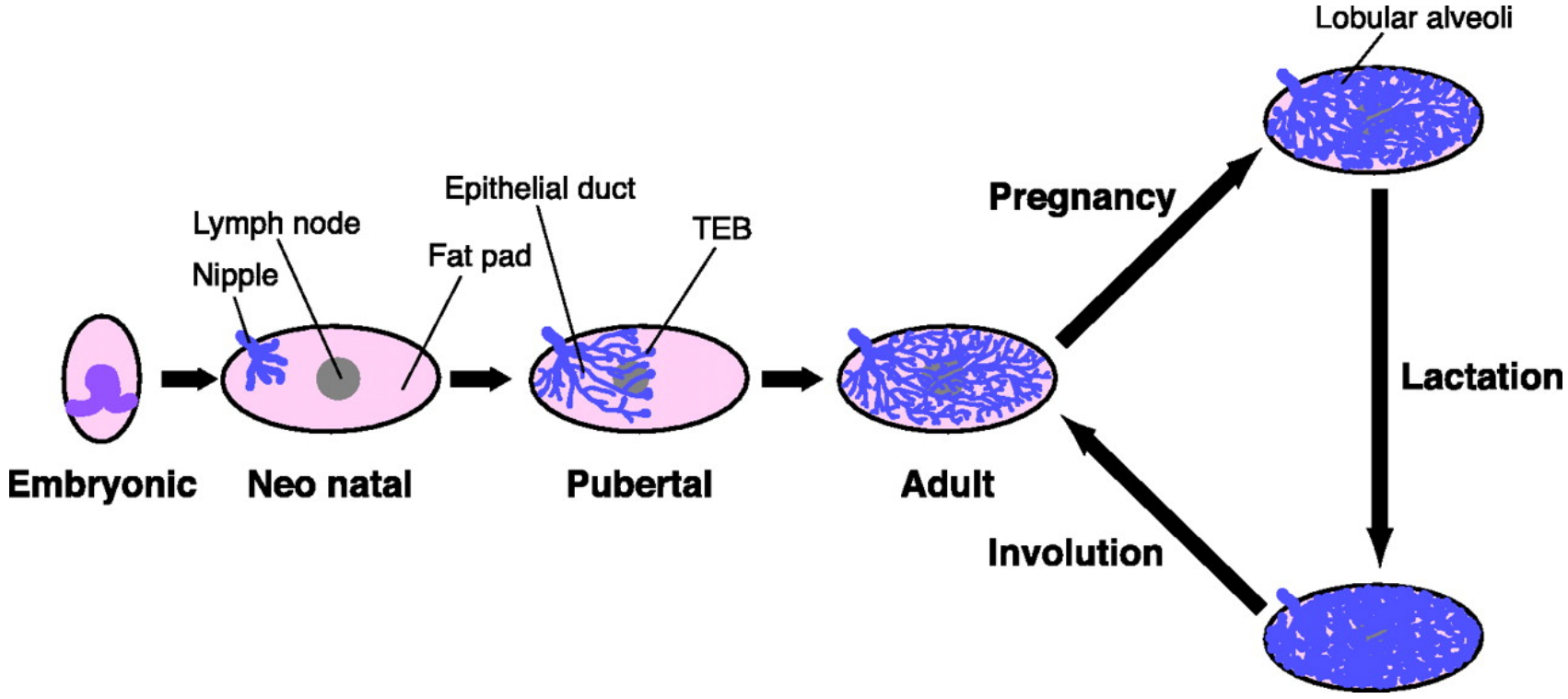
Mammary Gland development

Epidermal appendage

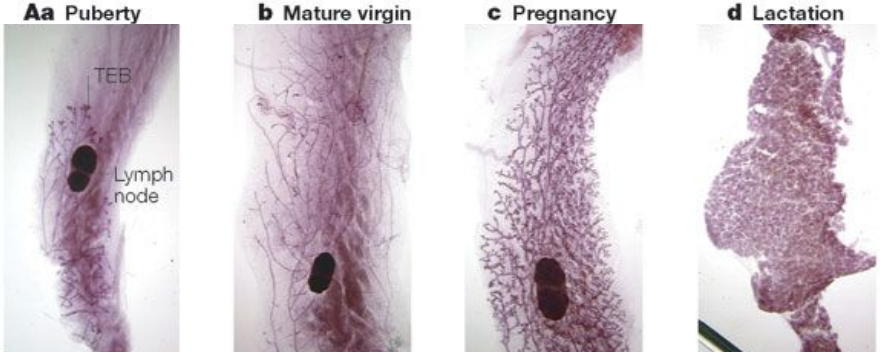
4 weeks:



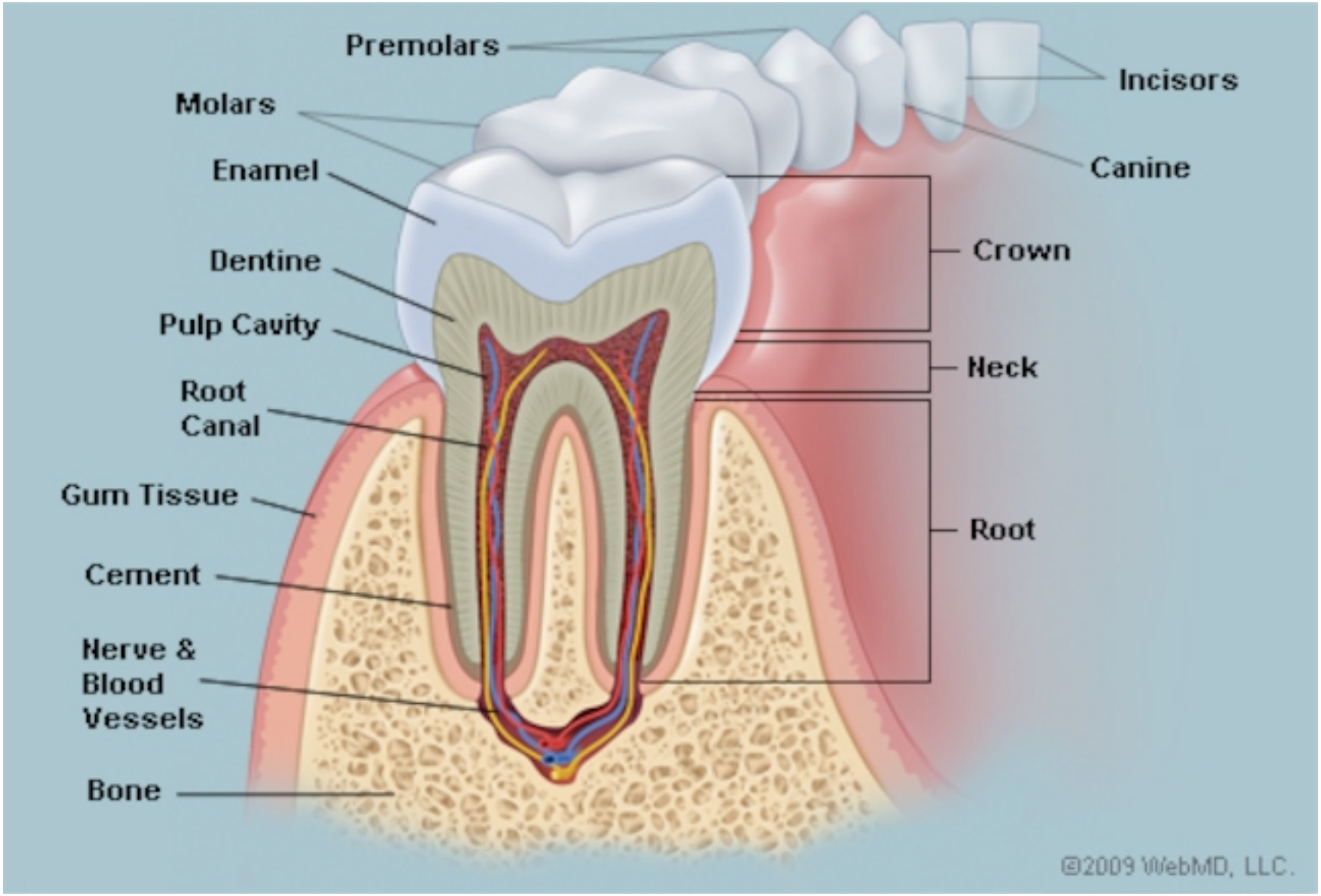
Mammary Gland Regeneration



Mouse mammary glands:

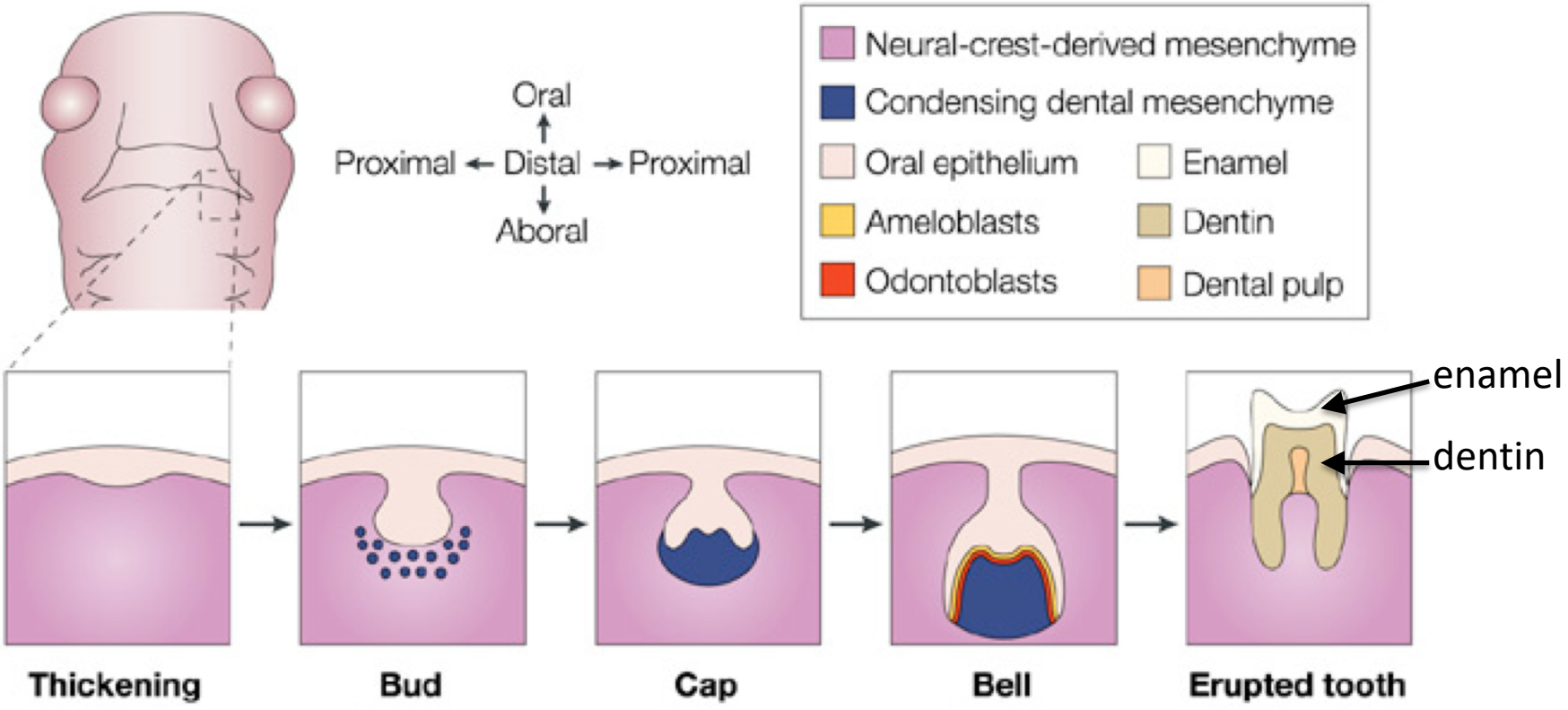


Teeth


Premolars
Incisors
Molars
Canine
Enamel
Crown
Dentine
Pulp Cavity
Neck
Root Canal
Gum Tissue
Root
Cement
Nerve & Blood Vessels
Bone
©2009 WebMD, LLC.

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

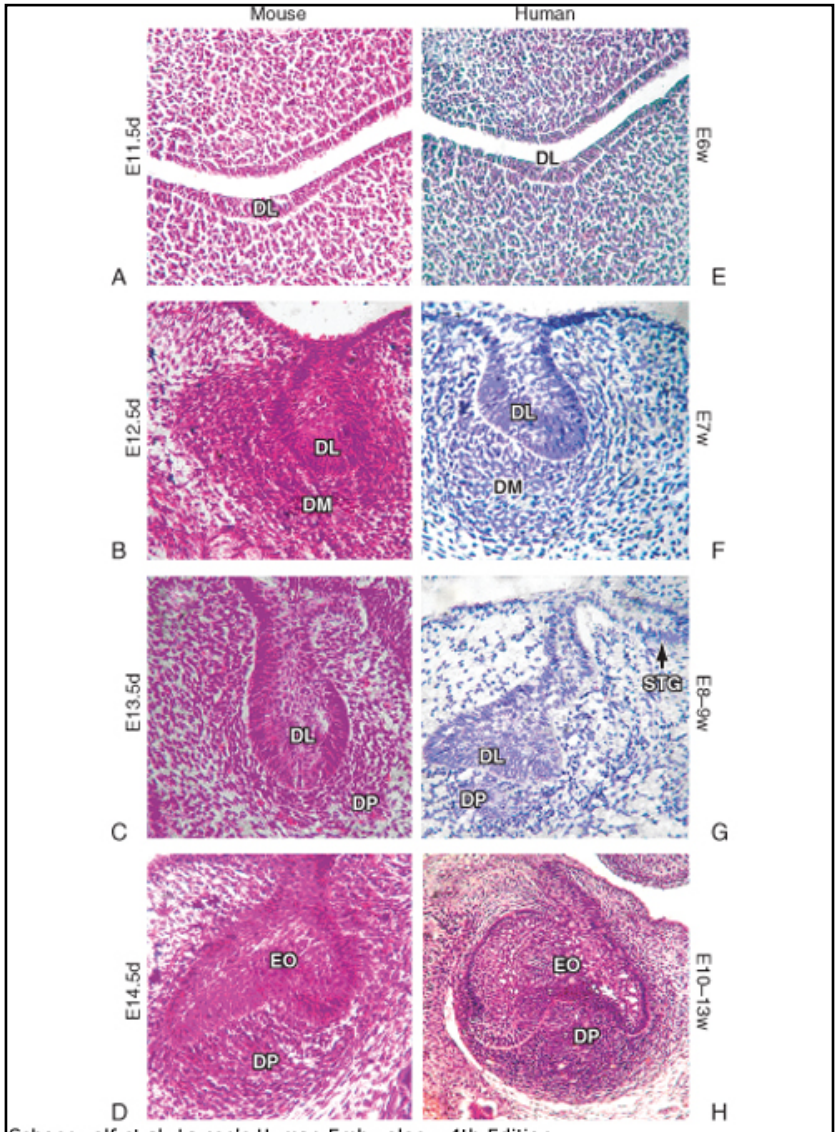
Tucker and Sharpe, Nature Genetics 2004

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

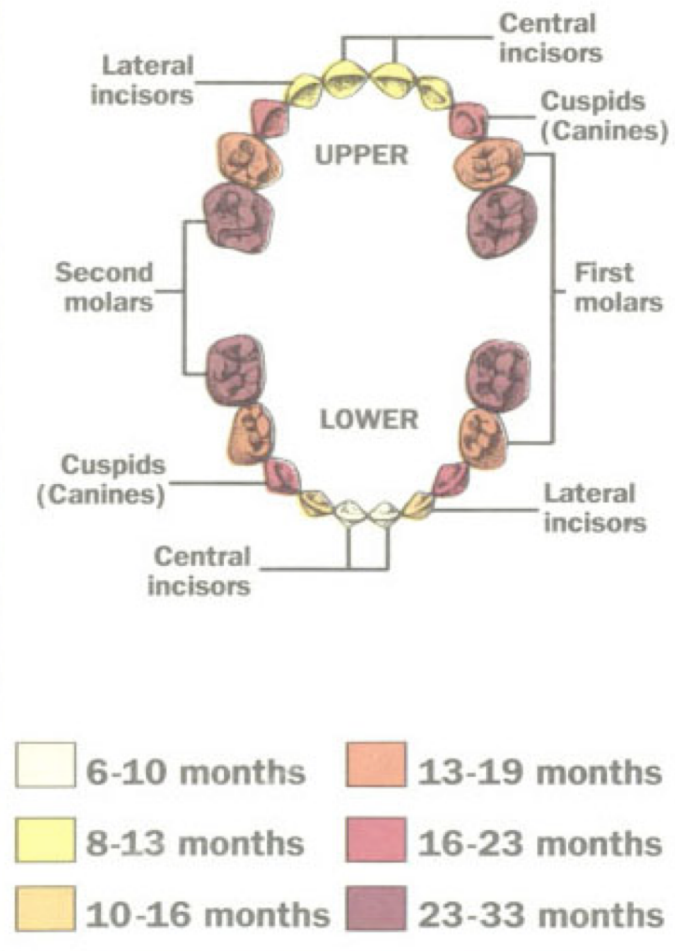


Oral epithelium: Ameloblasts, enamel

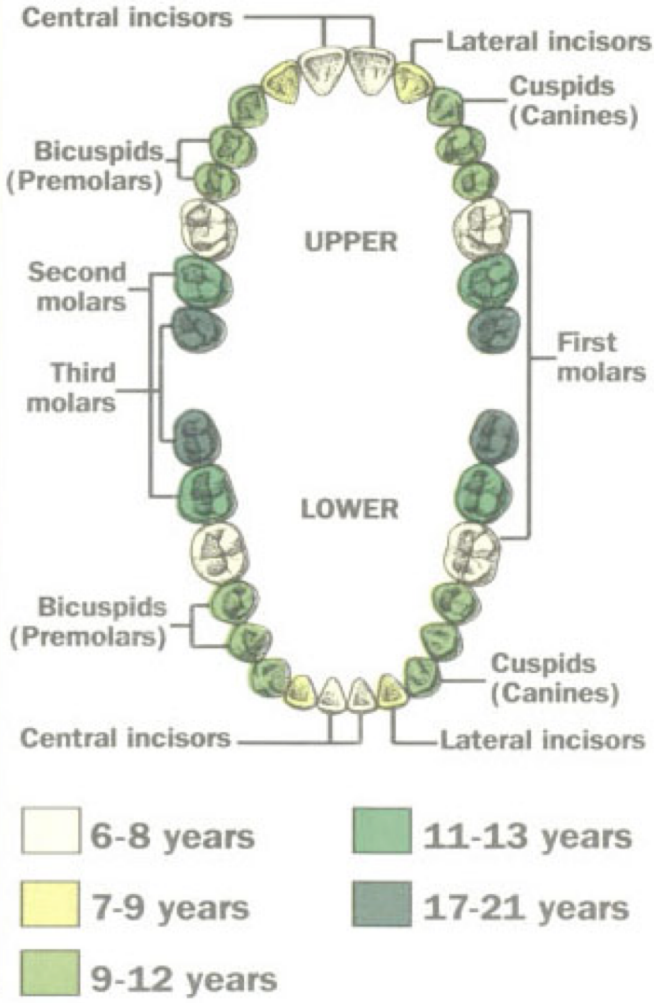
Dental papilla: Odontoblast, dentin

Postnatal Tooth Development

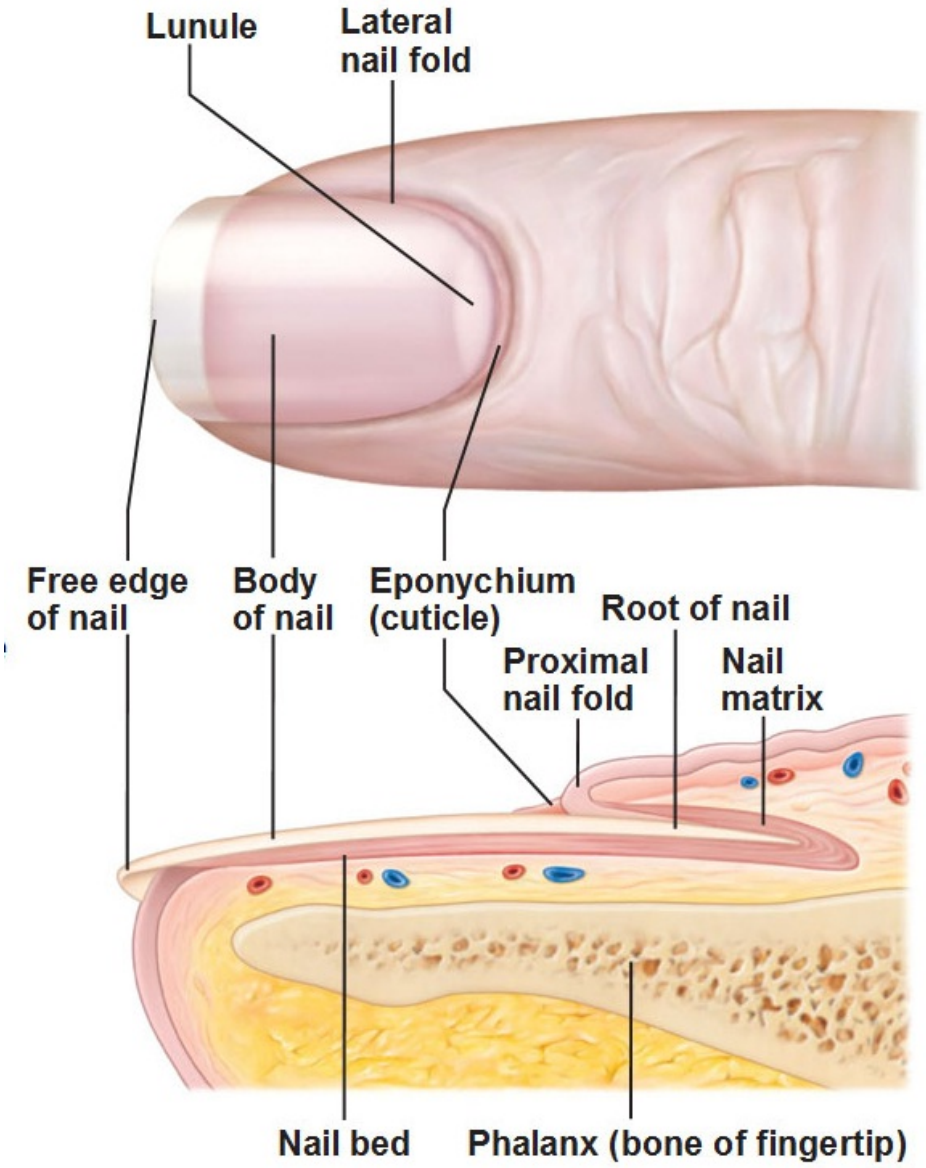
Primary teeth
10 + 10



Adult teeth
16 + 16



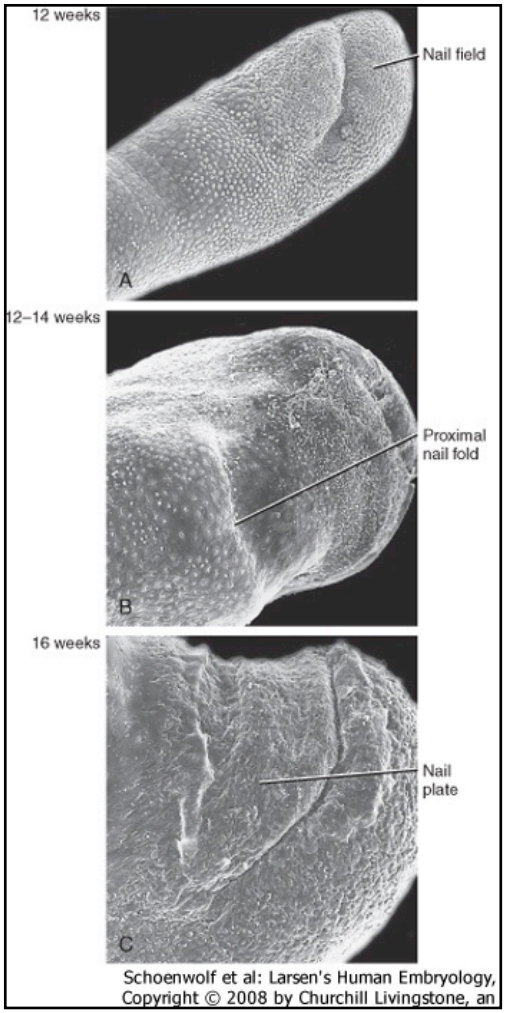
Nails


Lunule
Lateral nail fold
Free edge of nail
Body of nail
Eponychium (cuticle)
Root of nail
Proximal nail fold
Nail matrix
Nail bed
Phalanx (bone of fingertip)

Nail development
Ectoderm

Week 10: epidermal thickening, nail field

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



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

Embryonic tissues contributing to skin development

Lateral Ectoderm

Neural Crest

Somitic and Lateral Plate Mesoderm

Week 4 embryo

Skin Contributions of the Neural Crest:

Craniofacial connective dermis
Melanocytes

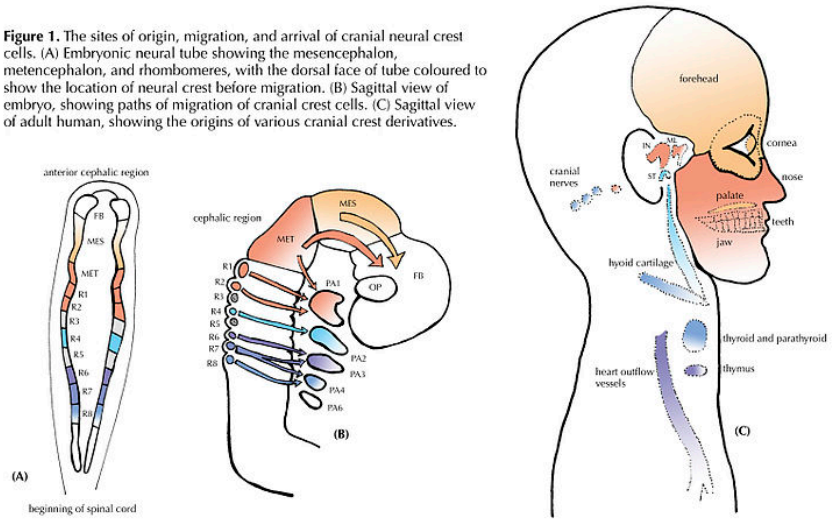
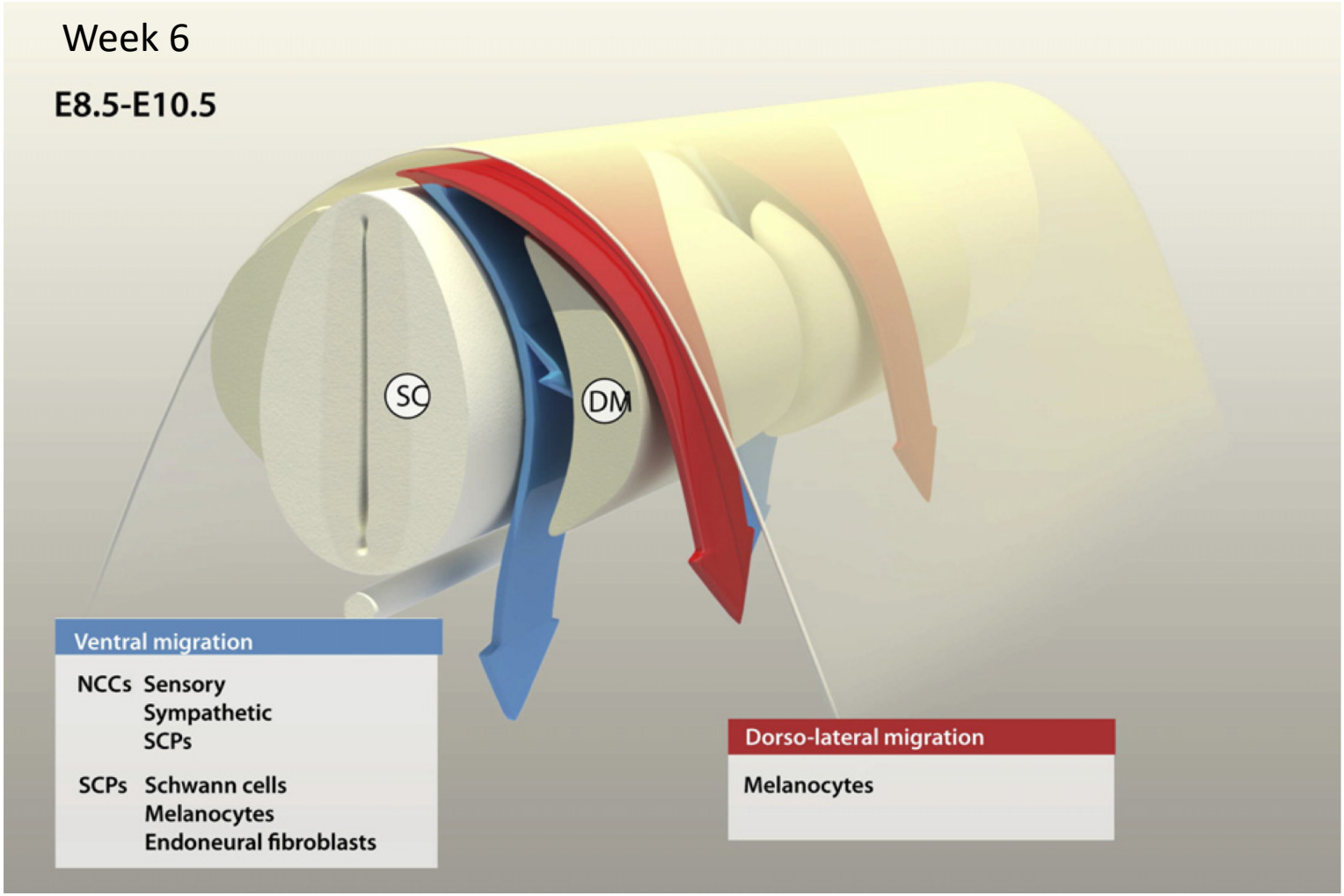


Figure 1. The sites of origin, migration, and arrival of cranial neural crest cells. (A) Embryonic neural tube showing the mesencephalon, metencephalon, and rhombomeres, with the dorsal face of tube coloured to show the location of neural crest before migration. (B) Sagittal view of embryo, showing paths of migration of cranial crest cells. (C) Sagittal view of adult human, showing the origins of various cranial crest derivatives.

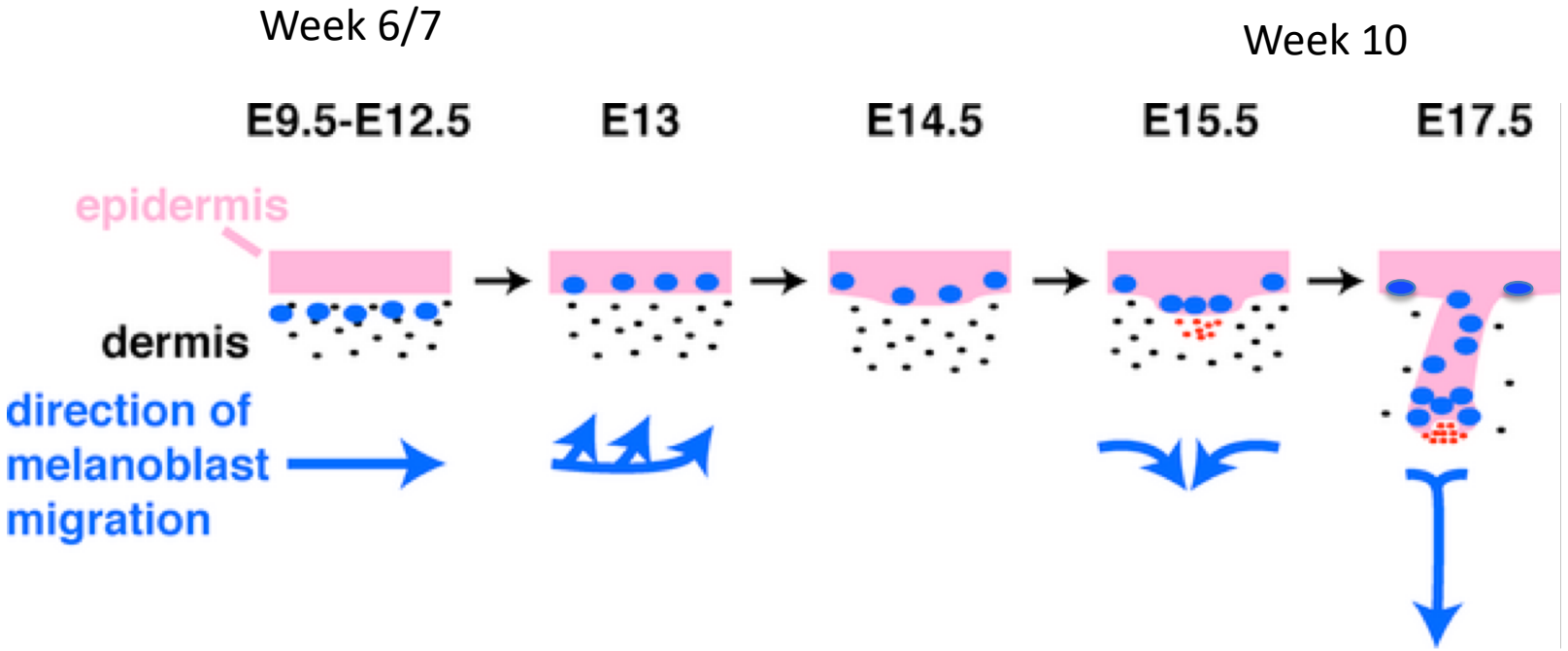
Melanocyte development
Neural crest



Ernfors, Exp Cell Res 2010

Melanocyte development

Neural crest



Millar, Plos Biology 2005

Embryonic tissues contributing to skin development

Lateral Ectoderm

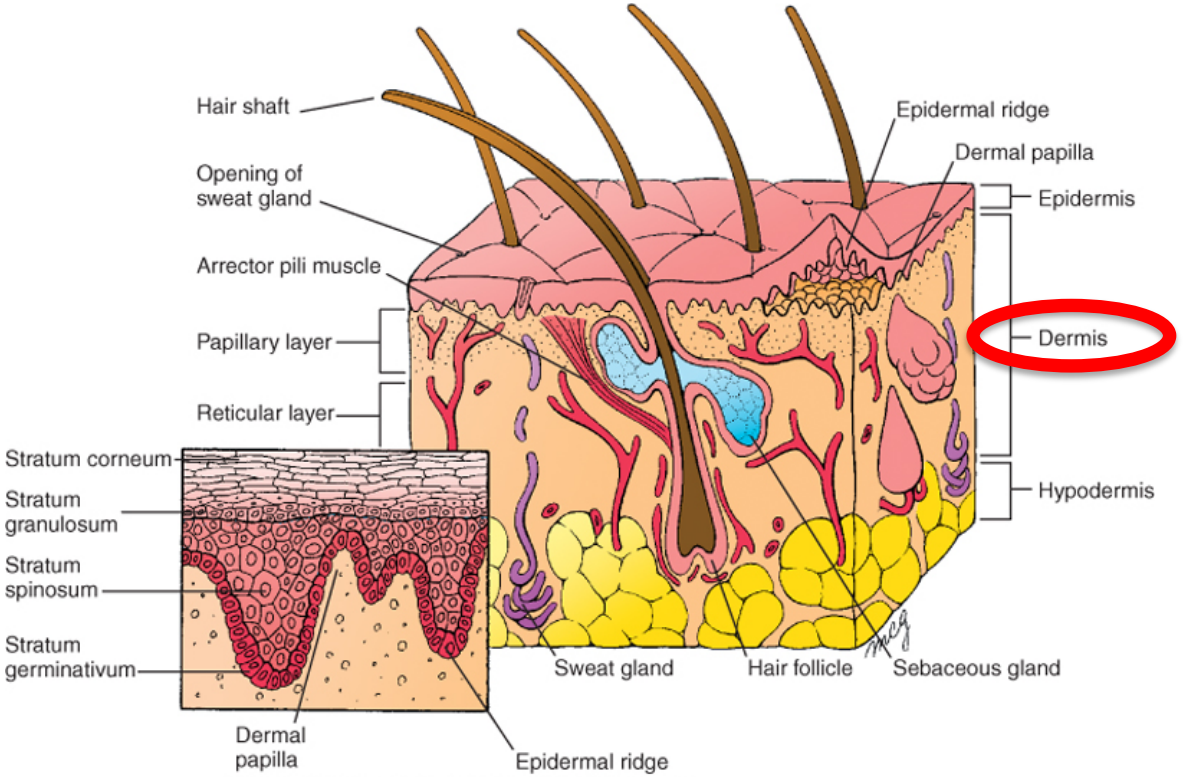
Neural Crest

Somitic and Lateral Plate Mesoderm

Week 4 embryo

Dermis

Connective tissue with:
Fibroblasts
Blood vessels
Nerve endings
Sensory receptors
Muscle bundles

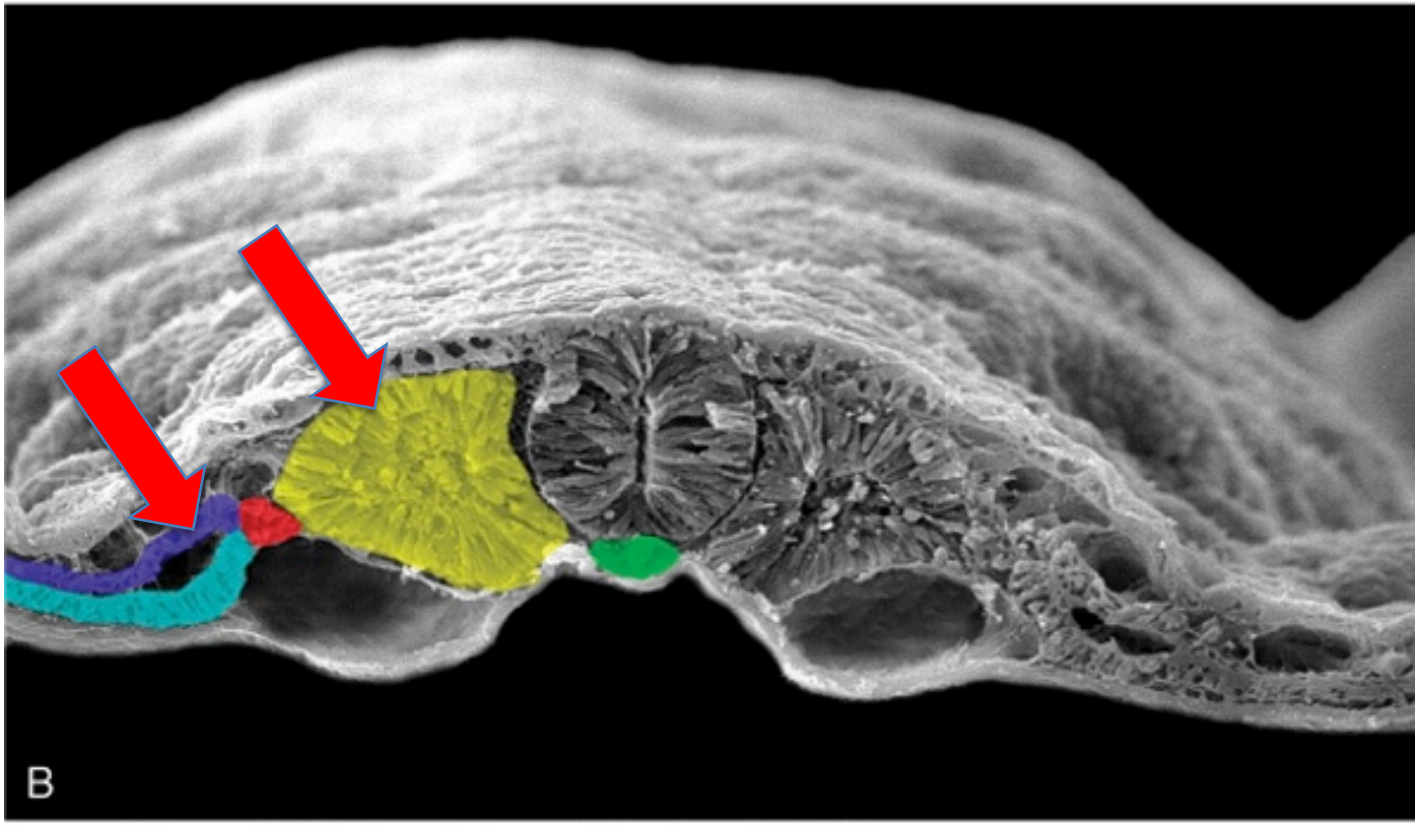


Dermis development

Somitic mesoderm -> trunk

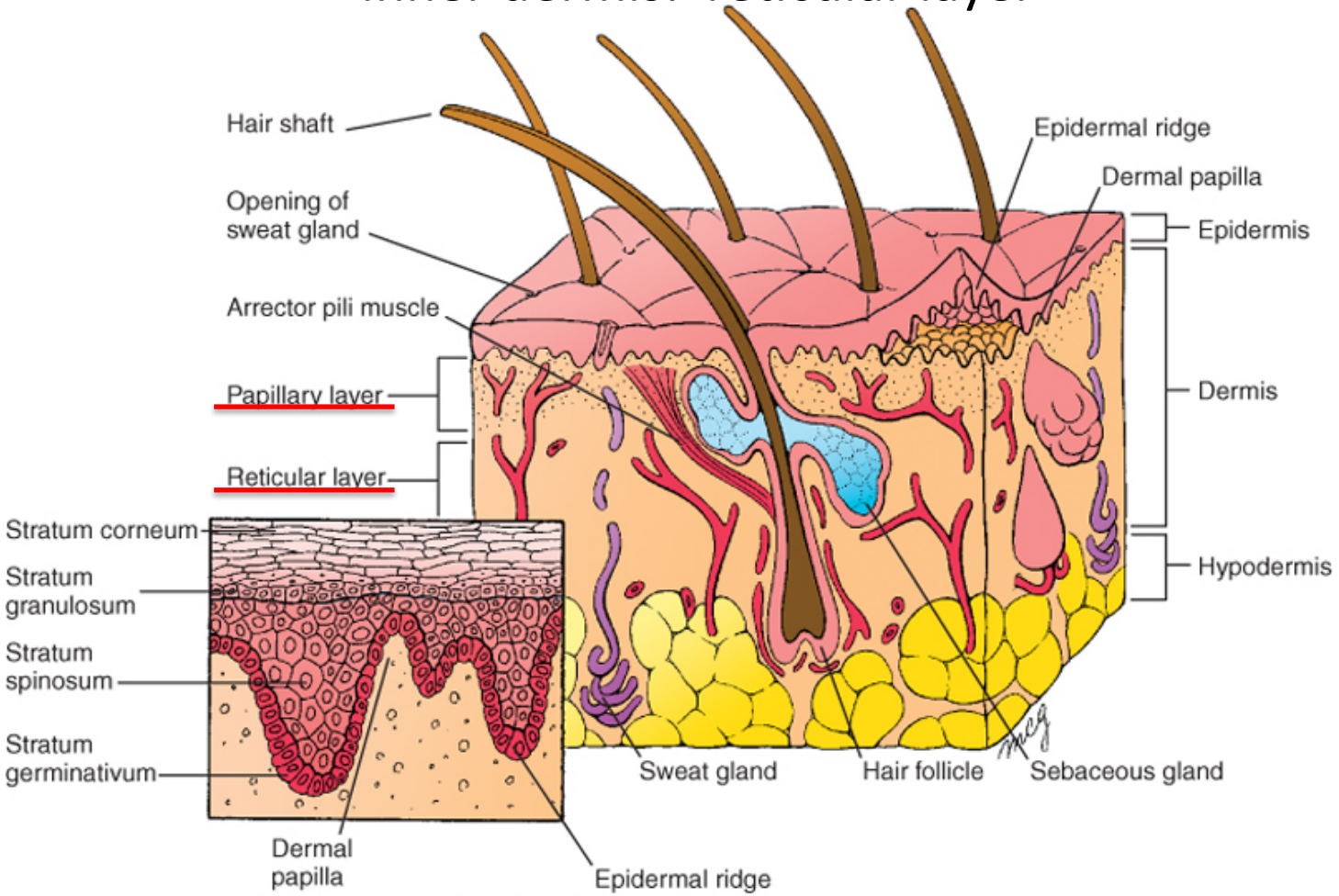
Somatic lateral plate mesoderm -> trunk, limbs

Cranial neural crest derived mesenchyme -> cranial region



Dermis development

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



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

Lecture overview

Skin

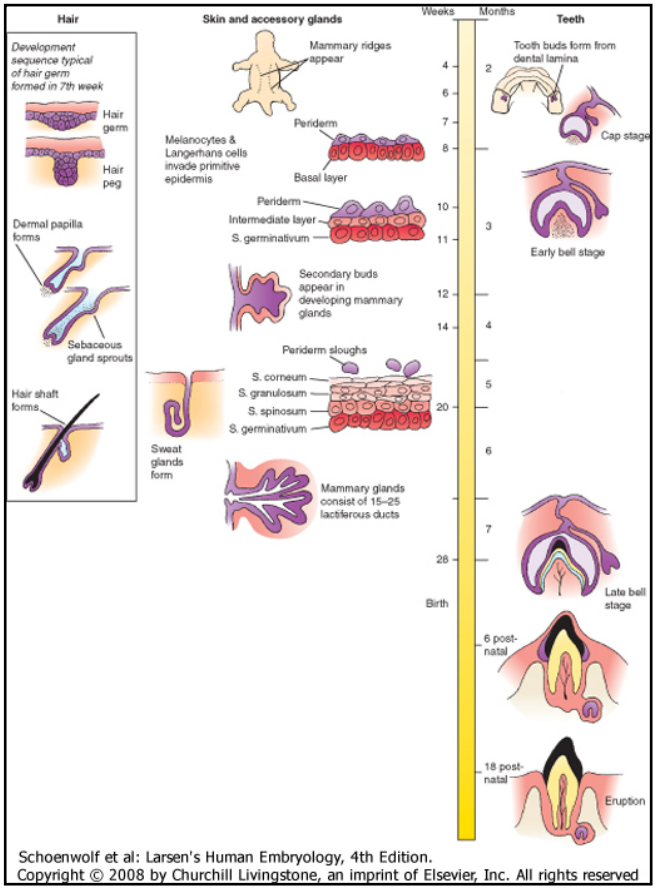
Skin origins

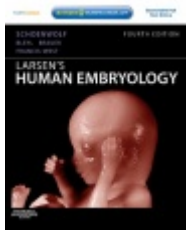
Development of the epidermis

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

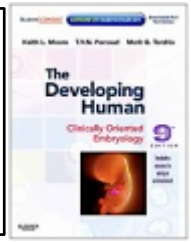
Development of Melanocytes

Development of the Dermis





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



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