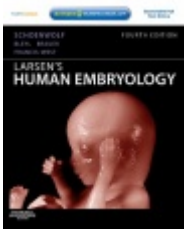
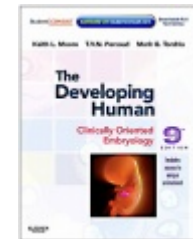


Development of the skin and its derivatives



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
Wallace Wurth Building Room 234 – A.Beverdam@unsw.edu.au

Lecture overview

Skin function and anatomy

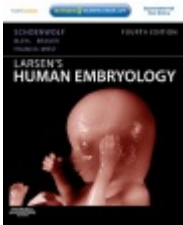
Embryonic origins of the skin

Development of the epidermis

Development of epidermal appendages:

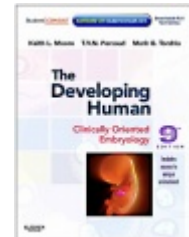
Development of the dermis

Development of melanocytes



Resources:

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



Lecture overview

Skin function and anatomy

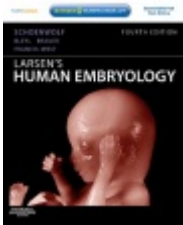
Embryonic origins of the skin

Development of the epidermis

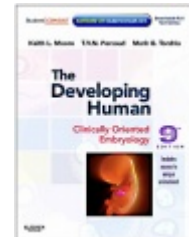
Development of epidermal appendages:

Development of the dermis

Development of melanocytes



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



Skin Function and Anatomy

Largest organ of our body

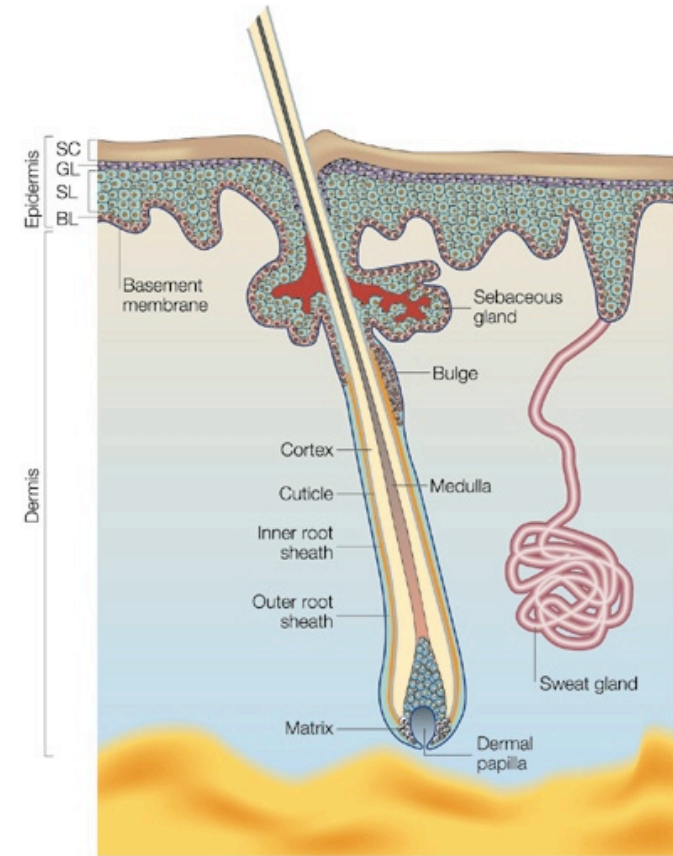
Protects inner body from outside world (pathogens, water, sun)

Thermoregulation

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

Consists of:

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



Lecture overview

Skin function and anatomy

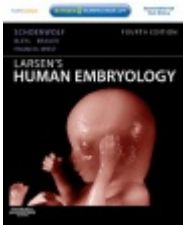
Embryonic origins of the skin

Development of the epidermis

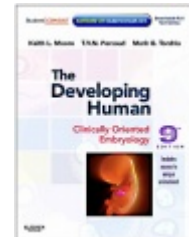
Development of epidermal appendages:

Development of the dermis

Development of melanocytes



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



Embryonic origins of the skin

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 origins of the skin

Lateral Ectoderm

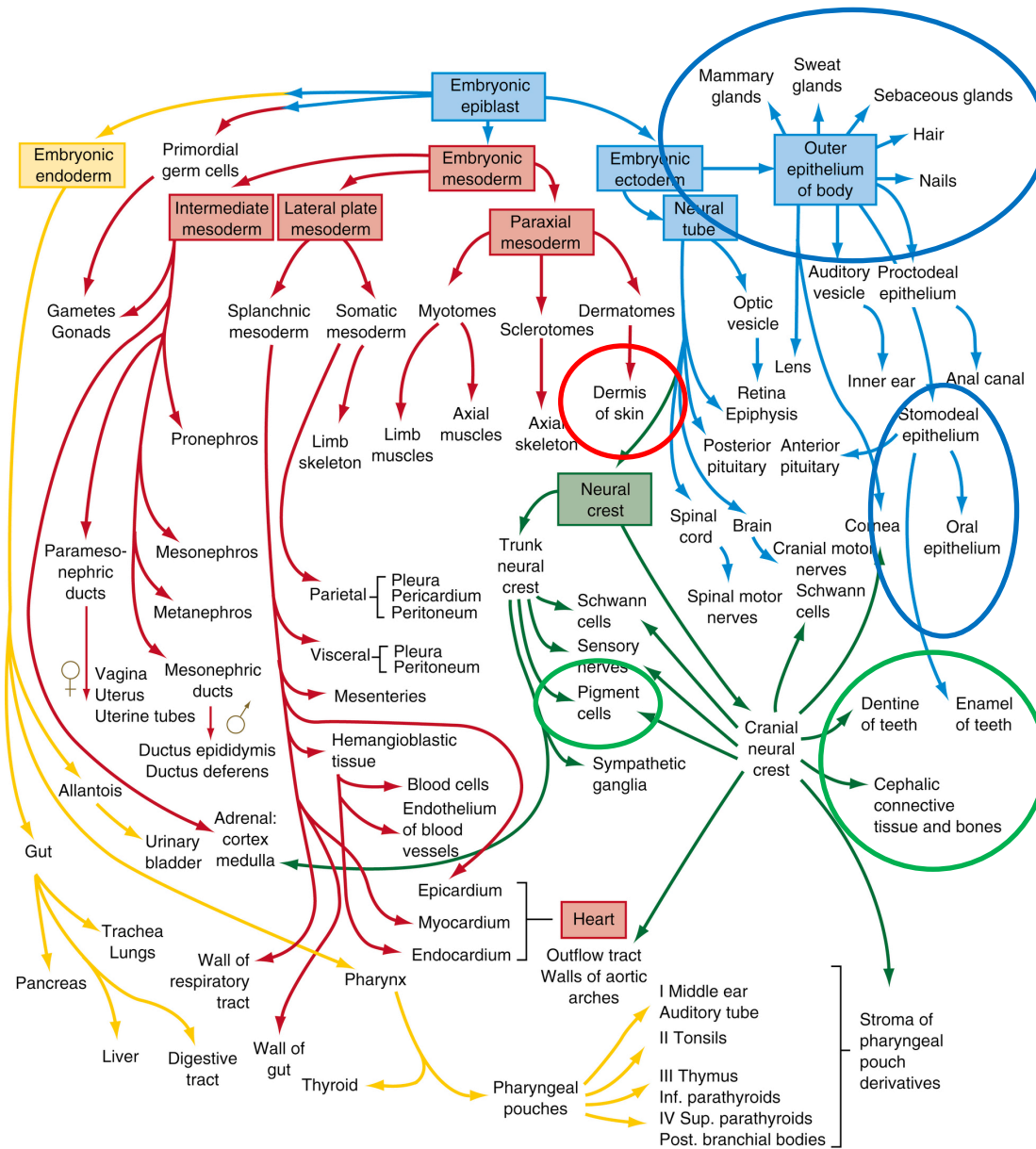
Neural Crest

Somitic and Lateral Plate Mesoderm



Week 4 embryo

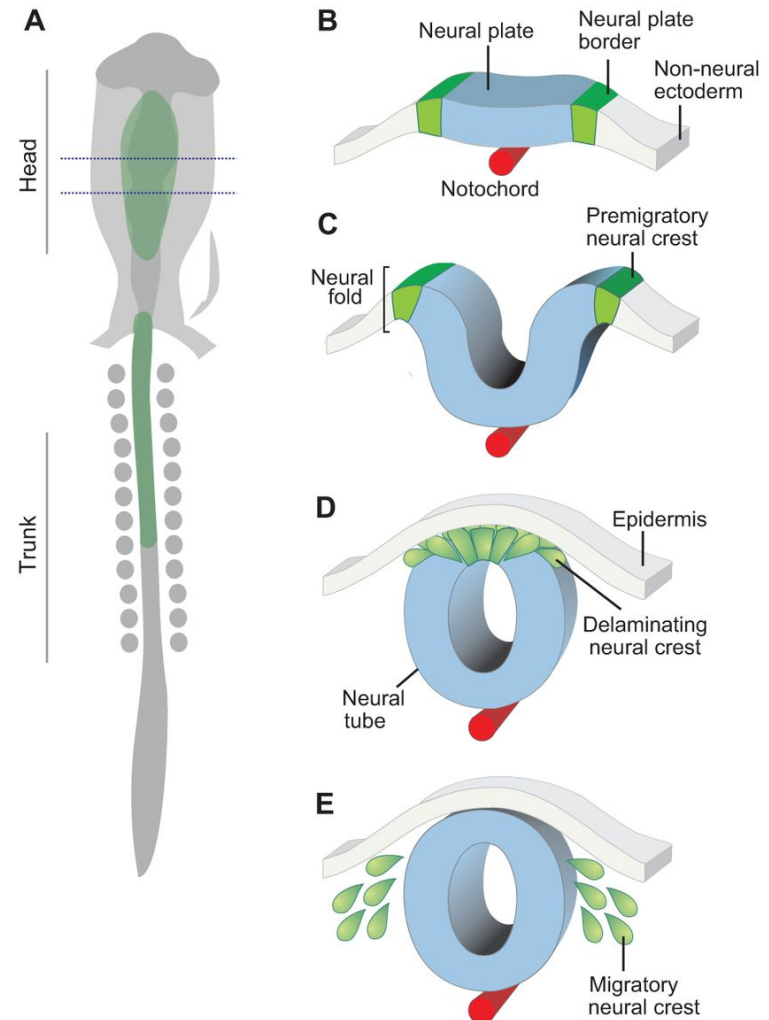
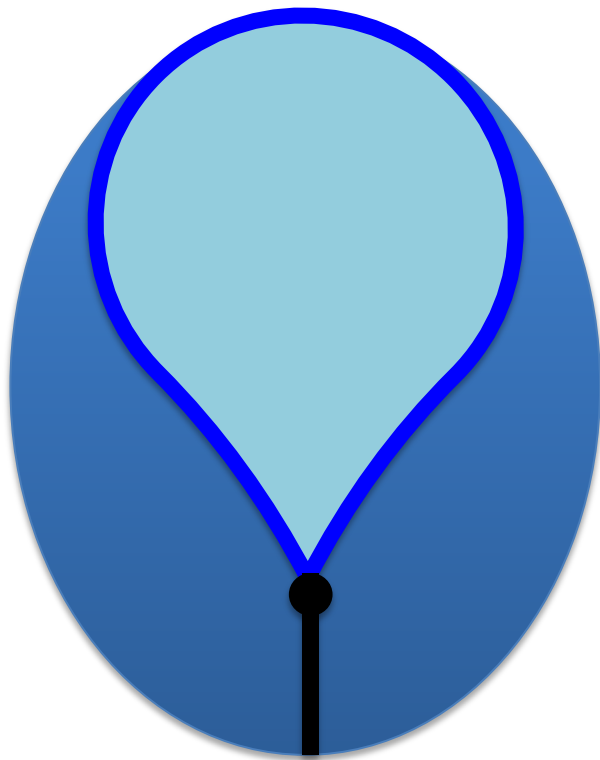
Embryonic origins of the skin



Embryonic origins of the skin

Lateral Ectoderm

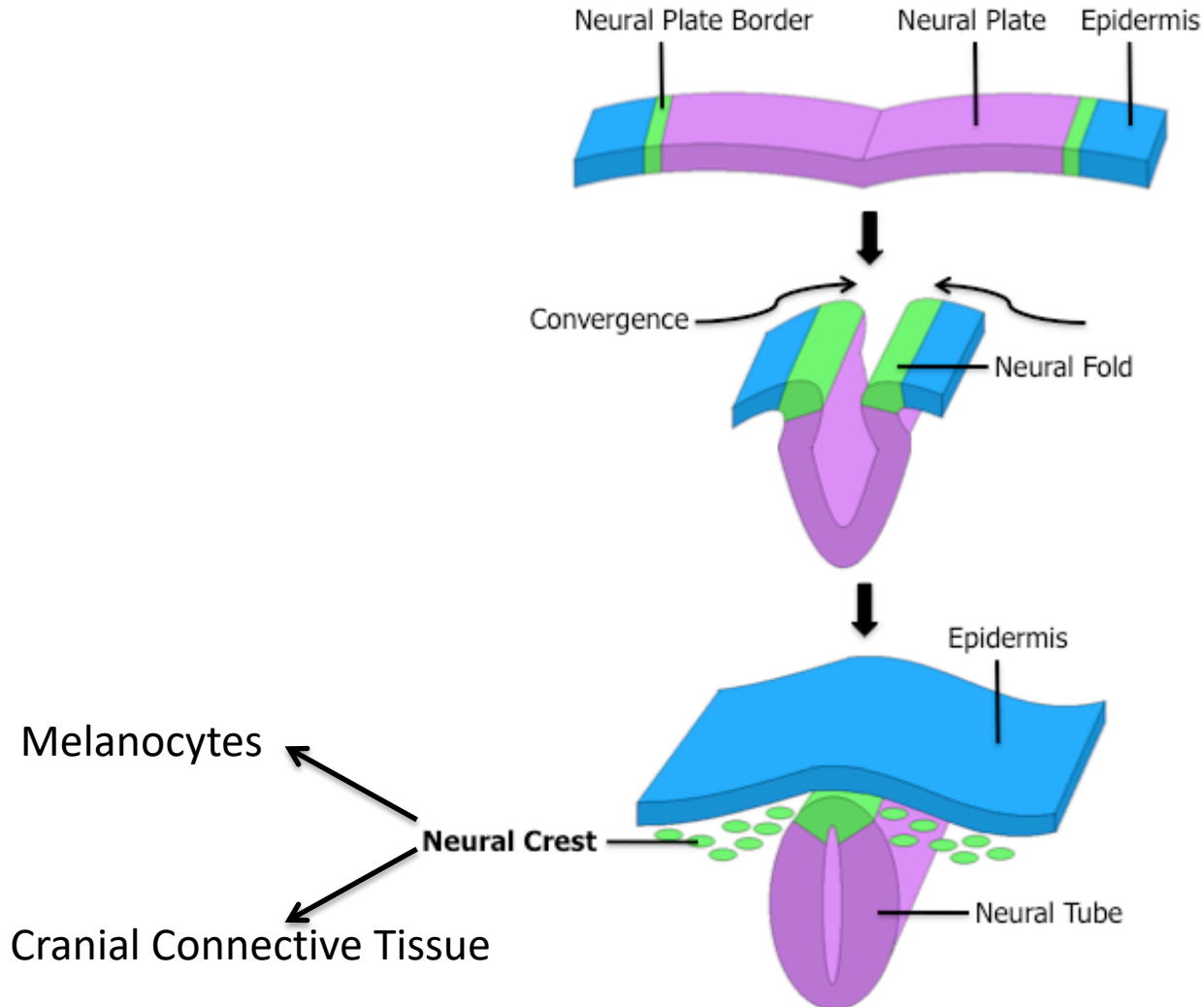
Overlying epidermis, epidermal appendages



Embryonic origins of the skin

Neural Crest

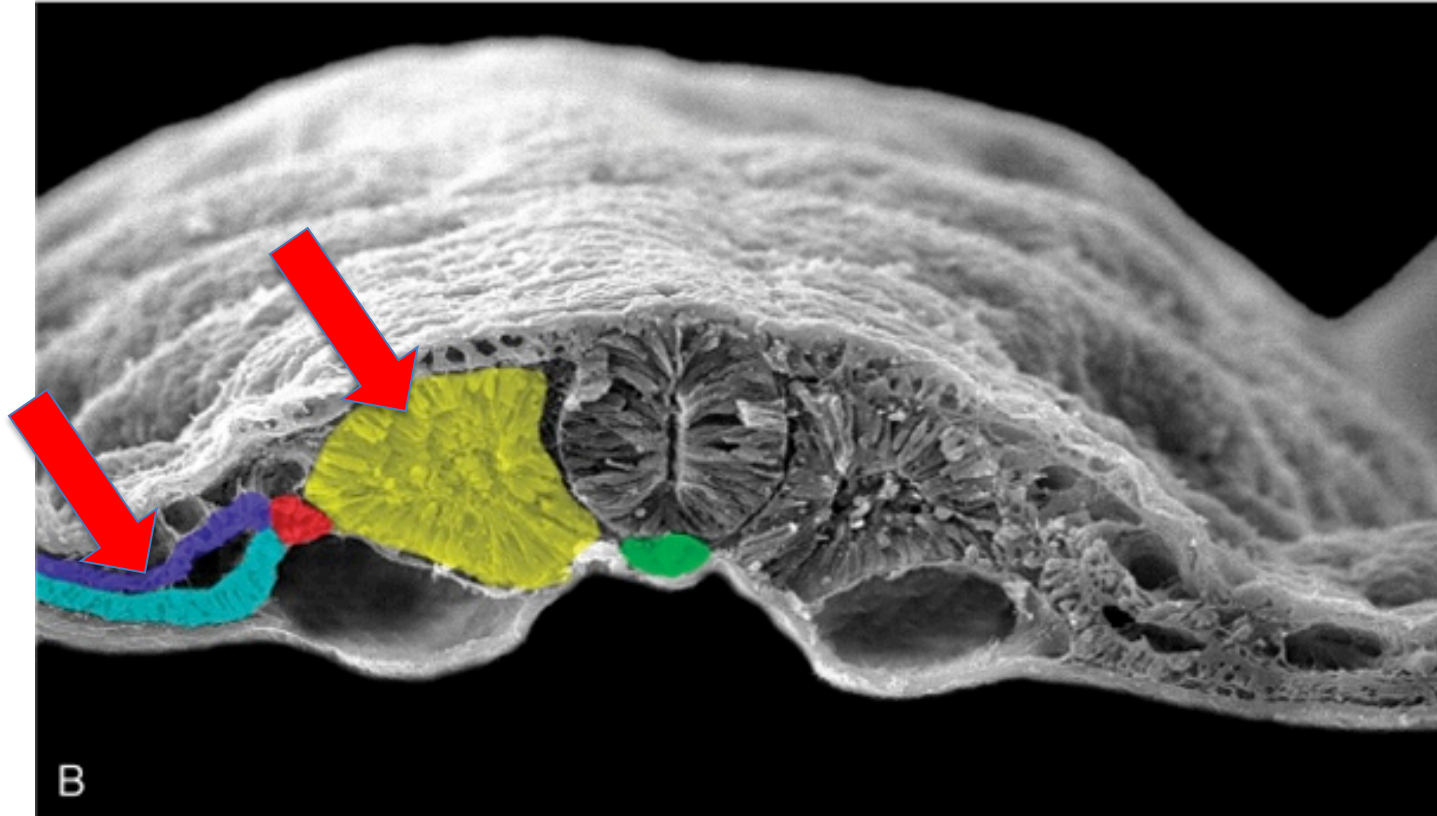
Melanocytes + Cranial Connective Tissue



Embryonic origins of the skin

Mesoderm

Dermis, Hypodermis



Schoenwolf et al: Larsen's Human Embryology, 4th Edition.
Copyright © 2008 by Churchill Livingstone, an imprint of Elsevier, Inc. All rights reserved

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

Lecture overview

Skin function and anatomy

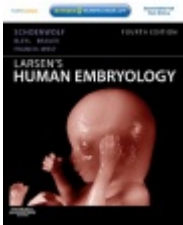
Embryonic origins of the skin

Development of the epidermis

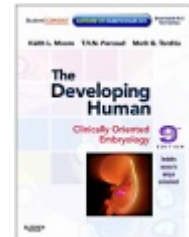
Development of epidermal appendages:

Development of the dermis

Development of melanocytes



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



Development of the epidermis

Interfollicular epidermis: stratified squamous epithelium

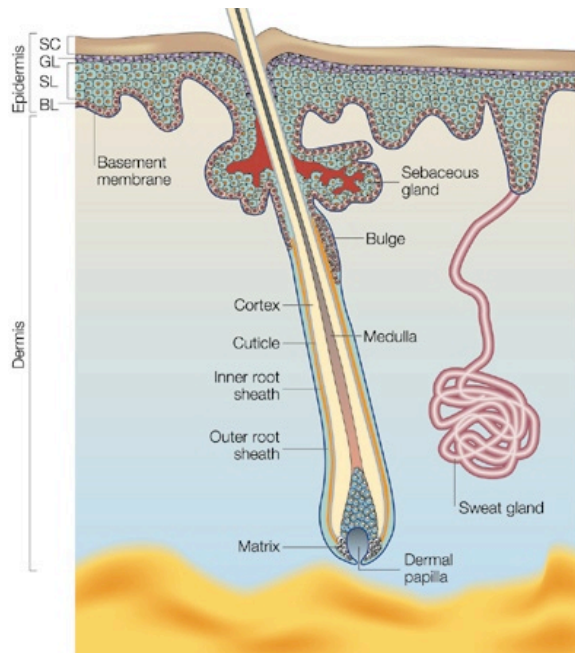
Appendages:

Hair follicles

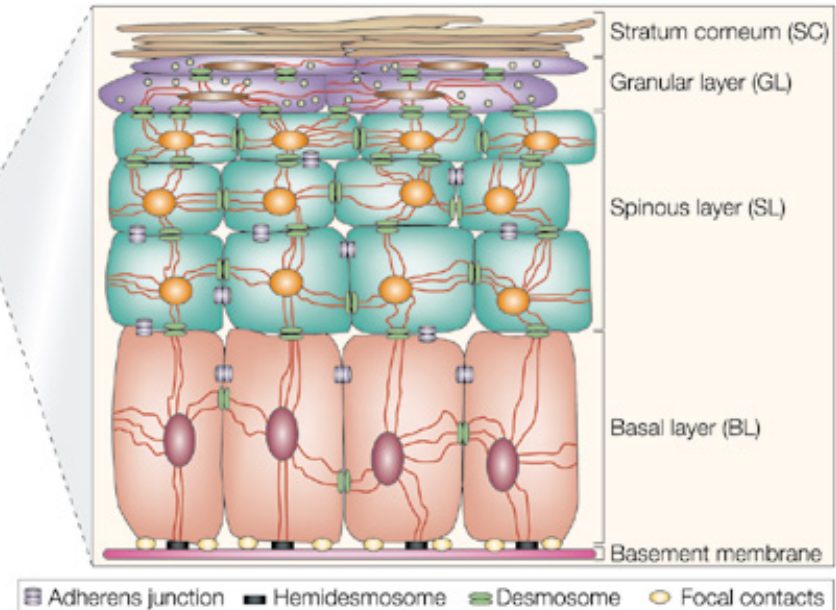
Glands (sebaceous, sweat, apocrine, mammary, lacrimal, salivary)

Teeth

Nails

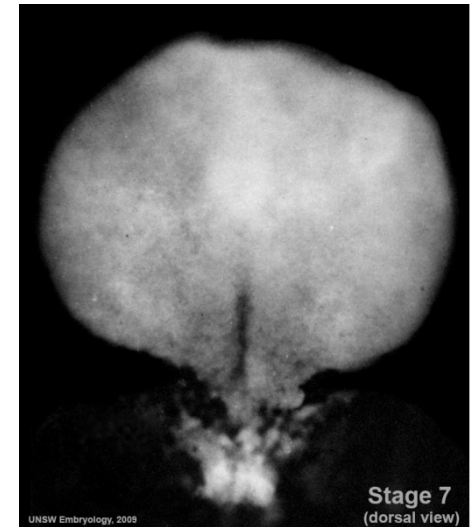
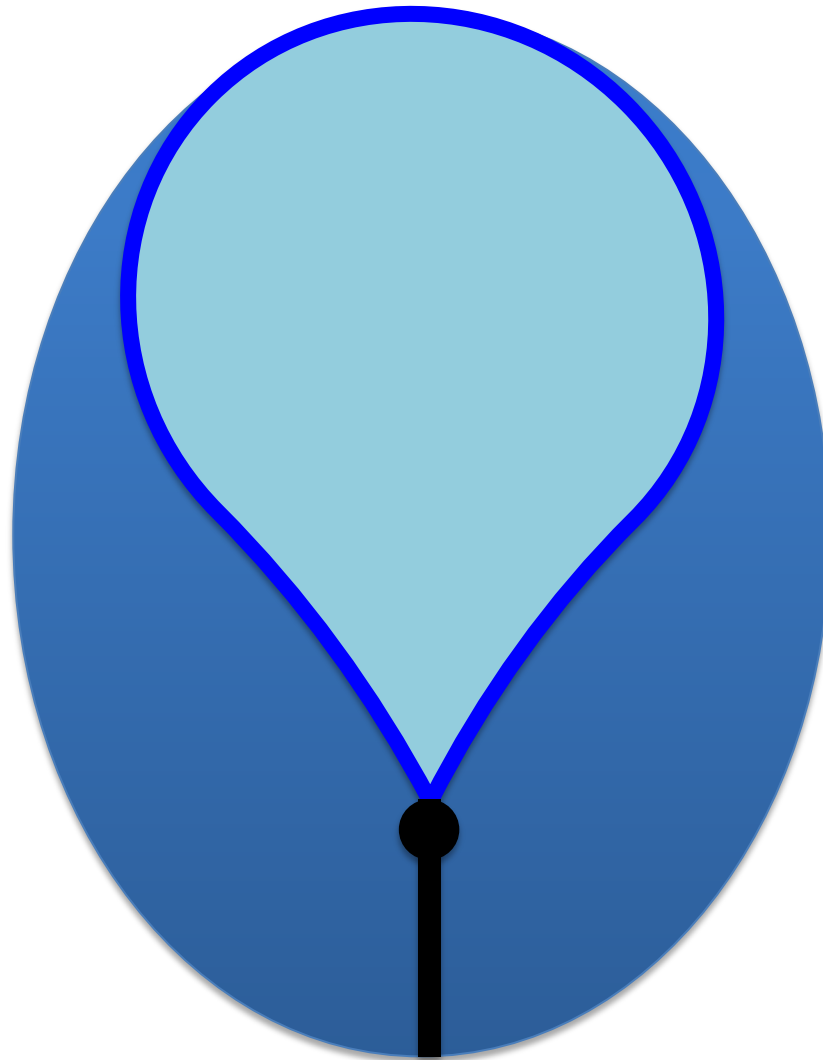


Epidermis



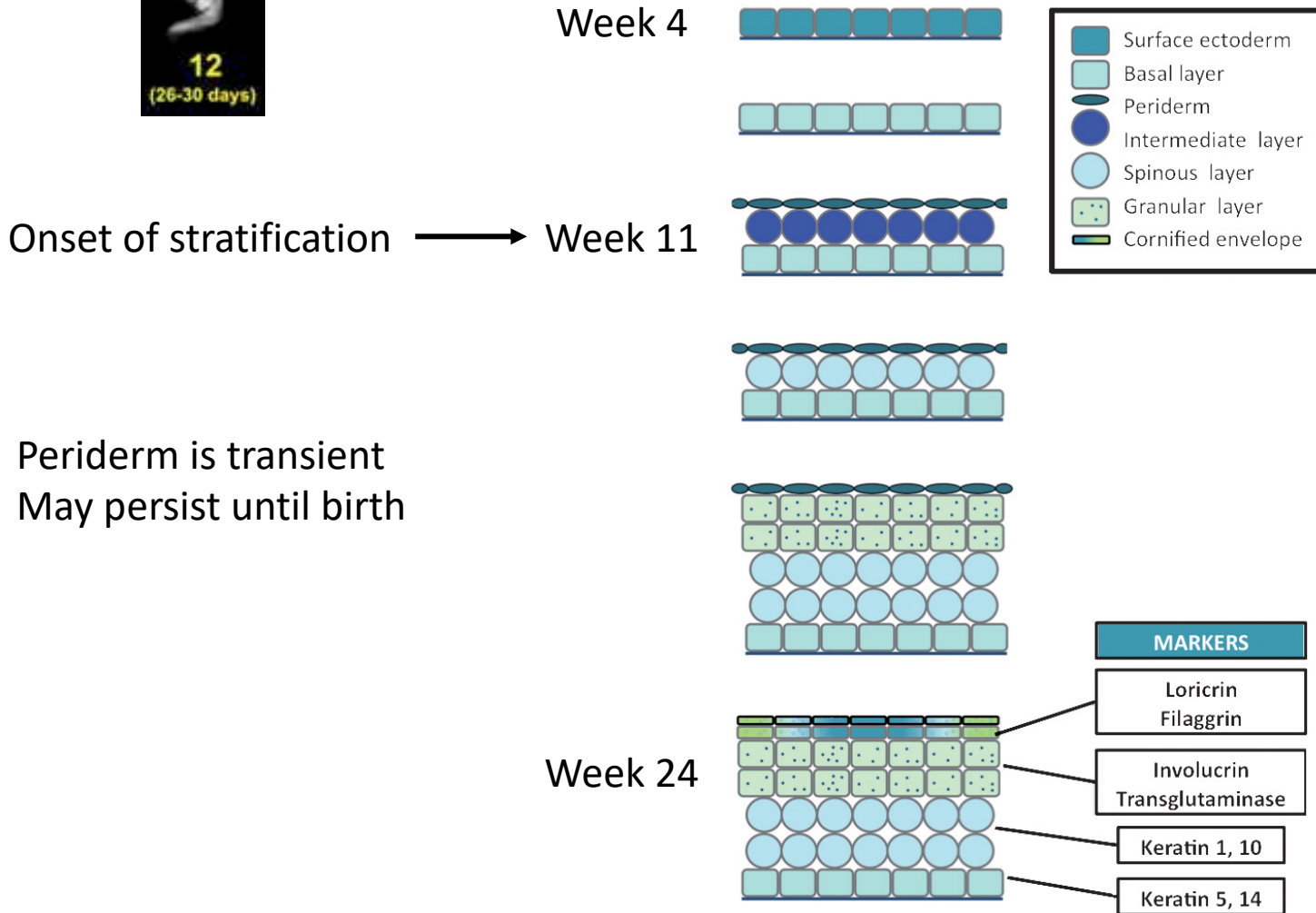
Development of the epidermis

Lateral ectoderm



Development of the epidermis

Interfollicular Epidermis (IFE)



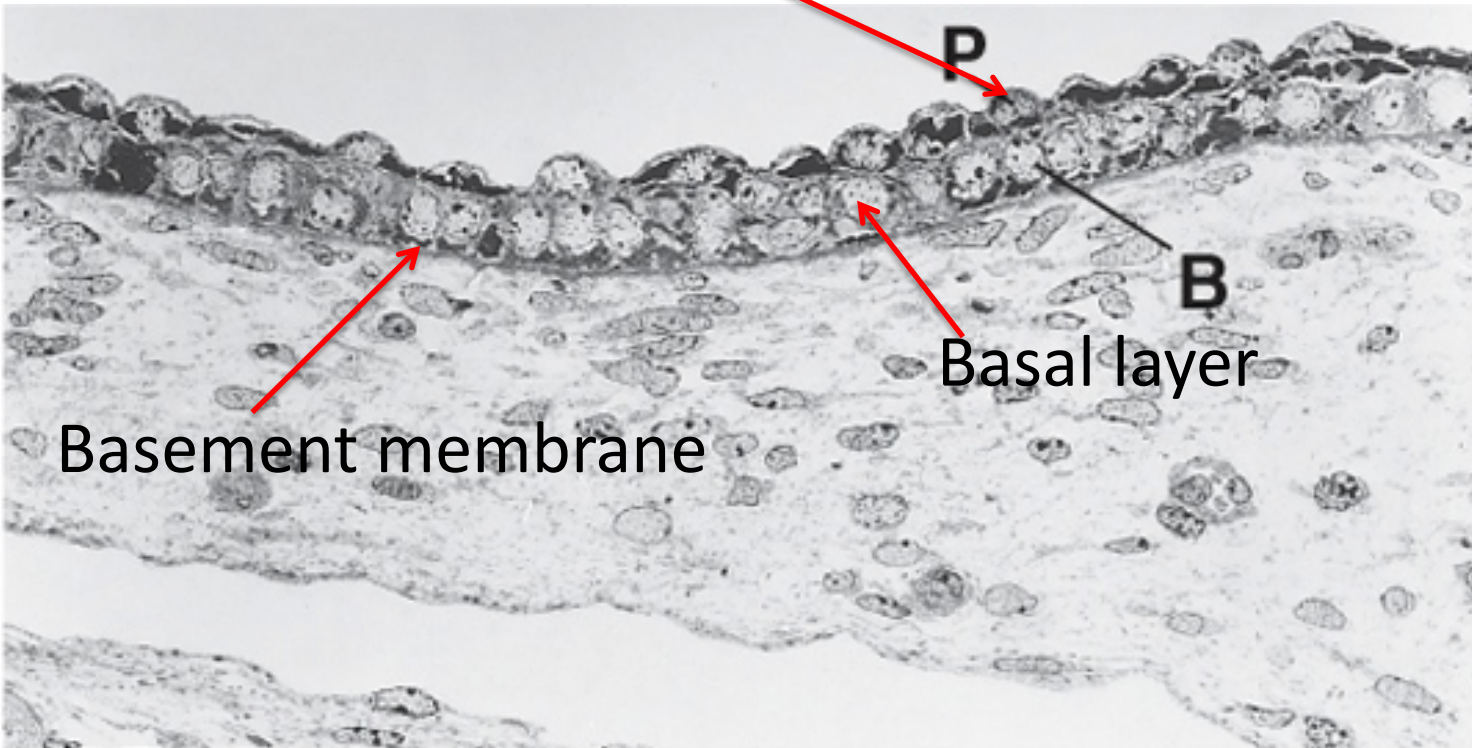
Development of the epidermis

Interfollicular Epidermis (IFE)



Periderm formation: 4 weeks

Periderm

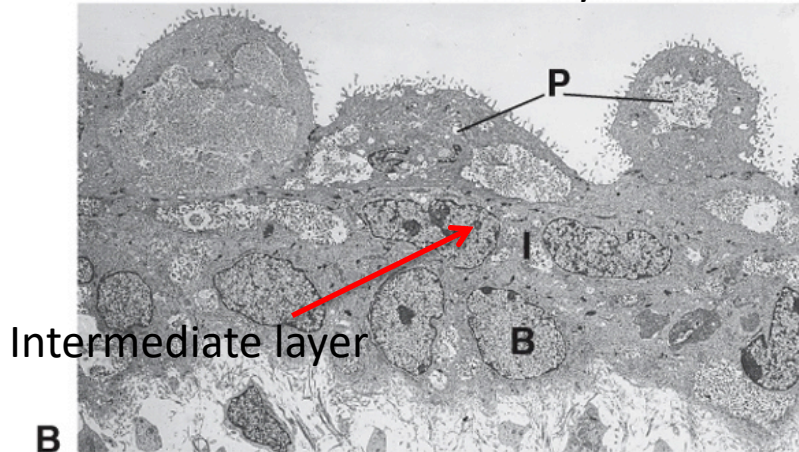


8 weeks

Development of the epidermis

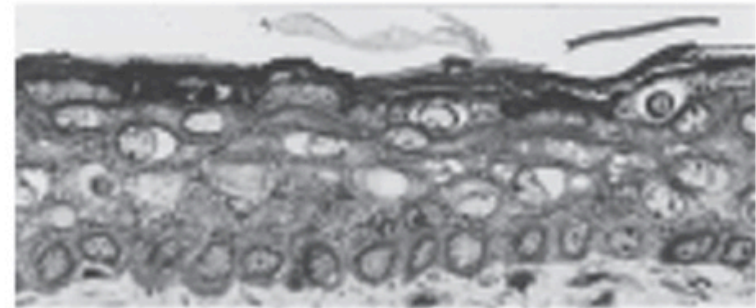
Interfollicular Epidermis (IFE)

Week 11: intermediate layer

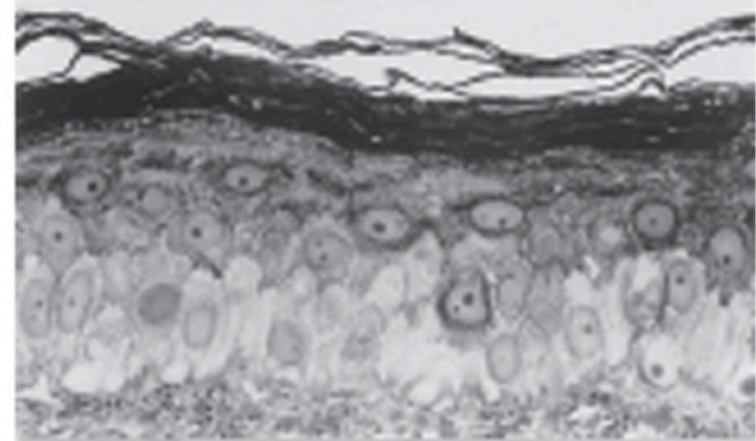


11 weeks
Schoenwolf et al: Larsen's Human Embryology, 4th Edition.
Copyright © 2008 by Churchill Livingstone, an imprint of Elsevier, Inc. All rights reserved

24 weeks

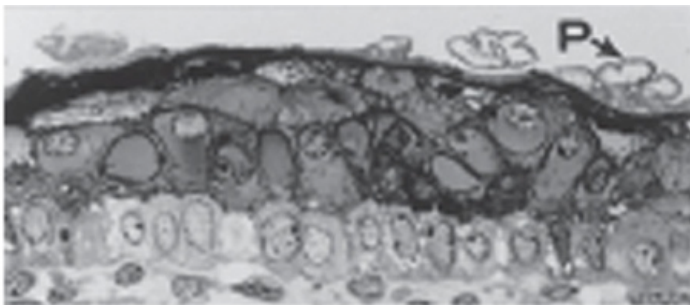


Adult



Schoenwolf et al: Larsen's Human Embryology, 4th Edition.
Copyright © 2008 by Churchill Livingstone, an imprint of Elsevier, Inc. All rights reserved

17 weeks



Development of the epidermis

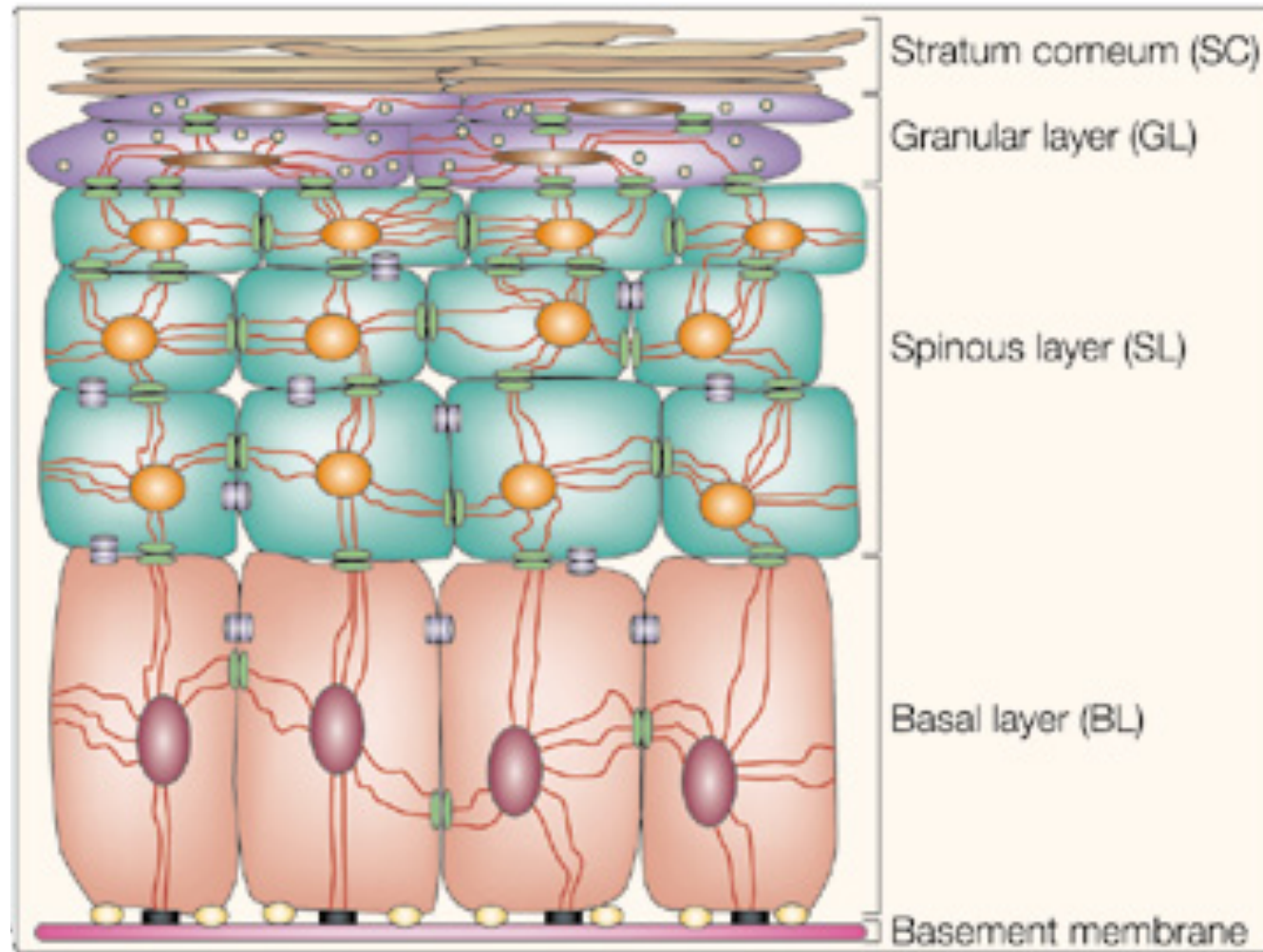
Interfollicular Epidermis (IFE)

Envelope proteins

Loricrin
Involucrin
Fillagrin

Keratin 1/10

Keratin 5/14



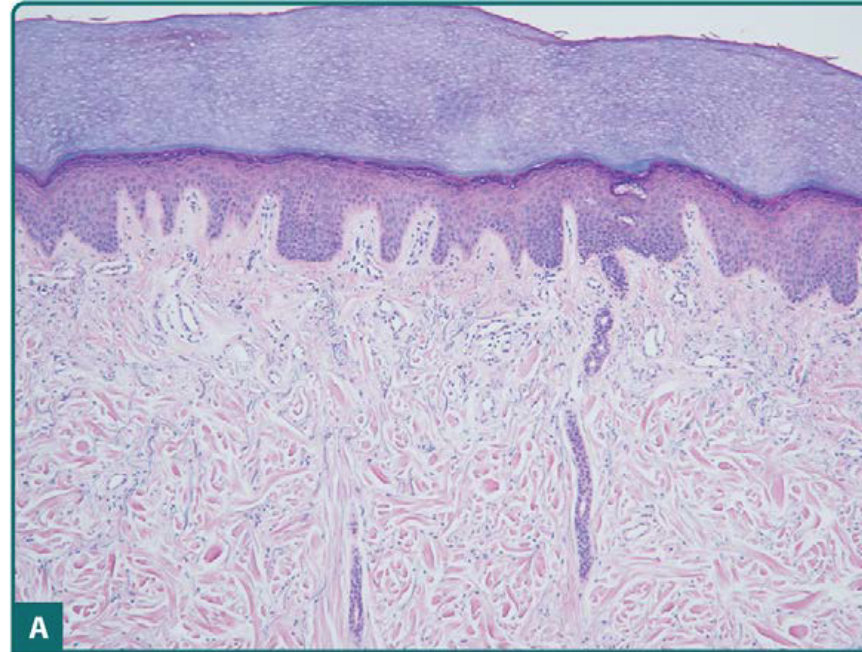
Junctions: Adherens junction Hemidesmosome integrins Desmosome Focal contacts

Regeneration, skin types

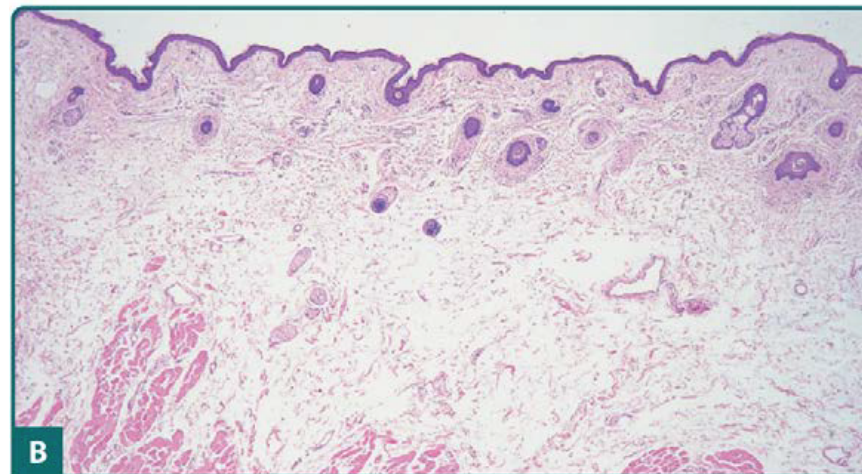
Development of the epidermis

Interfollicular Epidermis (IFE)

Thick skin



Thin skin



Lecture overview

Skin function and anatomy

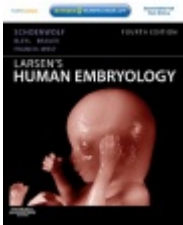
Embryonic origins of the skin

Development of the epidermis

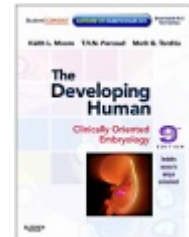
Development of epidermal appendages:

Development of the dermis

Development of melanocytes



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



Development of the epidermal appendages

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

Common developmental mechanism:

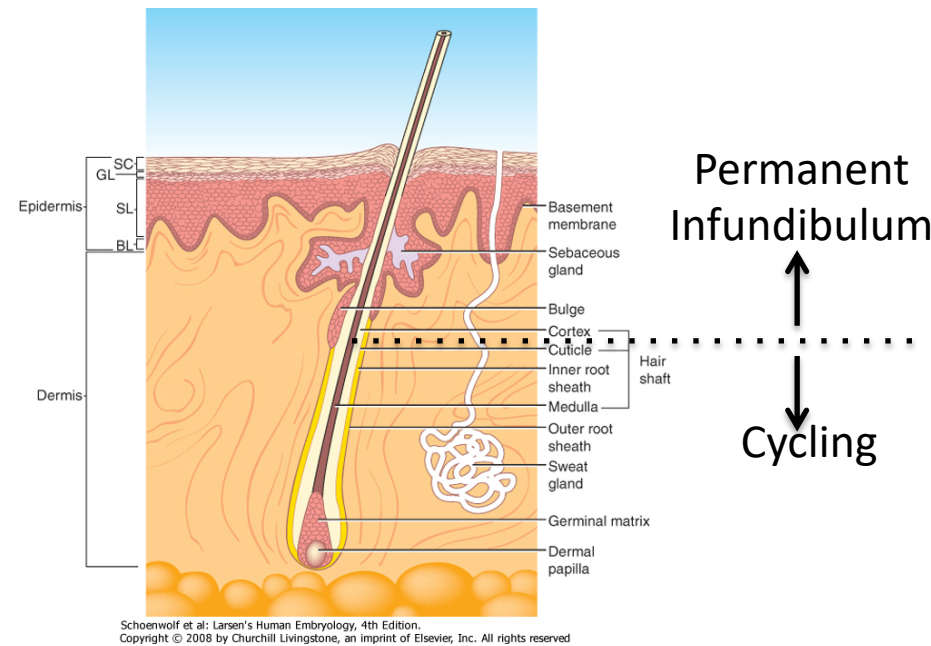
Epithelial to mesenchymal signaling inducing formation of placode and mesenchymal condensations, invagination of epidermis into dermis.

Development of the epidermal appendages

Hair follicles

Involved in thermoregulation/sun protection

Postnatal cycling



Month 2-4: Onset hair follicle development

Hair follicles develop first in cranial region

Month 5: most hair follicles present $\approx 5,000,000$ hair follicles

Anatomy

Development of the epidermal appendages

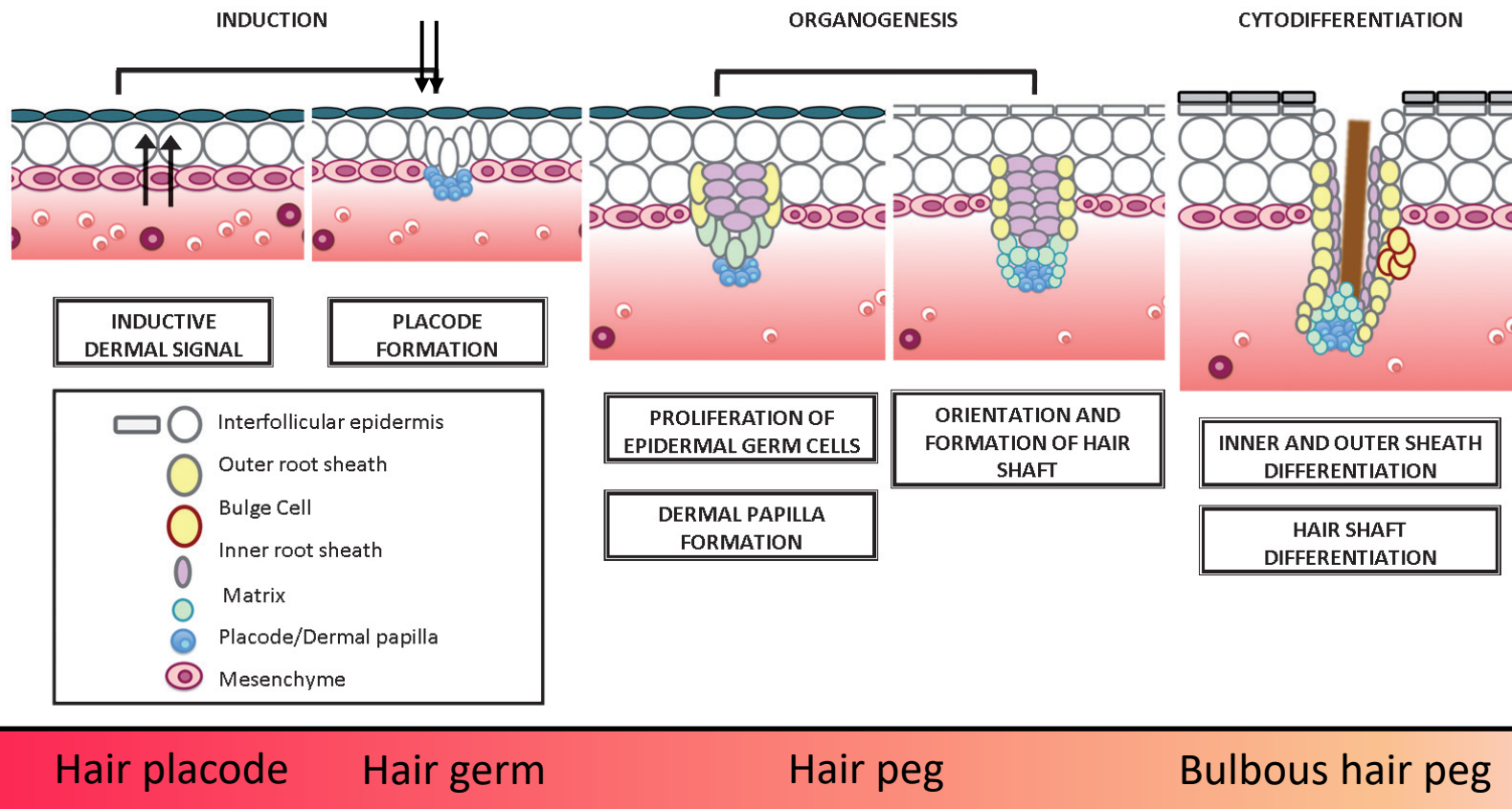
Hair follicles

Hair follicles develop from month 2 until birth

Approximately 5000,000 will be formed

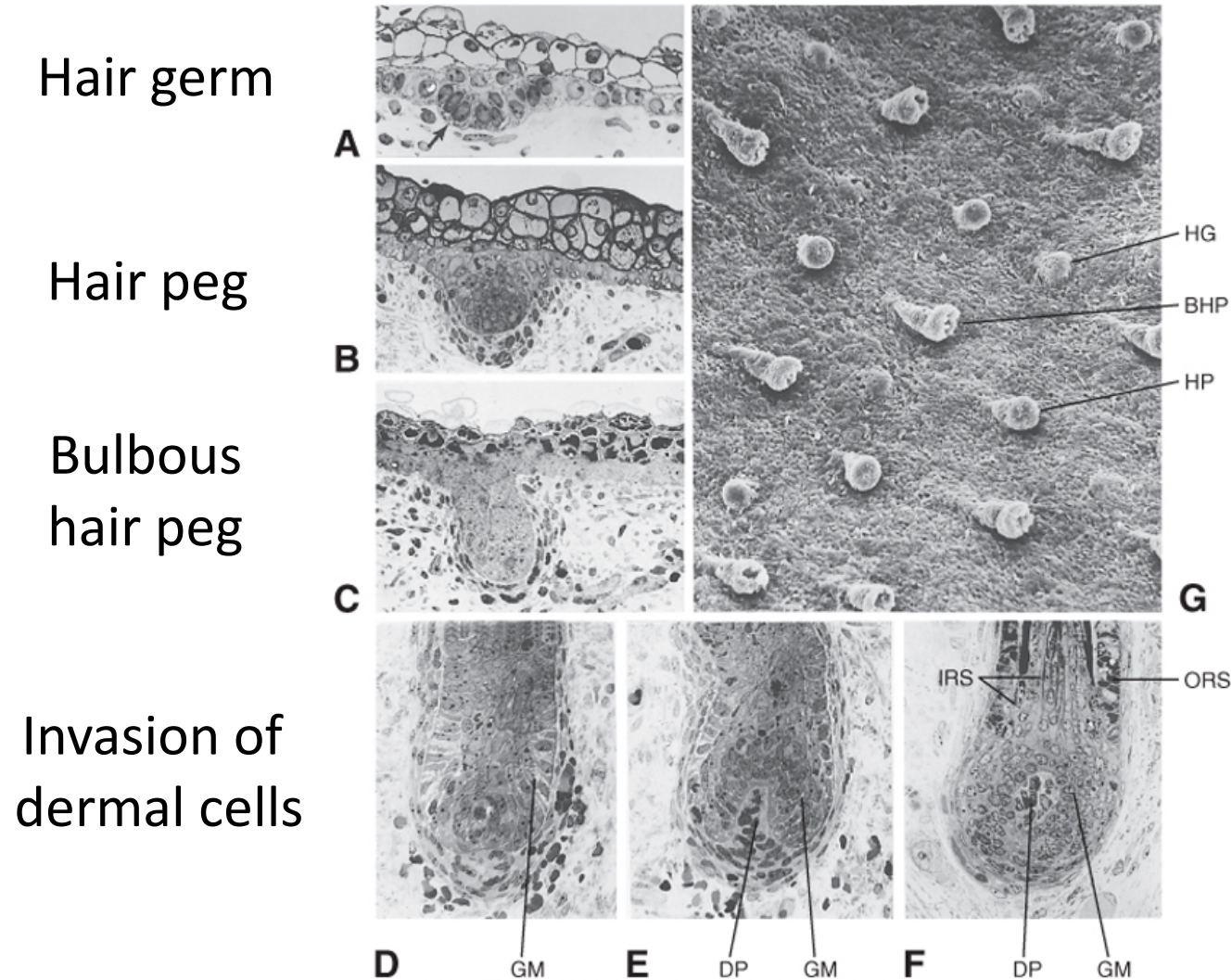
No new hair follicles will be formed after birth

4 stages of hair follicle development



Development of the epidermal appendages

Hair follicles



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

Copyright © 2008 by Churchill Livingstone, an imprint of Elsevier, Inc. All rights reserved

Development of the epidermal appendages

Hair follicles

Formation of:

Arrector pili muscle

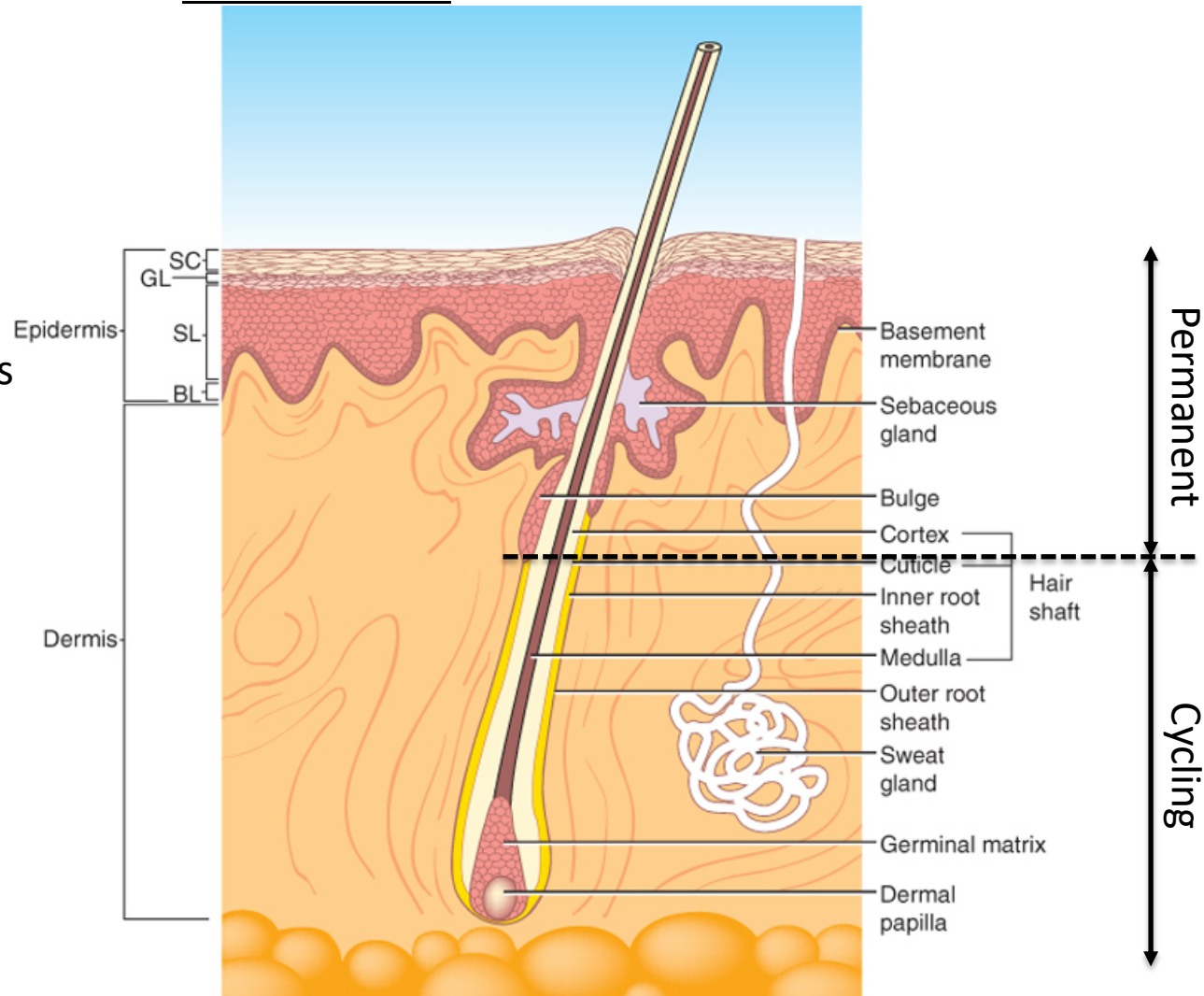
Hair follicle bulge

Germinal matrix

Inner and outer root sheaths

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

Postnatal regeneration:
Hair follicle cycling



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

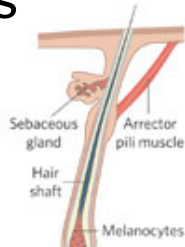
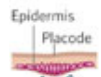
Copyright © 2008 by Churchill Livingstone, an imprint of Elsevier, Inc. All rights reserved

Development of the epidermal appendages

Hair follicles

← Prenatal development →

Hair germ
Hair peg
Bulbous peg

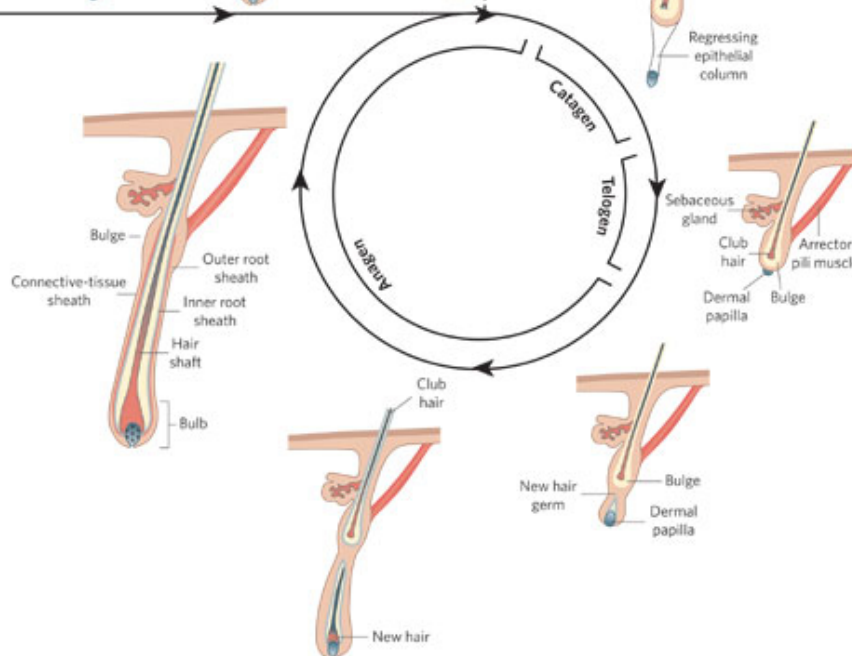


Postnatal hair follicle cycling:

- Telogen: rest
- Anagen: growth
- Catagen: regression

Ageing

Follicular morphogenesis



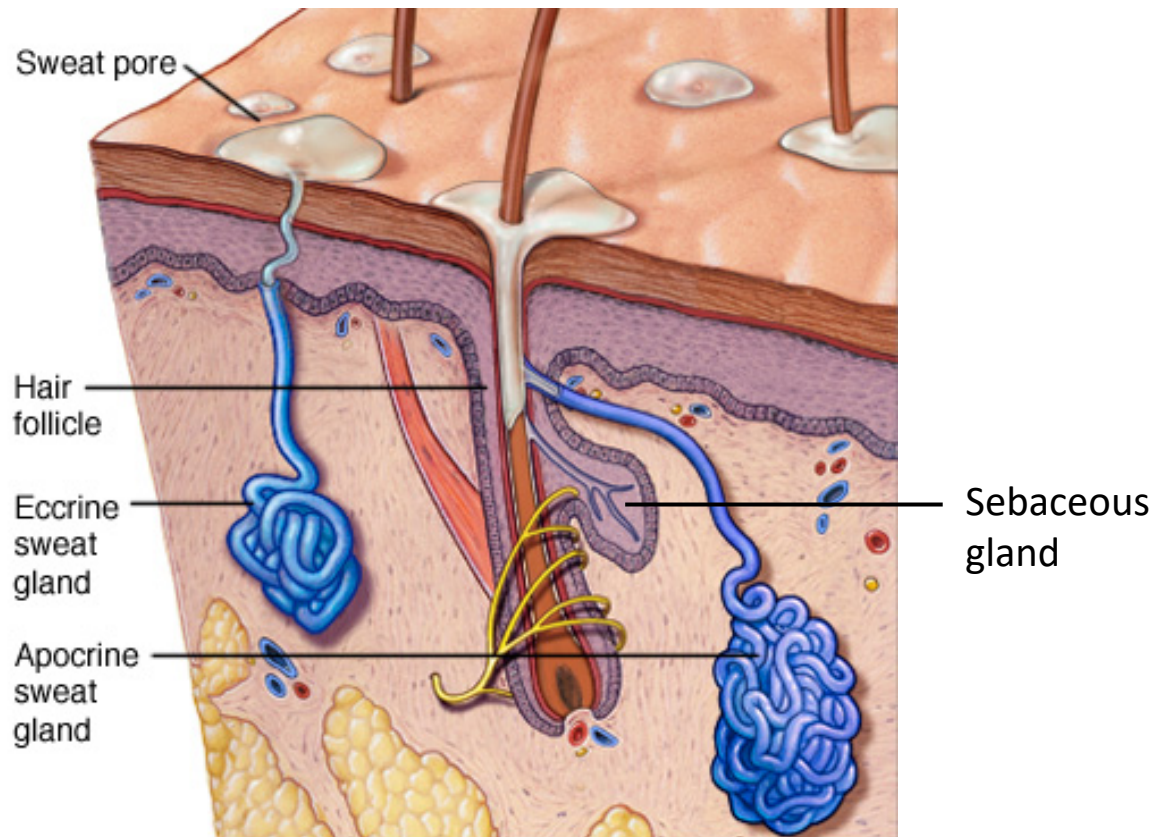
Development of the epidermal appendages

Epidermal glands

Sebaceous glands (Sebum): develop from hair follicle

Sweat/eccrine glands: develop from basal layer IFE (20 weeks+)

Apocrine glands (pheromones): develop in association with HFs



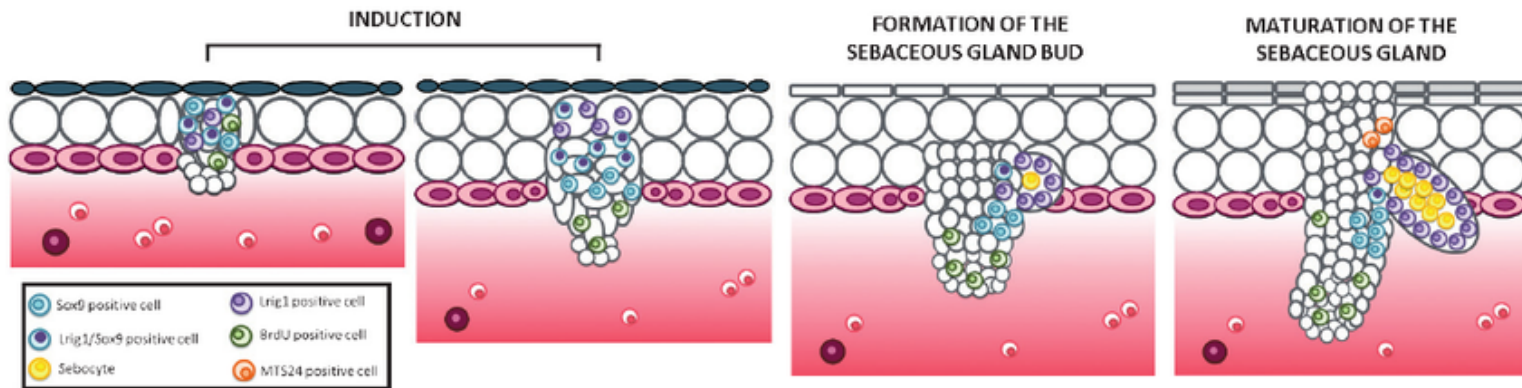
Development of the epidermal appendages

Epidermal glands

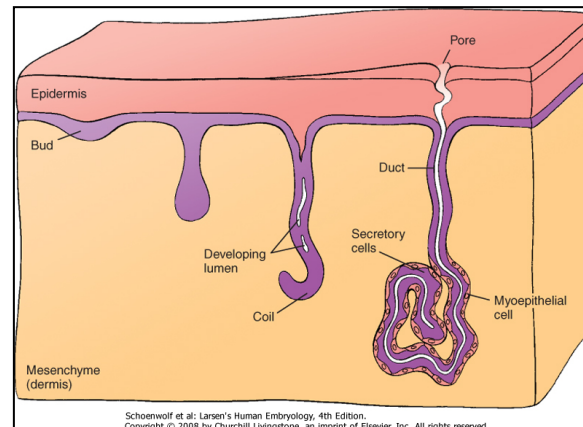
Sebaceous glands: develop from hair follicle

Sweat glands: develop from basal layer IFE (20 weeks+)

Apocrine glands: develop in association with HFs, most lost late in fetal dev.



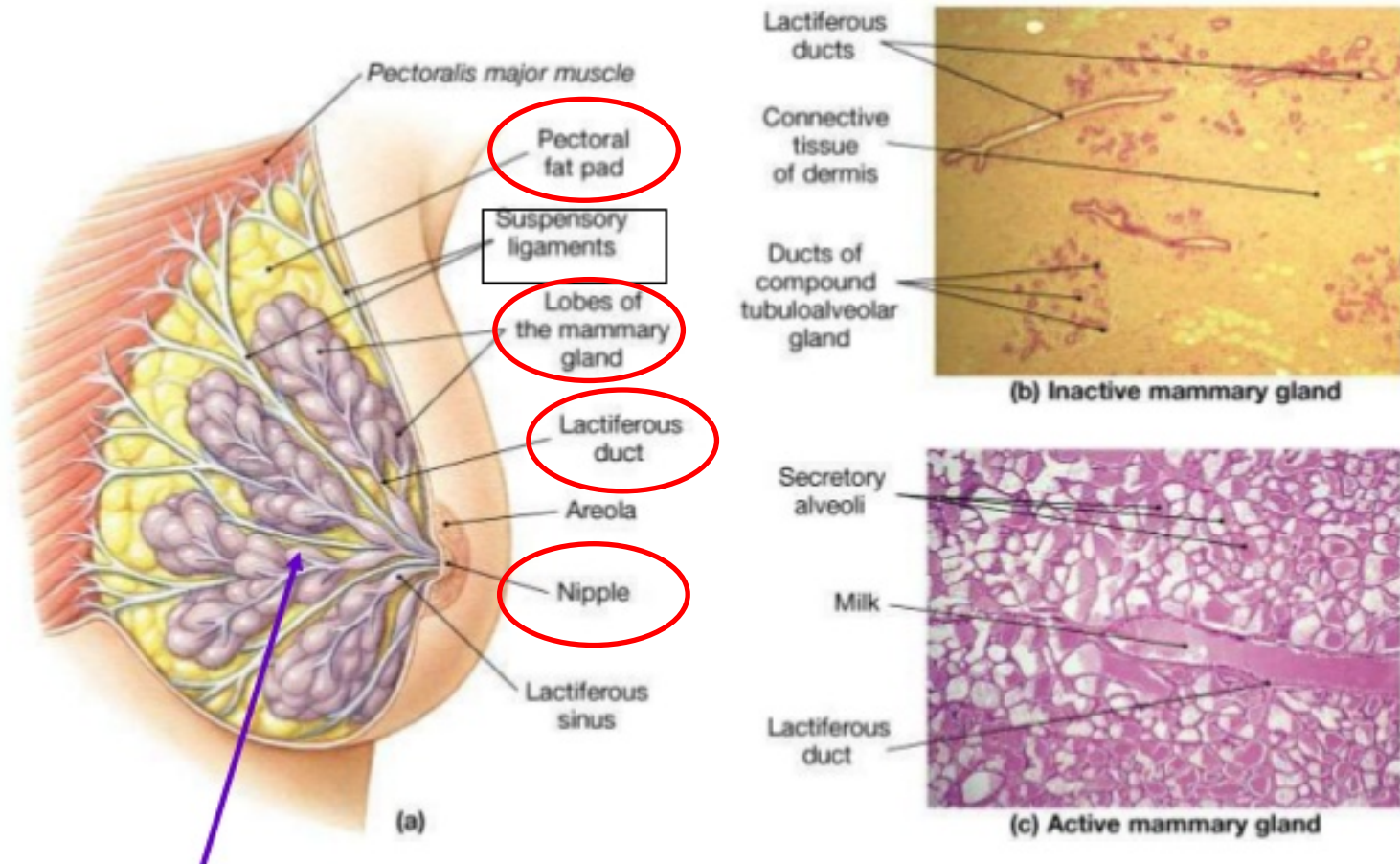
Eccrine gland
Development:



Development of the epidermal appendages

Epidermal glands

Mammary Gland Anatomy

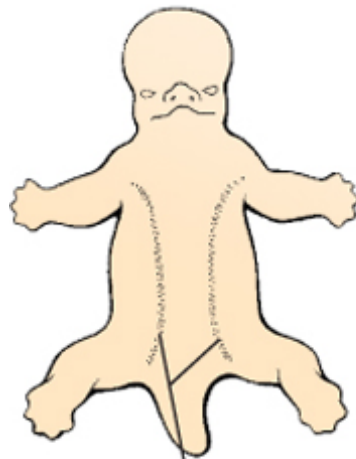


Development of the epidermal appendages

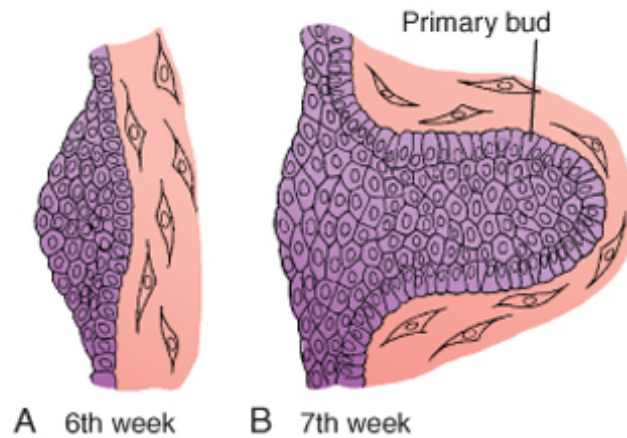
Epidermal glands

Mammary Gland development

4 weeks:

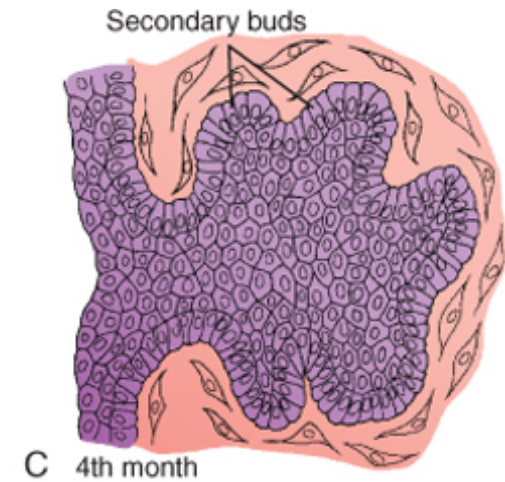


Mammary ridges

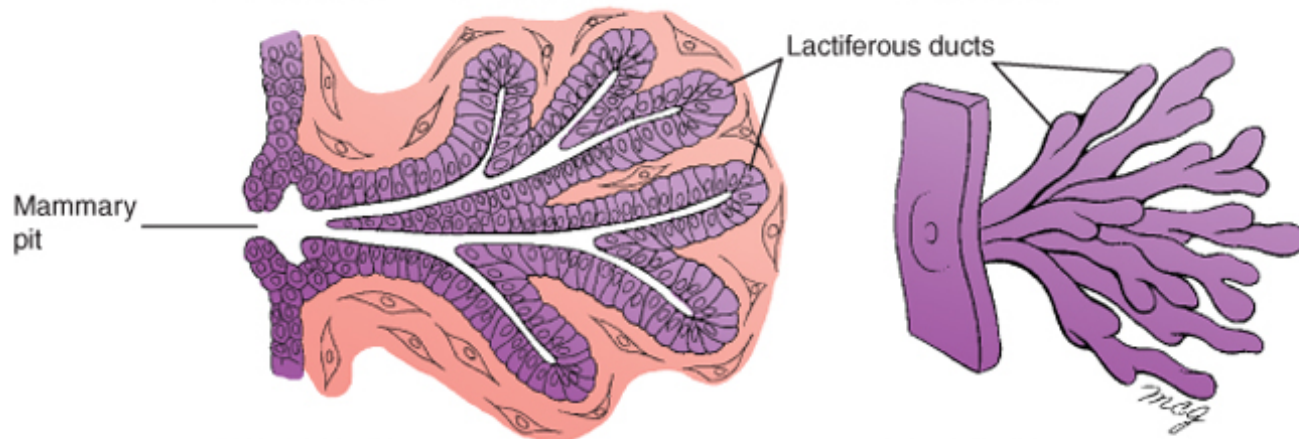


A 6th week

B 7th week



C 4th month



Mammary pit

Lactiferous ducts

D 6th month

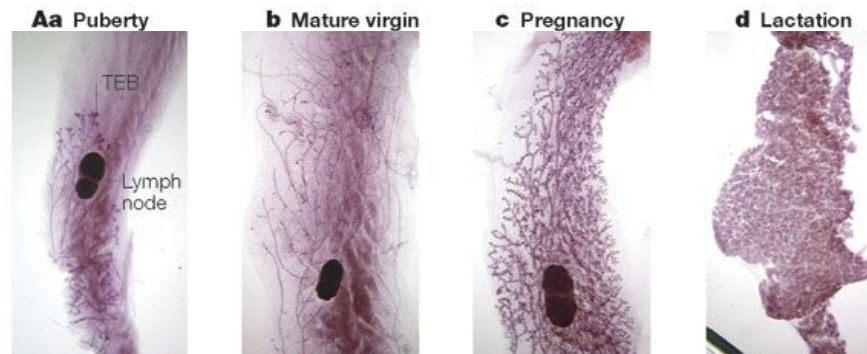
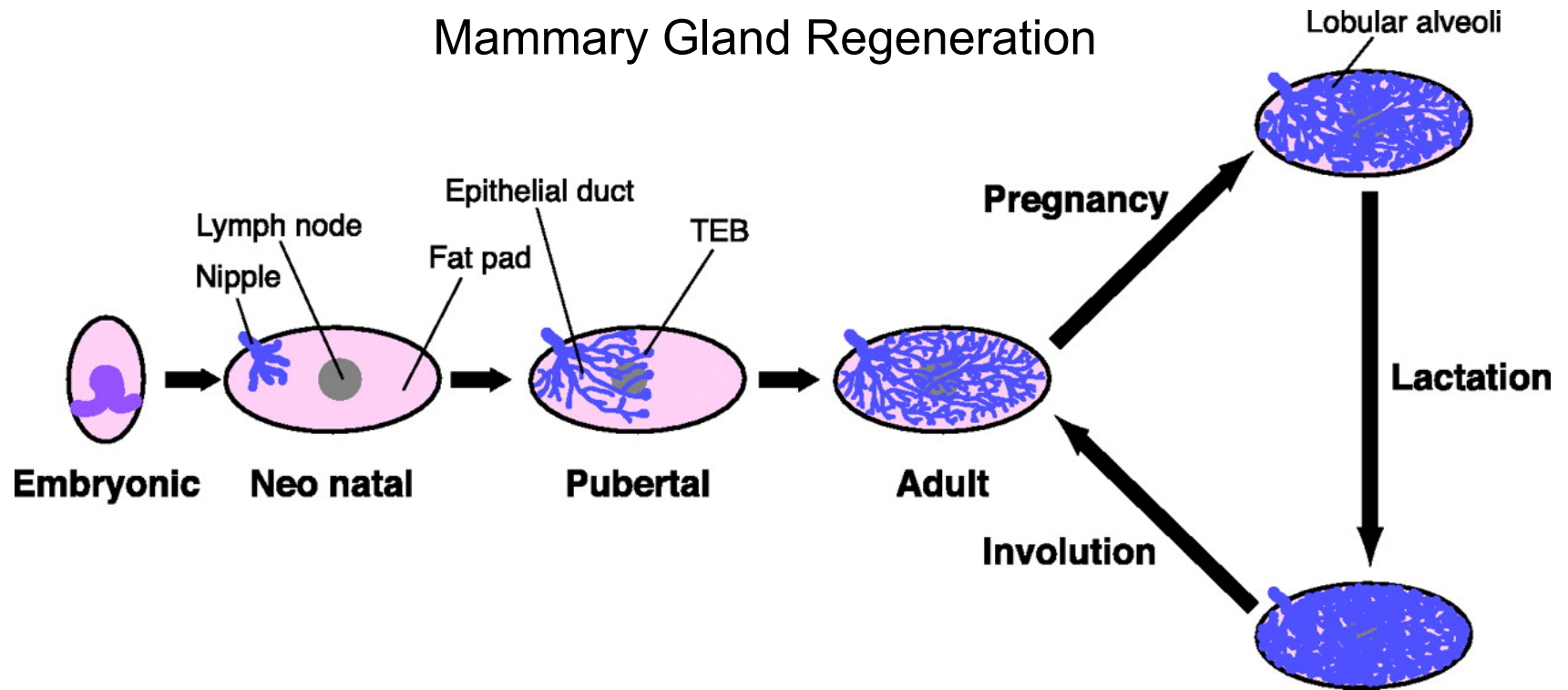
E 8th month

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

Copyright © 2008 by Churchill Livingstone, an imprint of Elsevier, Inc. All rights reserved

Development of the epidermal appendages

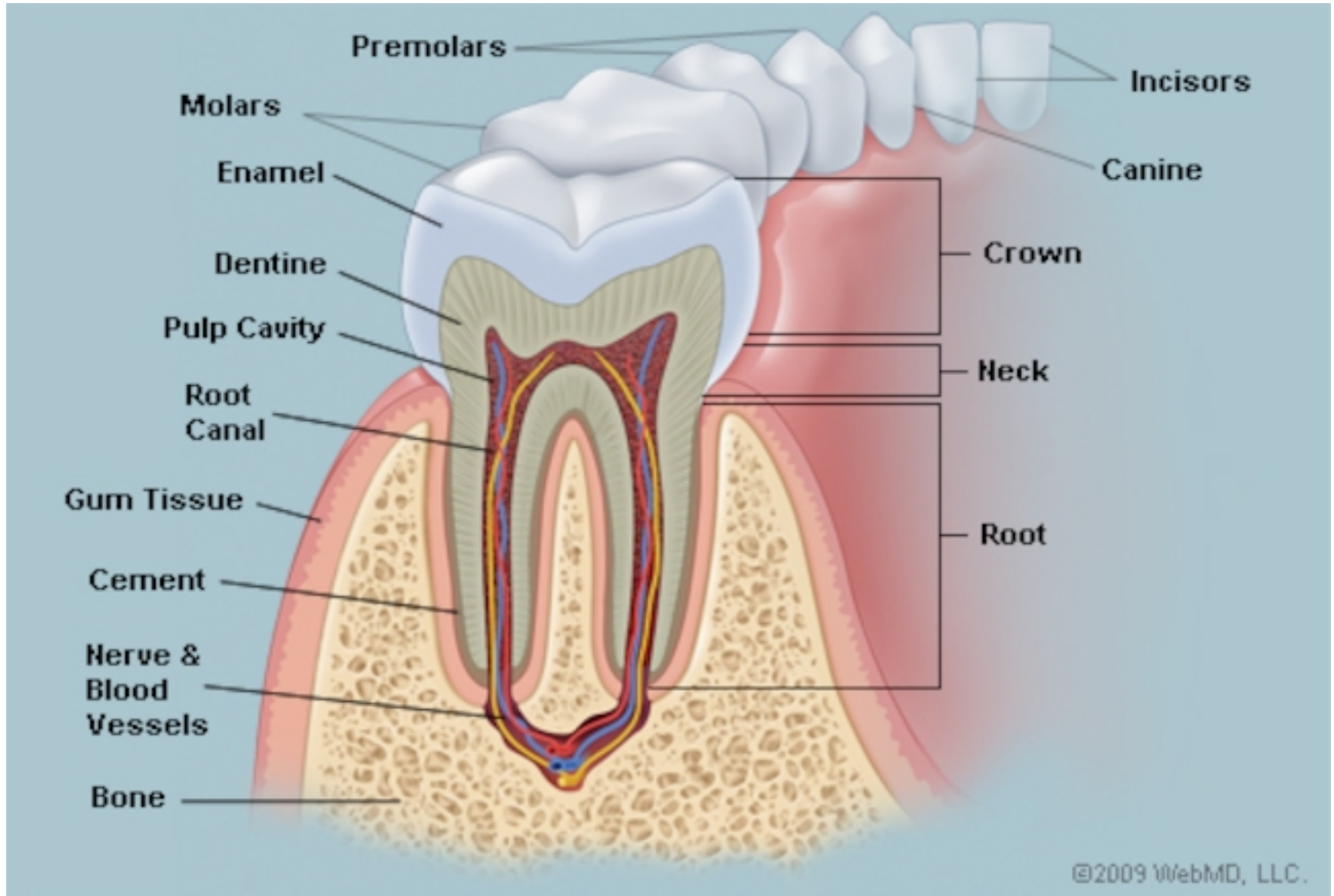
Epidermal glands



Mouse mammary glands:

Development of the epidermal appendages

Teeth

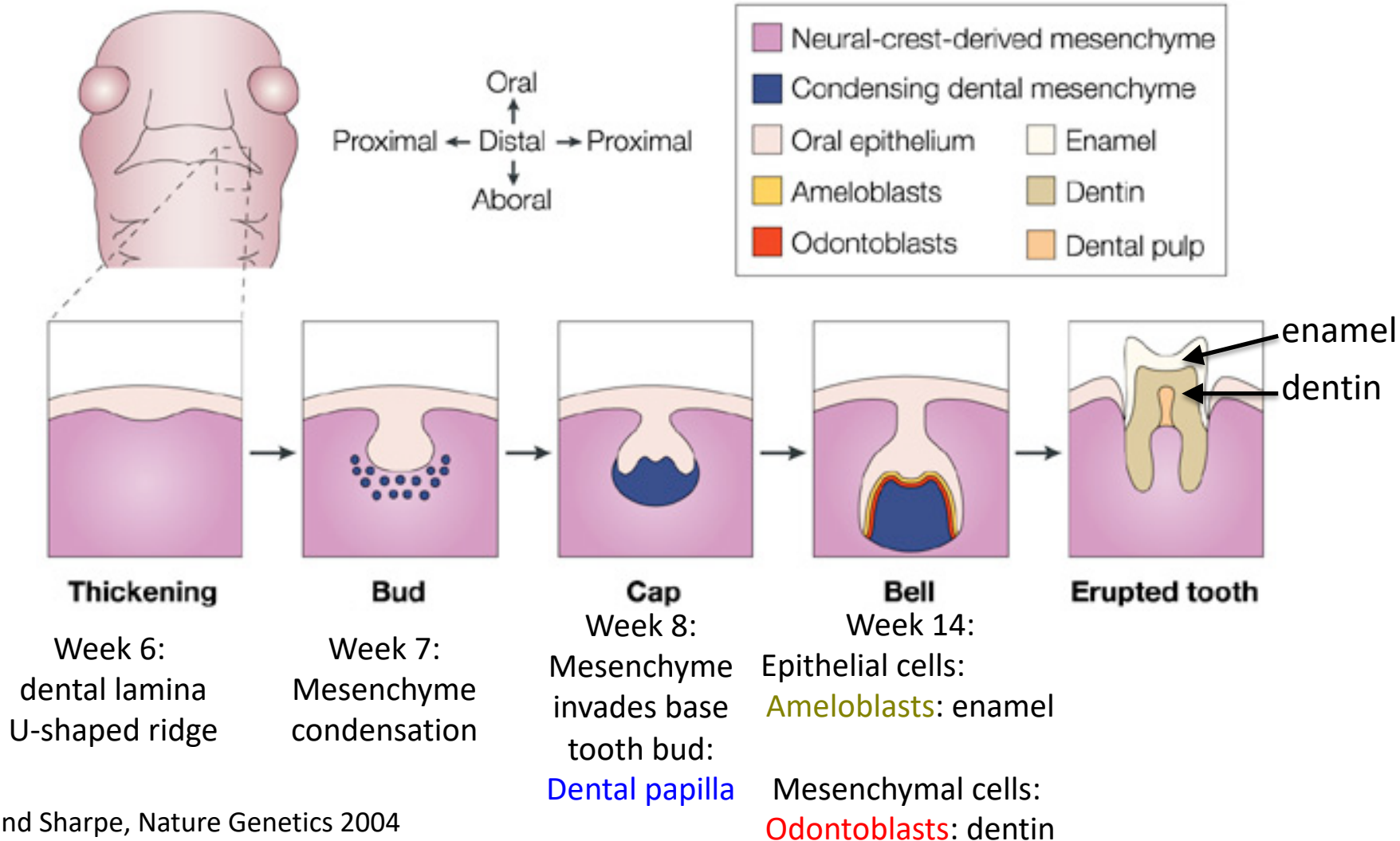


Development of the epidermal appendages

Teeth

Tooth development

Ectoderm/cranial neural crest derived mesenchyme



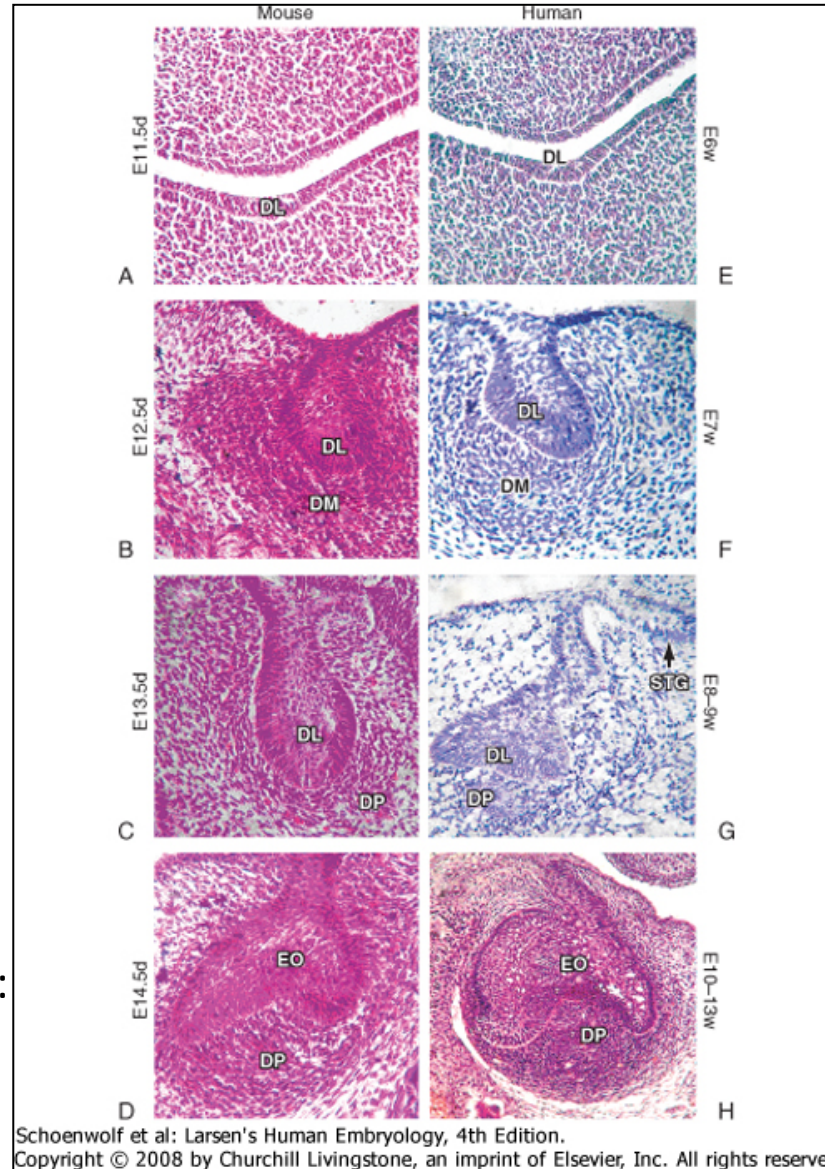
Development of the epidermal appendages

Teeth

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

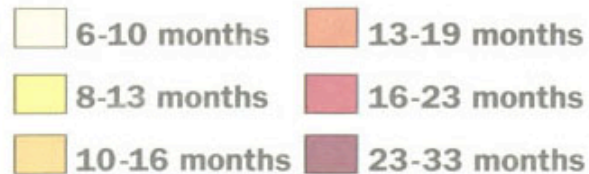
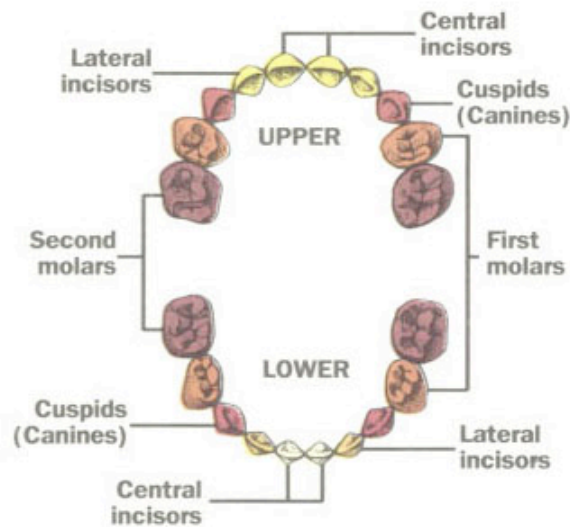
Dental papilla:
Odontoblast, dentin

Development of the epidermal appendages

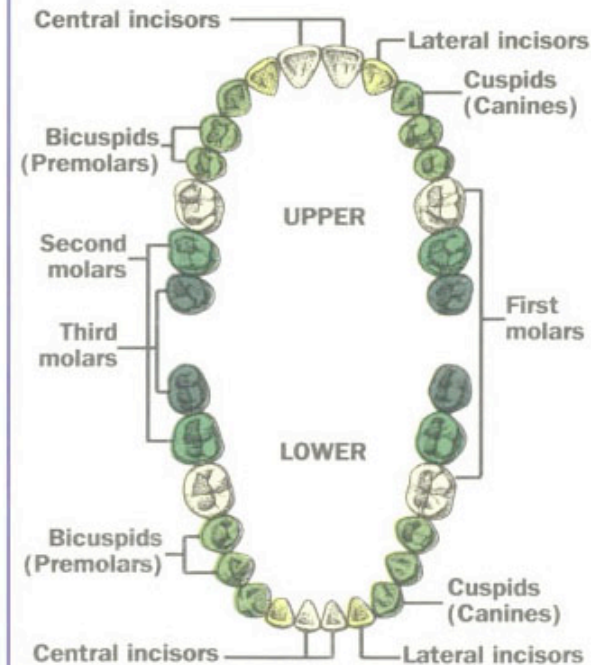
Teeth

Postnatal Tooth Development

Primary teeth
10 + 10



Adult teeth
16 + 16



Lecture overview

Skin function and anatomy

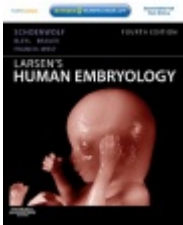
Embryonic origins of the skin

Development of the epidermis

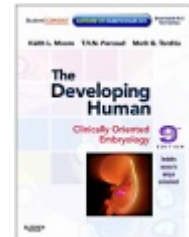
Development of epidermal appendages:

Development of the dermis

Development of melanocytes



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



Development of the dermis

Connective tissue with:

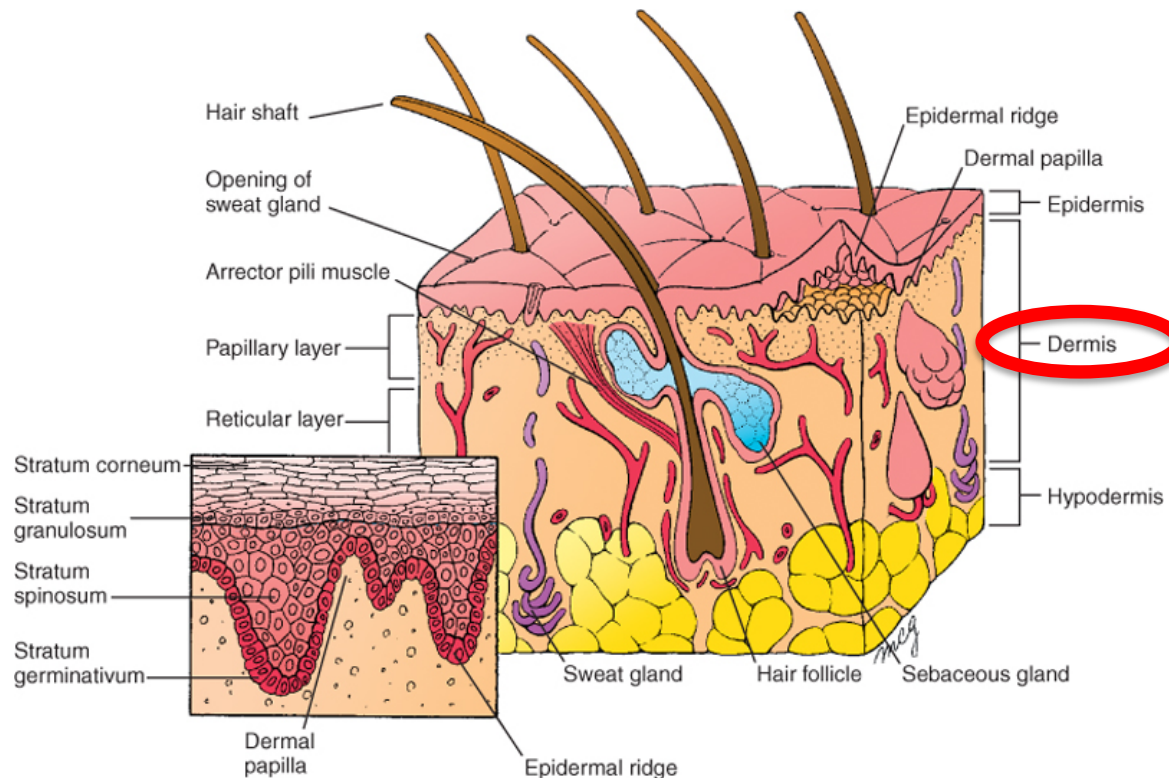
Fibroblasts

Blood vessels

Nerve endings

Sensory receptors

Muscle bundles



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

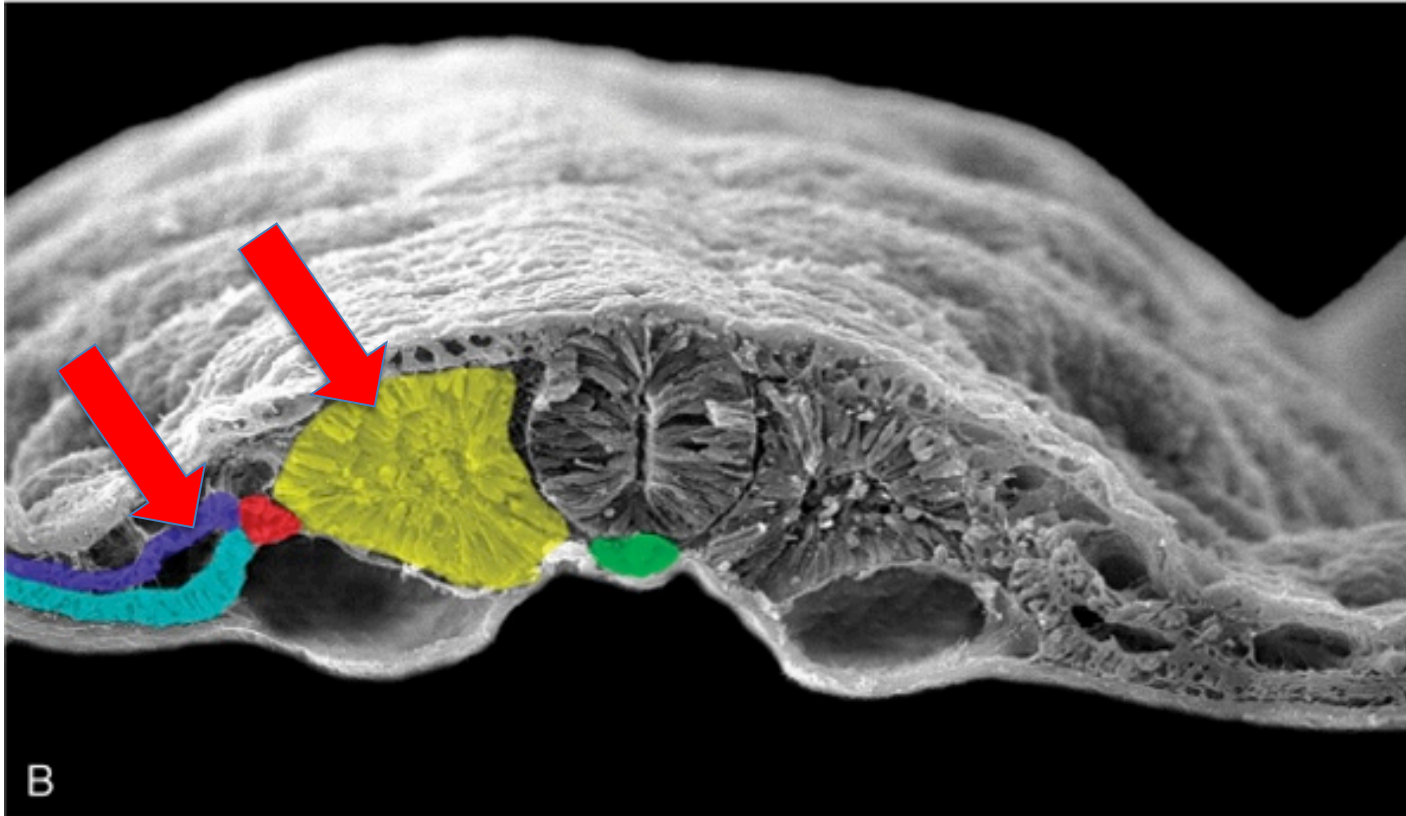
Copyright © 2008 by Churchill Livingstone, an imprint of Elsevier, Inc. All rights reserved

Development of the dermis

Somitic mesoderm -> trunk

Somatic lateral plate mesoderm -> trunk, limbs

Cranial neural crest derived mesenchyme -> cranial region



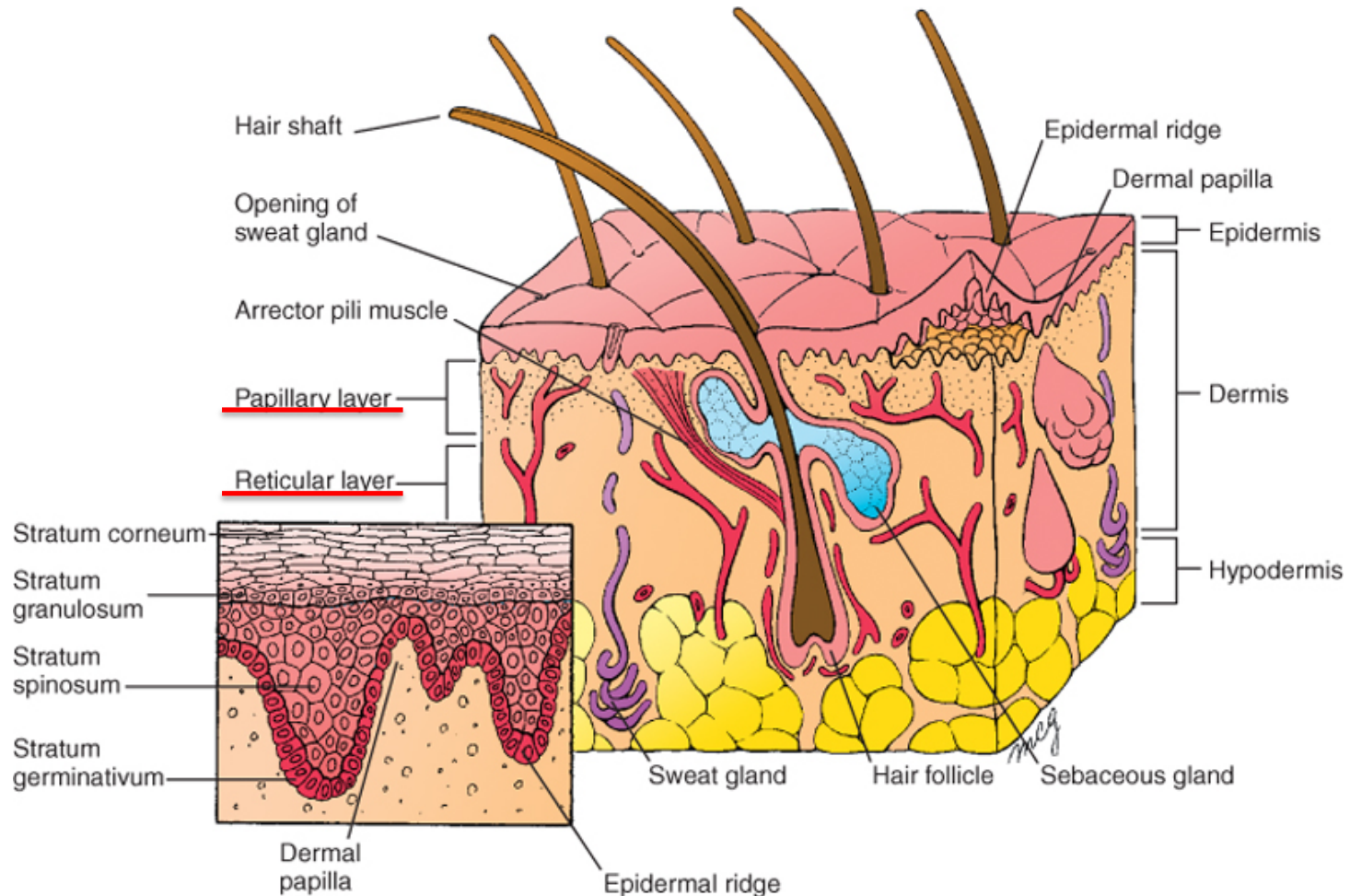
Schoenwolf et al: Larsen's Human Embryology, 4th Edition.

Copyright © 2008 by Churchill Livingstone, an imprint of Elsevier, Inc. All rights reserved

Development of the dermis

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

Inner dermis: reticular layer



Lecture overview

Skin function and anatomy

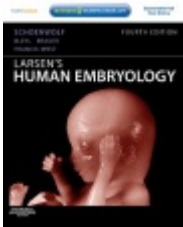
Embryonic origins of the skin

Development of the epidermis

Development of epidermal appendages:

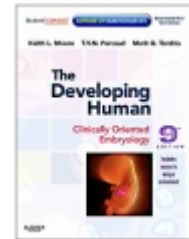
Development of the dermis

Development of melanocytes



Resources:

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



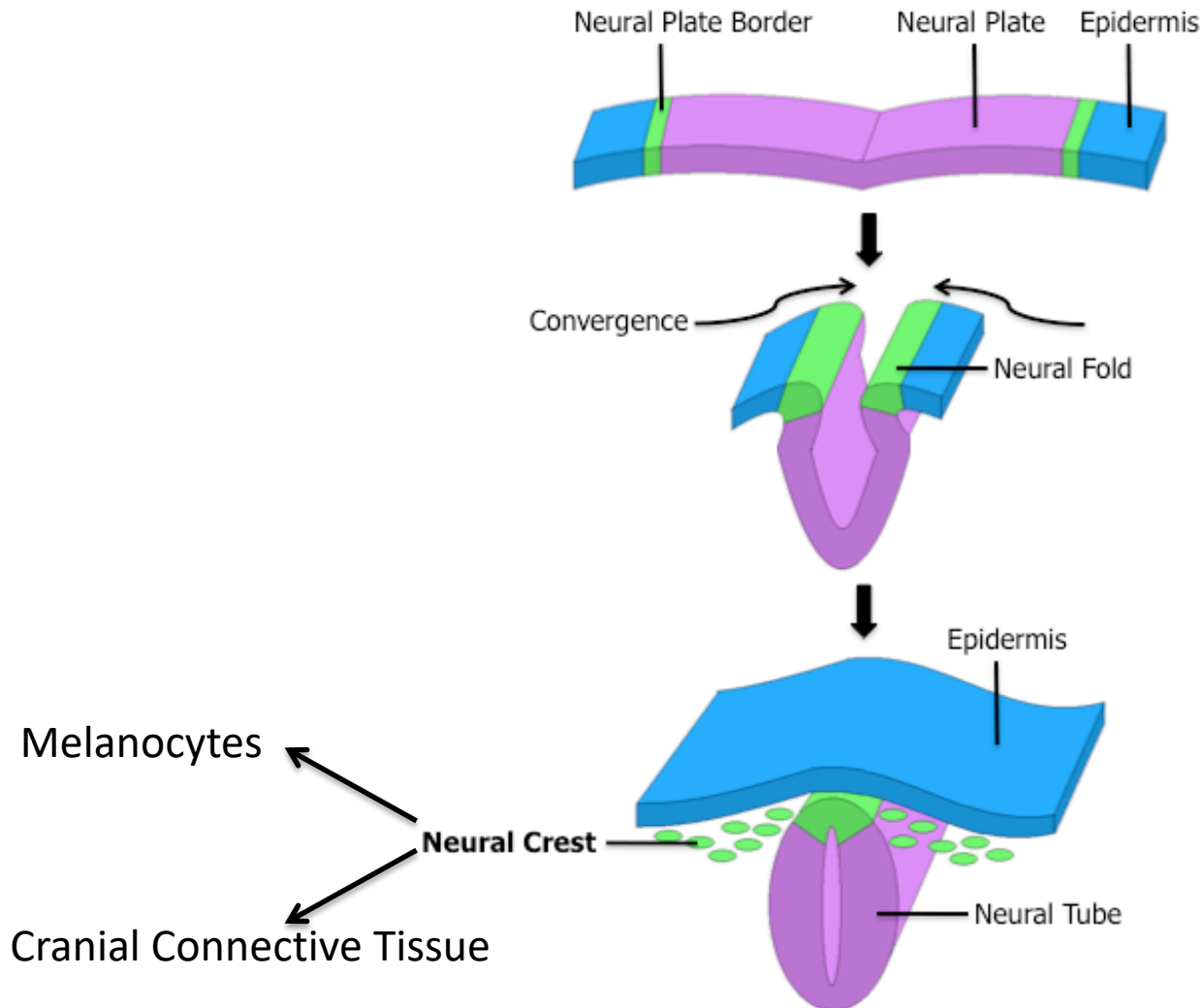
Development of melanocytes



Development of melanocytes

Neural Crest

Melanocytes + Cranial Connective Tissue

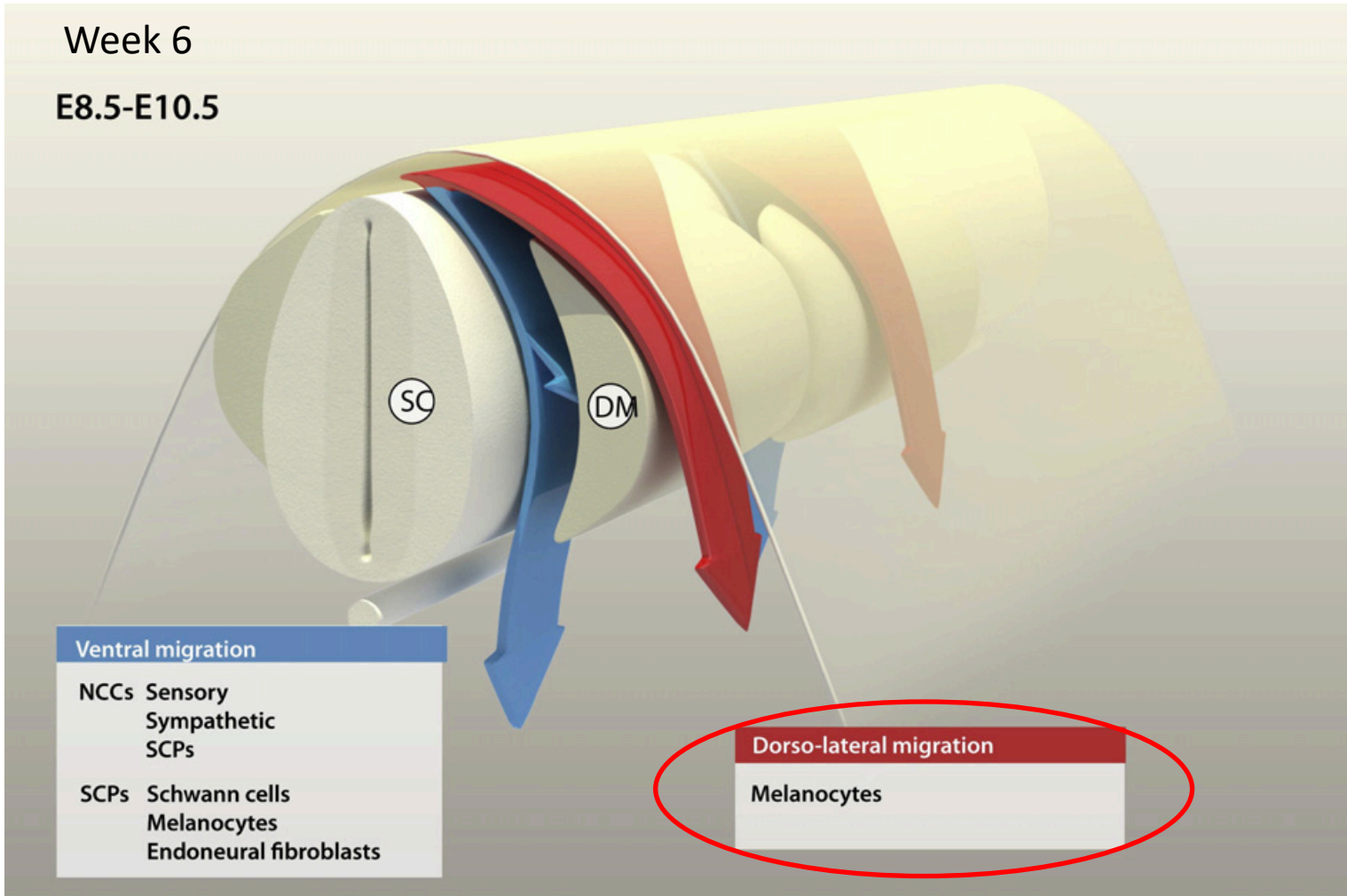


Development of melanocytes

Neural crest

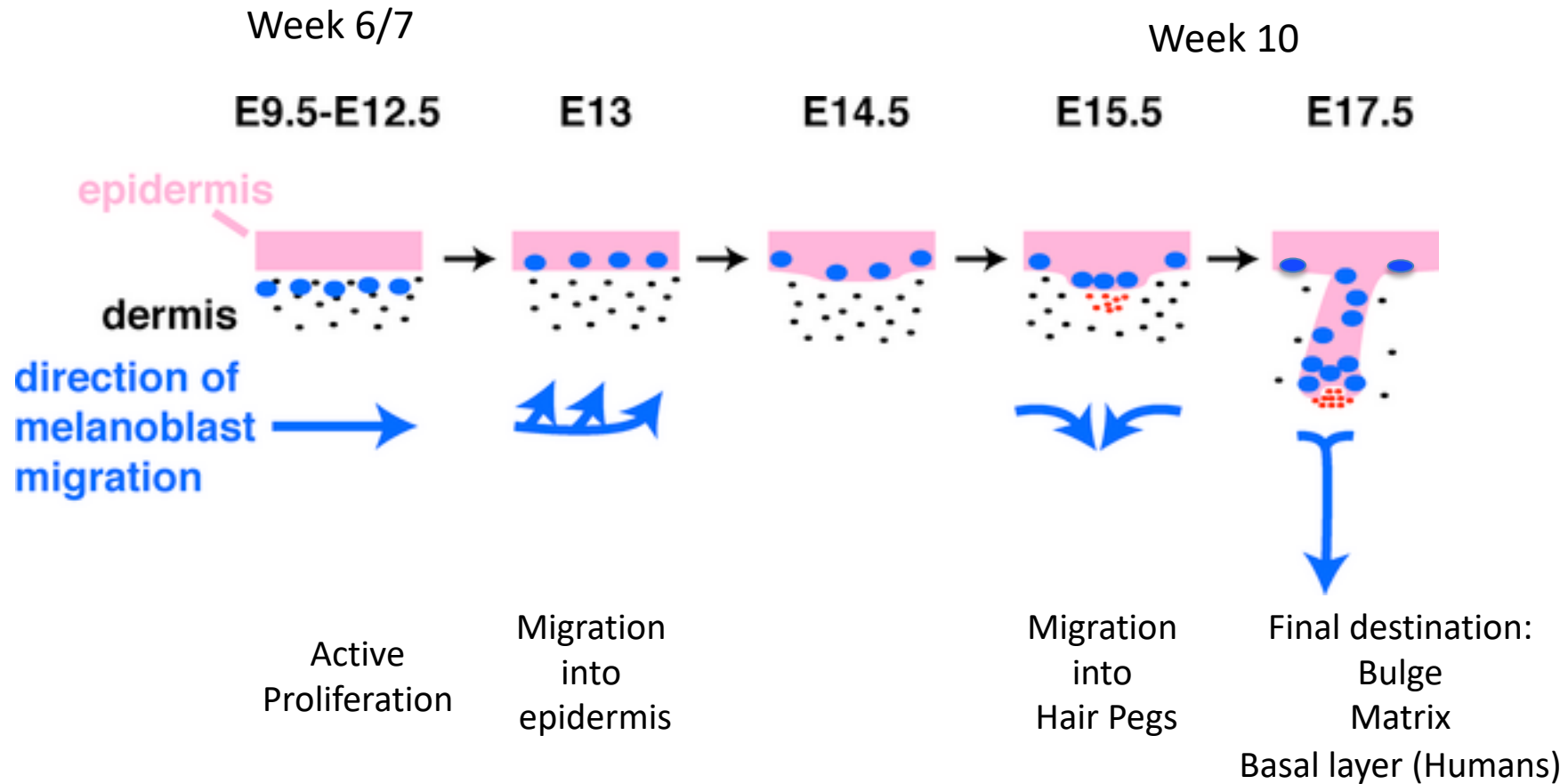
Week 6

E8.5-E10.5



Ernfors, Exp Cell Res 2010

Development of melanocytes



Lecture overview

Skin function and anatomy

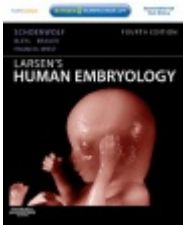
Embryonic origins of the skin

Development of the epidermis

Development of epidermal appendages:

Development of the dermis

Development of melanocytes



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

