Tissues

- Histogenesis – Various cell types develop in concert to form a tissue
- Cytodifferentiation – Individual cells become increasingly specialized, finally reaching a terminal differentiated state

Integument - Skin

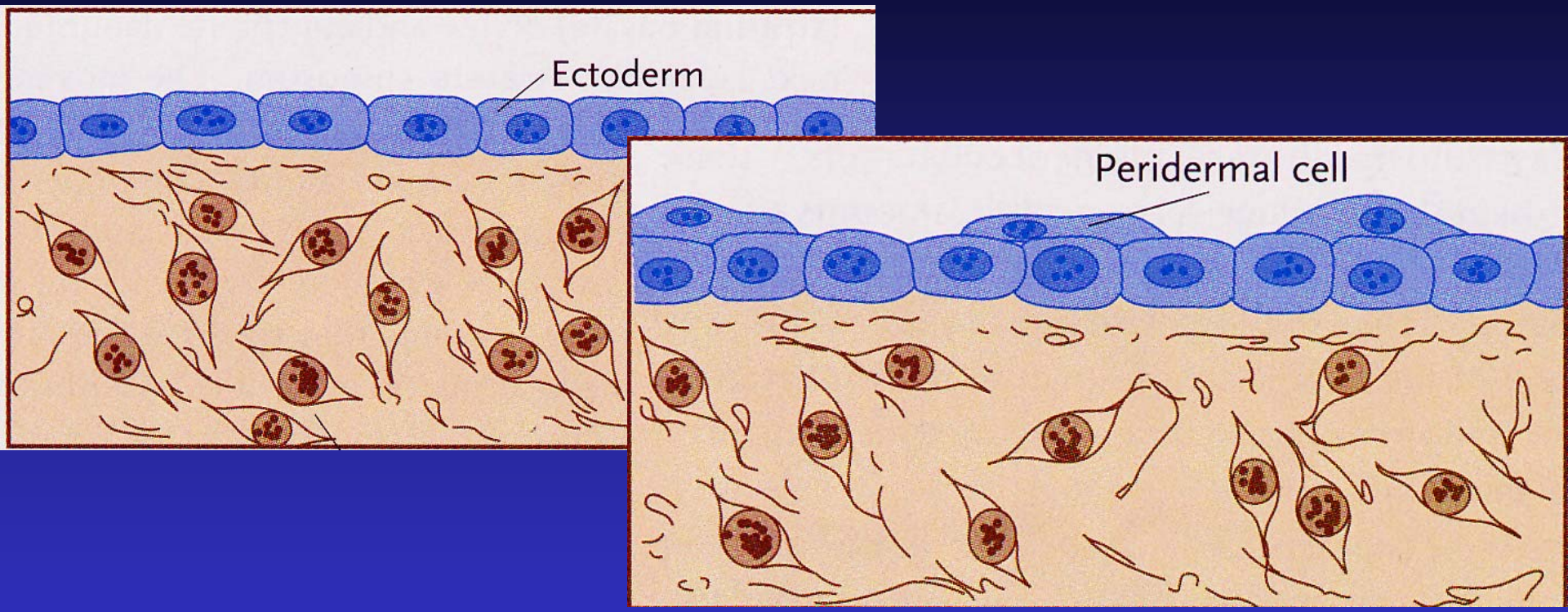
Ectoderm → Epidermis

Mesenchyme → Dermis

Derivatives:

- Hair
- Mammary Gland
- Teeth (Chapter 13, pp 298-303)

Ectoderm → Epidermis



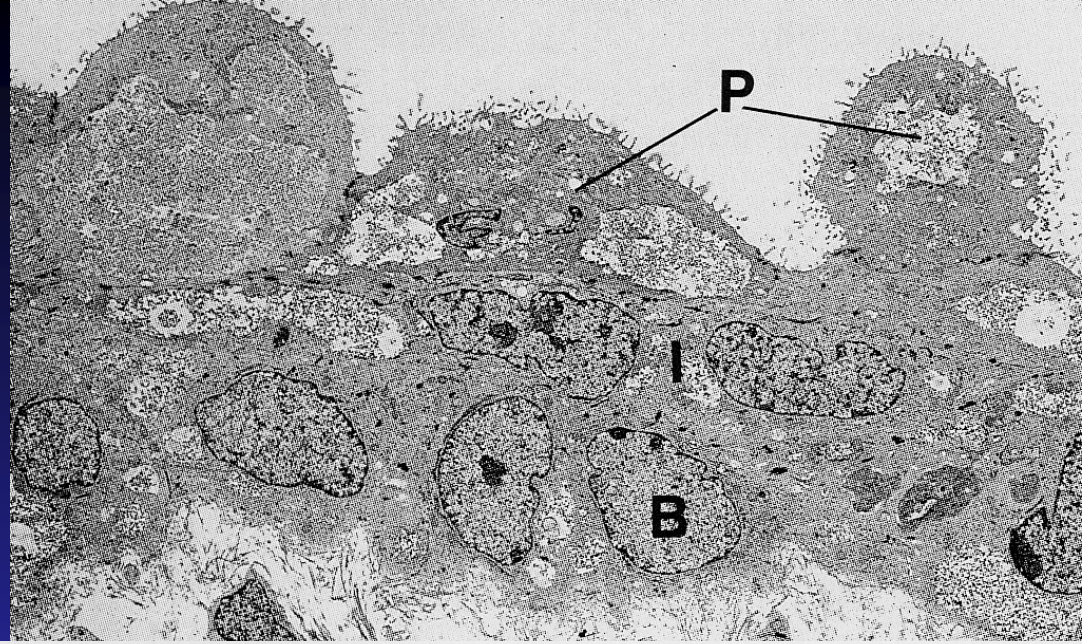
Ectoderm - Single layer - Simple Cuboidal Epithelium

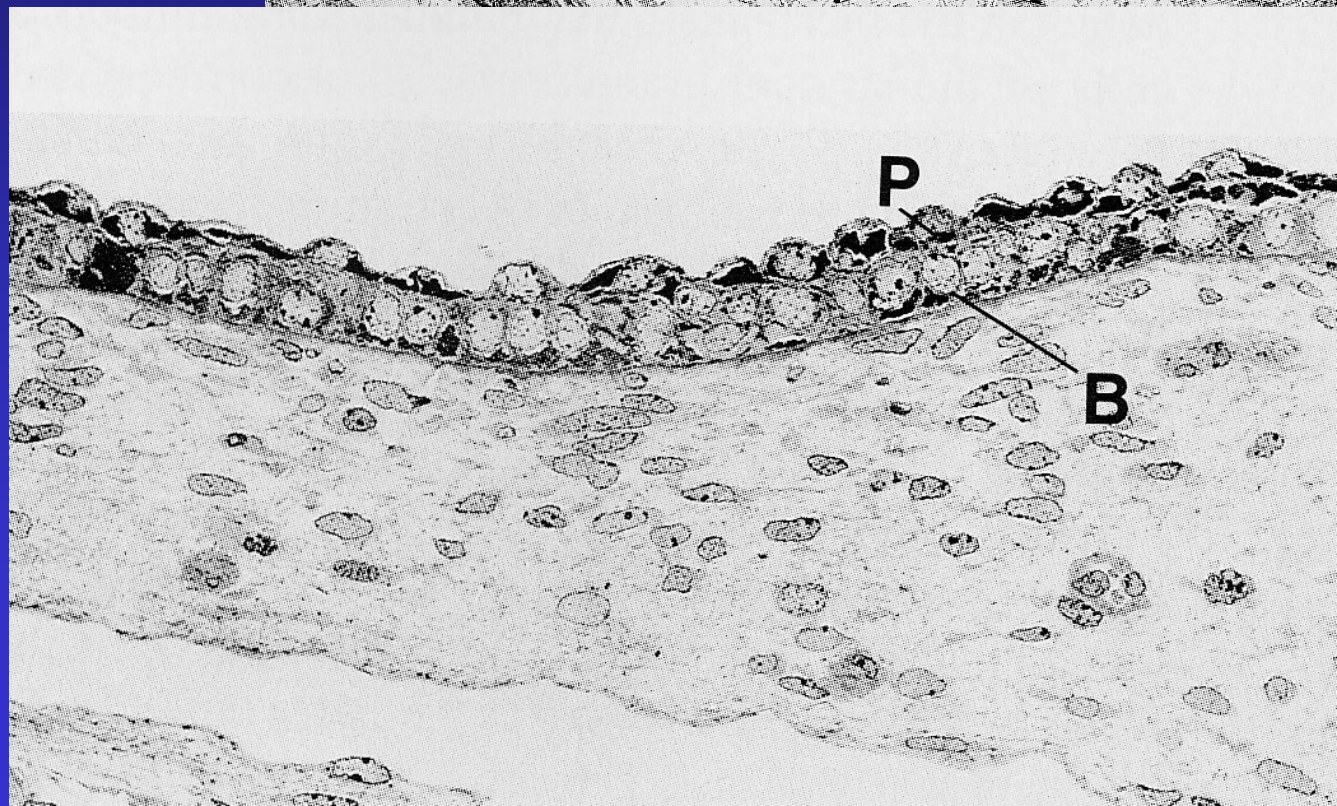
Layers – 4 weeks of gestation – Periderm

Flattened cells – involved in exchange between the basal layer and the amniotic fluid

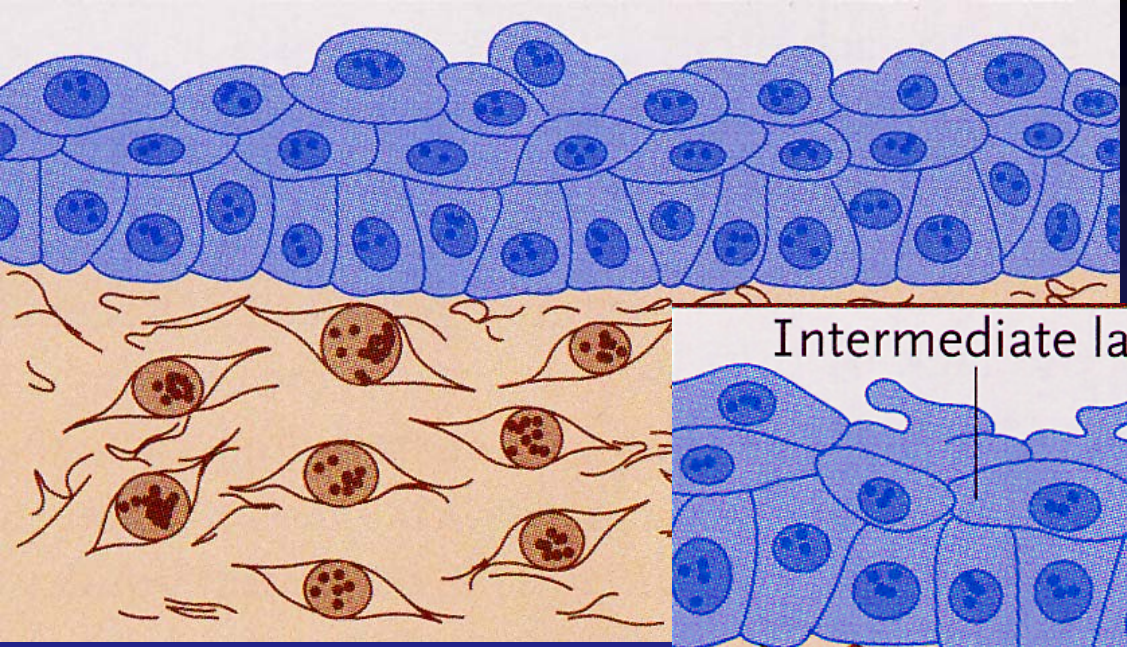
Periderm

Peridermal cells (slough off)
- Apoptosis
- Gone by 21st Week

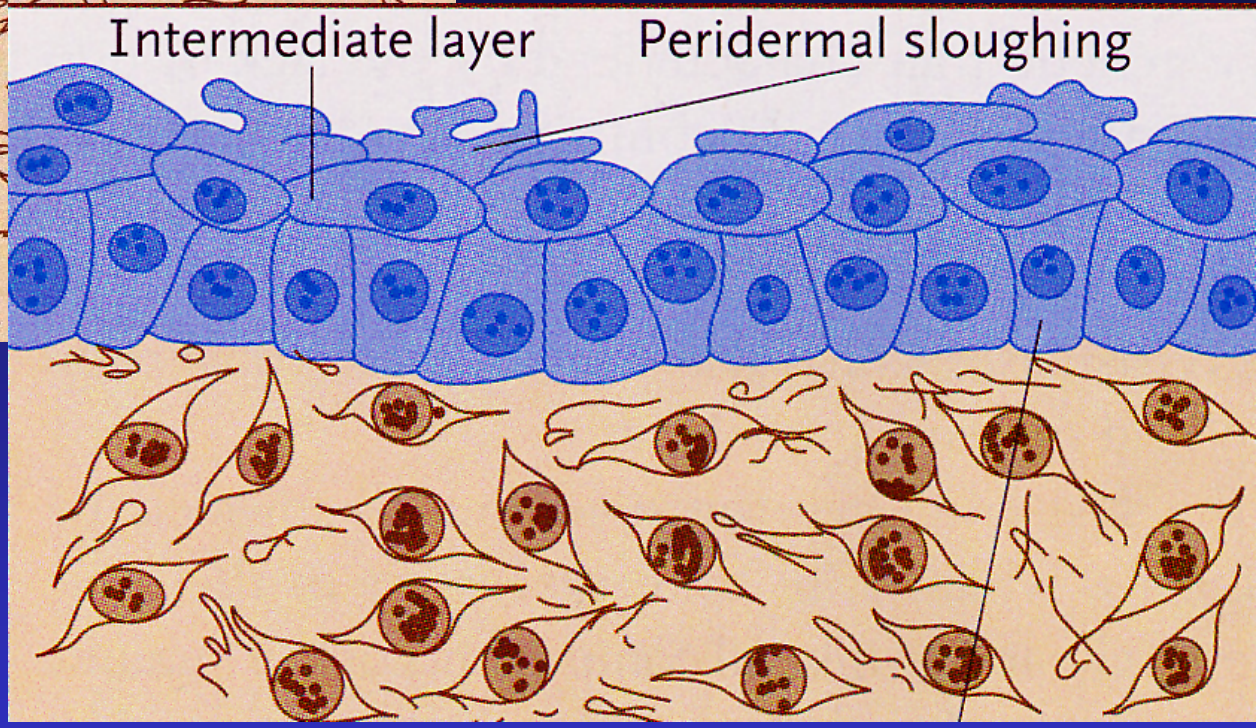




Basal Layer



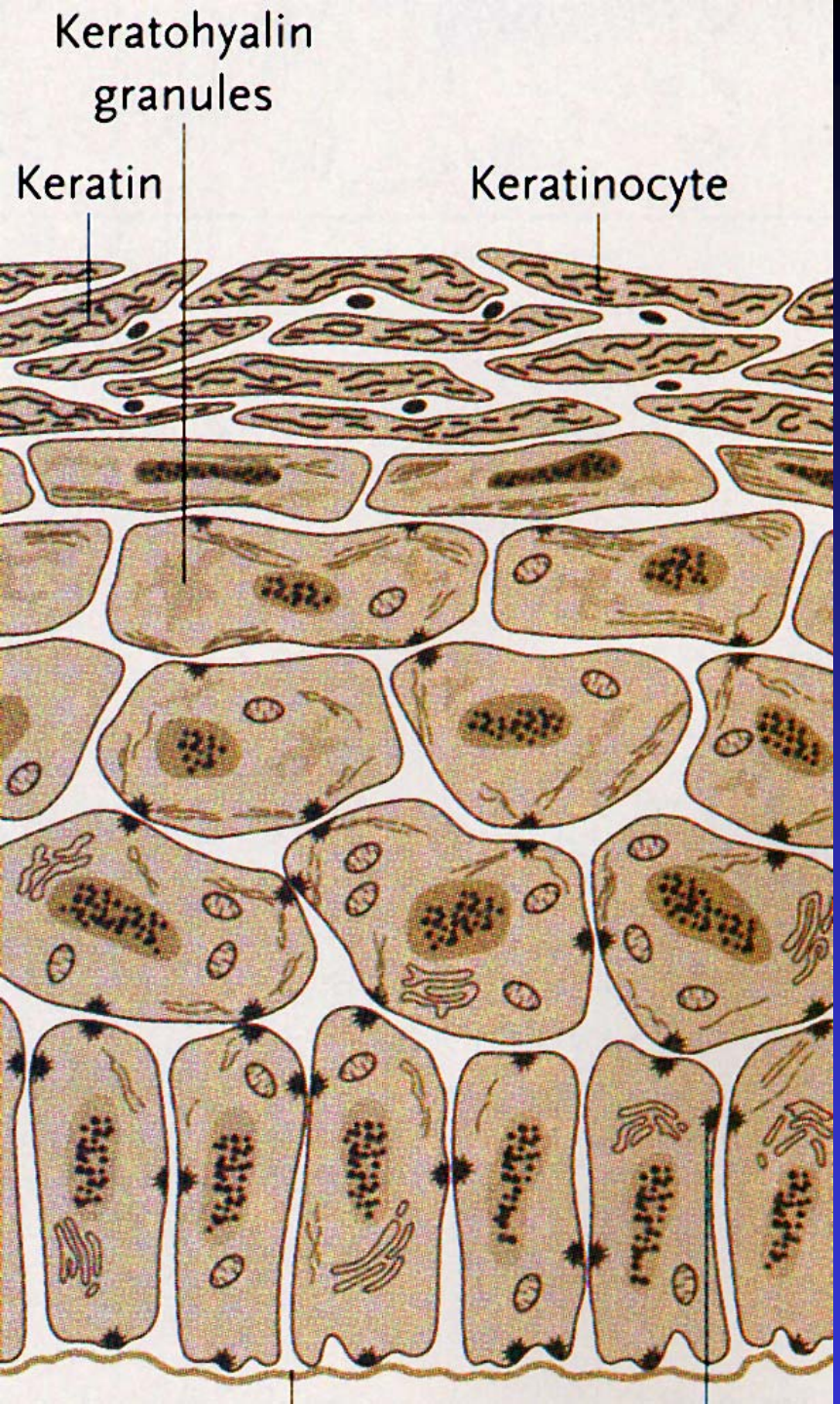
12 weeks



16 weeks

Basal layer (stratum germinativum, stratum basale) - Stem Cells of epidermis

Intermediate layer - Keratinocytes - keratin = intermediate filaments



Stratum corneum

Stratum granulosum

Stratum spinosum

Stratum basale

Epidermal Layers

Stratum Basale – Stem Cells

Growth Stimulators - e.g. Epidermal Growth Factor (EGF), Fibroblast Growth Factor (FGF), Insulin-like Growth Factor (IGF), Transforming Growth Factorα (TGFα)

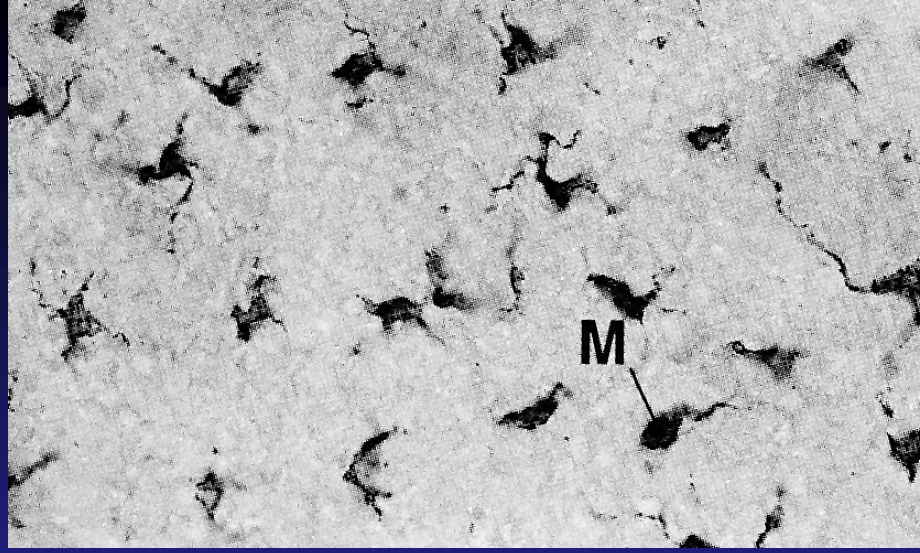
Growth Inhibitor - e.g. Transforming Growth Factorβ (TGFβ), Tumor Necrosis Factor (TNF), Interferons.

Stratum Spinosum – Keratin produced in cytoplasm - Keratinocytes

Stratum Granulosum – post-mitotic cells - Keratohylin granules – protein (histidine-rich and sulfur-rich) – Keratin aggregates

Stratum Corneum – Dead cells – lose their nuclei – bags of keratin. 15-20 layers thick. Shed 1300 cells/cm^2/hr. – House Dust

Other Cell Types



Melanocytes – melanoblasts are migratory neural crest cells that invade the epidermis. Contain pigment granules called melanosomes. Number of melanocytes is constant – variation in the amount of melanin synthesized (from tyrosine via tyrosinase)

Langerhans cells – from bone marrow – immune system macrophage-like cells - immune surveillance and contact sensitivity (skin allergies)

Merkel cells - Pressure detecting mechanoreceptors – prominent in thick skin of palm and plantar (sole) regions. Neural crest derived.

Dermis

Derived from Somite - Mesenchyme cells

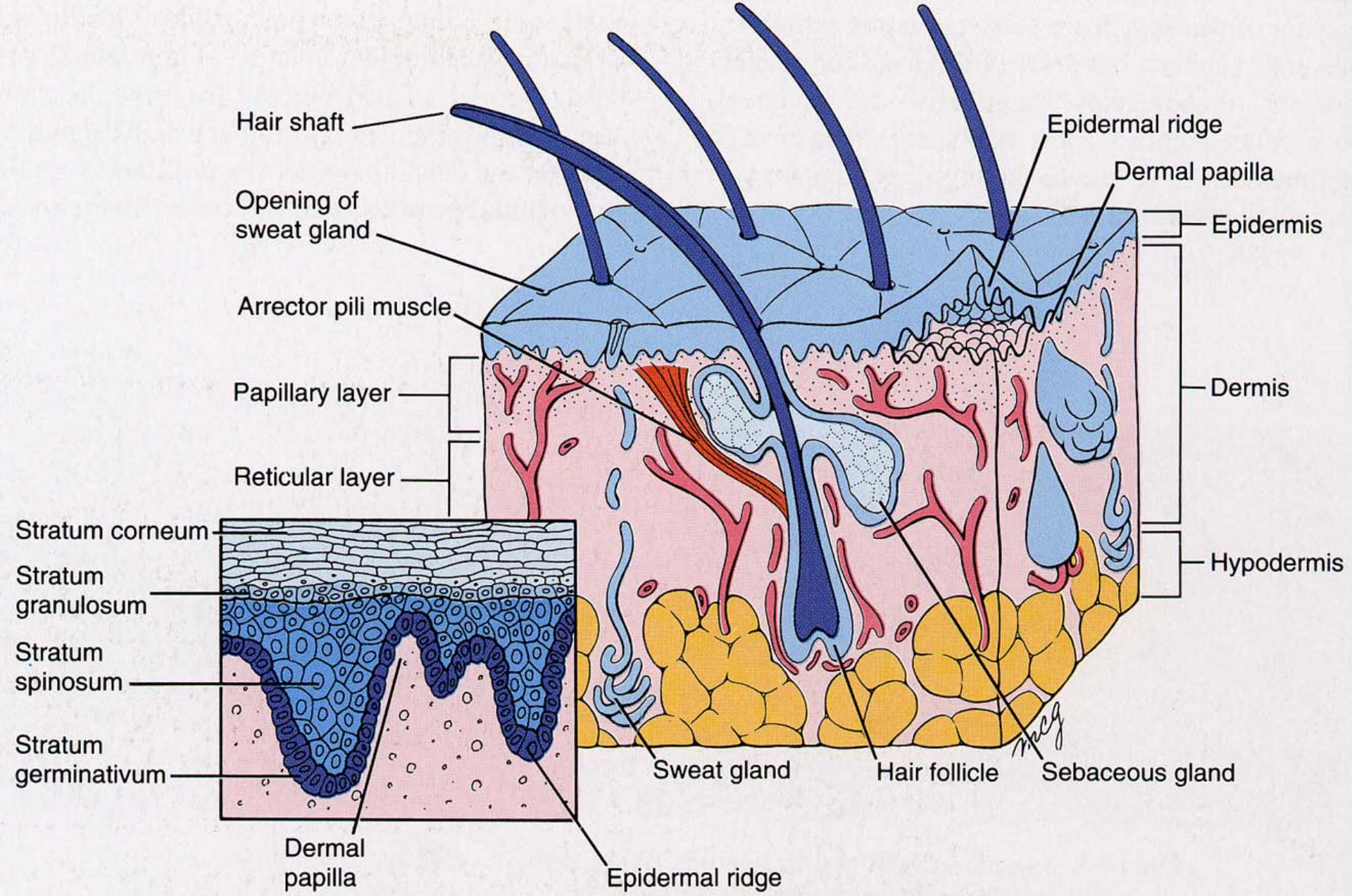
Cells produce collagen fibers and elastin fibers

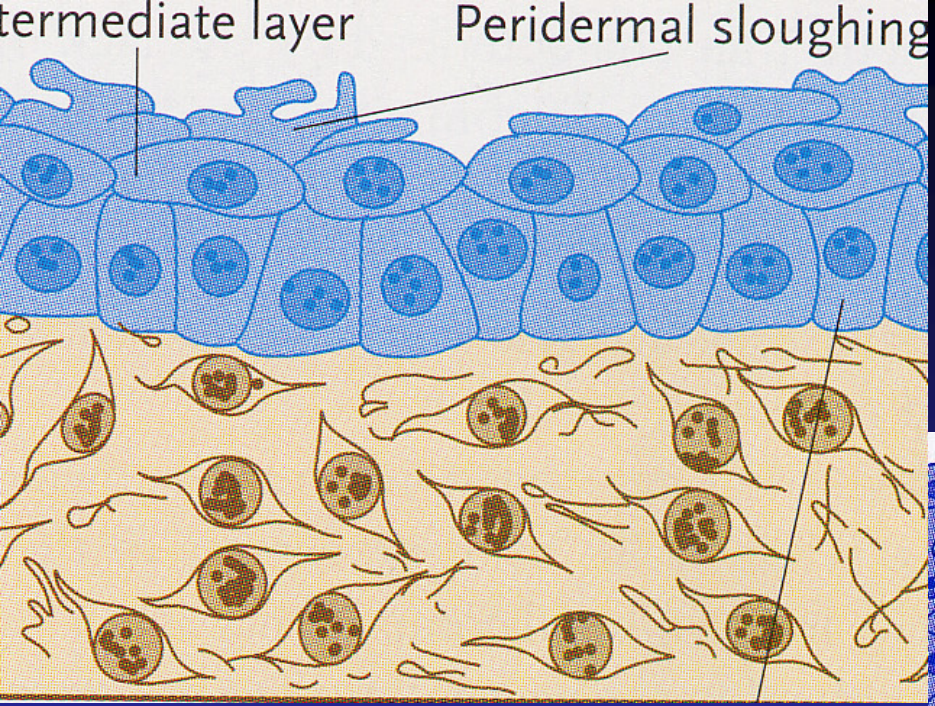
Dermal papillae form in conjunction with epidermal ridges

Papillary layer = Superficial region just beneath the epidermis

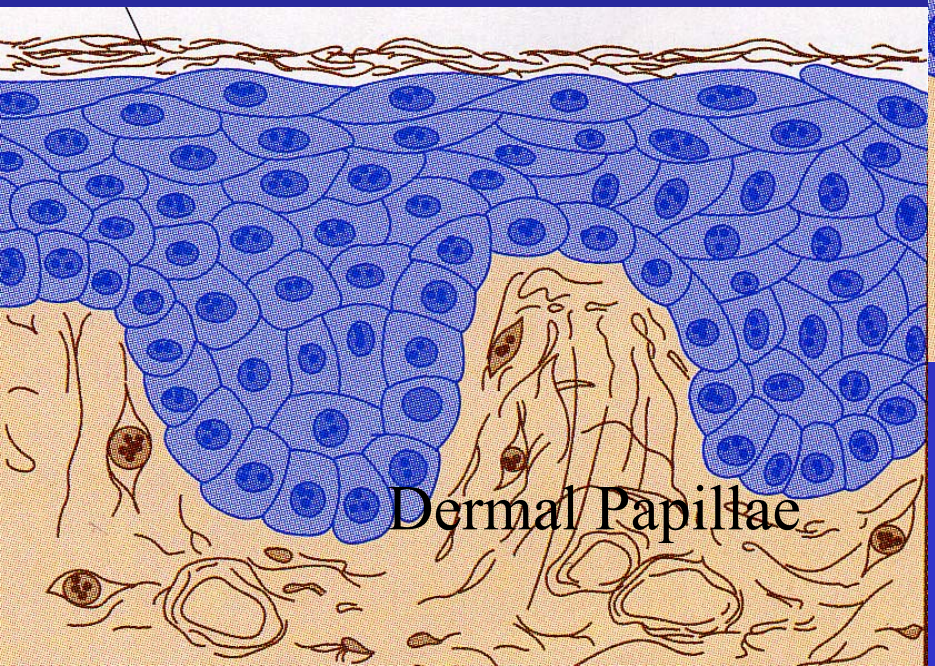
Reticular layer = thick, irregular layer beneath the papillary layer

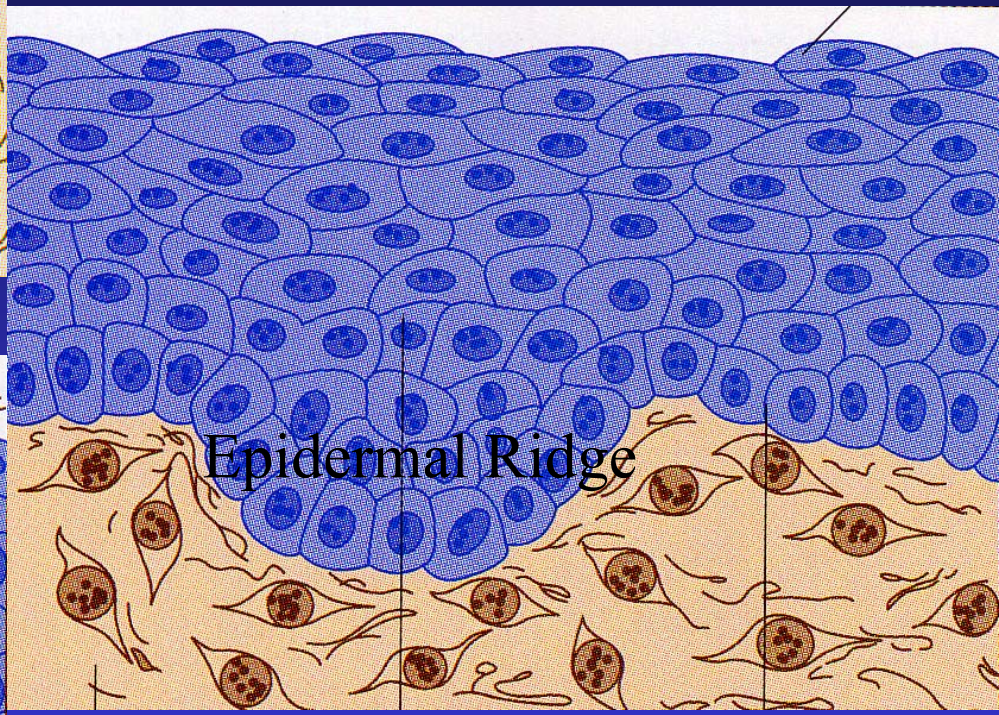
Hypodermis = between the reticular layer and the subcutaneous fatty connective tissue


Hair shaft
Opening of sweat gland
Arrector pili muscle
Papillary layer
Reticular layer
Epidermal ridge
Dermal papilla
Epidermis
Dermis
Hypodermis
Stratum corneum
Stratum granulosum
Stratum spinosum
Stratum germinativum
Dermal papilla
Epidermal ridge
Sweat gland
Hair follicle
Sebaceous gland


termediate layer
Peridermal sloughing

Dermis


Dermal Papillae


Epidermal Ridge

Dermatoglyphics

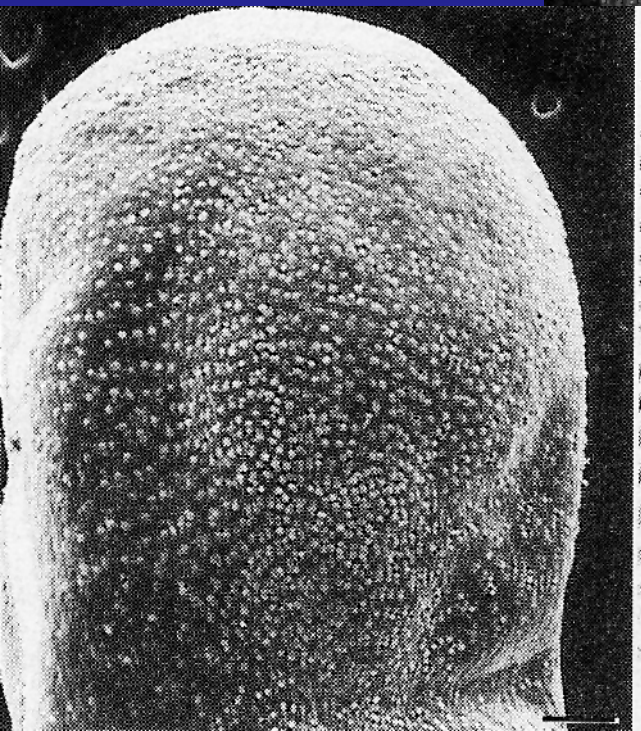
Ridge/papillae pattern

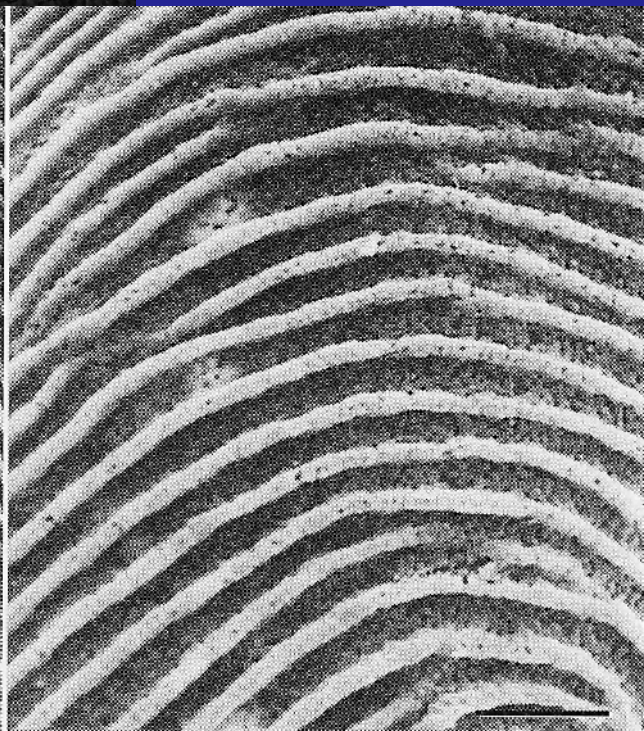
Volar Pads on ventral fingers and toes
– transient, 6-11 weeks

Epidermal ridges form between 11 and 17 weeks
Pattern of Whorls, Loops, Arches

Fingerprints - once established - pattern is permanent - even after grafting

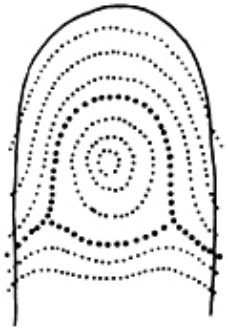
It even regenerates





Ridge Count

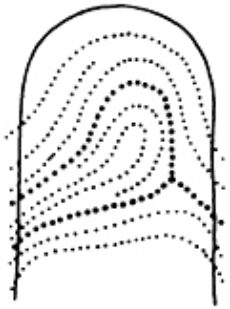
High pad



Whorl

17

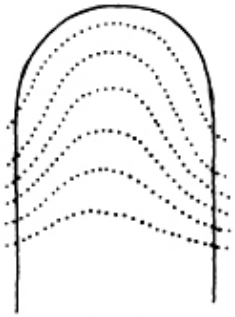
Intermediate pad
(steep radial side)



Loop
(ulnar)

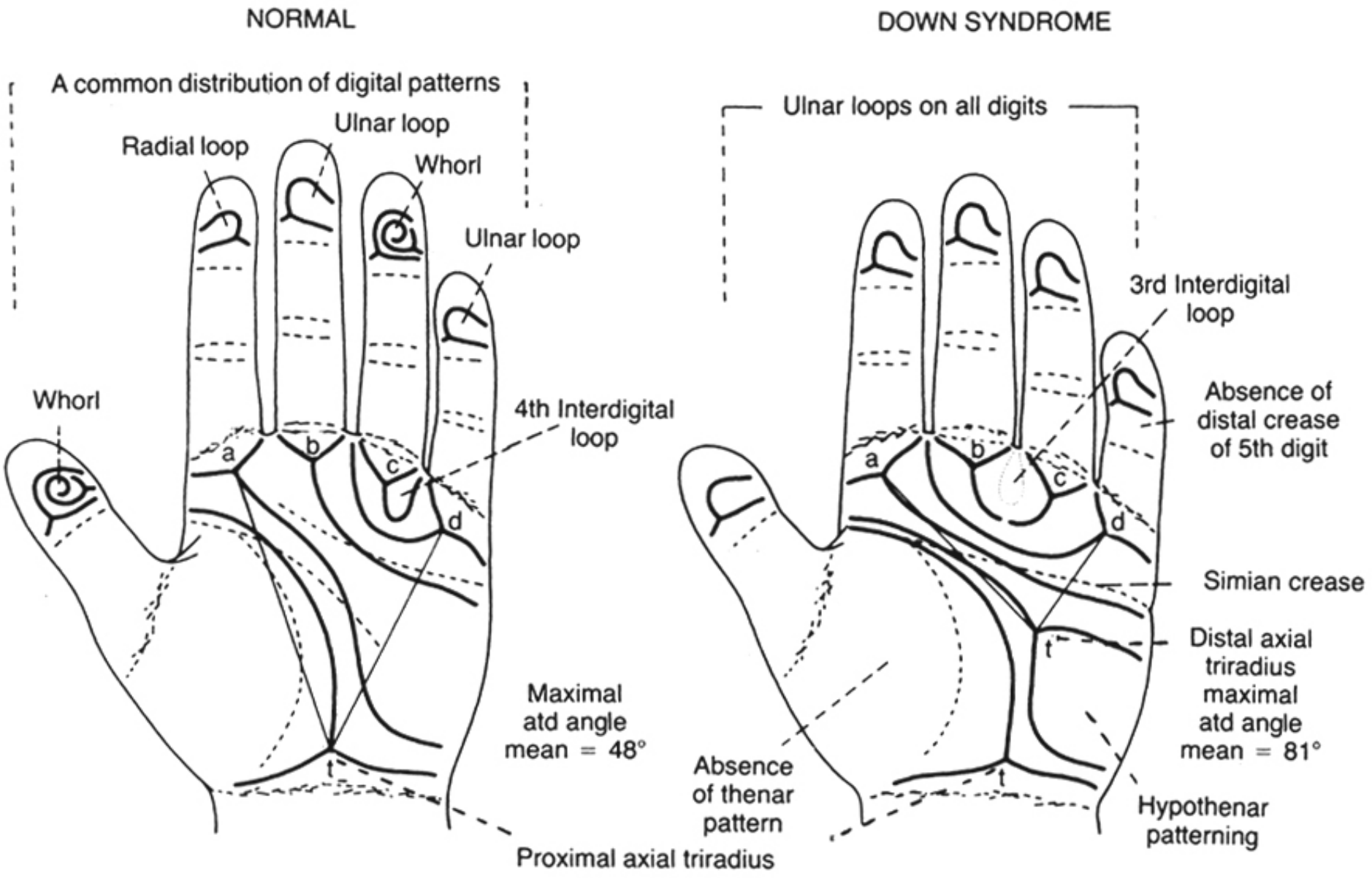
13

Low pad

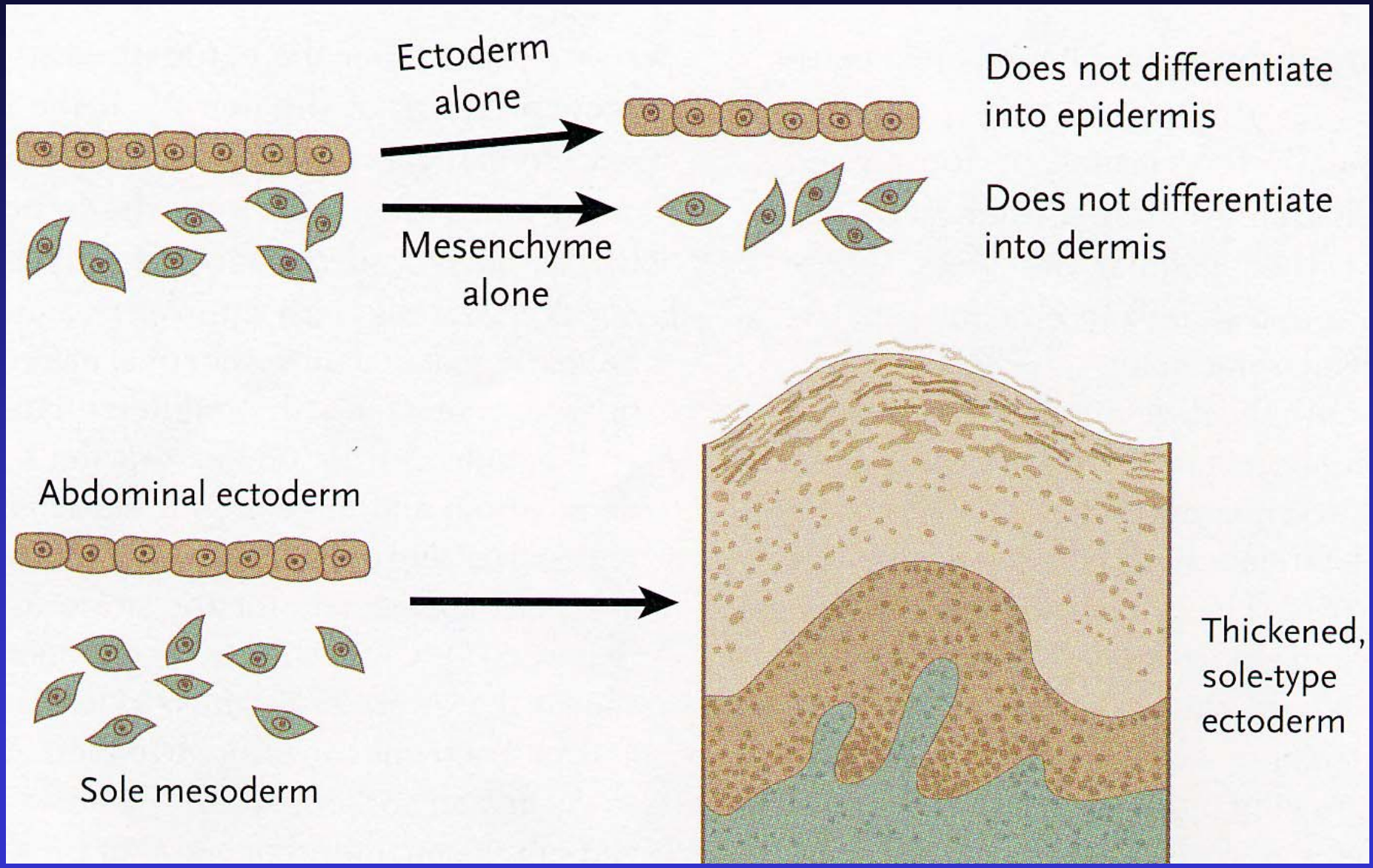


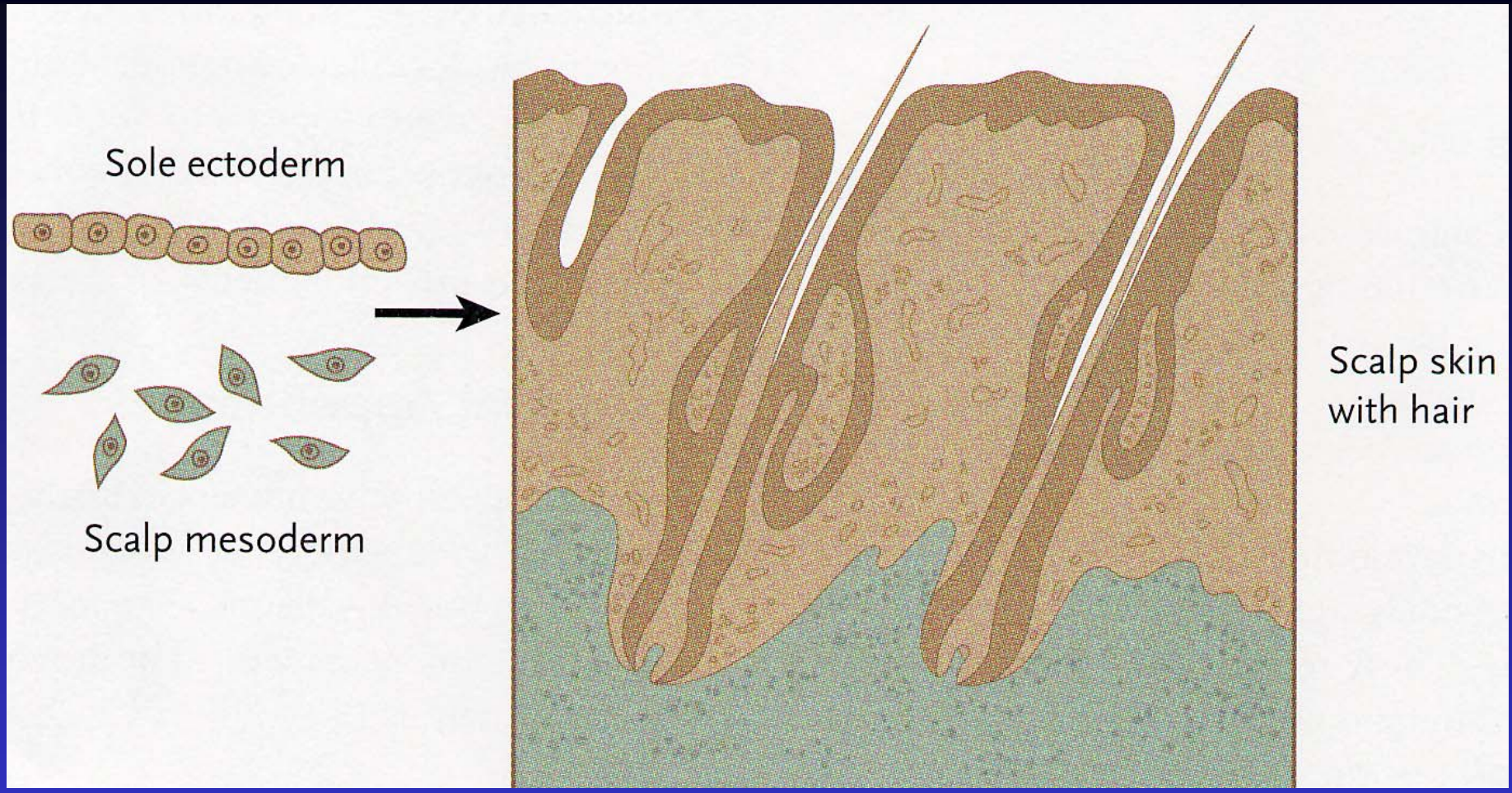
Arch

0


NORMAL
A common distribution of digital patterns
Radial loop
Ulnar loop
Whorl
Ulnar loop
Whorl
4th Interdigital loop
a
b
c
d
t
Maximal atd angle mean = 48°
Proximal axial triradius
DOWN SYNDROME
Ulnar loops on all digits
3rd Interdigital loop
Absence of distal crease of 5th digit
Simian crease
Distal axial triradius maximal atd angle mean = 81°
Absence of thenar pattern
Hypothenar patterning

Induction - Epidermal Appendages





Induction – Dermis → Epidermis

Dermis controls epidermis type, e.g. course hair, fine hair, no hair.

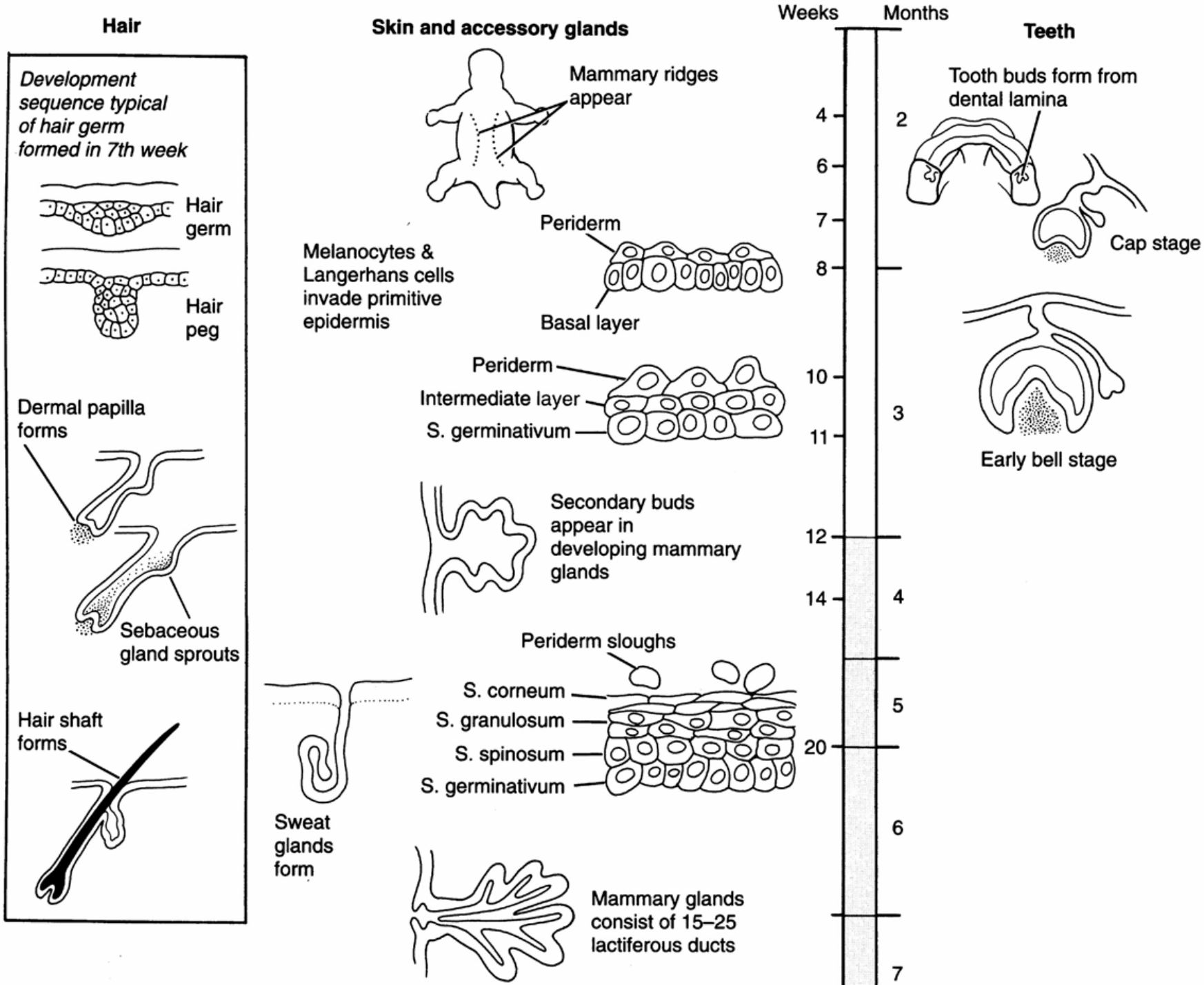
Integument Anomalies

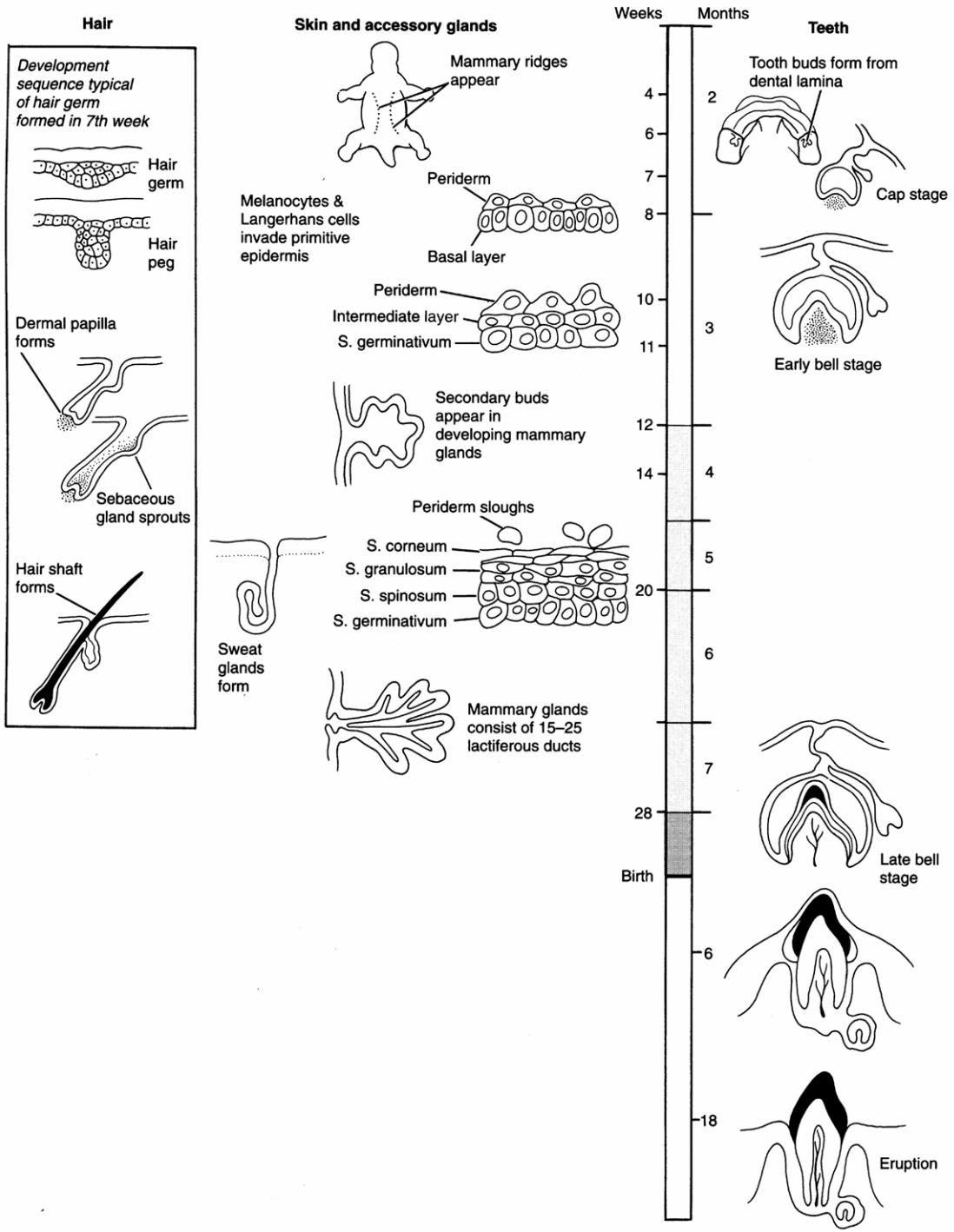
Collodion Baby – Periderm persists forming a cocoon around the newborn that must be removed.

Melanoma – Cancer of melanocyte - deadly

Basal Cell Carcinoma – BCC – most common cancer – high cure rate – involves Sonic Hedgehog signaling pathway

Lamellar Ichthyosis – Skin that scales off in flakes


Hair
Development sequence typical of hair germ formed in 7th week
Hair germ
Hair peg
Dermal papilla forms
Sebaceous gland sprouts
Hair shaft forms
Skin and accessory glands
Mammary ridges appear
Periderm
Melanocytes & Langerhans cells invade primitive epidermis
Basal layer
Periderm
Intermediate layer
S. germinativum
Secondary buds appear in developing mammary glands
Periderm sloughs
S. corneum
S. granulosum
S. spinosum
S. germinativum
Sweat glands form
Mammary glands consist of 15–25 lactiferous ducts
Weeks
Months
4
6
7
8
10
11
12
14
20
2
3
4
5
6
7
Teeth
Tooth buds form from dental lamina
Cap stage
Early bell stage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Weeks
Months
Teeth
Tooth buds form from dental lamina
Cap stage
Early bell stage
Late bell stage
Eruption
4
6
7
8
10
11
12
14
20
28
Birth
2
3
4
5
6
7
6
18

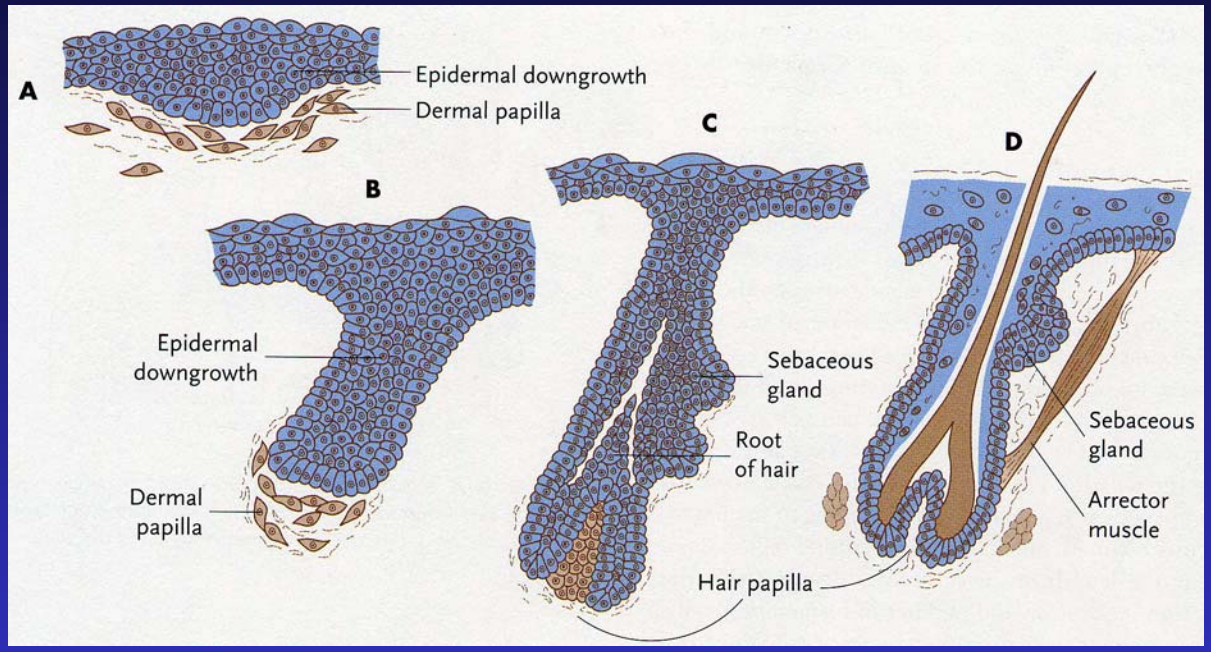
Integument - Skin

Ectoderm → Epidermis; Mesenchyme → Dermis

Derivatives:

- **Hair**
- Mammary Gland
- Teeth (Chapter 13, pp 298-303)

Hair Development
(12th Week)



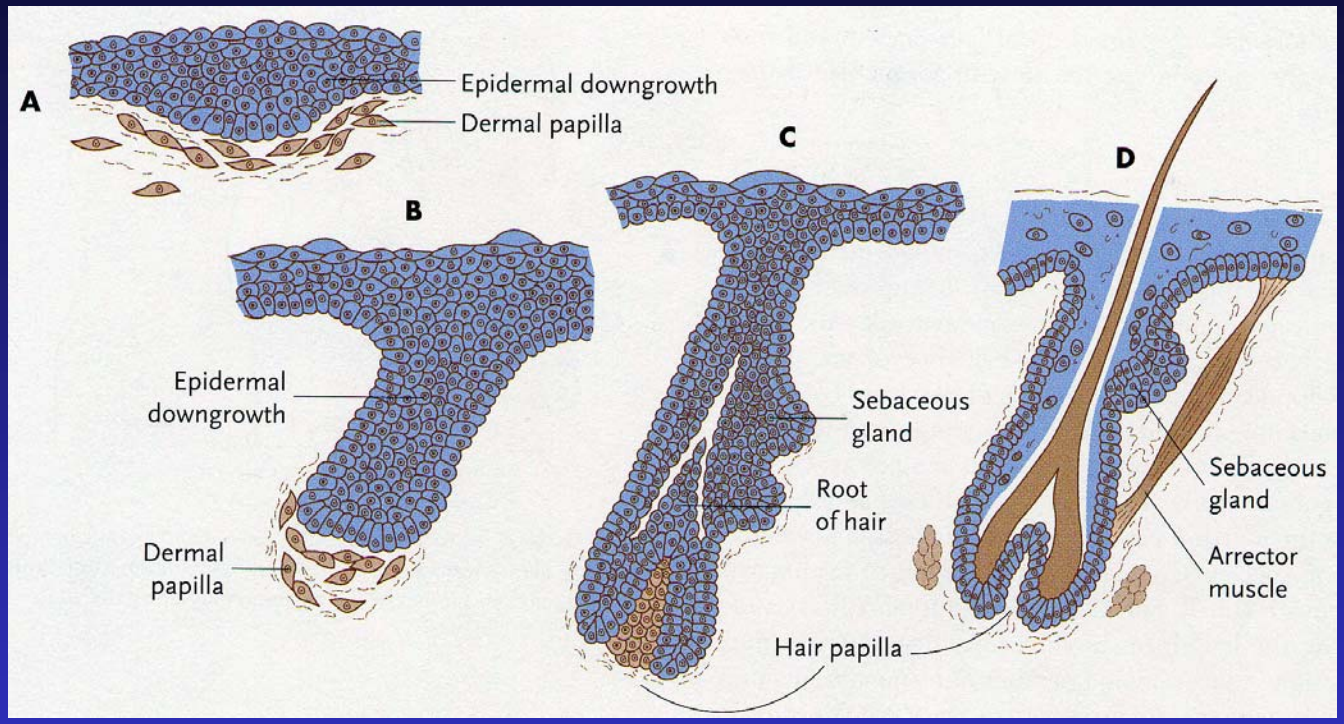
Hair germ - stratum germinativum proliferation

Hair peg - downward extension as a solid cylinder of epidermis

Hair Bulb - deepest epidermal part

Germinal Matrix = cells of the bulb that gives rise to the hair.

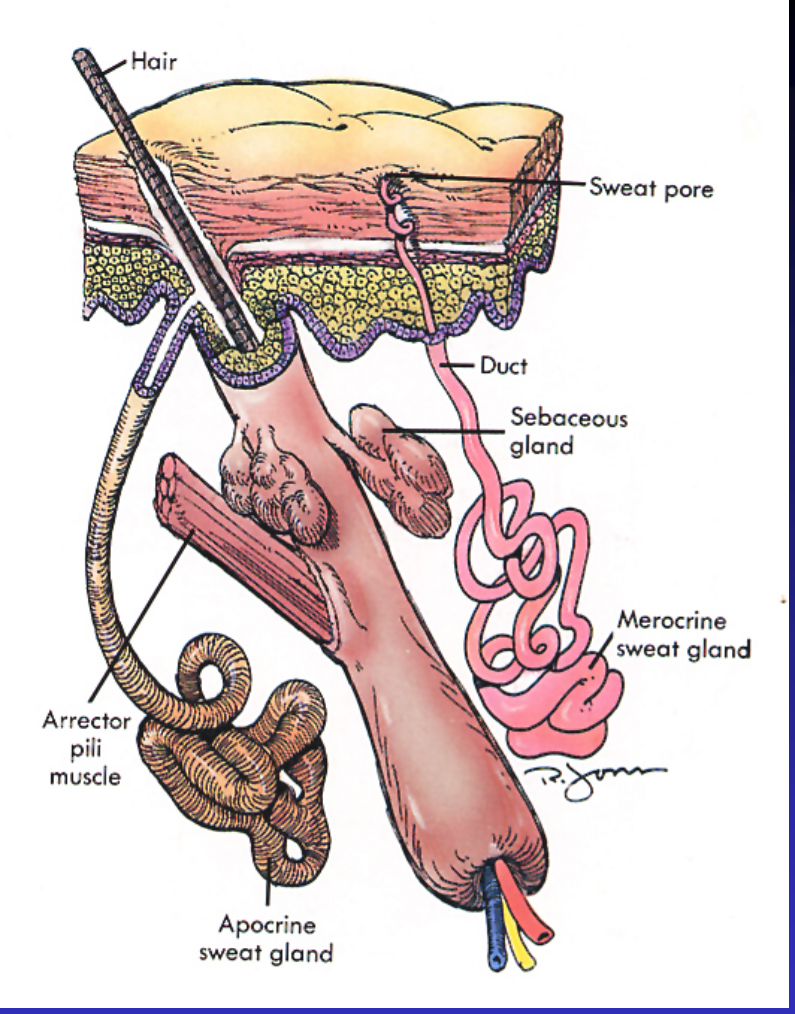
Hair Development

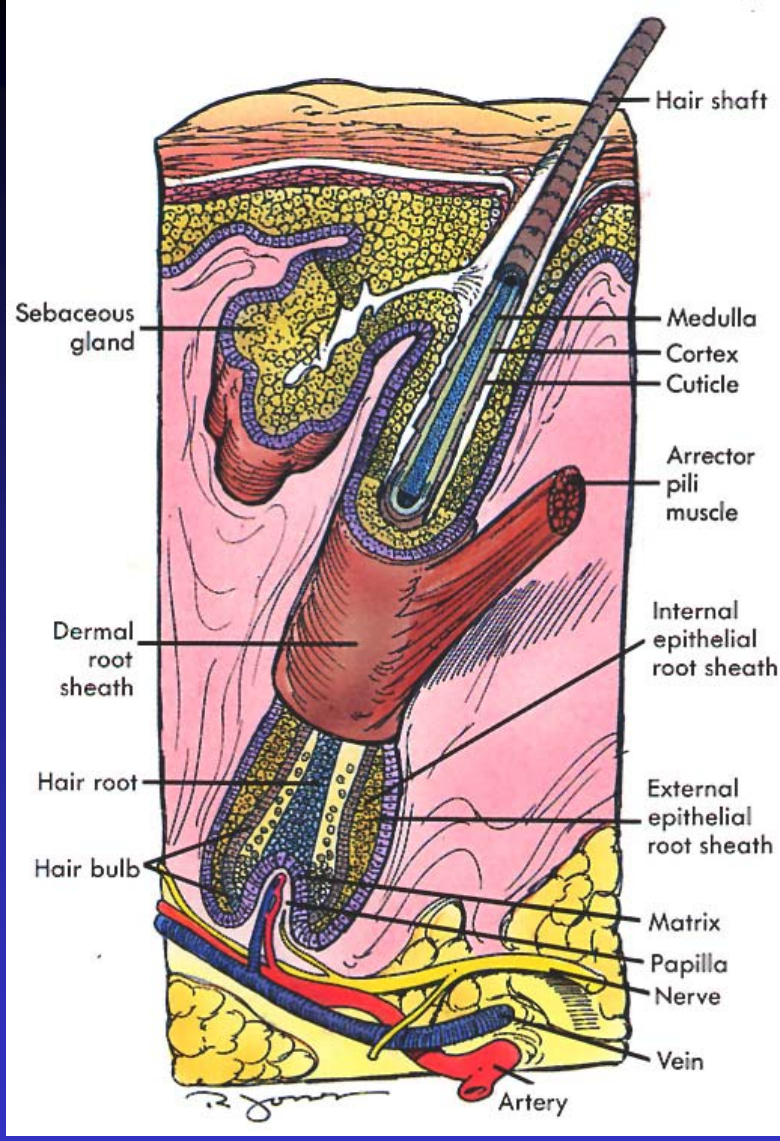


Hair Papillae - Mesenchyme papillae in the bulb

Hair Follicle – Bulb and Papillae

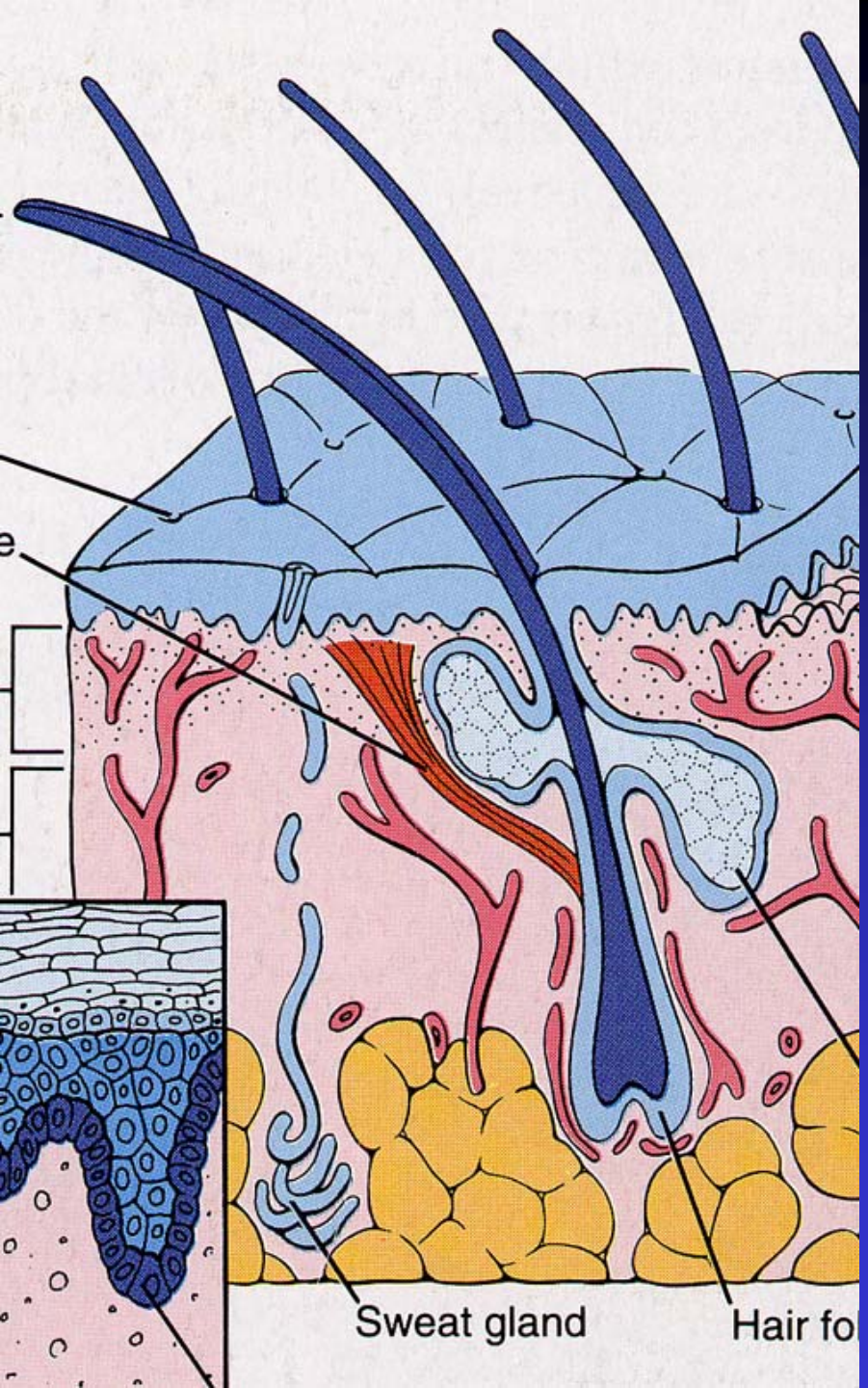
Lanugo - Fetal hair - fine and unpigmented, shed and replaced by coarser hair before birth





Two layers surrounding the hair shaft:
inner epithelial root sheath
outer dermal root sheath

Hair growth - germinal matrix pushes differentiated cells distally



Adult Hair

- hair shaft
  - Granules of trichohyalin – imparts hardness to hair
- bulb
- dermal root sheath
- epithelial root sheath
- sebaceous gland
  - Sebum
  - Vernix Caseosa (fetal sebum)
- arrector pili muscle

Epidermal Glands
Holocrine Gland (Sebaceous Gland)

Holocrine secretion - cells fill up and explode

Sebaceous Gland:

- Buds from the sides of developing hair follicles
- Not all hair - some hairs lacks sebaceous glands
- Branches to form several alveoli and ducts
- Sebum - oily lubricant
- Stem cells renew secretory cells

Epidermal Glands
Apocrine Gland

Apocrine glands

Apocrine secretion - small portions of cytoplasm pinches off and released into the lumen

Unbranched, highly coiled

Associated with hair follicle

Function in sexual and social communication

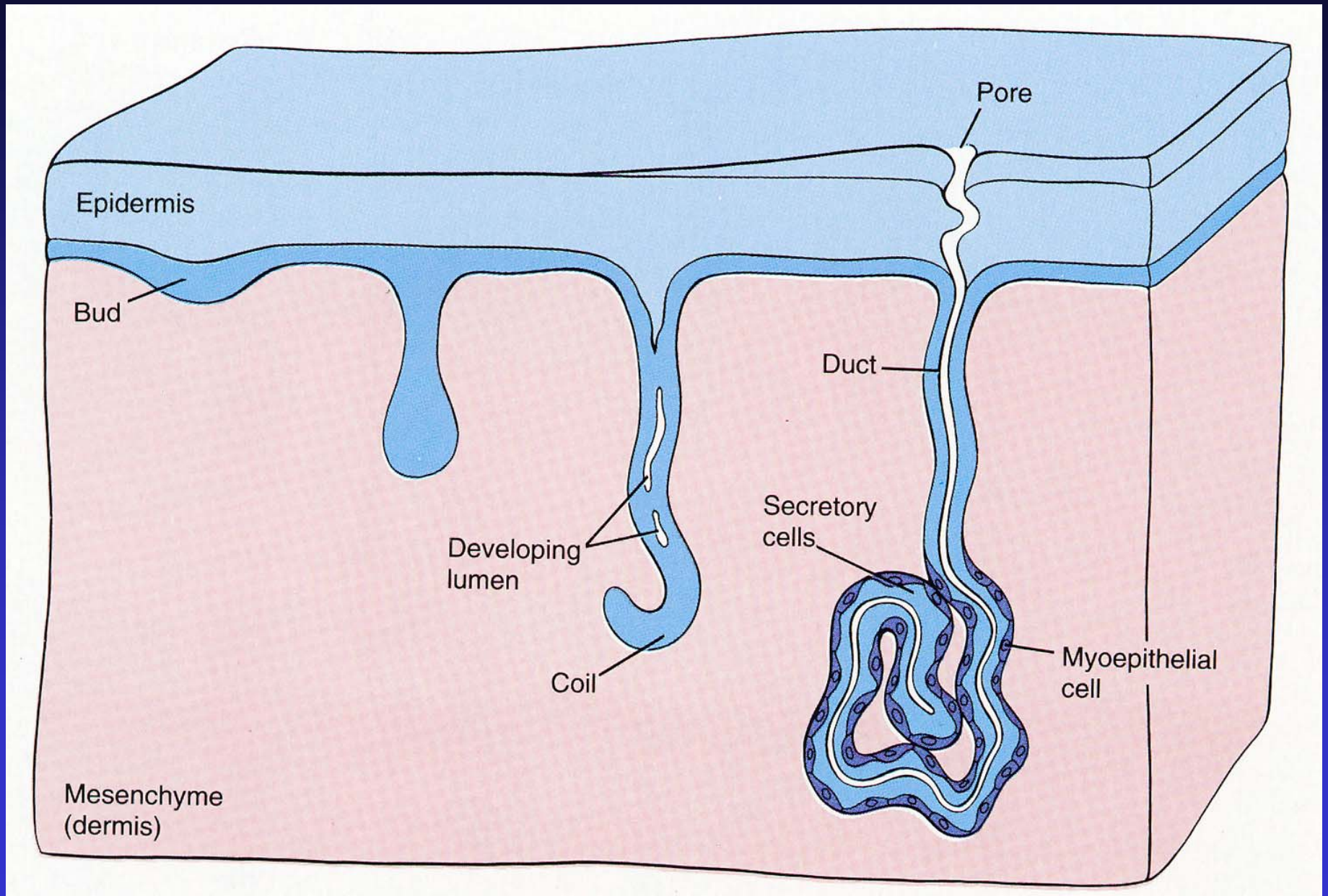
Restricted to certain areas (scrotum, labia minora)

Secretion begins at puberty

Epidermal Glands
Eccrine Gland (Sweat Gland)

Eccrine secretion - directly across plasma membrane

Solid unbranched epithelial downgrowth
Bud coils at tip to form secretory portion
Duct forms at attachment with epidermis
Central cells degenerate to from lumen
Secretory cells differentiate from cells lining duct
Myoepithelium from ectoderm, smooth muscle-like


Pore
Epidermis
Bud
Duct
Secretory
cells
Developing
lumen
Myoepithelial
cell
Coil
Mesenchyme
(dermis)

Integument - Skin

Ectoderm → Epidermis; Mesenchyme → Dermis

Derivatives:

- Hair
- **Mammary Gland**
- Teeth (Chapter 13, pp 298-303)

Mammary Glands

Modified appocrine glands

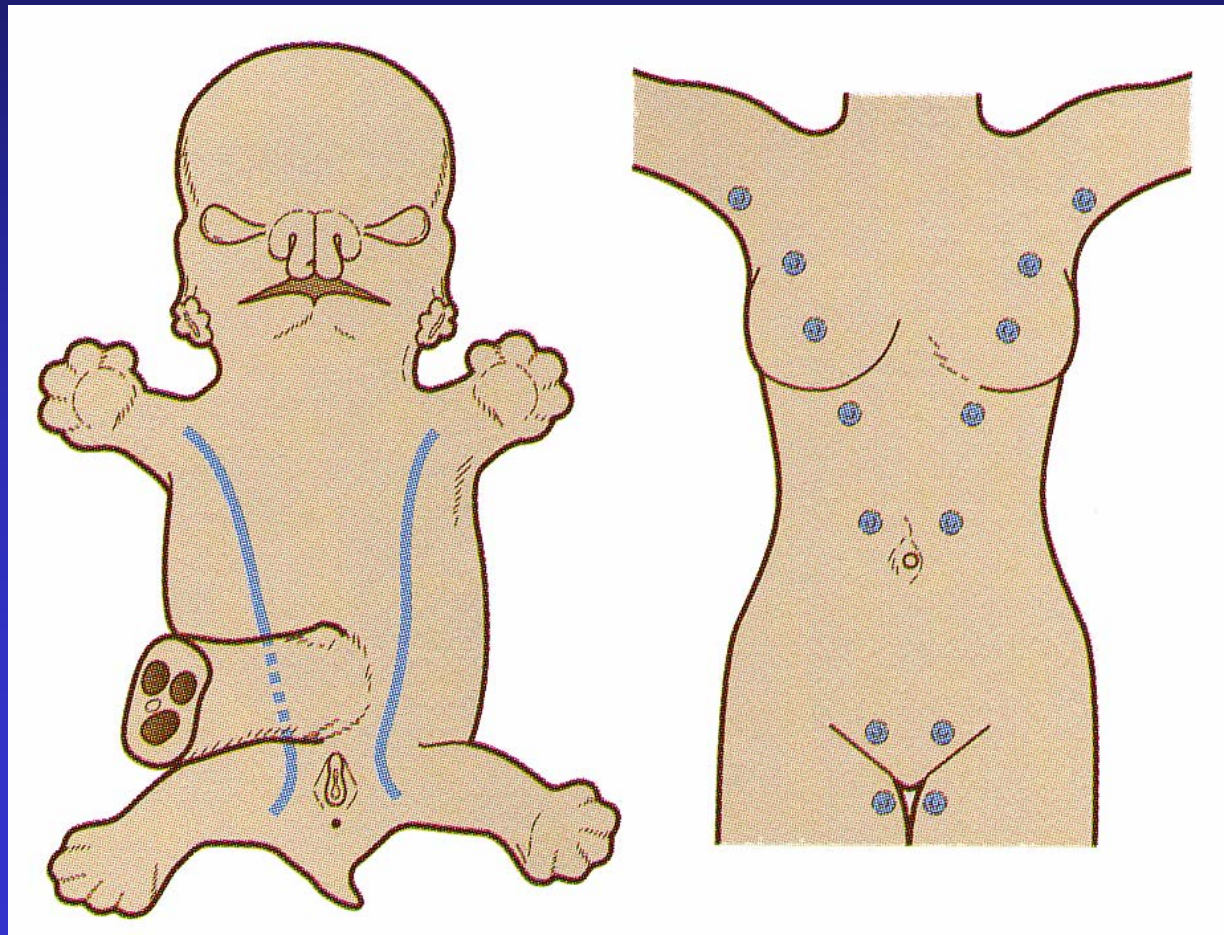
Milk Lines – two bands of ectodermal thickenings

Cranial to caudal - ventrolateral body wall

Species-specific

Supernumerary breast polymastia

Supernumerary nipple polythelia



Mammary Gland Development

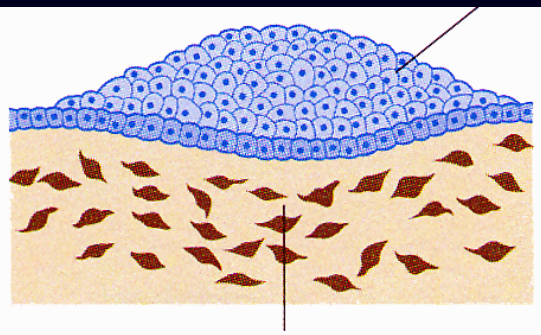
Week 5 - Primary bud = Thickening of epidermal cells – from ridge

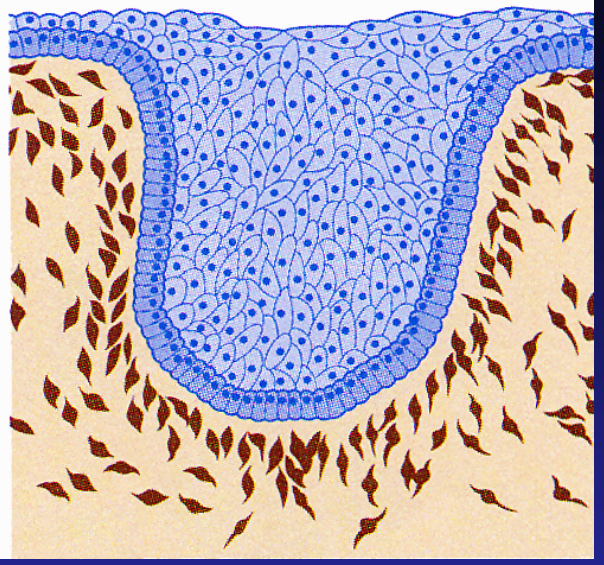
Down growth into the dermis

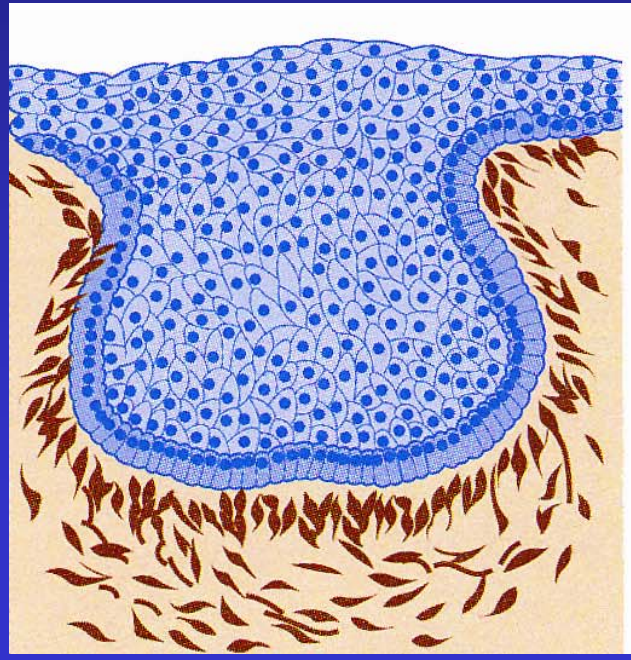
Two Mesodermal components
- Fibroblastic cells – controls branching pattern
- Fatty cells – controls shape of duct system

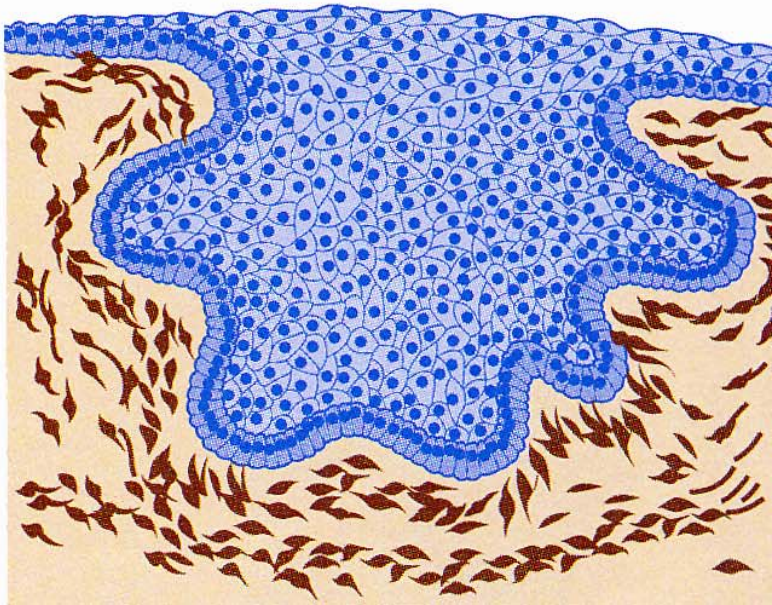
Week 10-12 - Branching to form many secondary buds
- Secondary buds lengthen and branch

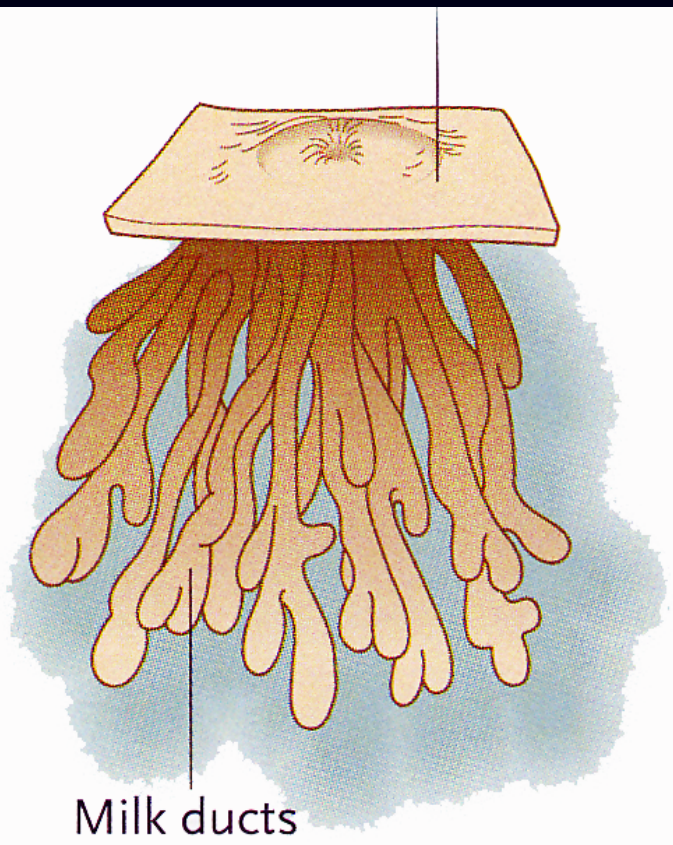
Ducts canalize to form lactiferous ducts

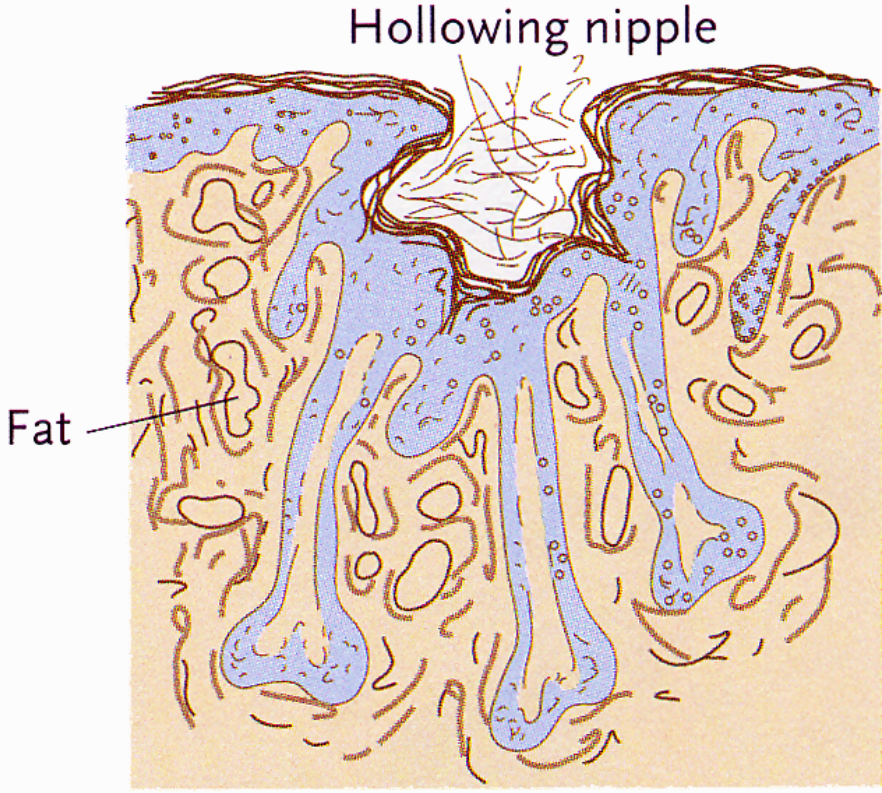

Dermal mesenchyme











Birth – 15-25 Lactiferous ducts that open into the Mammary pit (external opening)

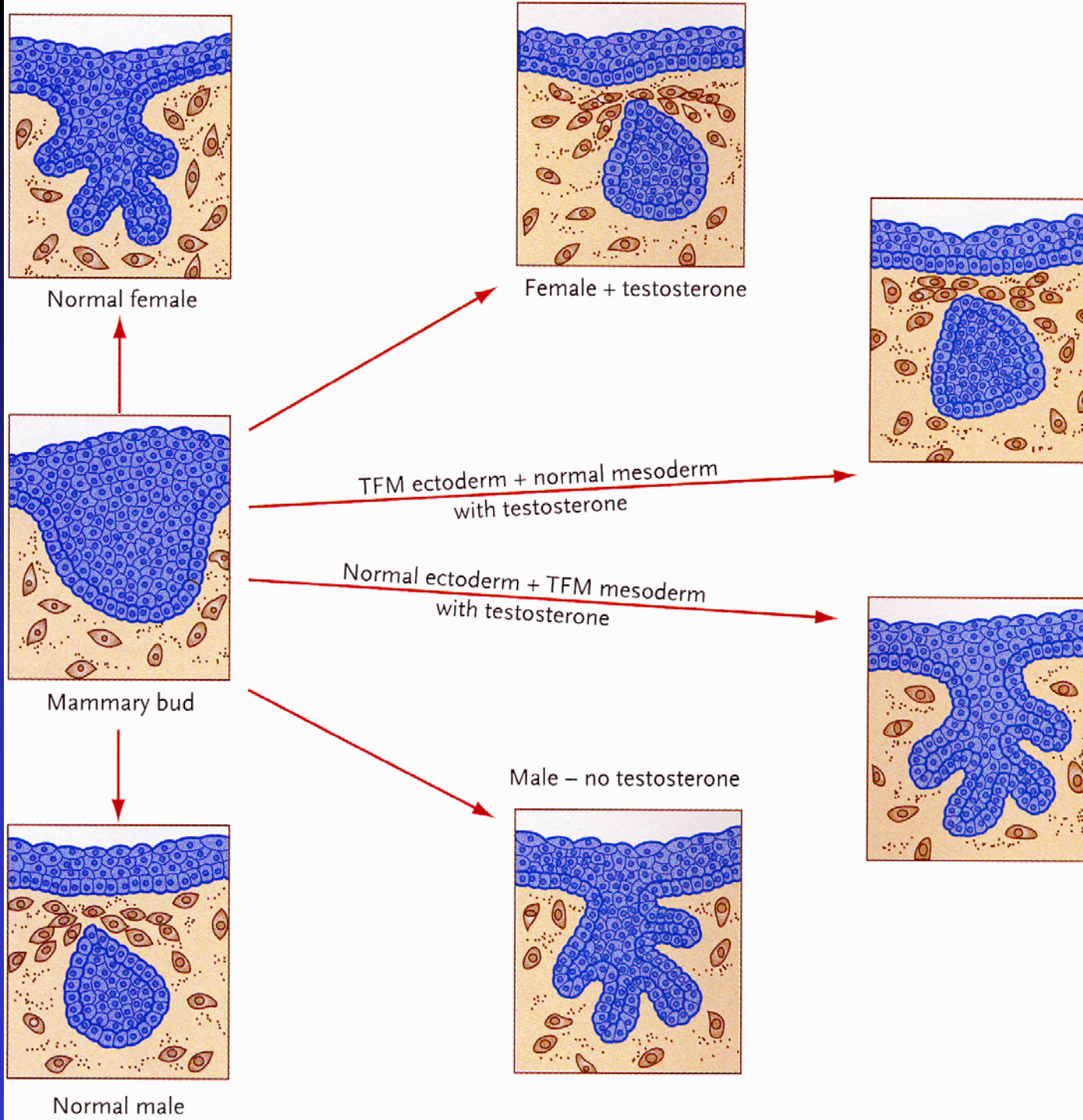
Mesodermal proliferation → areola and protruding nipple (lack of proliferation - inverted nipple)

Boys vs. Girls

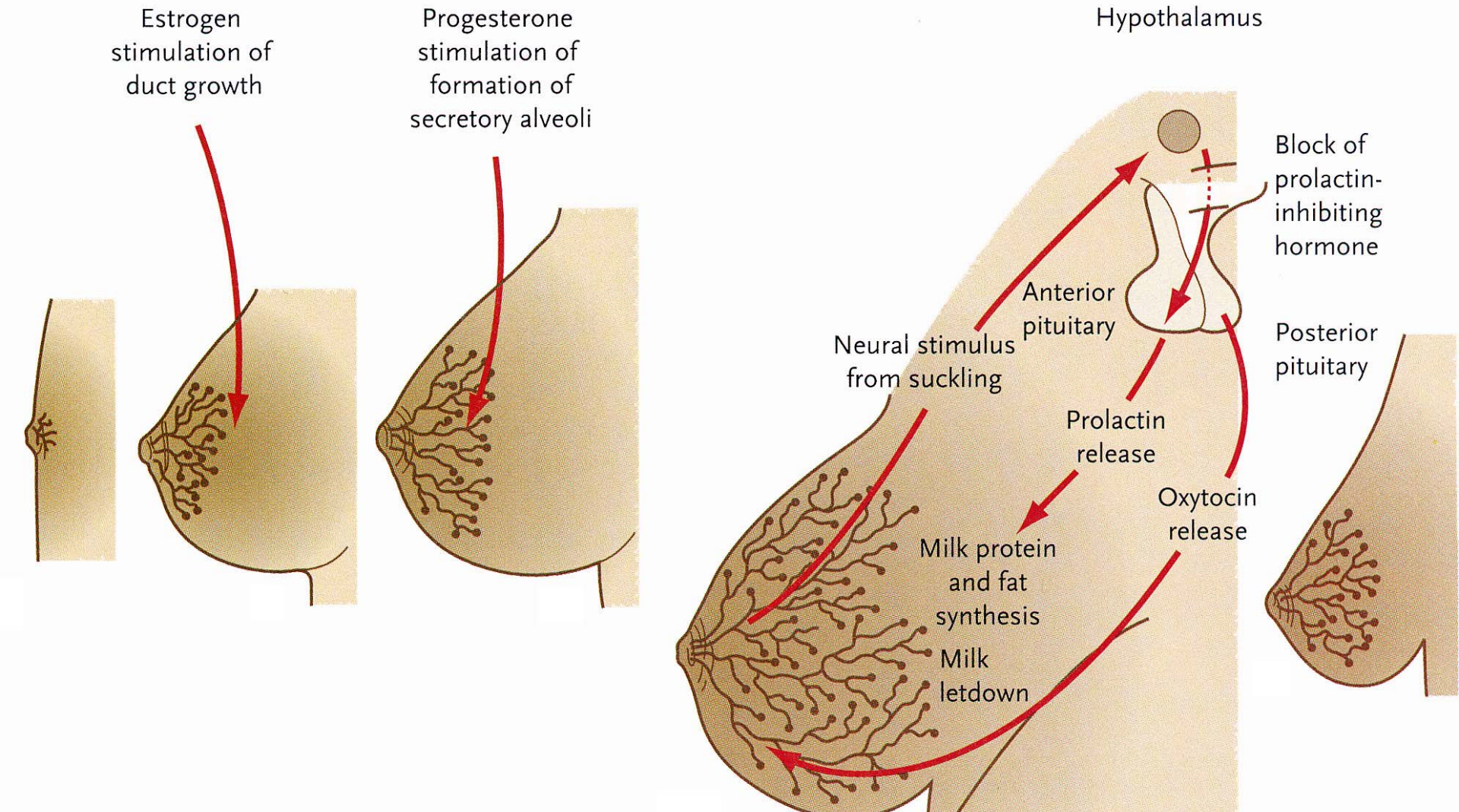
Testicular Feminization Syndrome

Testosterone receptor mutations

Mesenchyme mediated signaling



Physiology – Post-Natal Breast Development and Breast Feeding



Integument - Skin

Ectoderm → Epidermis; Mesenchyme → Dermis

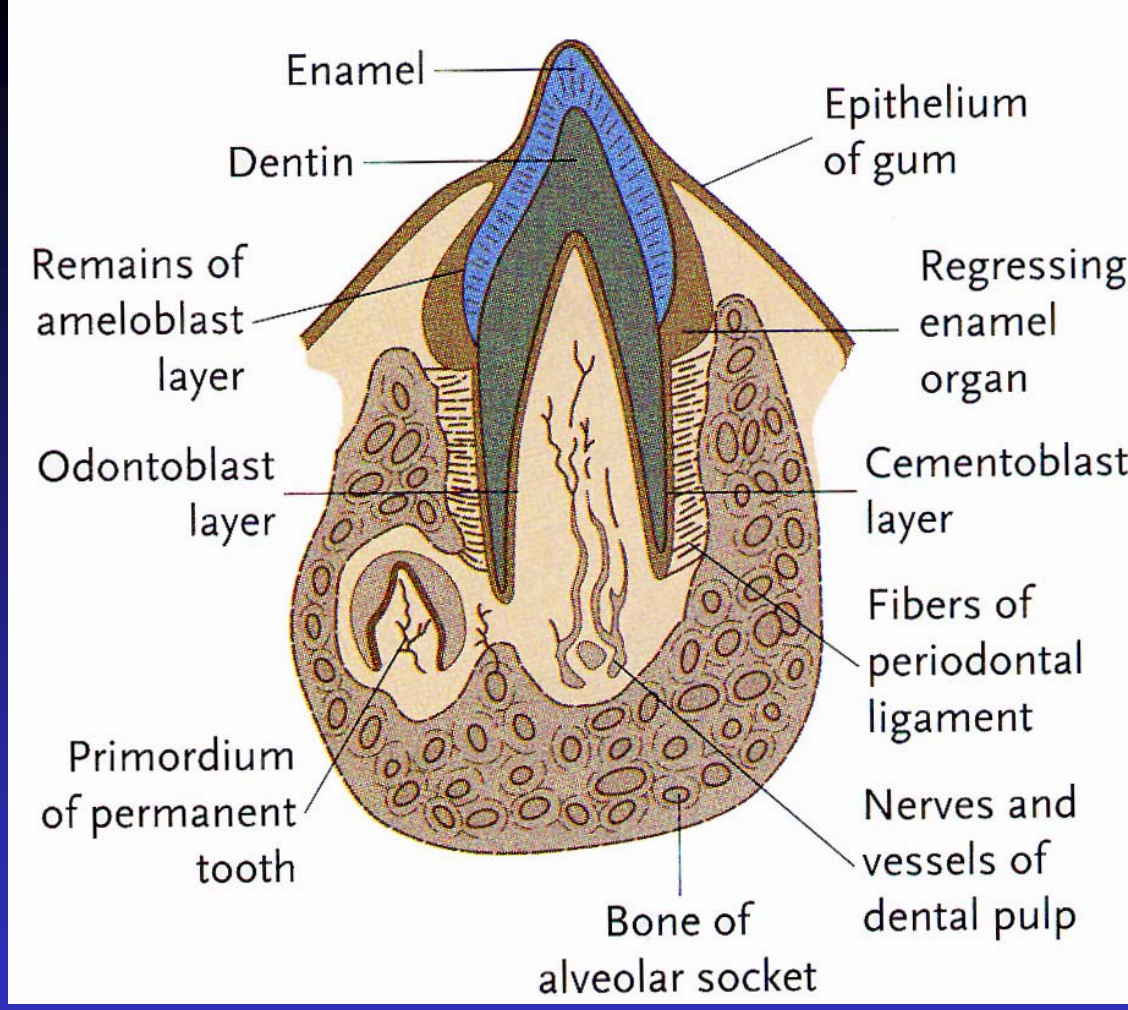
Derivatives:

- Hair
- Mammary Gland
- **Teeth** (Chapter 13, pp 298-303)

Tooth Development

Ectoderm - enamel

Mesoderm - everything else



Teeth - 2 sets form

primary dentition (deciduous or milk teeth)

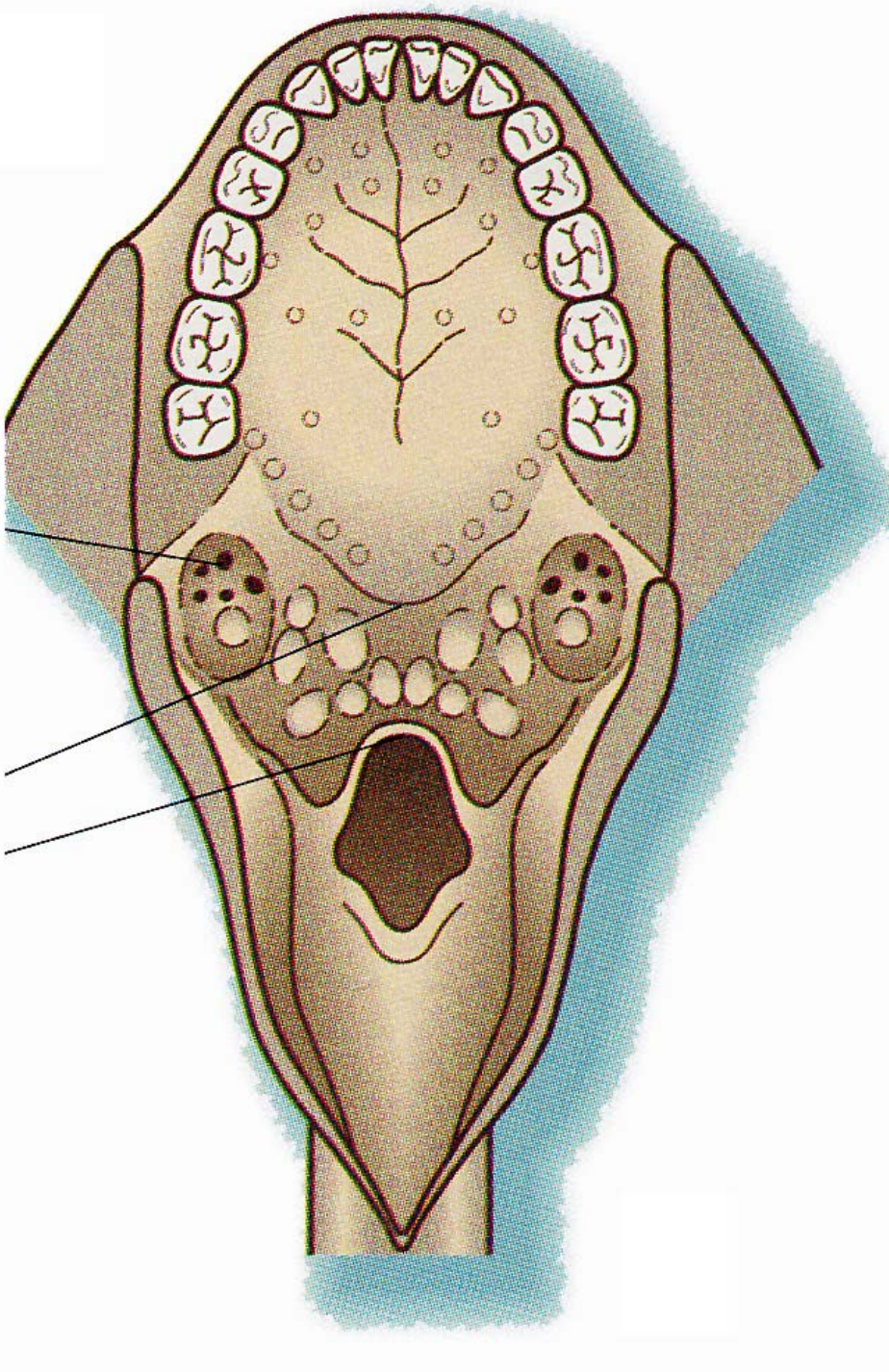
secondary dentition (permanent teeth).

General anatomy - Enamel, dentin, dental pulp, boney socket, periodontal ligament, cementoblast, cememtum.

32 permenant teeth
16 top; 16 bottom

20 with deciduous teeth
10 top; 10 bottom
medial, lateral incisors;
canine, 1st and 2nd
premolar

12 w/out deciduous teeth
6 top; 6 bottom
1st, 2nd, 3rd molars,
(3rd molar, wisdom,
often fails to develop
or erupt)



Tooth Development

6th Week - U-shaped thickening of oral epithelium called dental laminae - follows curve of the jaw.

Mesenchyme is derived from neural crest migration

Reciprocal Epithelial-Mesenchymal interactions

Stages:

Bud – Ectoderm grows into the mesenchyme

Cap - Tooth bud forms a cup around the mesenchyme (dental papilla)

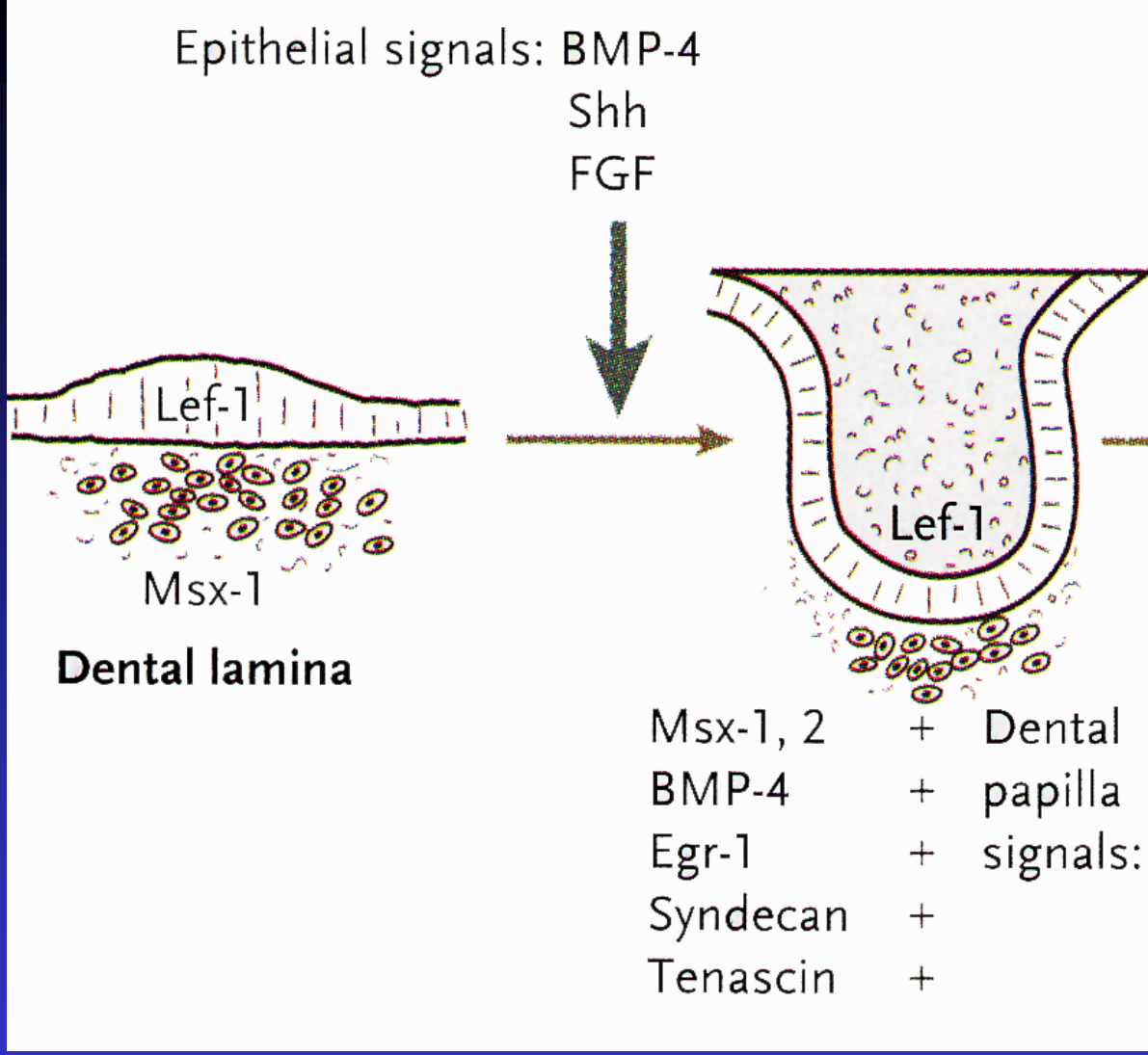
Bell - Tooth is bell shaped – around dental papilla

Bud Stage

Bud Stage, ectodermal swellings (10 per jaw) that grow into the mesenchyme

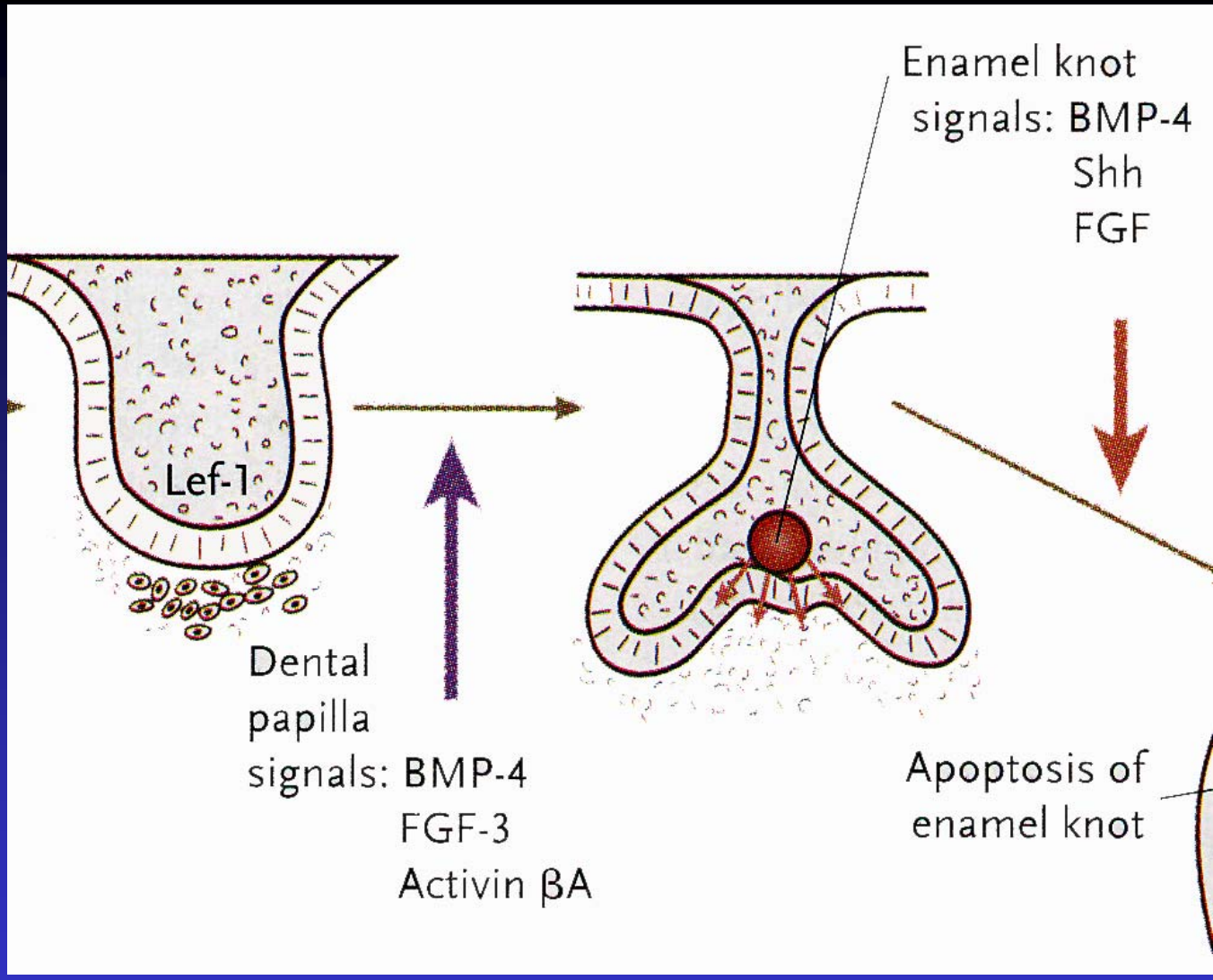
Lef1 (lymphoid enhancer factor 1) – defines ectoderm

Msx1 – defines mesenchyme



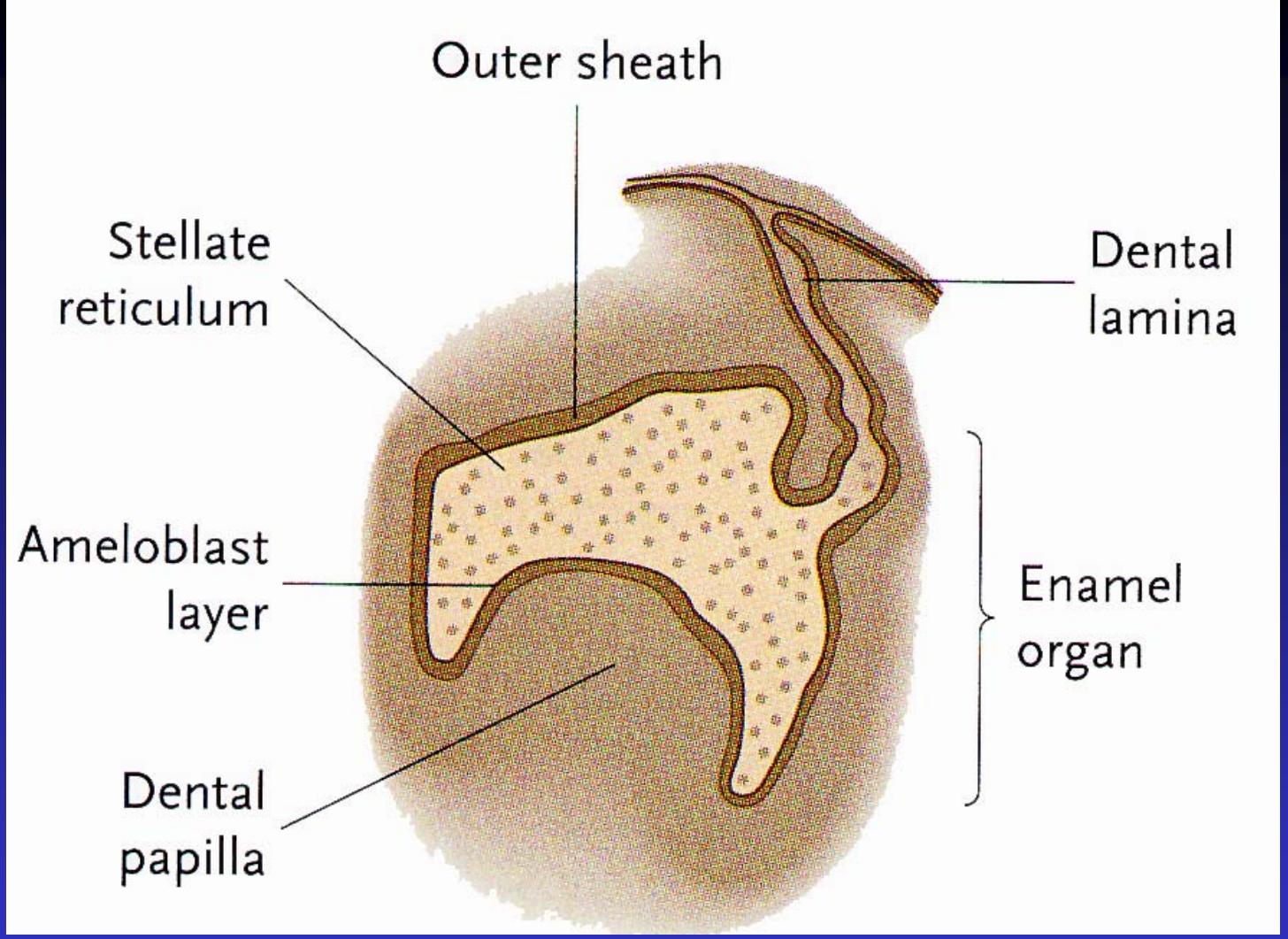
BMP4, FGF8 and SHH – induce the mesenchyme to participate in tooth formation

Cap Stage



Dental papilla signals (BMP4, FGF3, Activin) ectoderm
Formation of the Enamel knot = signaling center

Dental mesenchyme controls the specific form of the tooth



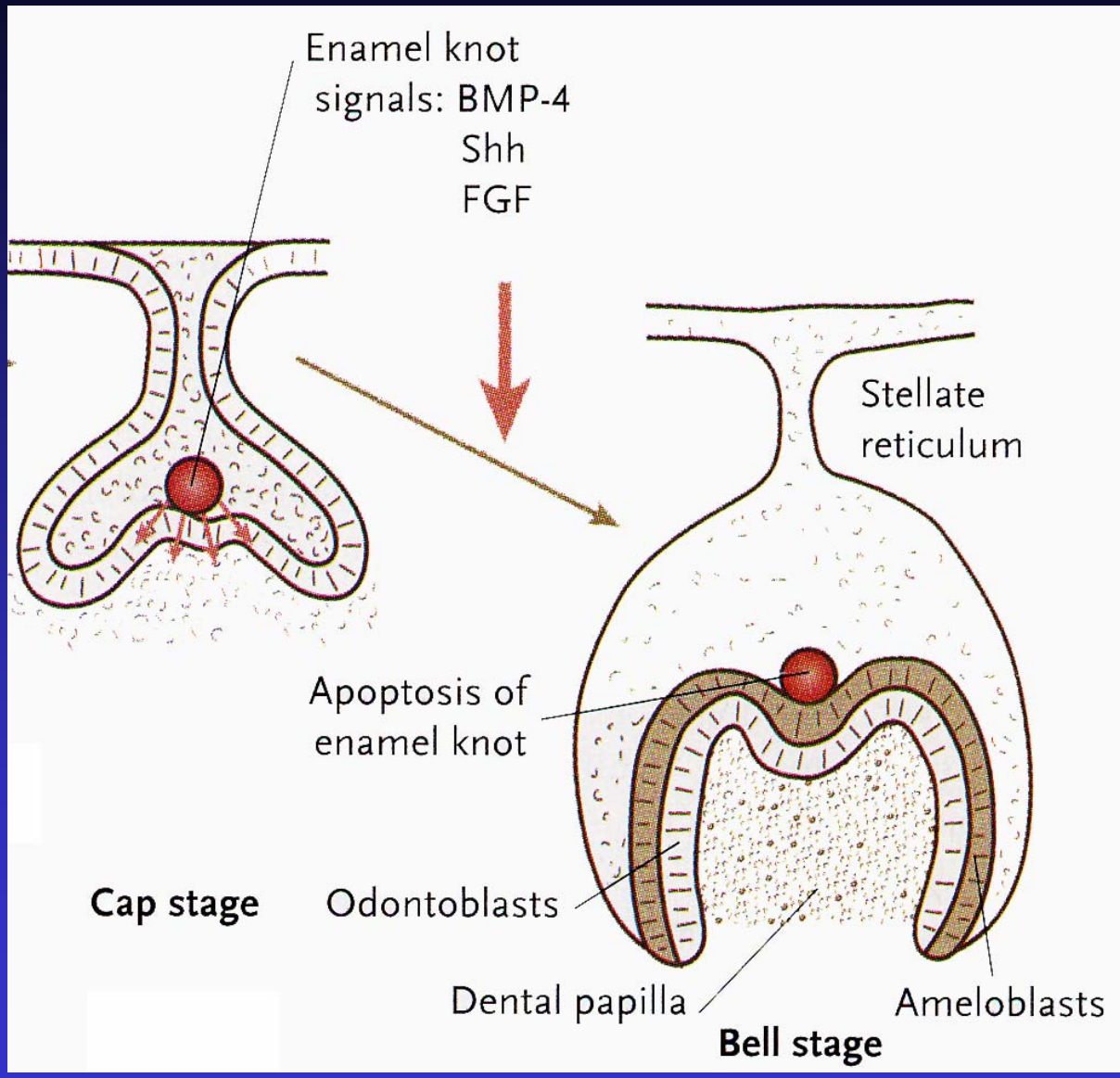
Dental papilla → Dental pulp

Epithelium → Enamel organ – produces enamel, connected to the oral epithelium via dental lamina (stalk) which degenerates

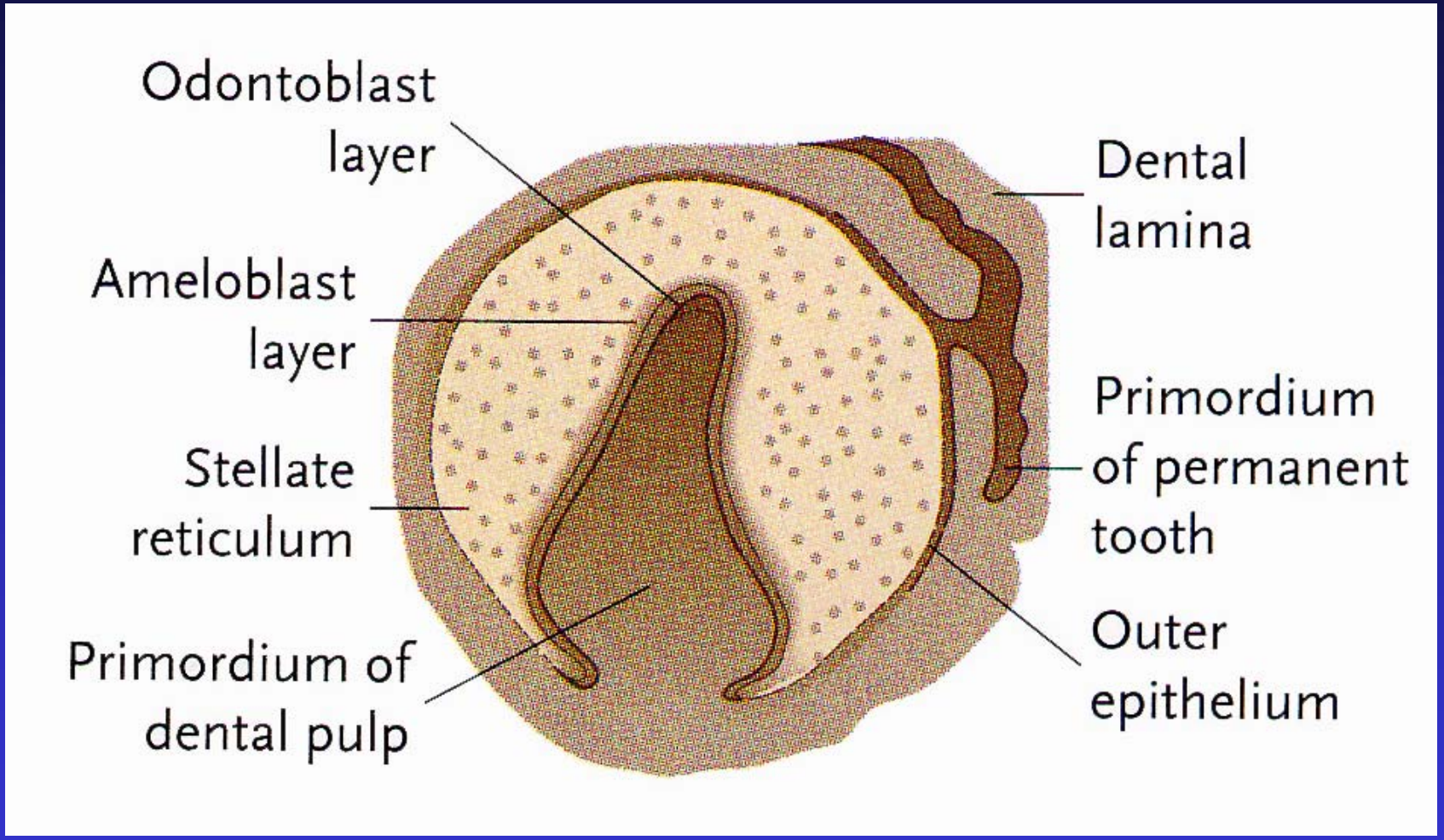
Bell Stage

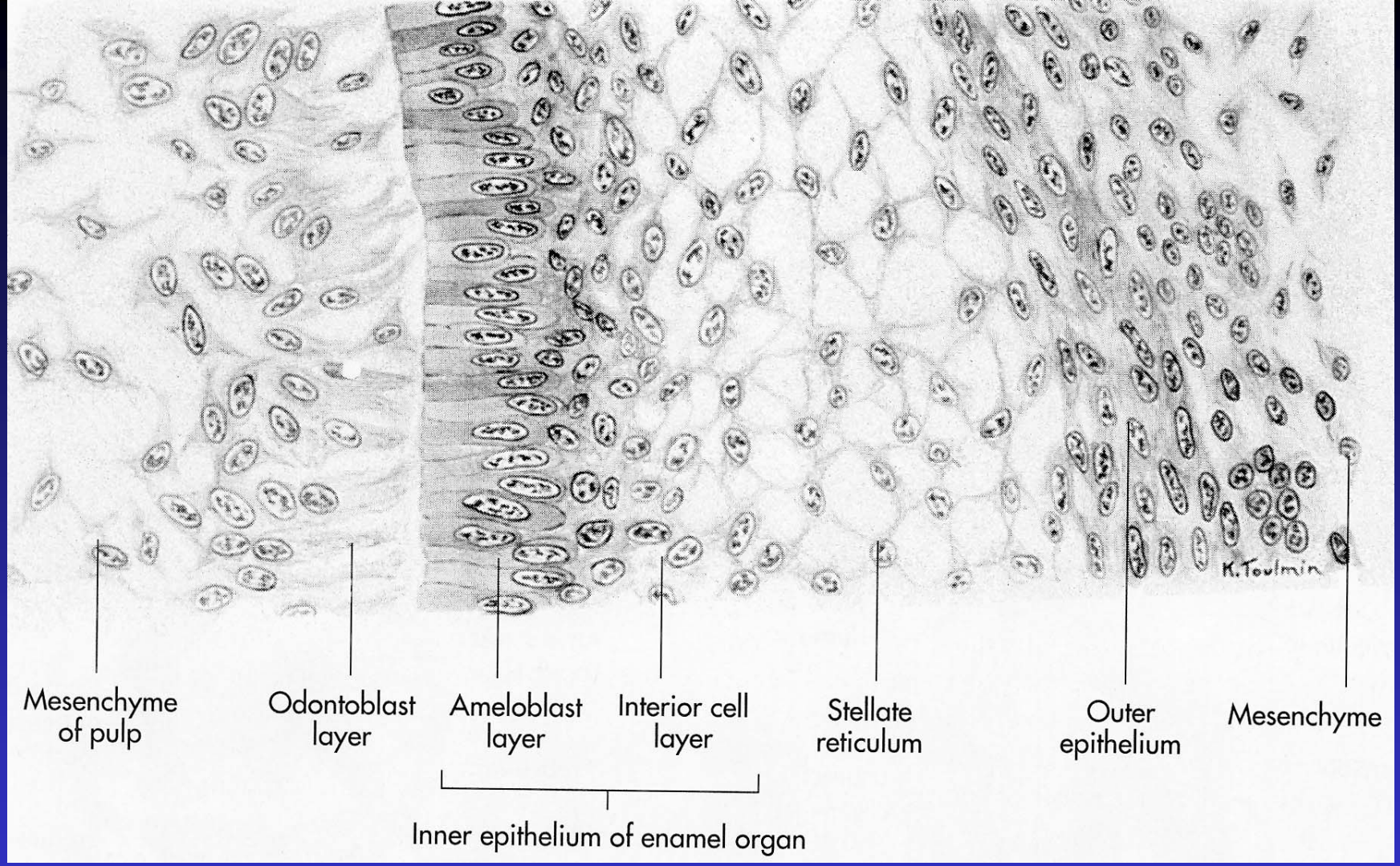
Enamel knot produces BMP-4, BMP-7, FGF-4 and SHH

Stimulate proliferation and differentiation of Ameloblast and Odontoblasts



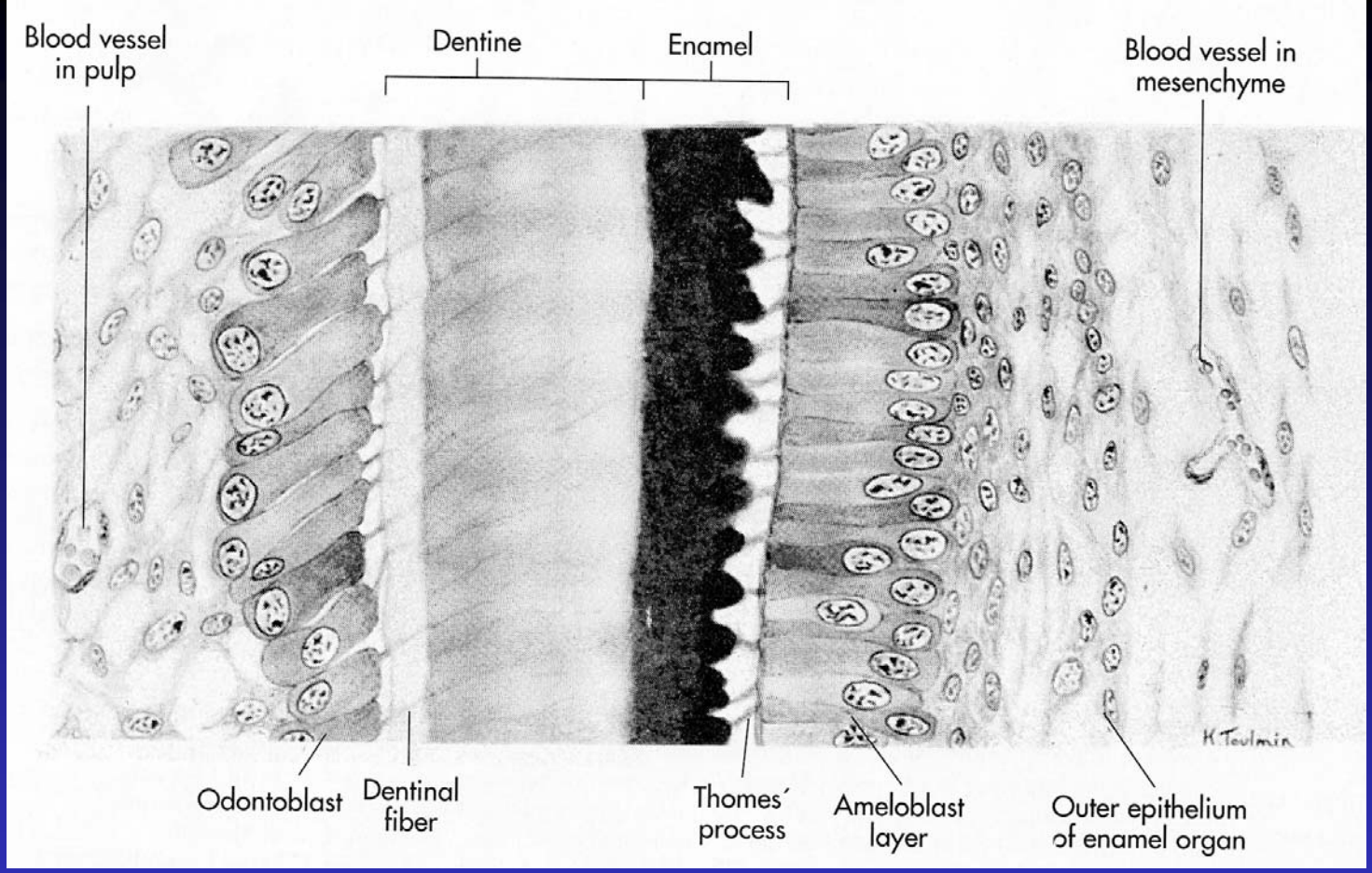
Bell Stage


Odontoblast layer
Ameloblast layer
Stellate reticulum
Primordium of dental pulp
Dental lamina
Primordium of permanent tooth
Outer epithelium



Enamel organ - 2 layers – Outer epithelium & Ameloblast (enamel producing cells). Stellate reticulum is between the 2 layers.

Dental pulp cells form Odontoblast layer (secrete dentin)

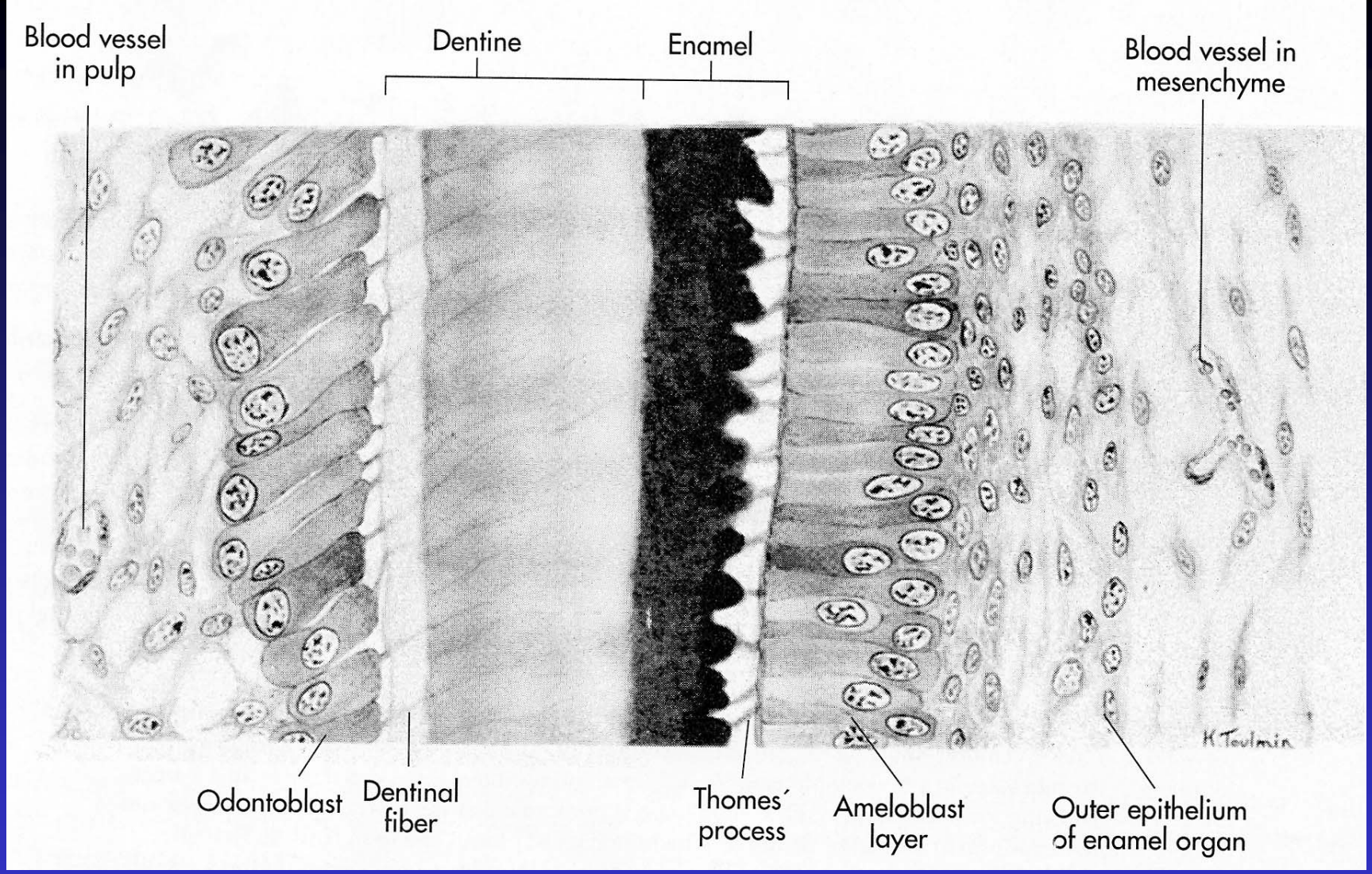


Odontoblast - produce predentin - deposited next to enamel epithelium

Predentin calcifies to become dentin

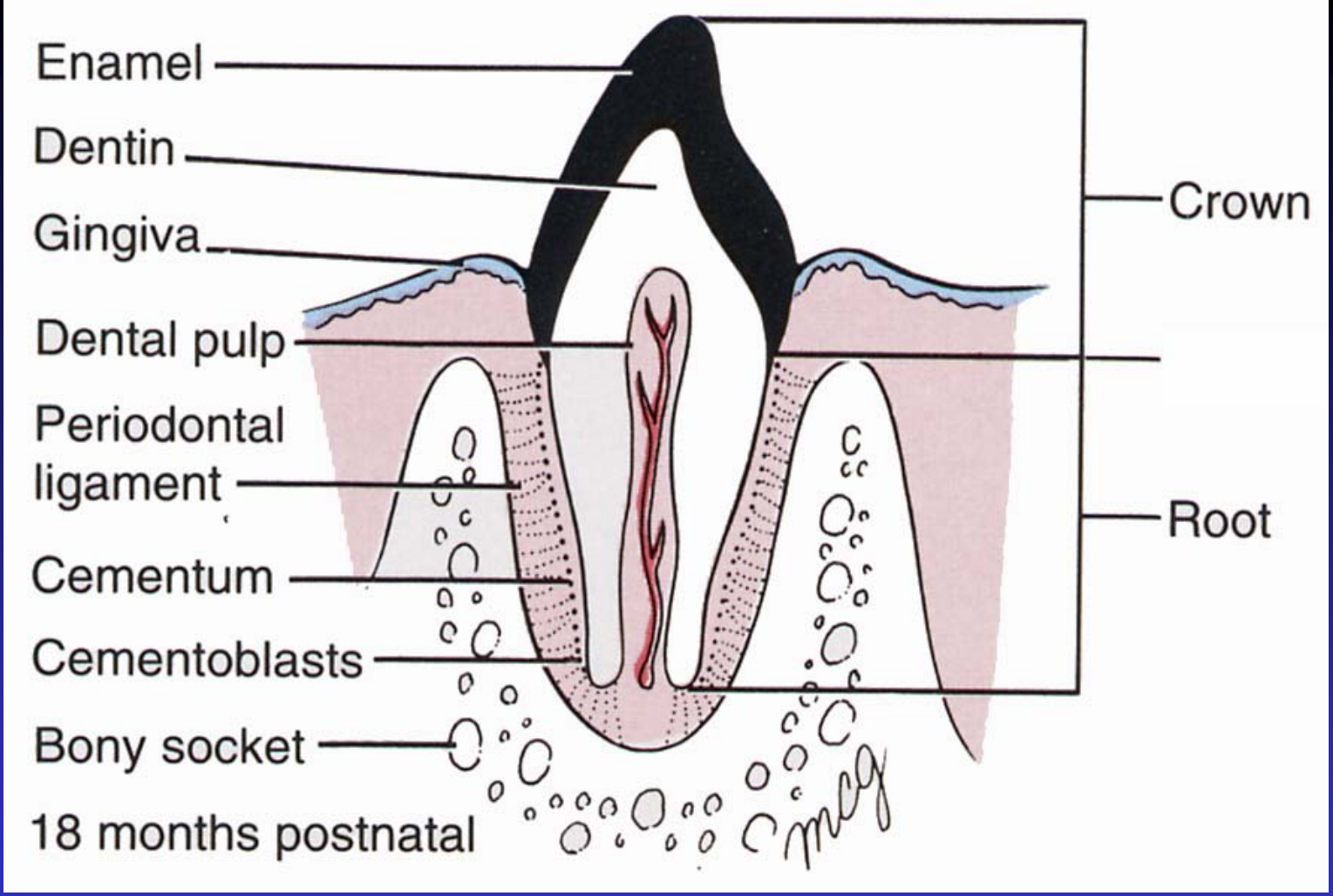
Odontoblast regresses, cytoplasmic extentions remain in dentin

Pulp cavity is reduced to form the root canal - vessels and nerves pass



Ameloblast – Induced by Odontoblasts - produce amelogenins and enamelins (organic components of enamel).

Enamel – 95% inorganic (hydroxyapatite crystals); 5% organic



Mesenchyme surrounding the tooth forms the dental sac. Dental sac gives rise to cementoblasts and the peridontal ligament.

Root Development

Epithelial root sheath - contiguous with ameloblast layer in crown

Mesenchymal cells next to this cell layer differentiate into odontoblasts and secrete predentin – contiguous with crown dentin

Cementoblasts (produce cementum) form from inner cells of the dental sac - cementum covers the surface of the dentin - cements the root to the jaw

Outer cells of dental sac - bone formation - forms the alveolus (bony socket) and the periodontal ligament