Integumentary system

(Integumentum commune)

=

Skin and accessory structures

Aleš Hampl

Skin – overall composition

Functional unit

Largest body system

16% of body weight

1,5 to 2 m^2

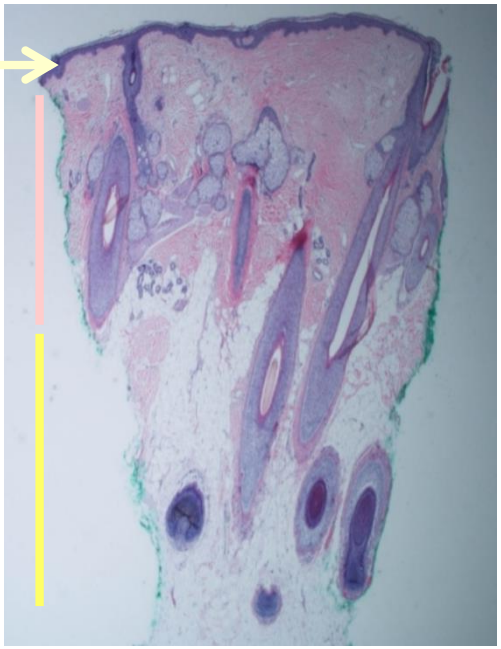
Integumentum commune
=
Body coverage

Cutis
=
Skin

Epidermis = keratinizing stratified squamous epithelium

Dermis = fibrous connective tissue

Tela subcutanea
=
Subcutis - Hypodermis



Accessory structures

- hairs and nails
- skin glands (sebaceous + sweat)
- mammary gland

Skin = Combination of 4 main tissues

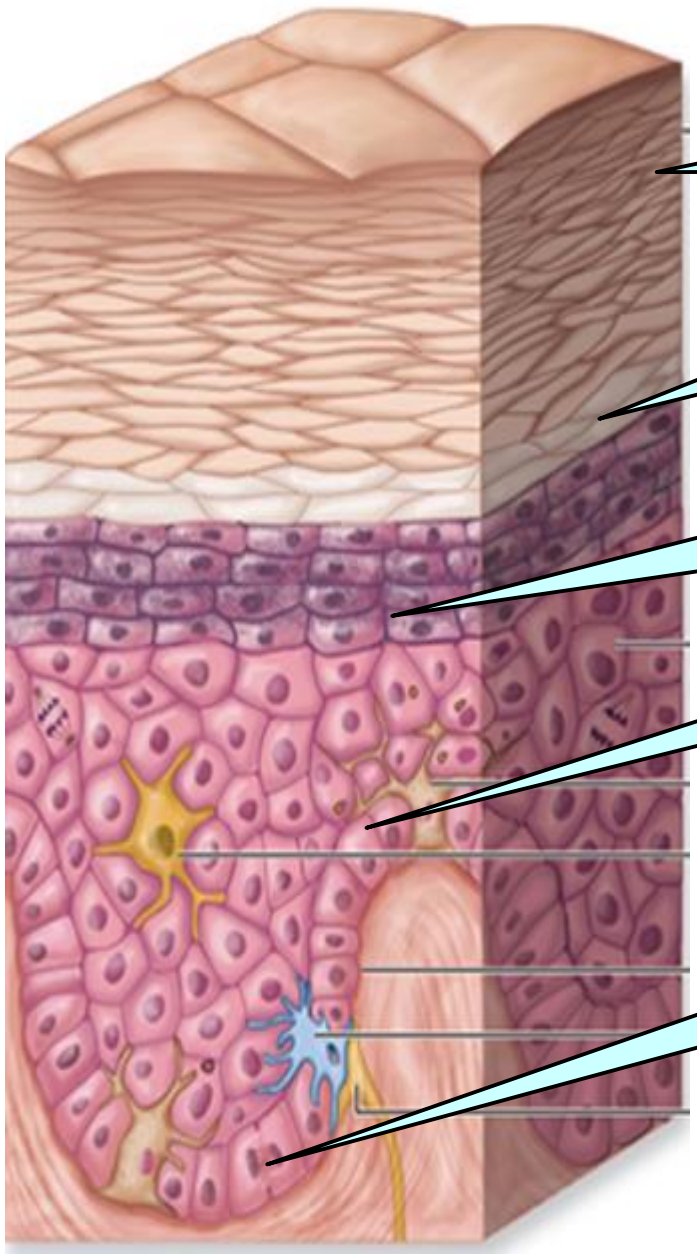
- Epithelial – outer layer
- Connective – underlies dermis
- Smooth Muscle – goose bumps
- Nervous – sensory receptors

Functions of the skin

1. **Regulation of body temperature**
   - Cellular metabolism produces heat as a waste product .
   - **High temperature**
     - dilate surface blood vessels
     - sweating
   - Low temperature
     - surface vessels constrict
     - shivering
2. **Protection**
   - physical abrasion
   - dehydration
   - ultraviolet radiation
3. **Sensation**
   - touch
   - vibration
   - pain
   - temperature
4. **Excretion**
5. **Immunity/ Resistance**
6. **Blood Reservoir**
   - 8-10 % in a resting adult
7. **Synthesis of vitamin D**
   - uv light
   - aids absorption of calcium

Epidermis - Layers

Keratinizing squamous stratified epithelium
(keratinocytes – 4 or 5 layers)



5. Stratum corneum
- dead, flat cells full of keratin (25 to 100 layers)
- corneodesmosomes
- polar lipids - ceramides

4. Stratum lucidum
- more apparent in thick skin
- 3-5 layers of clear cells
- transitional state

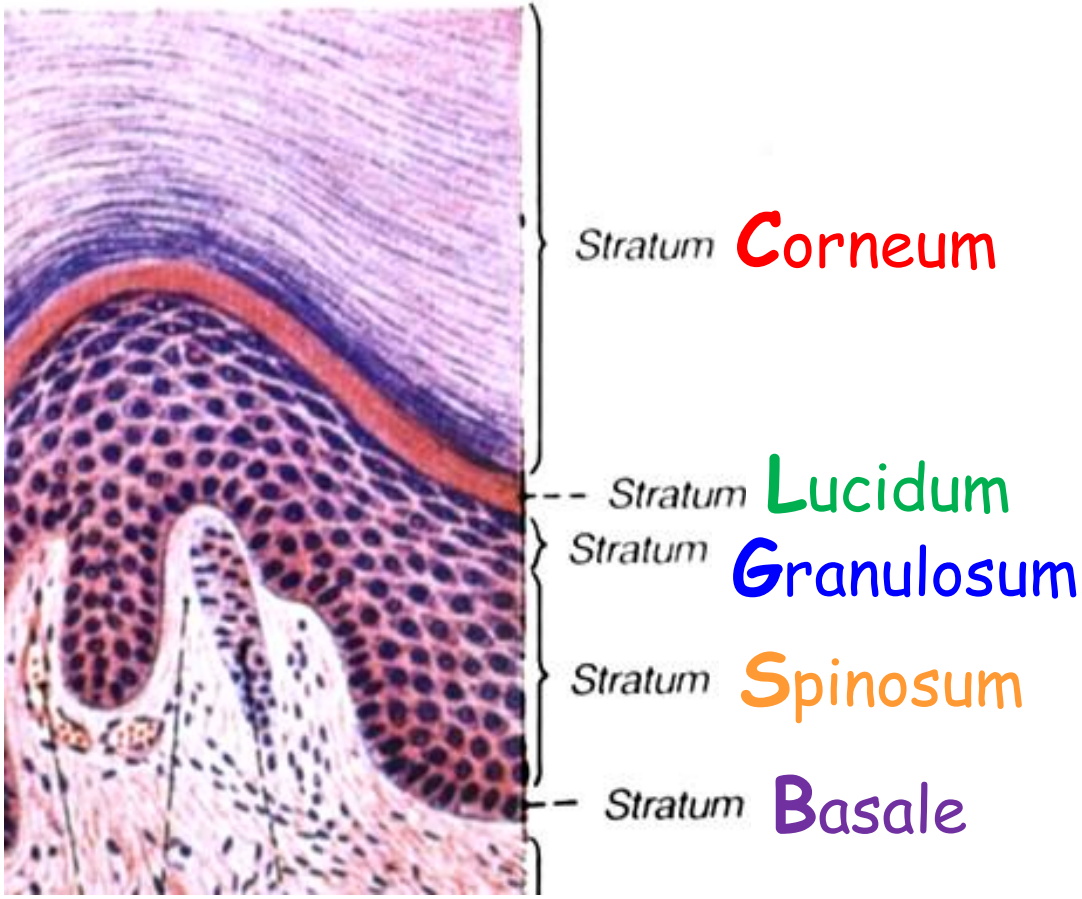
3. Stratum granulosum
- 3-5 layers
- tight junctions = zonulae accludentes
- keratohyalin found in granules
- cells beginning to die
- keratohyalin and lamellar granules

2. Stratum spinosum
- polygonal cells (keratines 1 and 10)
- 8-10 layers of keratinocytes
- desmosomes – shrinkage - spines

1. Stratum basale (germinativum)
- cylindrical cells – one layer (keratines 5 and 14)
- stratum germinativum
- the only proliferating cells (stem, progenitor)
- hemidesmosomes

Desquamation = Maturation (about 25 days)

Easy to remember - Mnemonic



Cancel

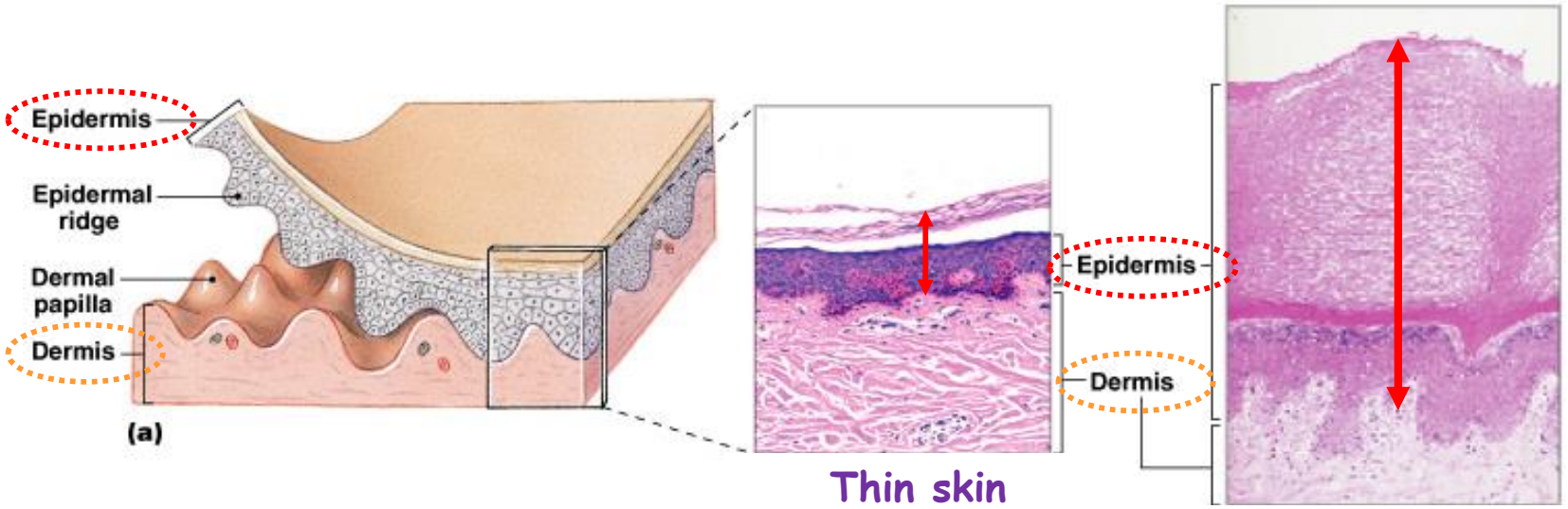
Lab !!!

Get

Some

Beer !!!

Epidermis - Thin x Thick skin



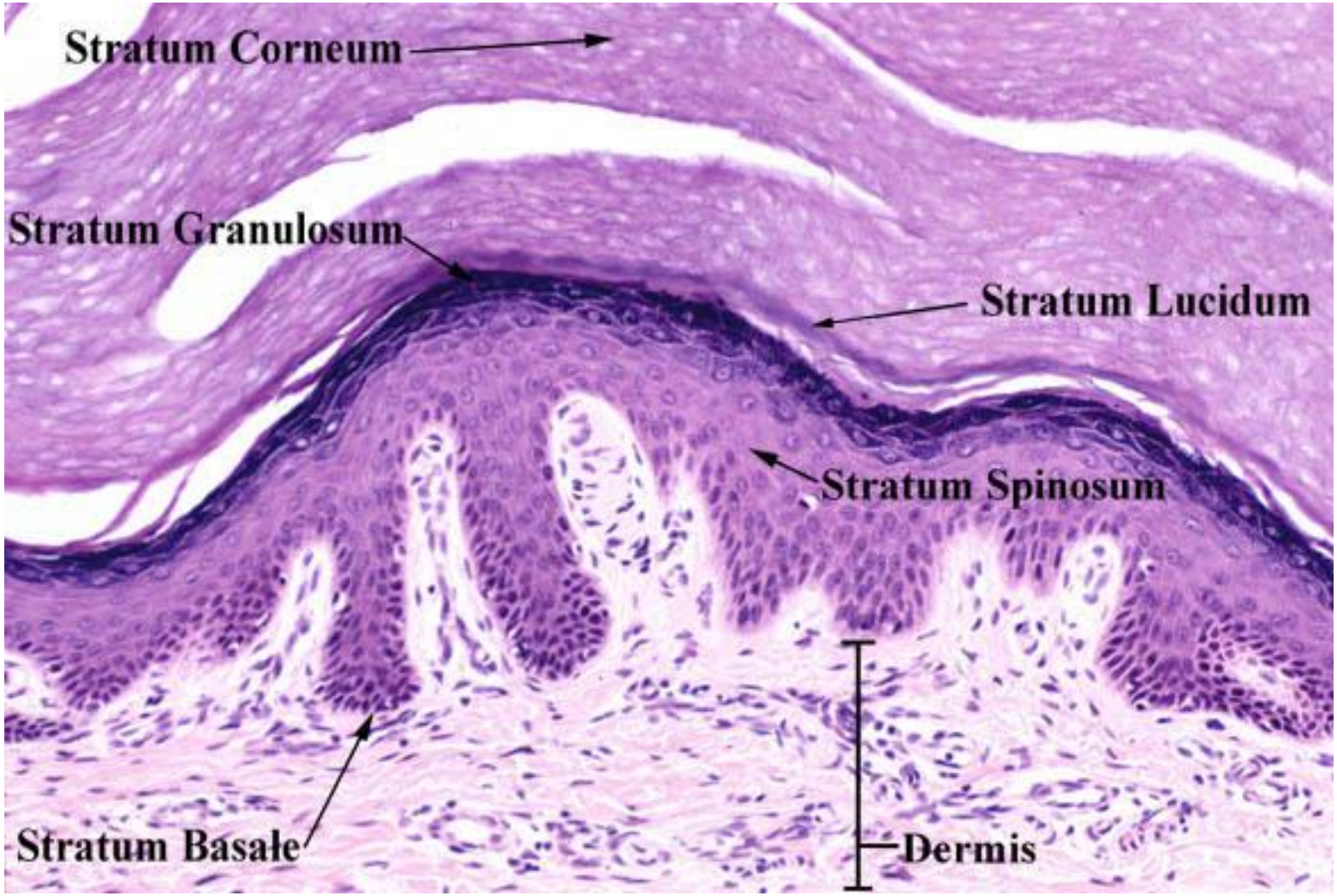
Thin skin
Epidermis 50 – 100 μm

Thick skin
Epidermis 500 – 1000 μm

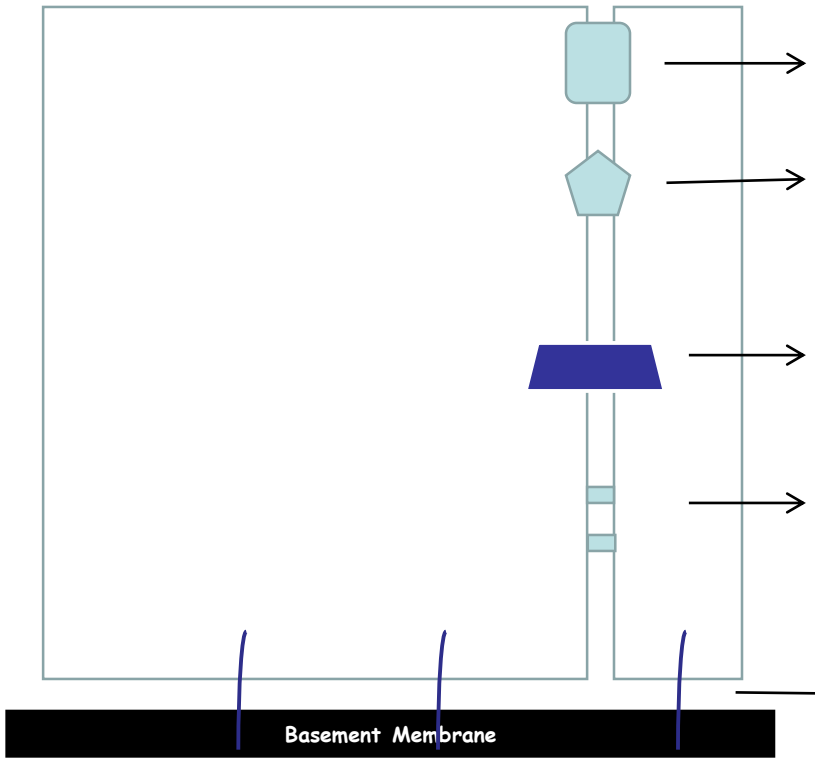
- **entire body** except thick skin areas
- typical **rhomboid** area organization
- **stratum corneum** – less than 25 layers of cells
- **stratum lucidum** is absent
- accessory struct.: sweat gl. + sebaceous gl. + hairs (except on lips, glans penis, labia minora)

- **palms** of hands and **soles** of feet = **acral skin**
- skin **ridges**
- **stratum corneum** – more than 100 layers of cells
- **stratum granulosum** – expanded
- accessory struct.: - eccrine glands only

Epidermis


Stratum Corneum
Stratum Granulosum
Stratum Lucidum
Stratum Spinosum
Stratum Basale
Dermis

Epidermis - Cell to Cell Adherence



Zonula occludens: tight junctions prevent diffusion across cells

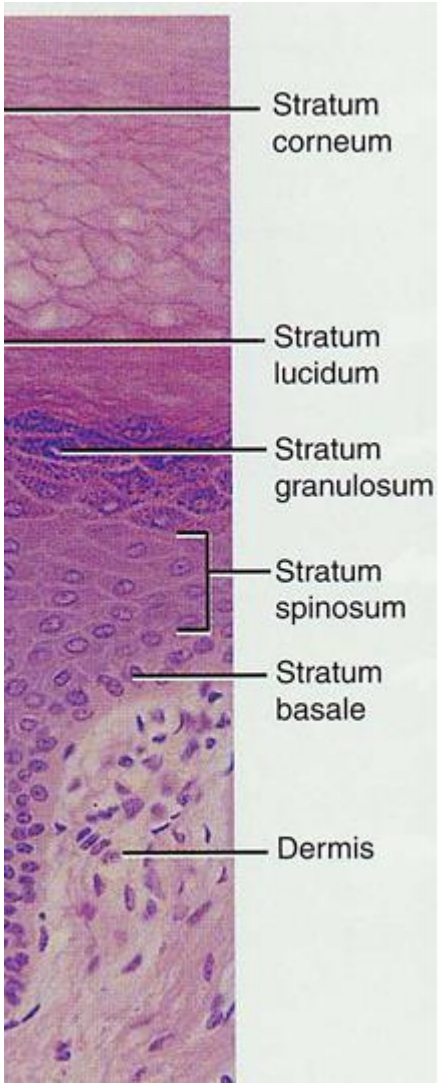
Zonula adherens: Ca++ dependent cadherins that connect to actin

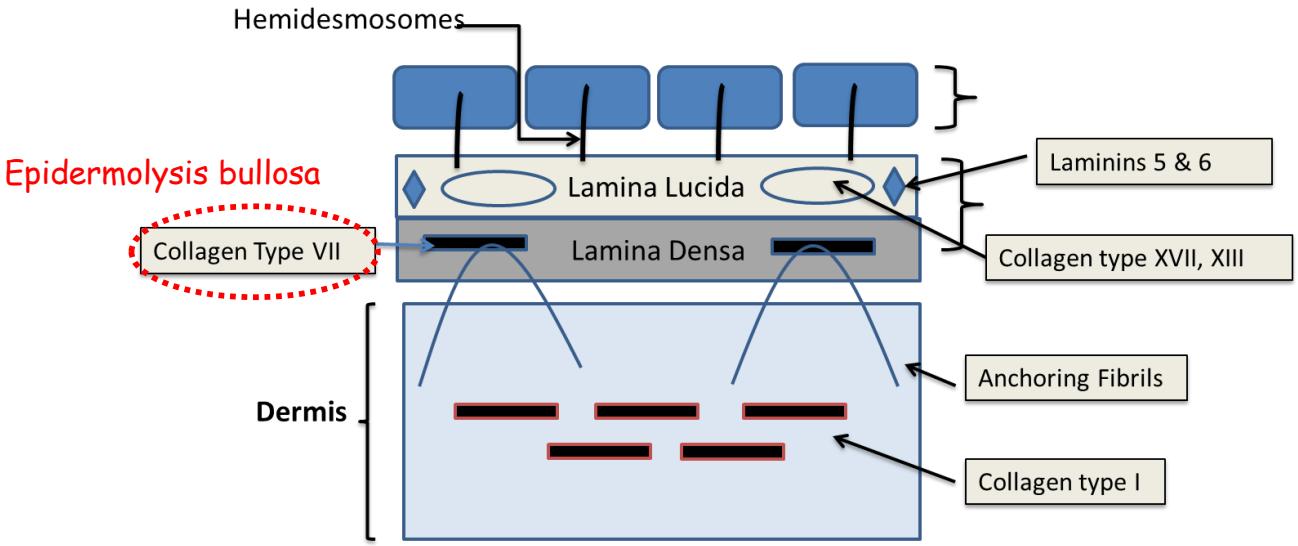
Macula adherens: made of desmosomes

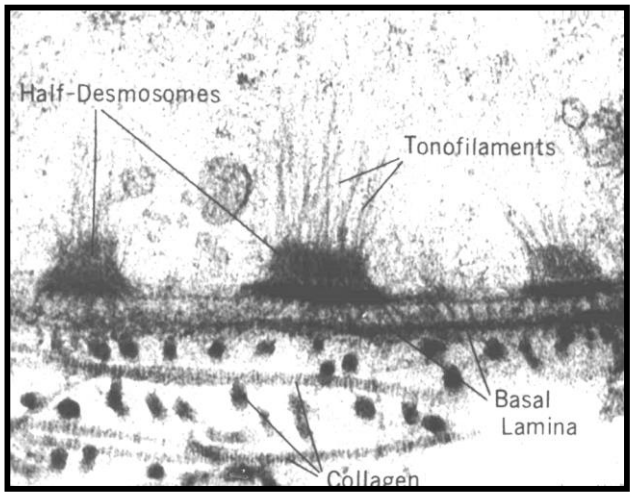
Gap junctions: communication for electric / metabolic function

Hemidesmosomes: connect cells to basal membrane

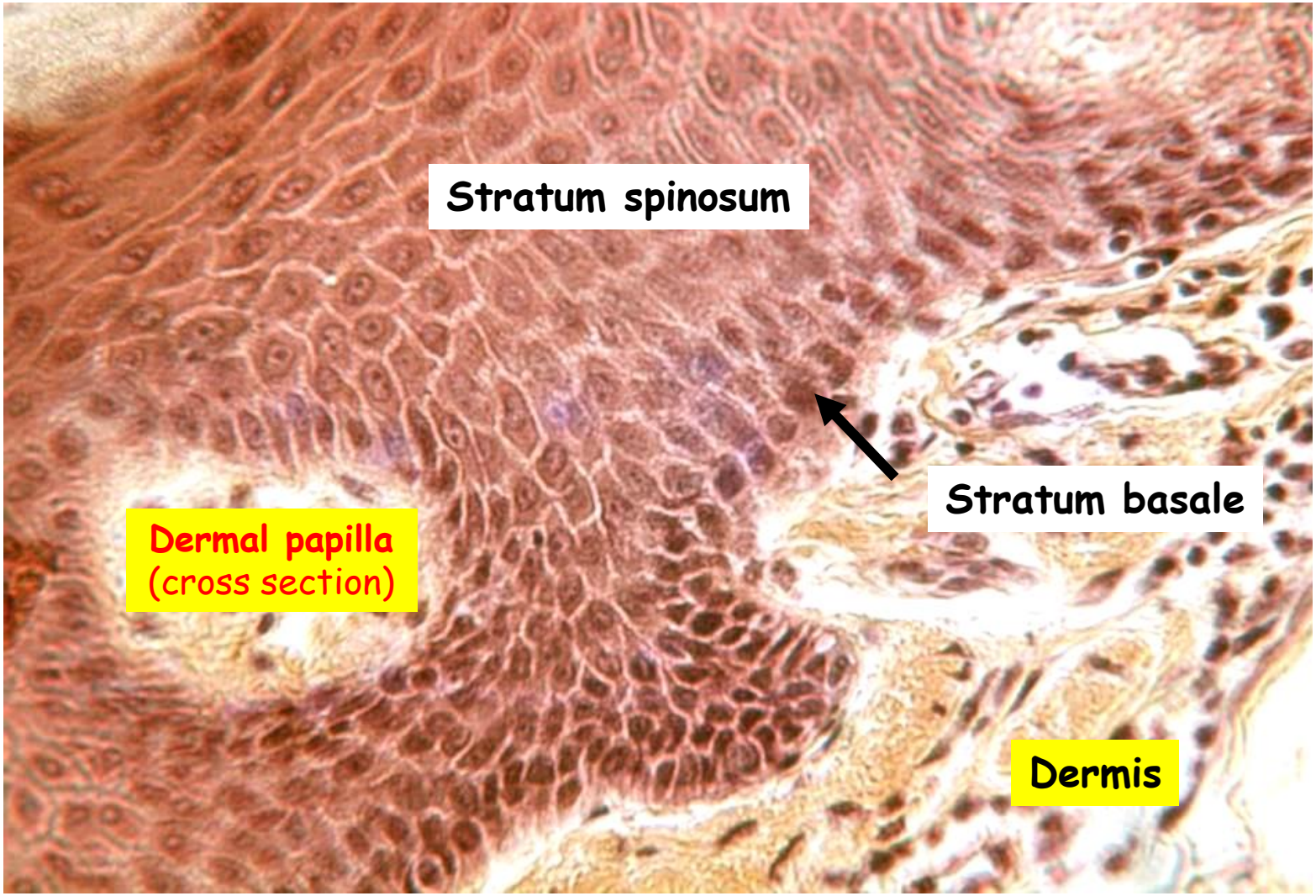
Junction: Dermis – Epidermis
Hemidesmosomes



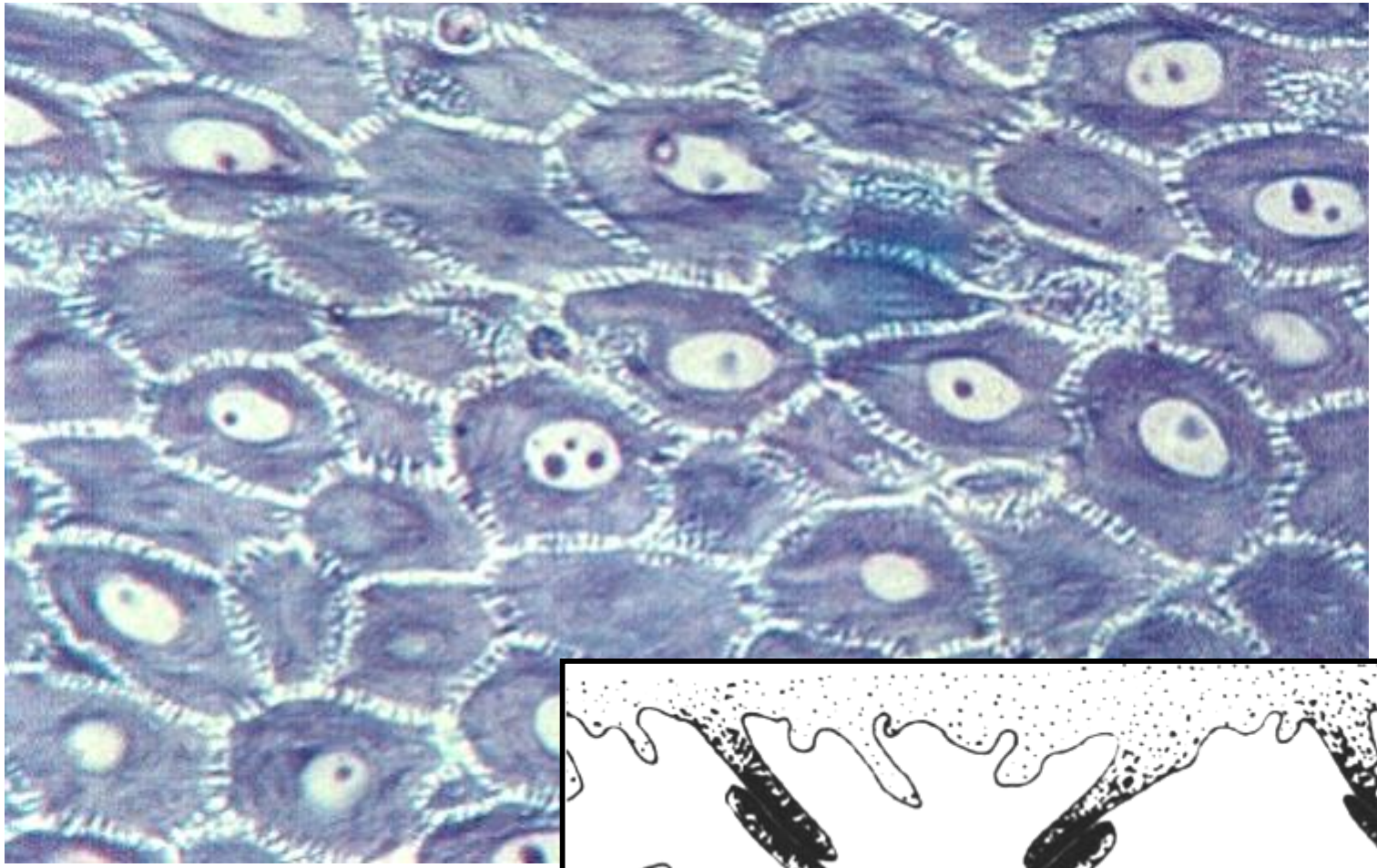




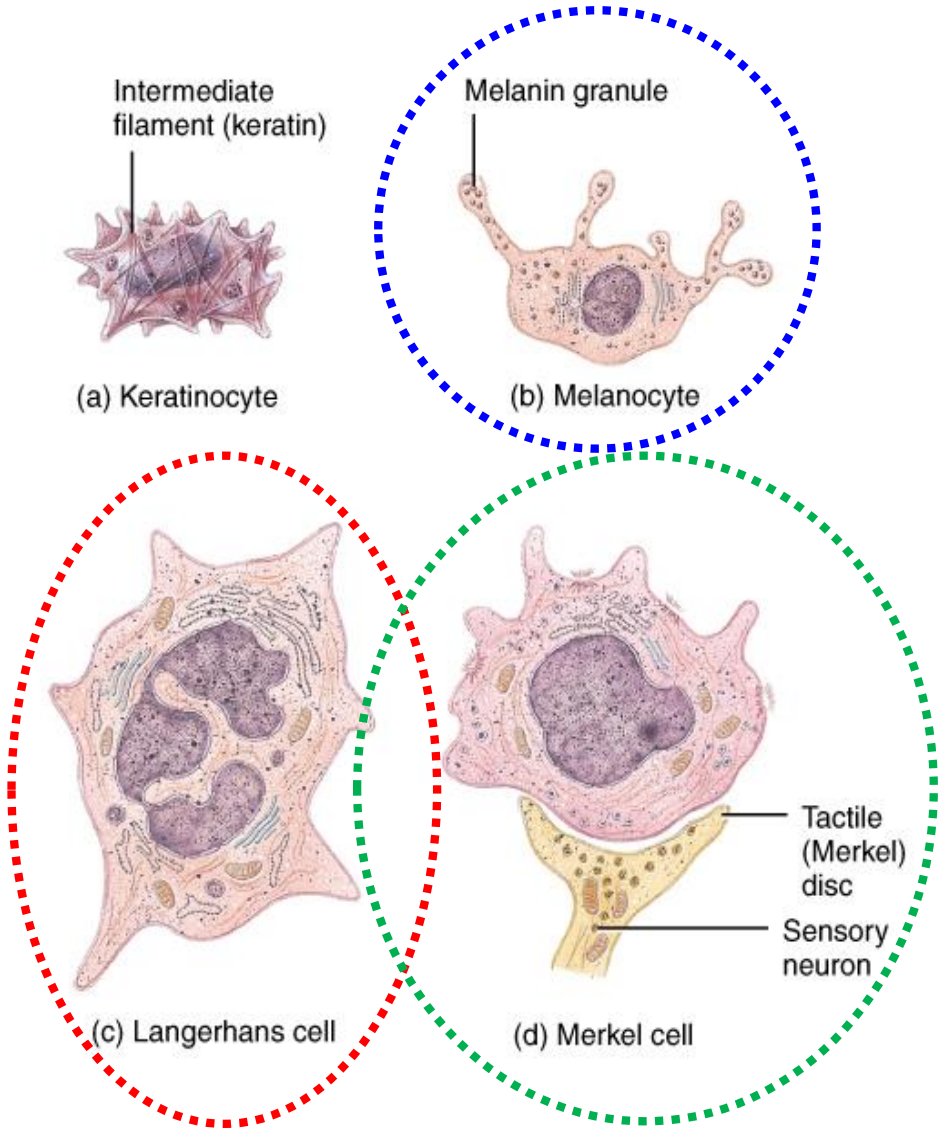
Epidermis – Stratum spinosum - Desmosomes



Epidermis - Cell to Cell Adherence

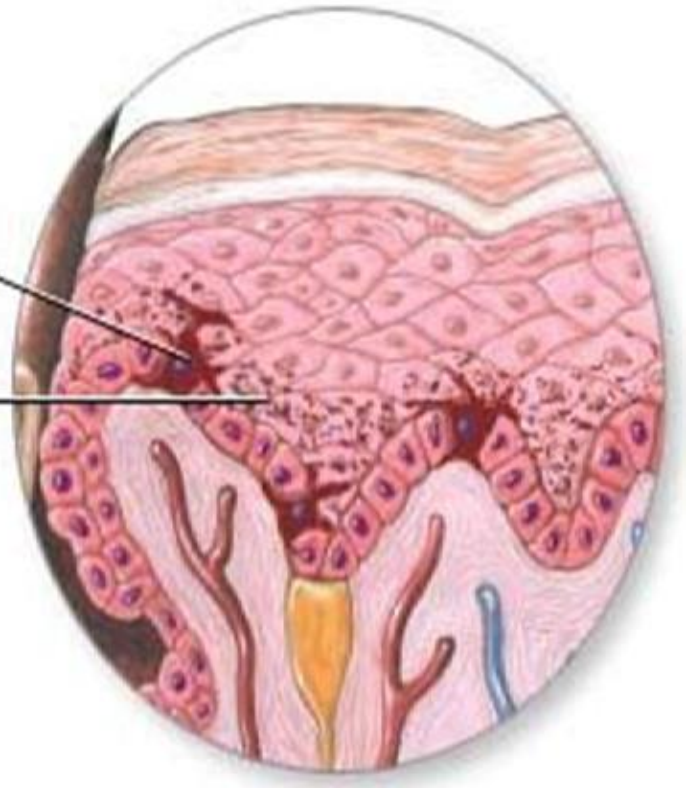


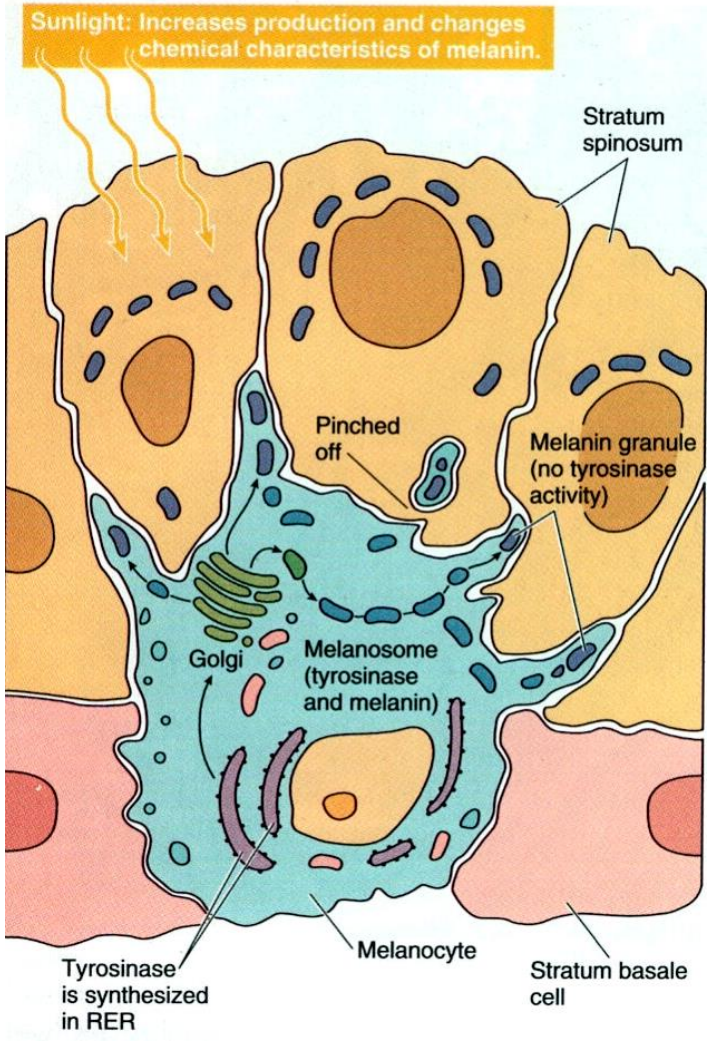
Epidermis – Non-keratinocyte cells



- **Keratinocytes** - 90%
  - produce keratin
- **Melanocytes** - 8 %
  - produces melanin pigment
  - melanin transferred to other cells with long cell processes
- **Langerhans cells**
  - from bone marrow
  - provide immunity
- **Merkel cells**
  - in deepest layer
  - form touch receptor with sensory neuron

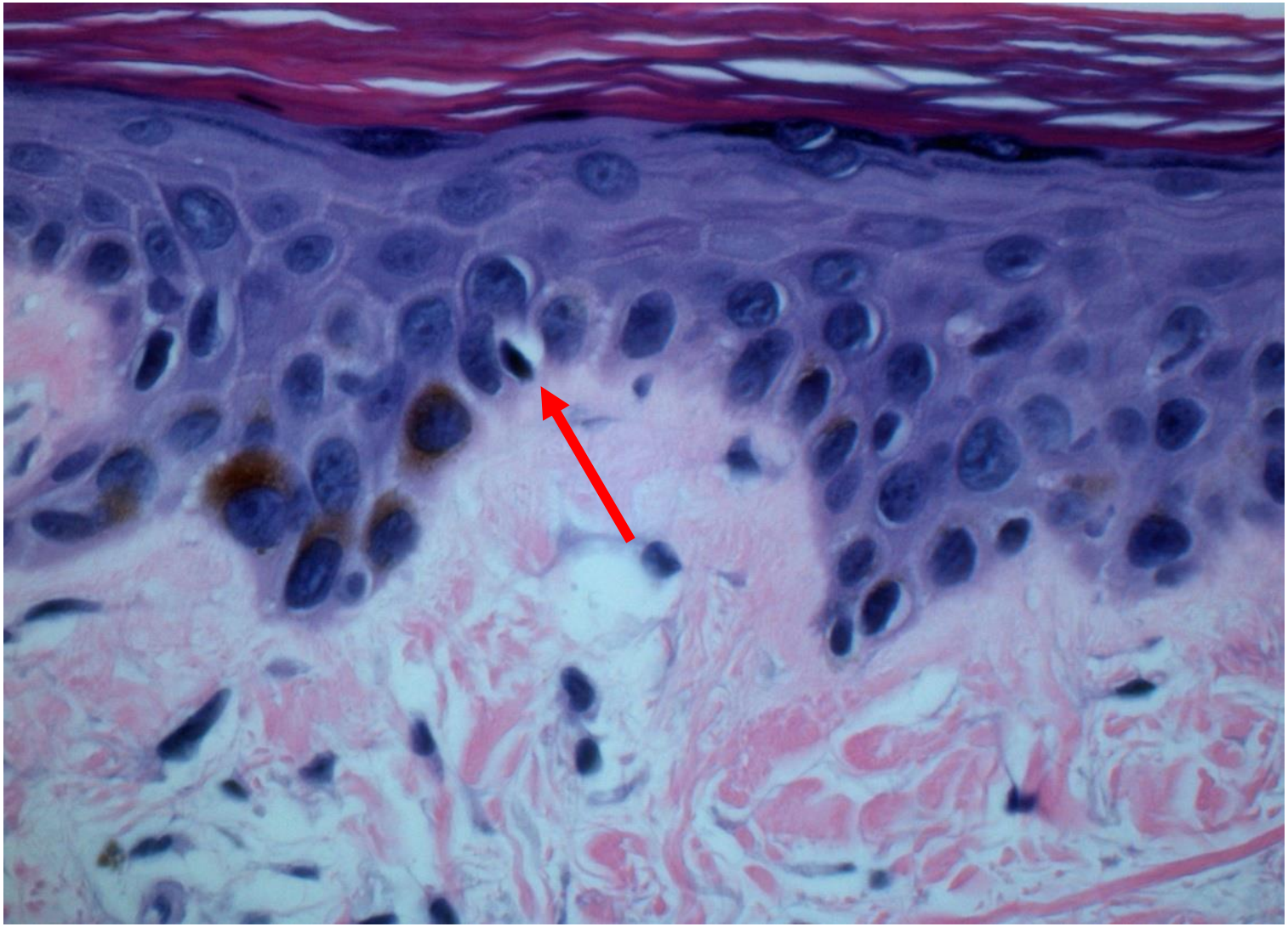
Epidermis – Melanocytes 1





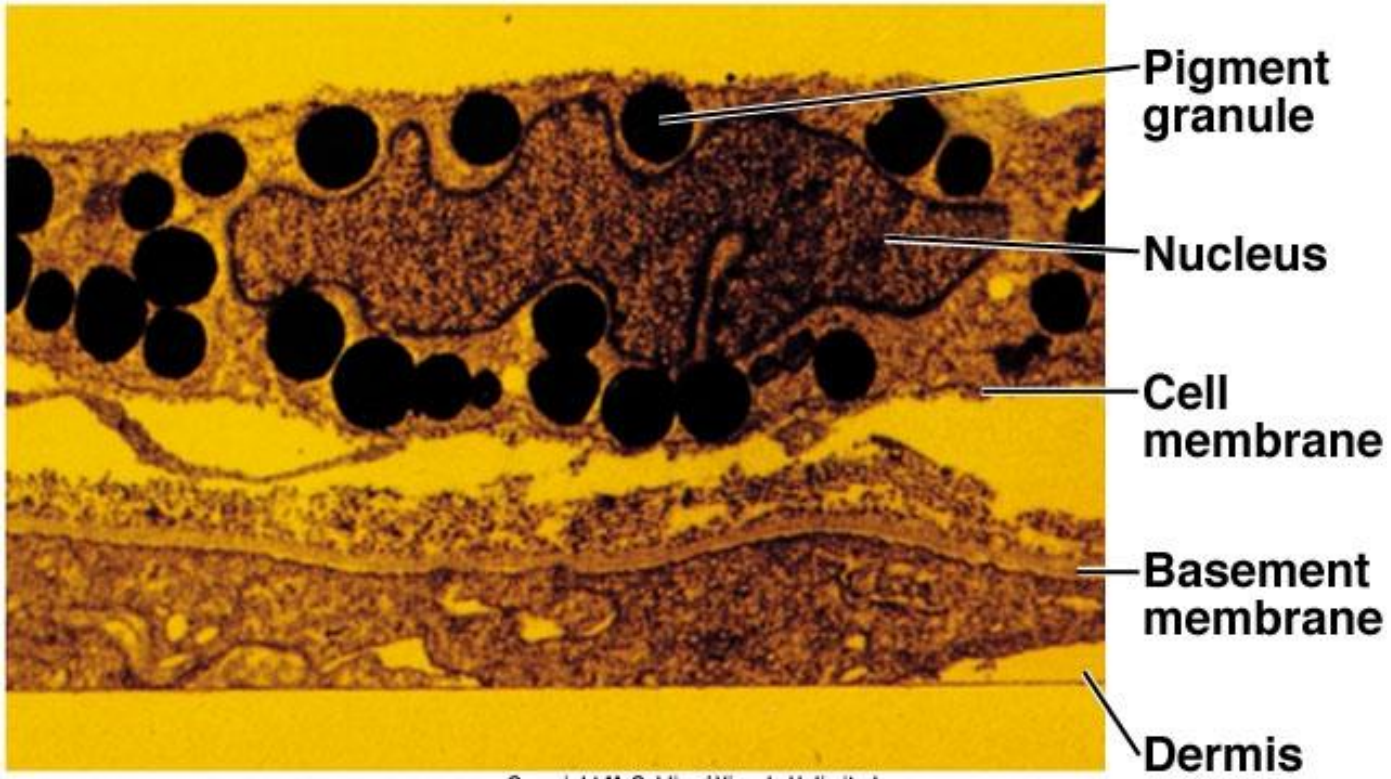
Melanocytes: clearish cells in basal layer with dark nuclei ; ratio of 1 : 40 – epidermal melanin unit.

Epidermis – Melanocytes 2



Epidermis – Melanocytes 3

Melanocyte with Pigment Granules



Epidermis – Melanocytes 4 - Pigments

Three pigments contribute to skin color

Melanin – yellow to reddish-brown to black pigment, responsible for dark skin colors

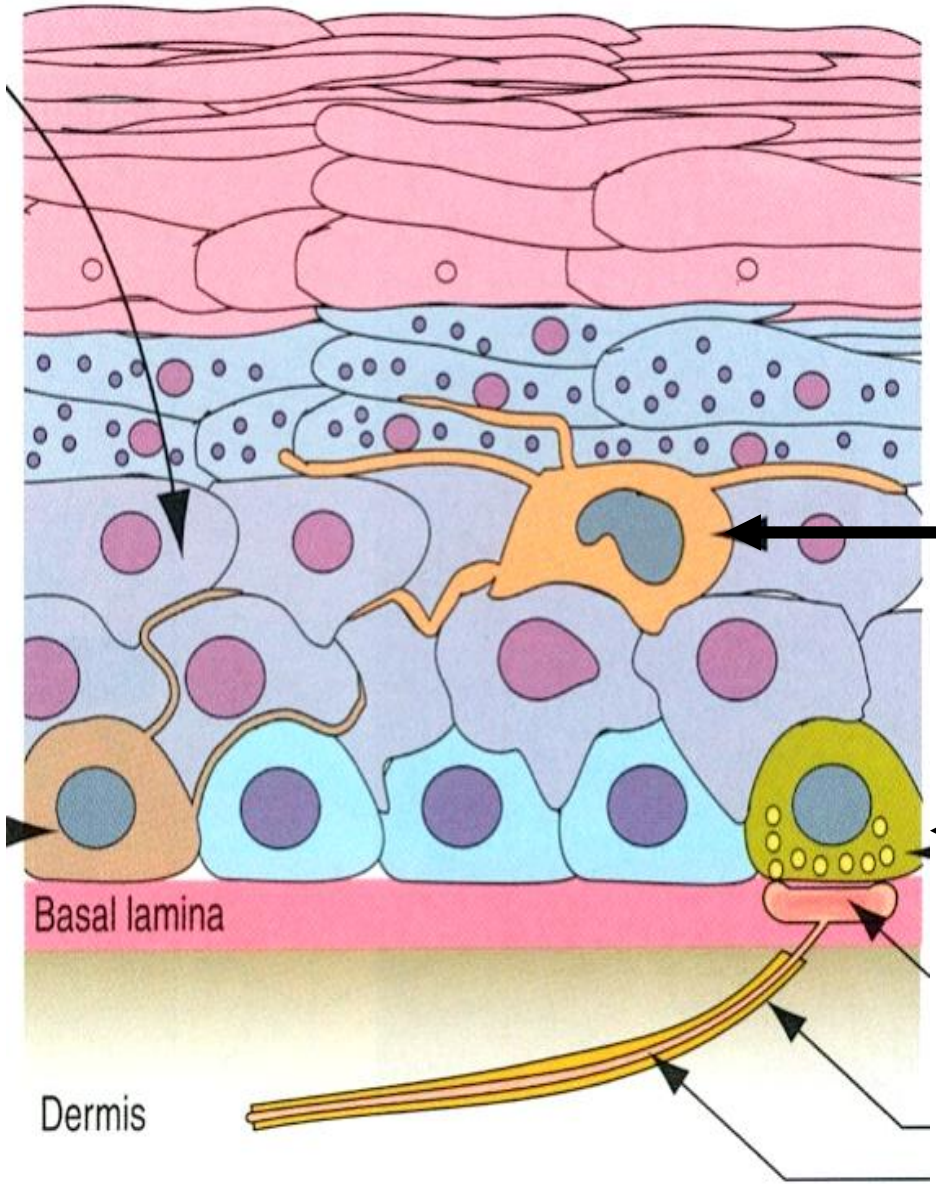
(Freckles and pigmented moles – result from local accumulations of melanin)

Carotene – yellow to orange pigment, most obvious in the palms and soles of the feet

Hemoglobin – reddish pigment responsible for the pinkish hue of the skin

Do some people have more melanocytes than other people?
NO !!!!

Epidermis – Langerhans cells + Merkel cells



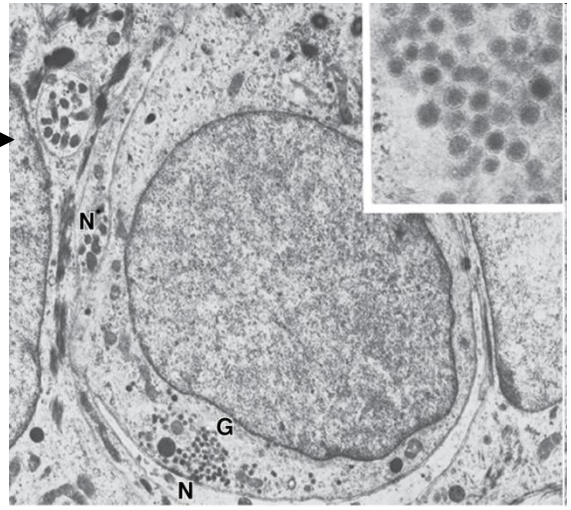
Migrate to lymph nodes

Langerhans cell

immune reaction that effects the skin
and may serve defense mechanism for the body

Merkel cell

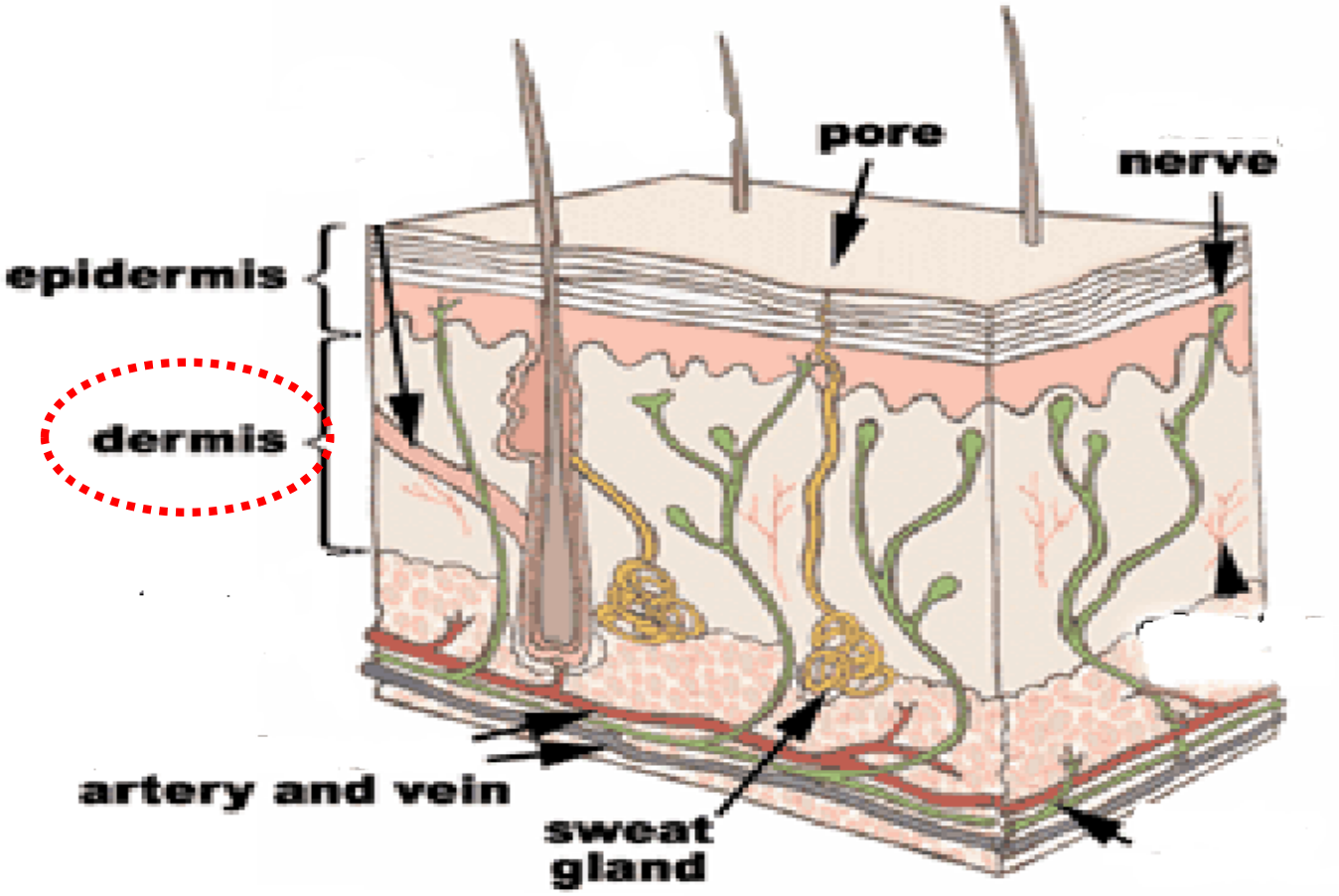
combines with
disclike sensory
nerve endings
to make Merkel's
discs



Dermis (Corium) 1

Everything below the dermal-epidermal junction / basement membrane

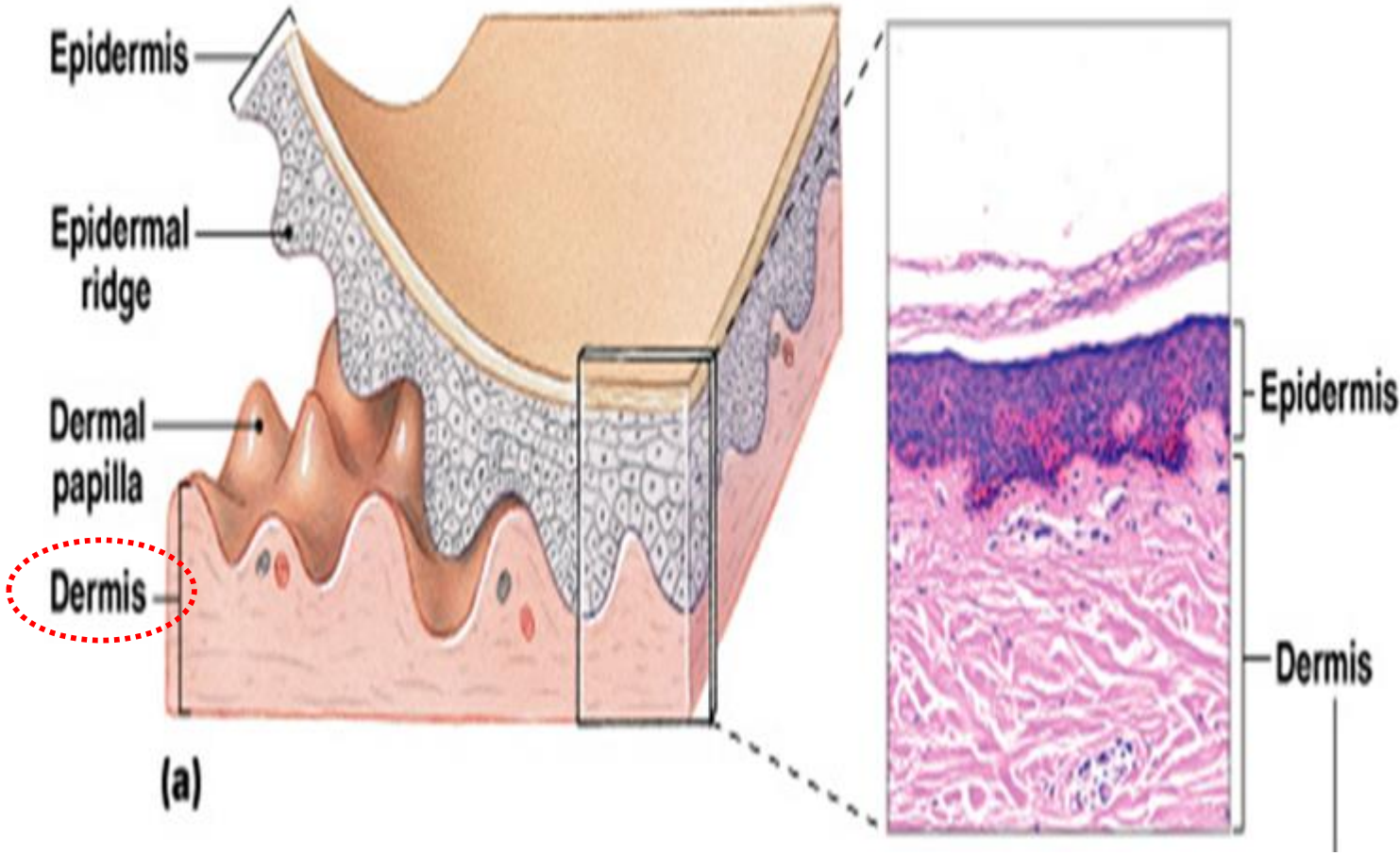
Connective tissue layer with contains blood vessels, nerves, sensory receptors, adnexal structures



Dermis 2

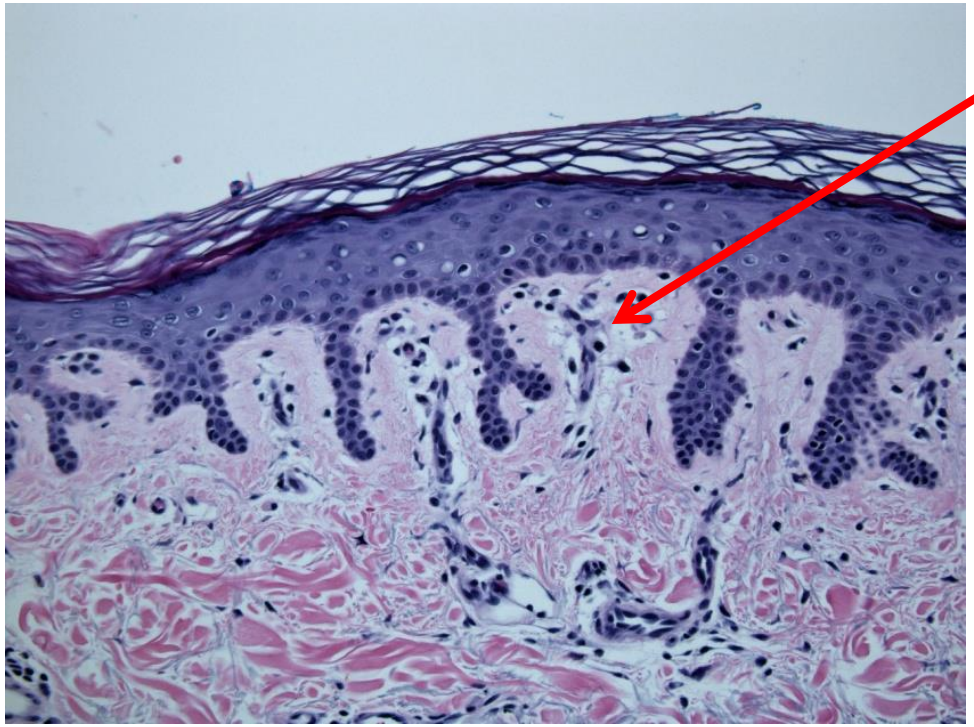
Papillary layer
(thin)

Reticular layer
(thick)



= True skin – up to 4 mm on soles and palms

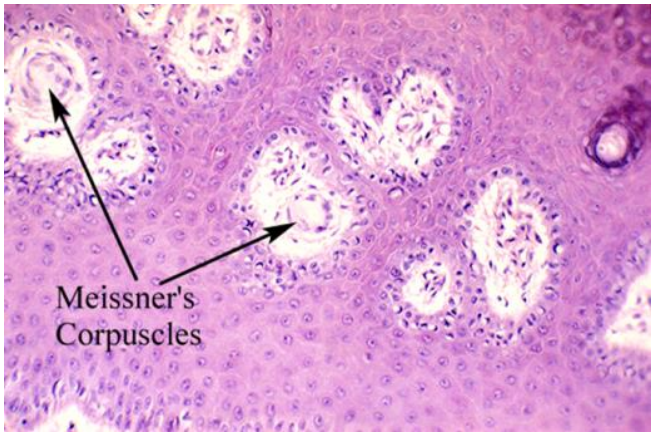
Papillary dermis 1



Capillaries

Papillary Dermis

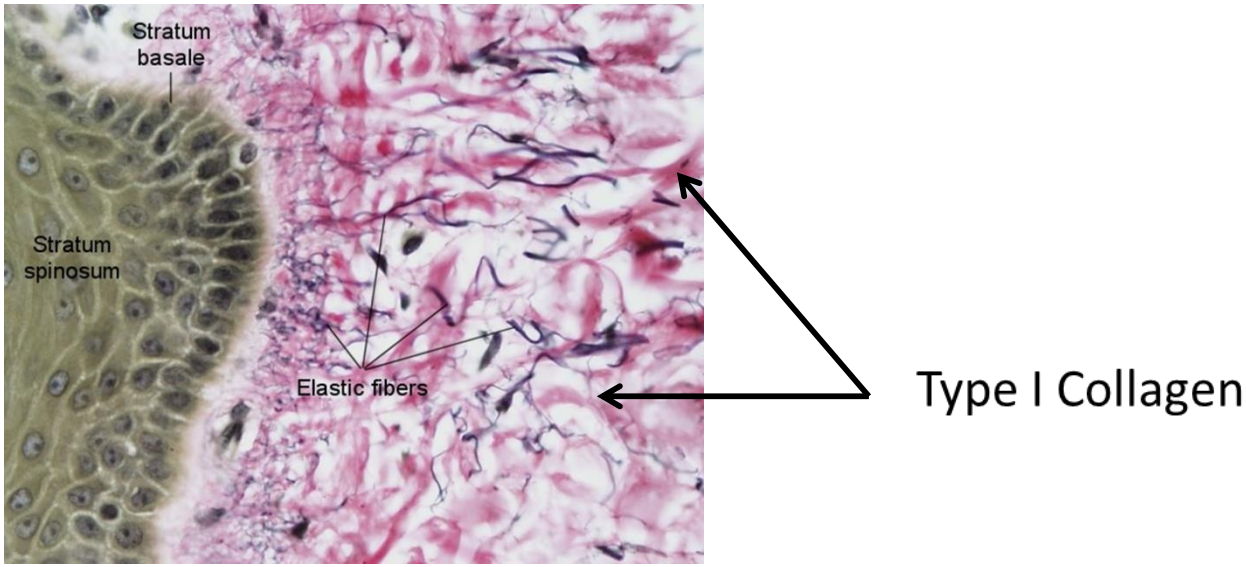
- **loose connective t.** & elastic fibers
- **dermal papillae** which project into epidermis
- anchors epidermis to dermis
- contains **Meissner's corpuscles** (touch) & **free nerve endings** (pain&temp)



Papillary dermis 2

Two major types of fibers:

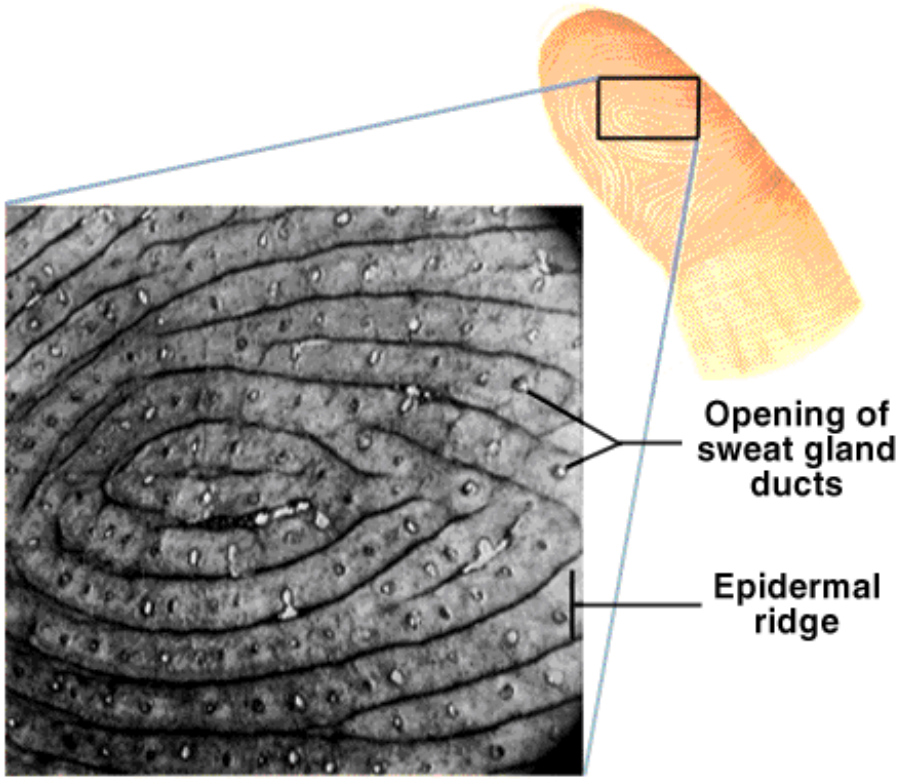
- Type I Collagen
- Elastic fibers: three types based on microfiber and elastin content



Papillary dermis 3

Epidermal ridges (palms + soles)

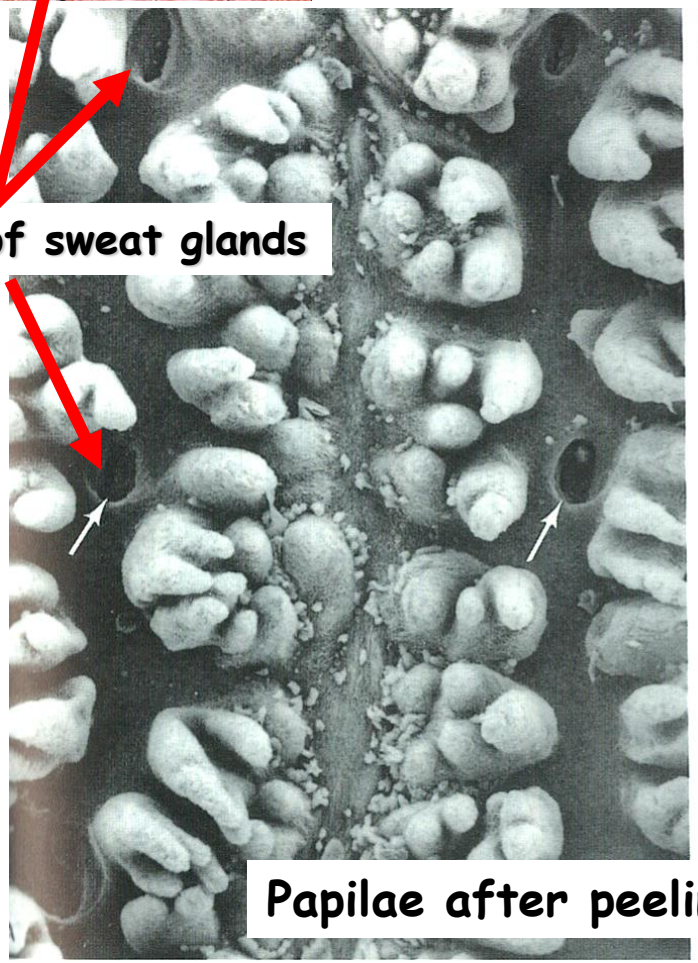
- reflect contours of the underlying dermal papillae
- form the basis for fingerprints (and footprints)
- increase firmness of grip by increasing friction
- Dermatoglyphics - the study of the pattern of epidermal ridges

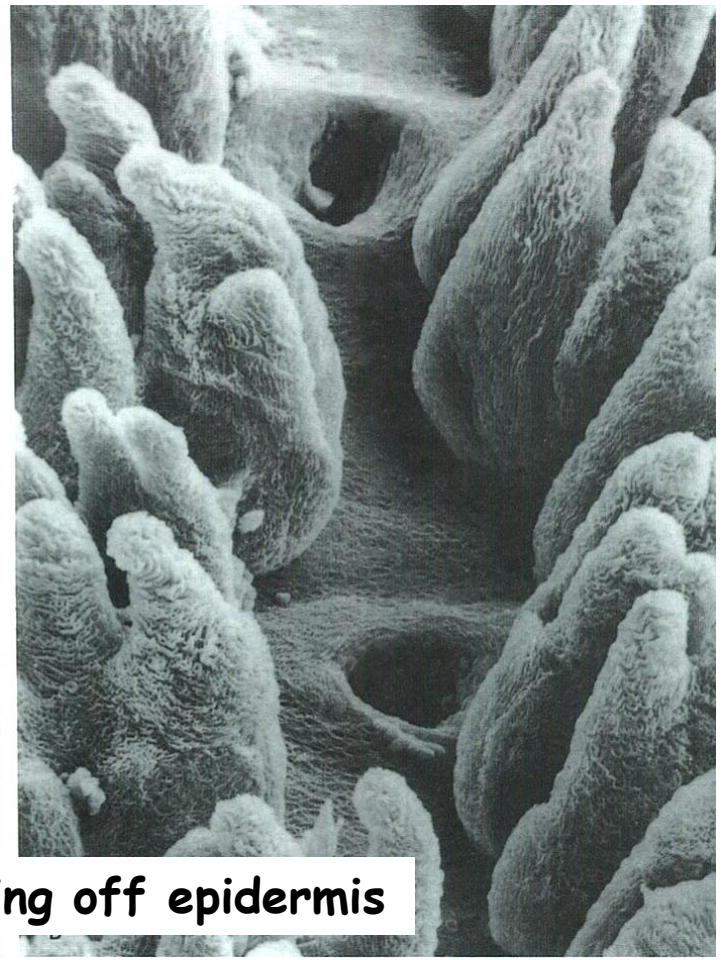


Papillary dermis 4

Epidermal ridges

Openings of sweat glands

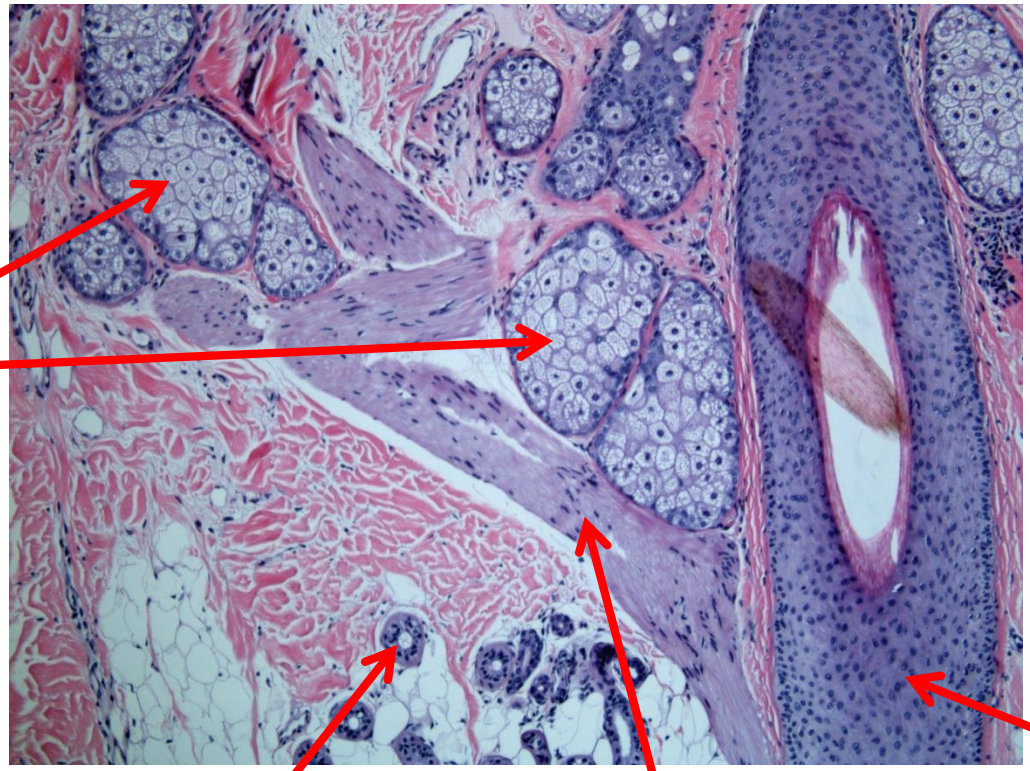




Papilae after peeling off epidermis

Reticular dermis + Accessory structures (Dermal appendages)

- **Dense irregular connective tissue**
- **Sebaceous** (oil) **glands**
- **Hair follicles**
- Ducts of **sweat** (sudoriferous) **glands**
- Striae or stretch marks
- **Meissner's corpuscles** and **Pacinian corpuscles** (on lips, ext. genitalia, nipples)



Dermal glands

Sweat	Eccrine	Tubular
	Apocrine	Tubular to tuboalveolar
Sebaceous	Holocrine	Branched acinar (alveolar)

Dermal glands – Eccrine sweat glands
(glandulae sudoriferae eccrinae)

- **Secretory part:**

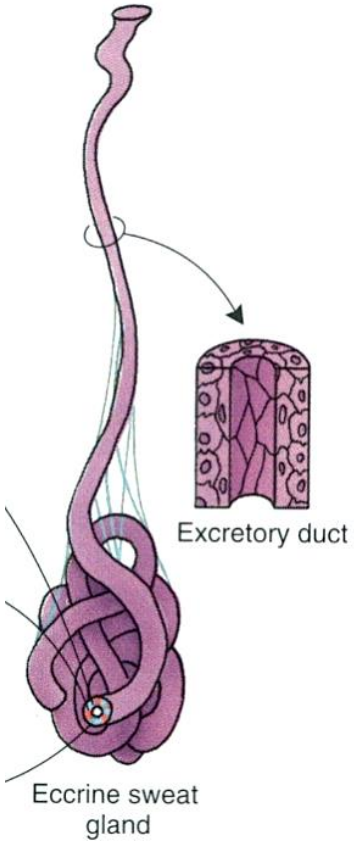
Simple cylindrical epithelium + myoepithelial cells

- **Ductular part:**

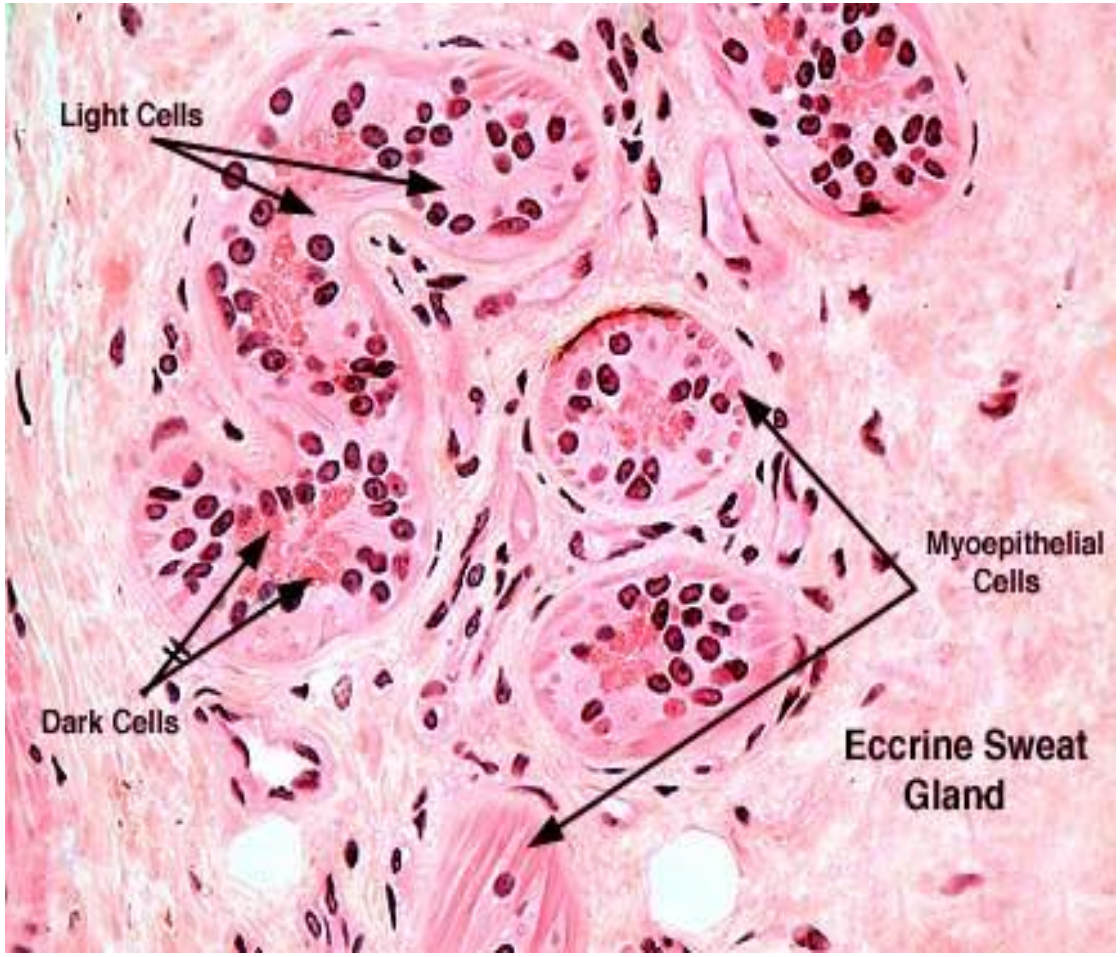
Two layered cuboid epithelium

Release to adjust body temperature

Not on: red lips, glans penis, preputium, labia minora



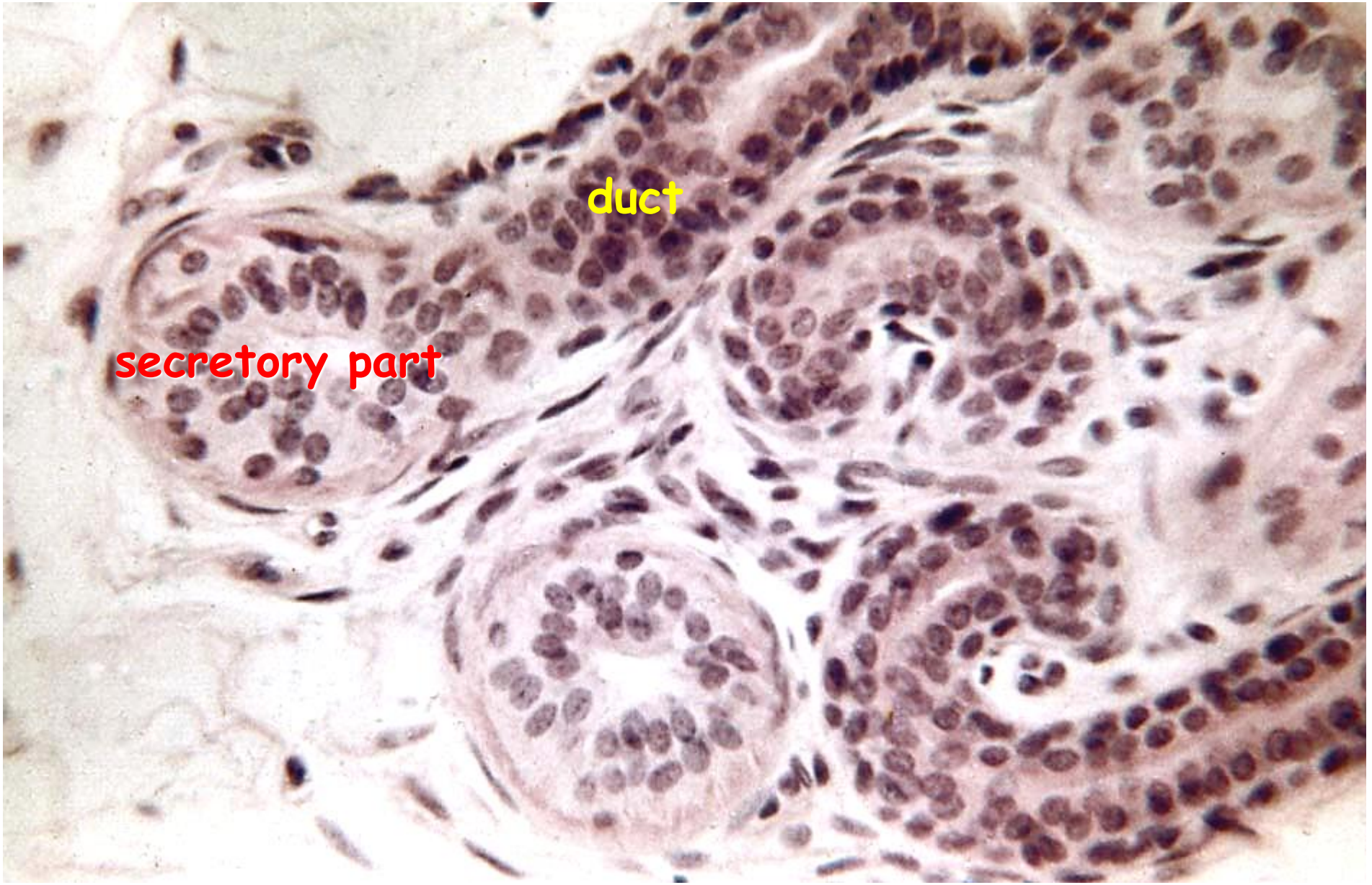
Eccrine sweat glands



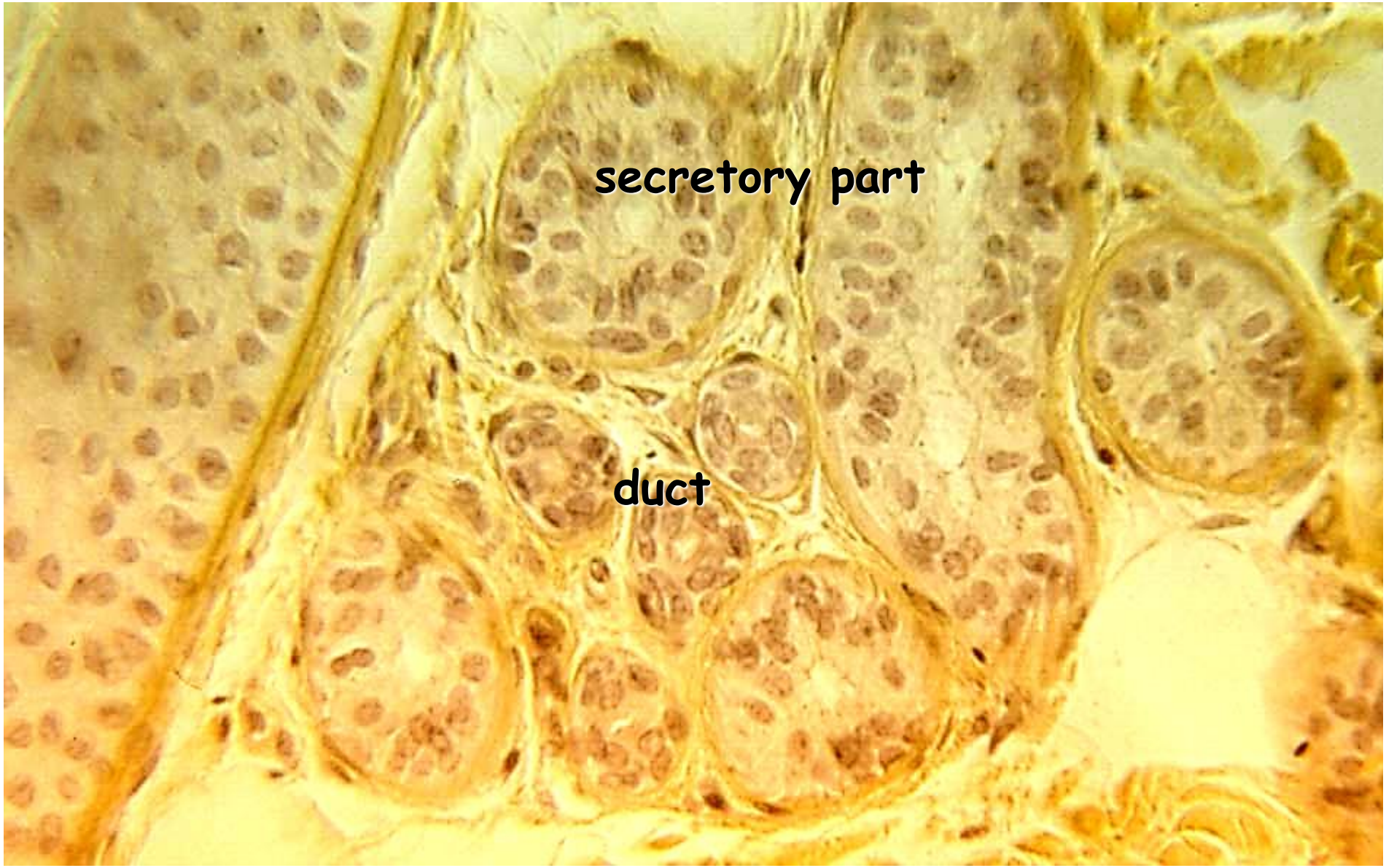
Three cell types

- **Dark cells**: pyramid shaped with secretory granules line lumen of tubule
- **Clear cells**: located toward basement membrane – secrete water and ions
- **Myoepithelial cells**: spindle shaped contractile cells

Eccrine sweat glands



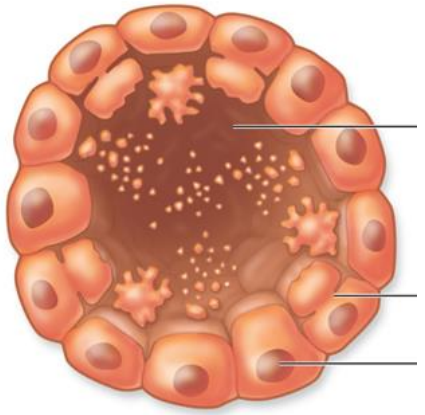
Eccrine sweat glands



Dermal glands – Apocrine sweat glands
(glandulae sudoriferae apocrinae)

- **Secretory part:**

Simple squamous to cylindrical epithelium (depending on the secretoty cycle) + myoepithelial cells



c Apocrine gland

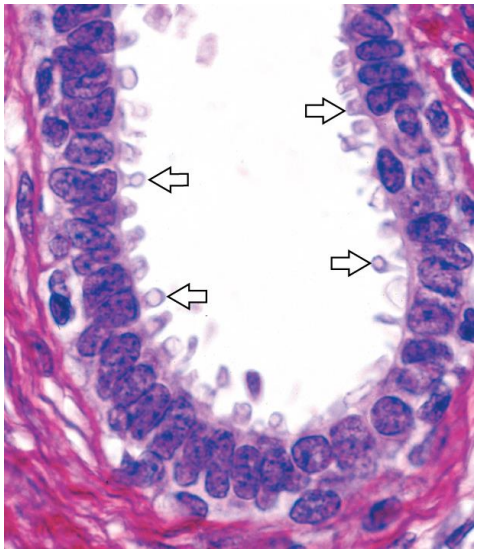
- **Ductular part:**

Two layered cuboidal epithelium

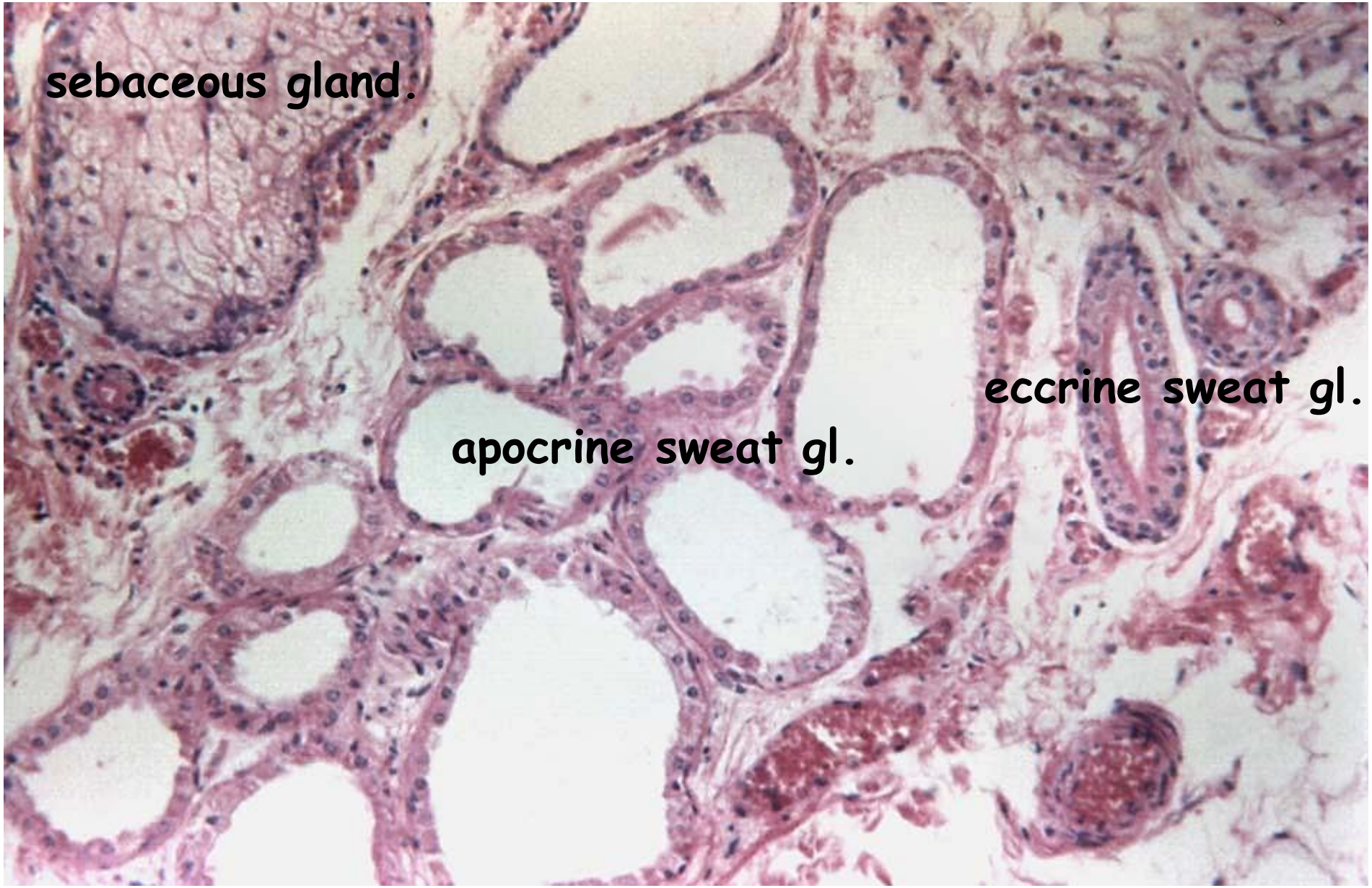
Always associated with hair follicle

Influenced by hormones (sexual **scent glands**)

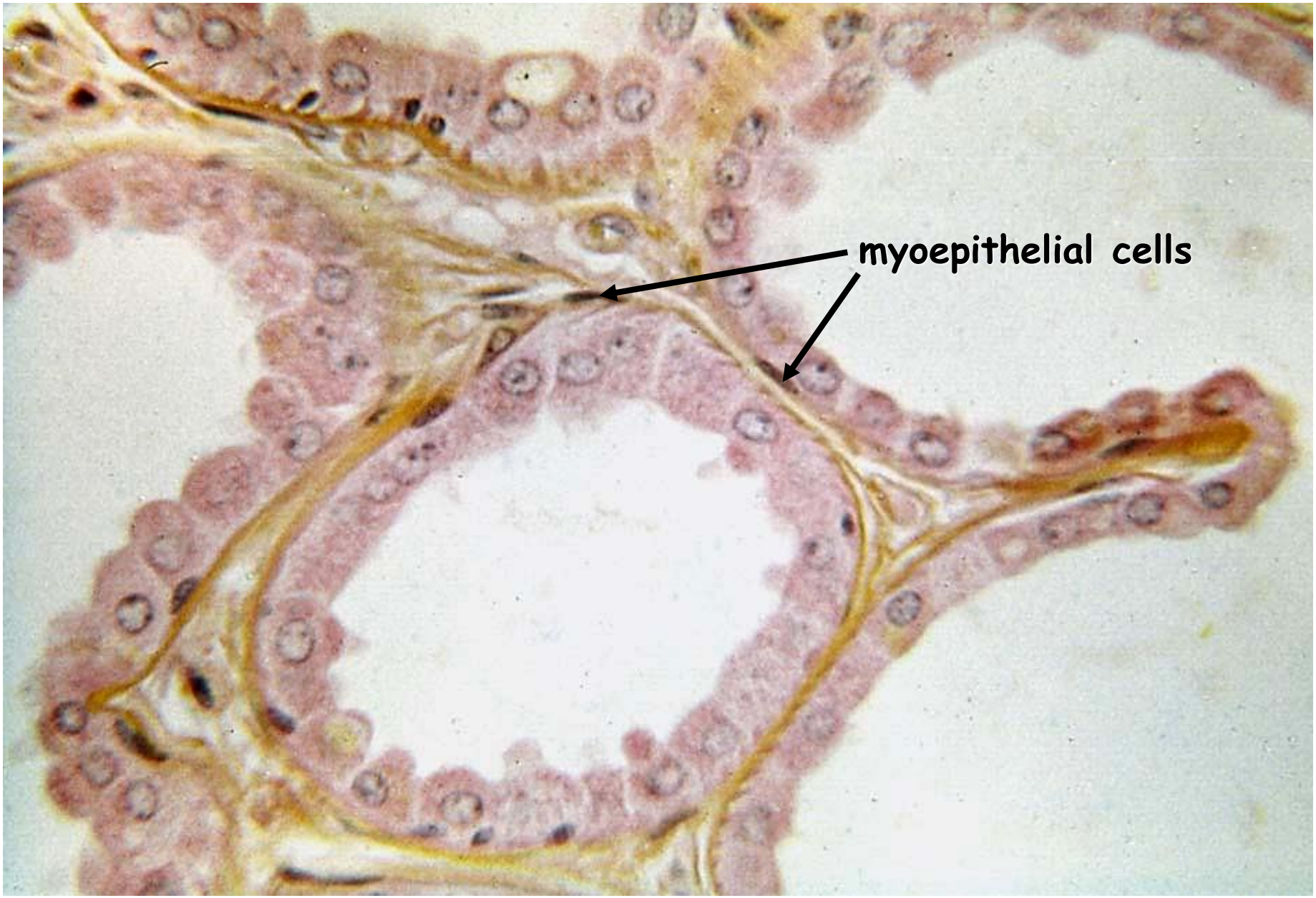
Only on: axilla, areola mammae, scrotum, labia maiora, mons pubis, perianal area, meatus acusticus, vestibulum nasi, eye lid



Apocrine sweat glands

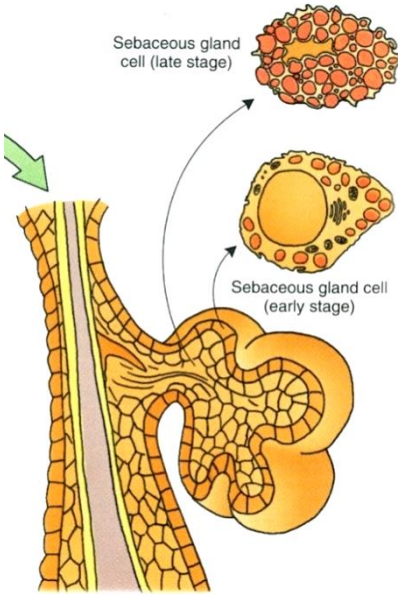


Apocrine sweat glands



Dermal glands – Sebaceous glands
(glandulae sebaceae)

Simple branched acinar glands
Several acini empty into single duct



- **Secretory part:**

multi layered epithelium, slow adipous degeneration

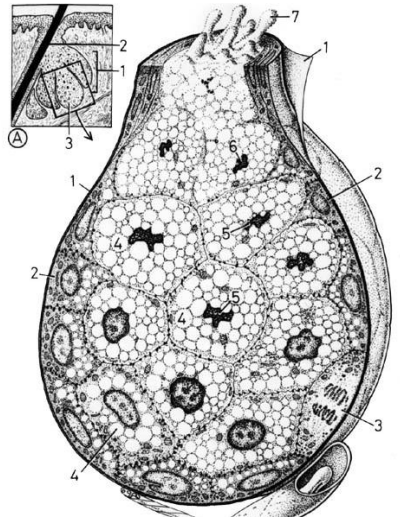
- **Ductular part:**

multi layered squamous epithelium

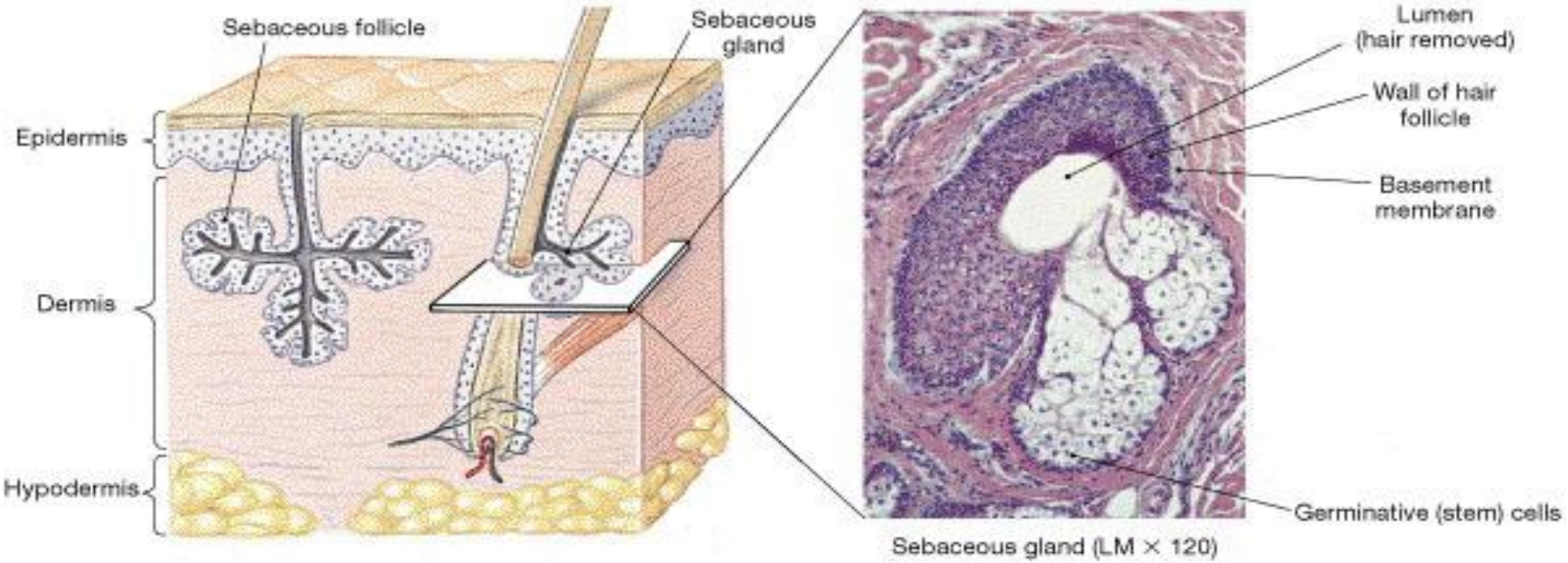
Usually associated with hair follicles

Freely open on: red lips, glans penis, preputium, labia minora, eze lid (Meiboms glands)

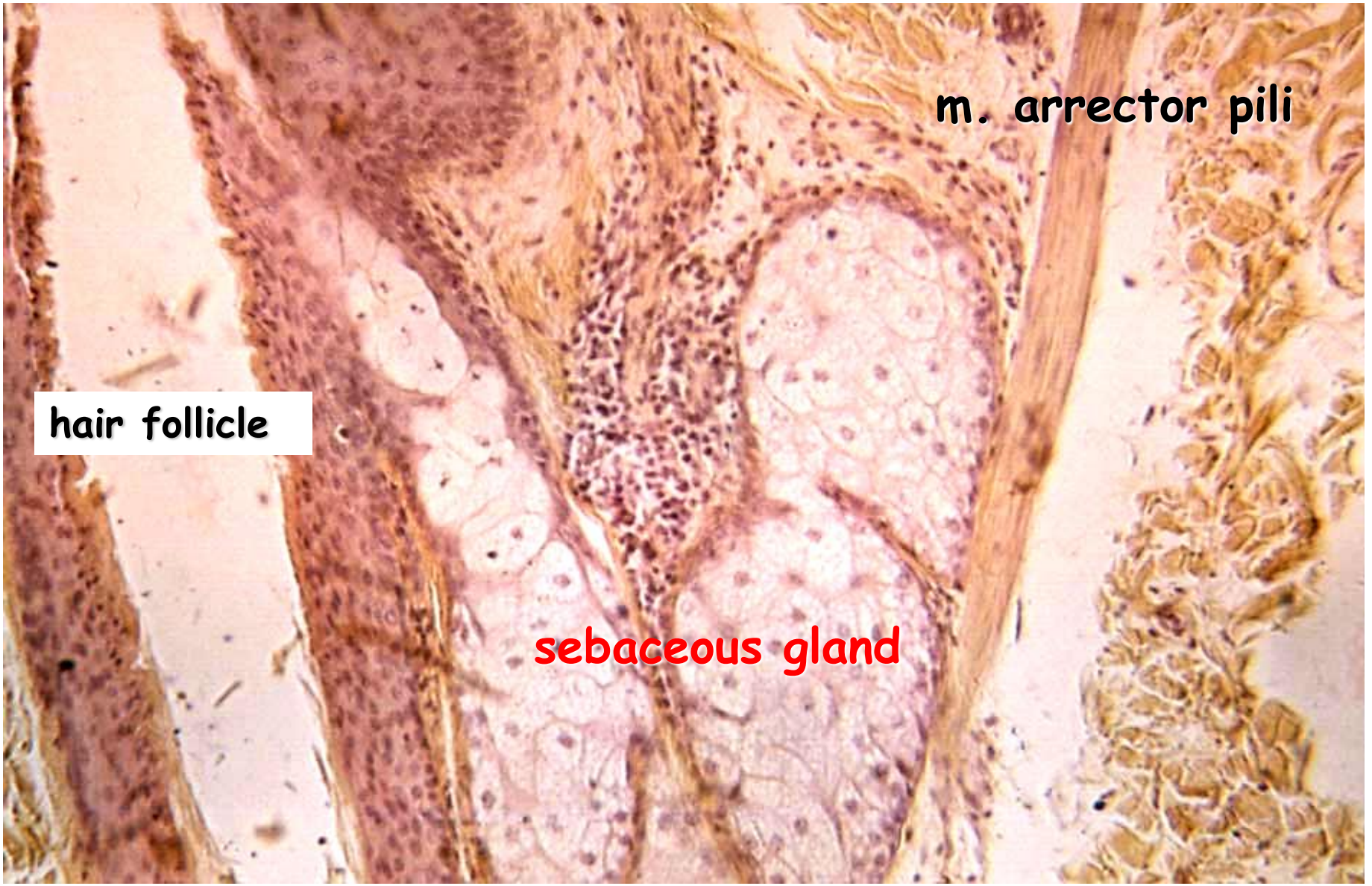
Not on: palms and soles



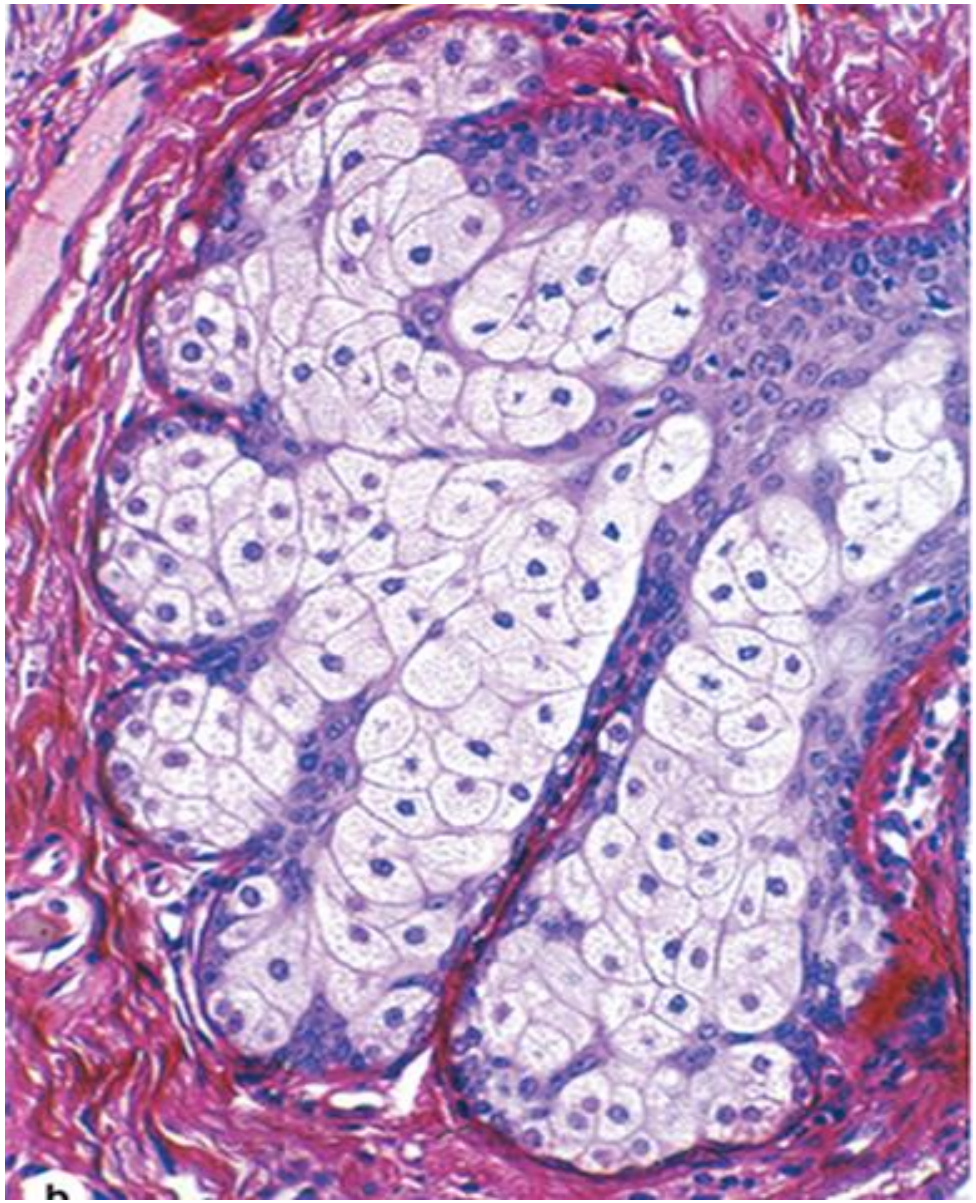
Sebaceous glands

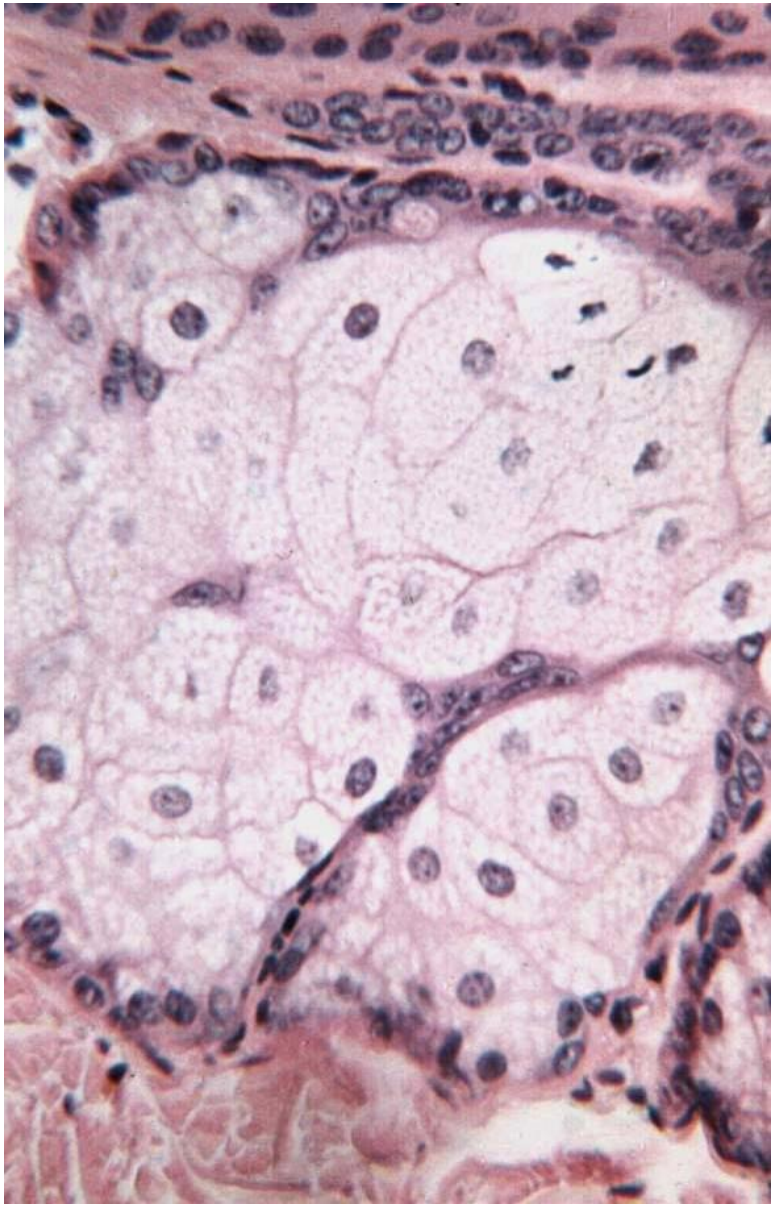


Sebaceous glands



Sebaceous glands



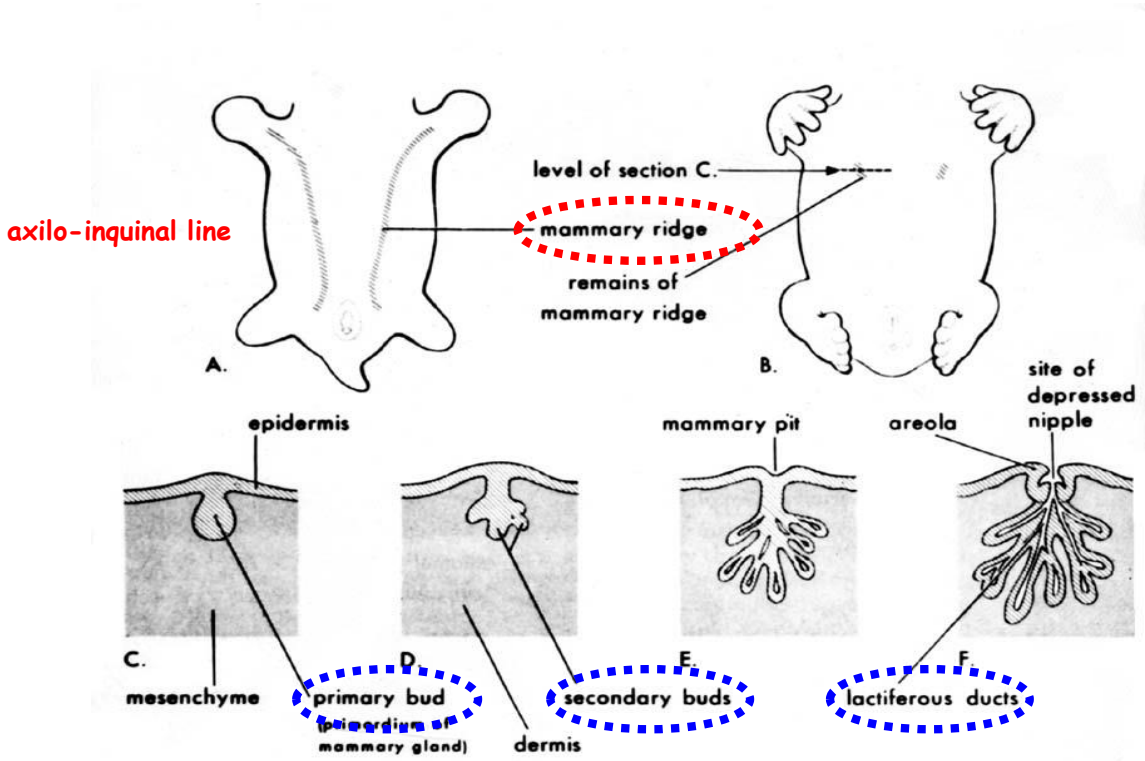


Mammary gland

Modified and highly specialized type of apocrine sweat glands.

Parenchyma
- Ducts
- Budding surface ectoderm
- (since week 6)

Stroma
- Connective tissue
- From mesenchyme

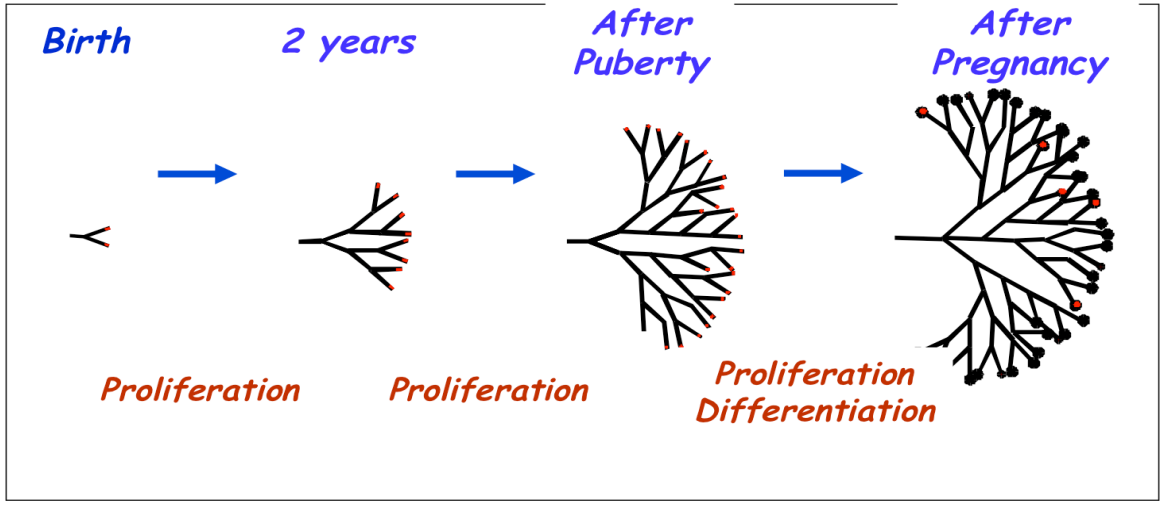


Supernumerary Breasts and Nipples

- An extra breast (**polymastia**) or nipple (**polythelia**) occurs in approximately 1% of the female population - inheritable.
- **Supernumerary nipples** are also relatively common **in males**.
- Less commonly, **supernumerary breasts** or nipples appear in the axillary or abdominal regions of females developing from extra mammary buds that develop along the mammary crests. They become more obvious in women when pregnancy occurs.

Development of the breast ductal tree

Occurs mainly after birth

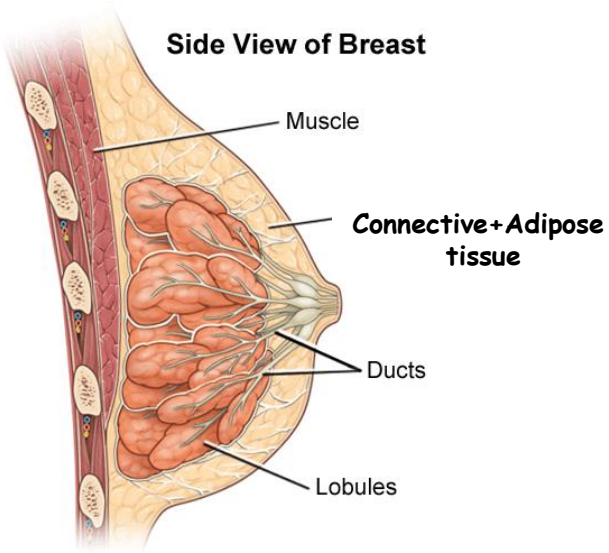


At **puberty** changes in the hormonal secretions in females cause further development and structural changes within the glands.

Secretions of estrogen and progesterone from the ovaries (and later from the placenta) and prolactin from the acidophils of the anterior pituitary gland initiate development of lobules and terminal ductules.

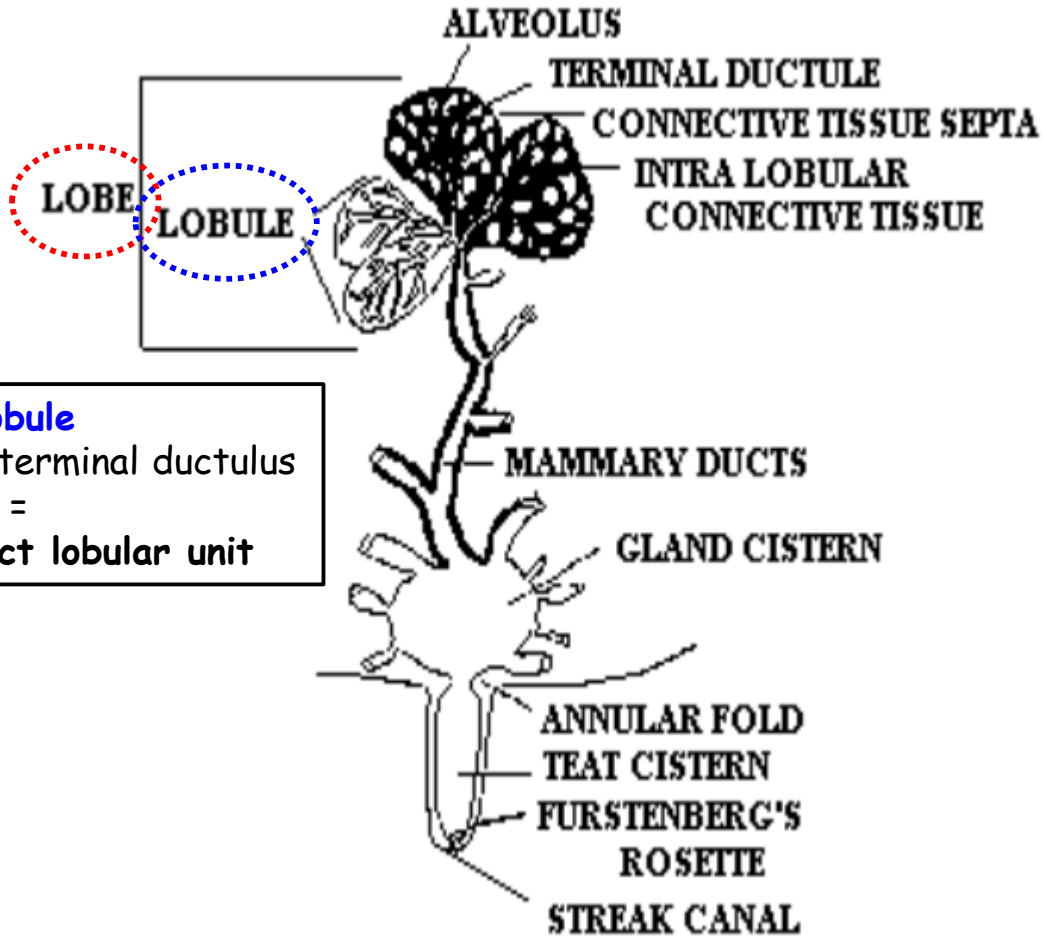
Full development of the ductal portion of the breast requires glucocorticoids and further activation by somatotropin.

Mammary gland - Anatomical organization



Lobe = 1 gland

- total of 15 to 20 lobes
- 1 lobe drained by 1 lactiferous duct



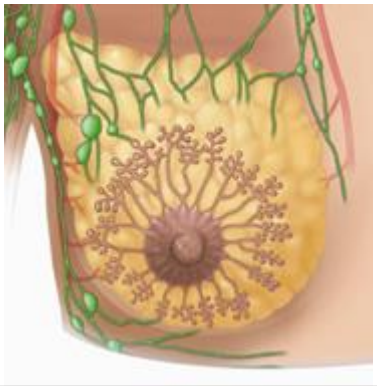
Lobule

- drained by terminal ductulus

=

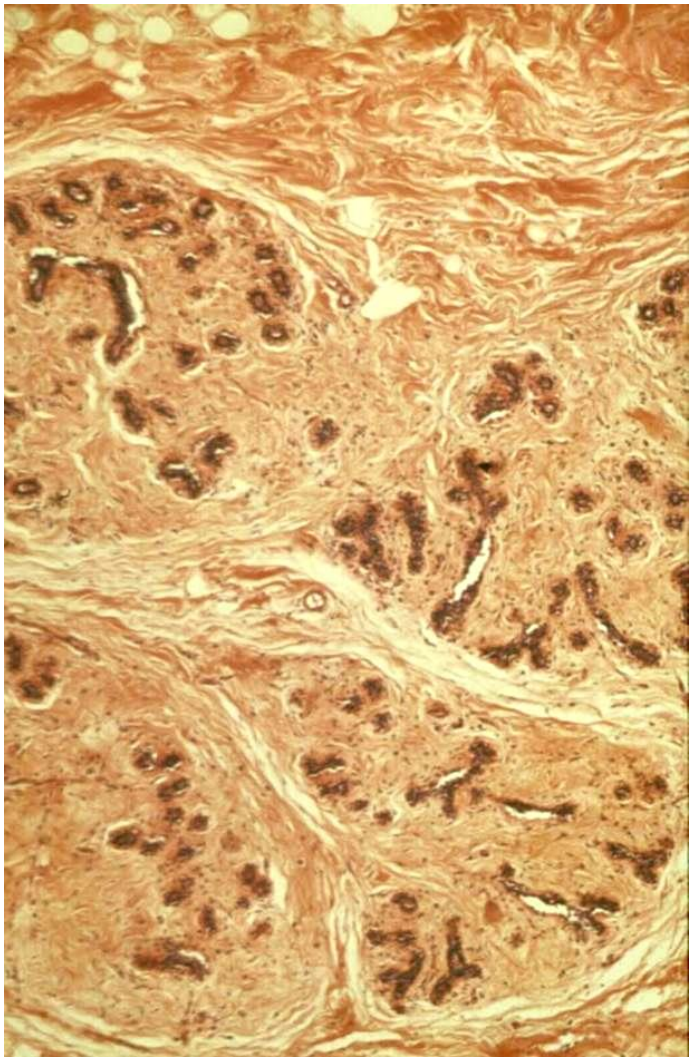
Terminal duct lobular unit

Radial organization

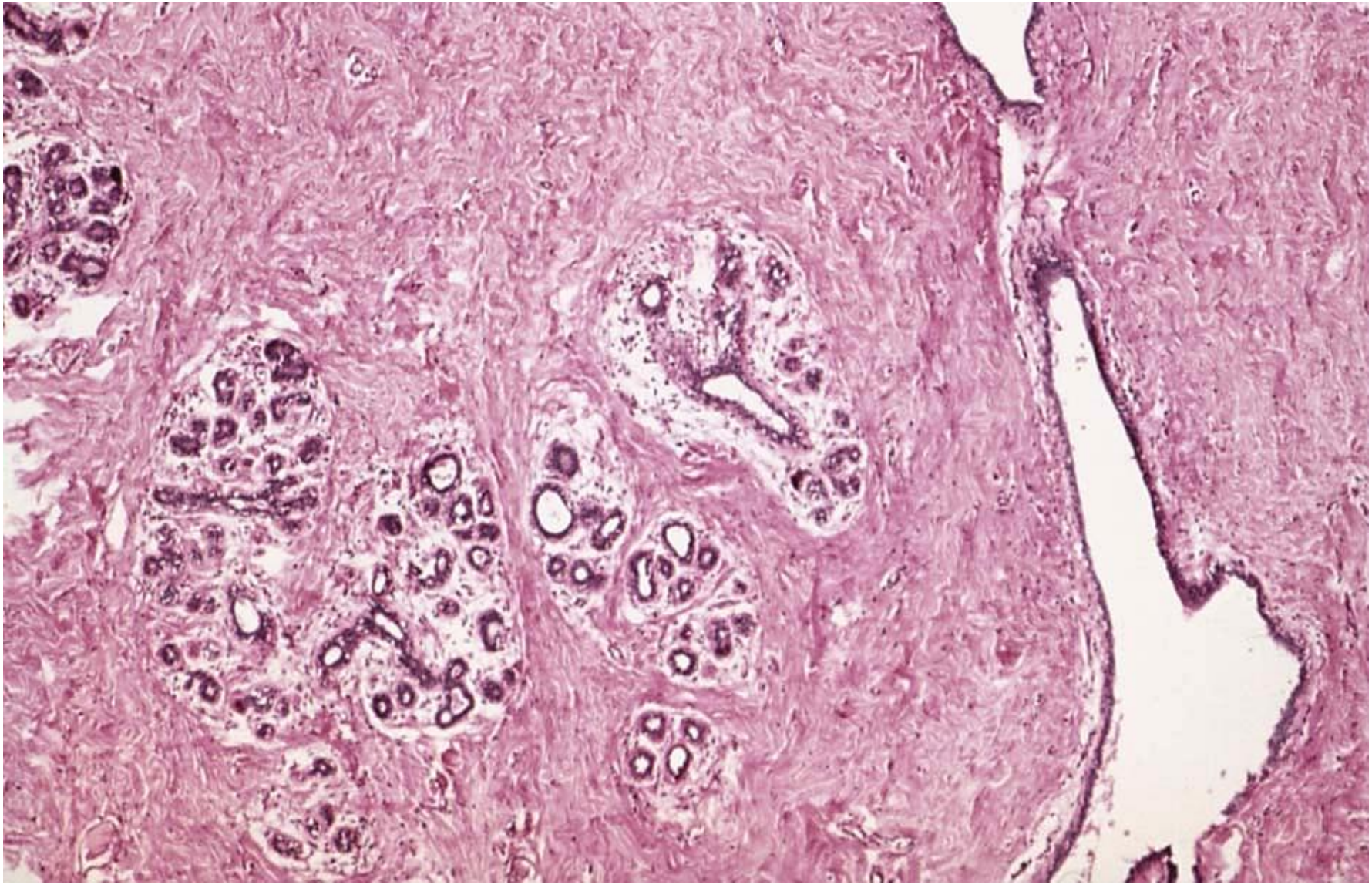


Mammary gland – After puberty – Nonlactating 1

- majority = connective tissue
- the same basic architecture as the lactating (active) mammary gland
- **Secretion parts** - alveoli are not developed, only small groups of cells at the endings of ductuli
- **Passages** – branched + partly luminized

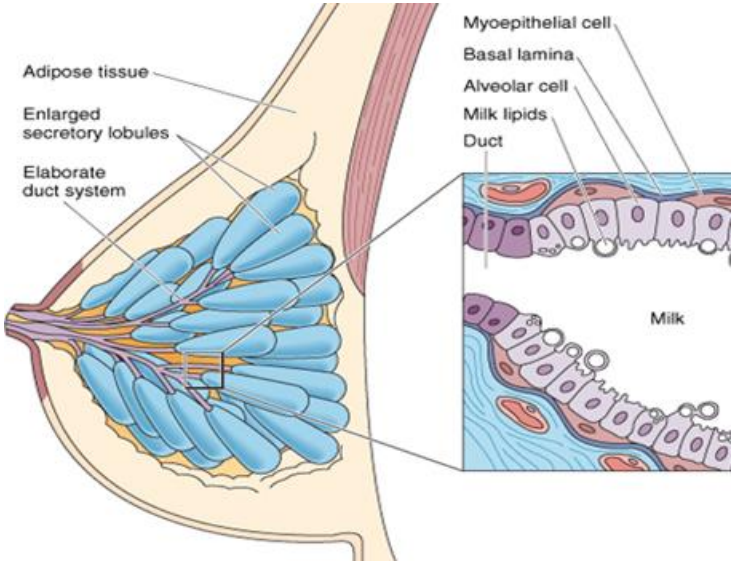


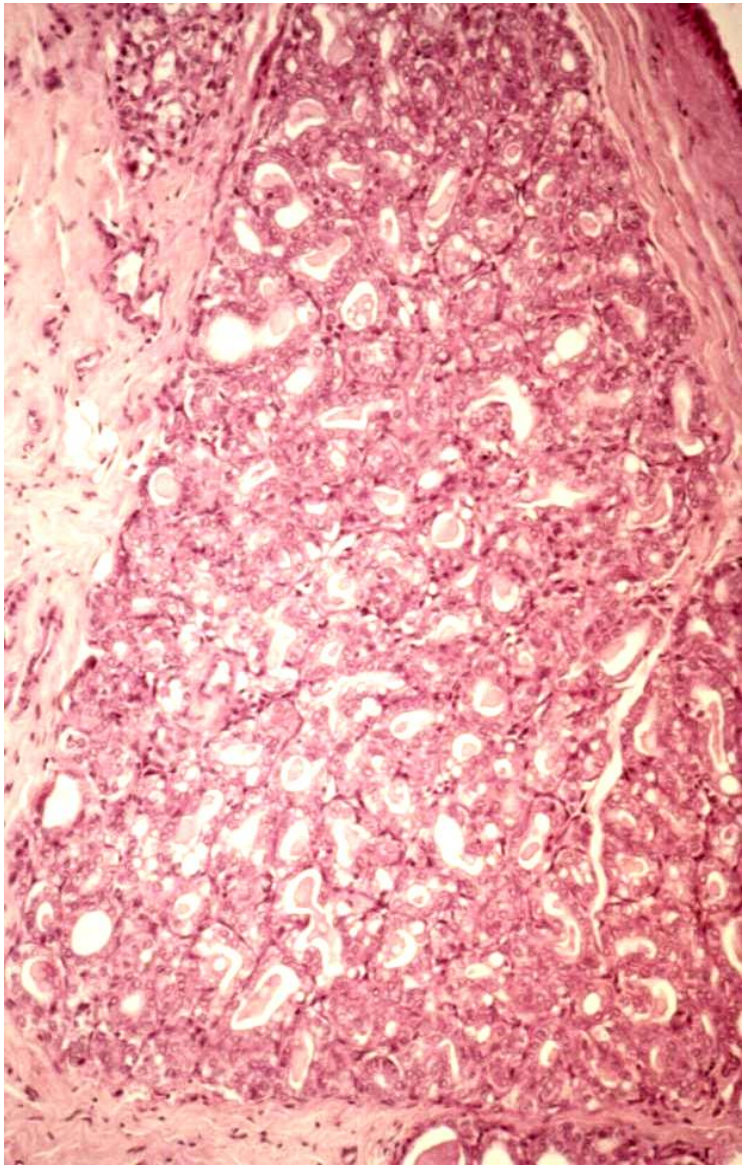
Mammary gland – After puberty – Nonlactating 2



Mammary Gland – Lactating 1

- majority = glands
- **Ducts:** proliferate, branch, luminize (estrogens)
- **Secreting alveoli:** proliferation, luminization (progesterone, prolactin)
- connective tissue – only thin septa





Mammary Gland – Lactating 2

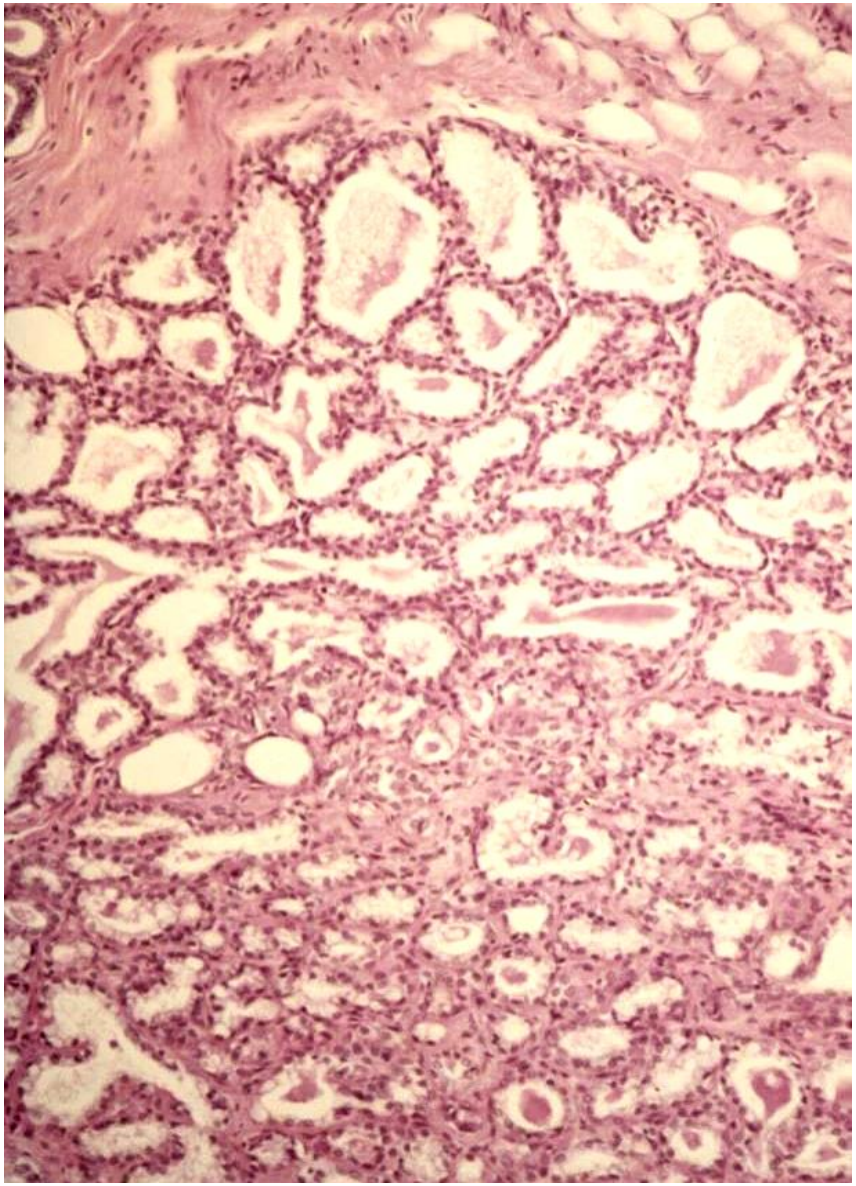
- **Secretion parts:** filled by secretion (lipid droplets = apocrine, proteins = eccrine - exocytosis)

- **Passages**:

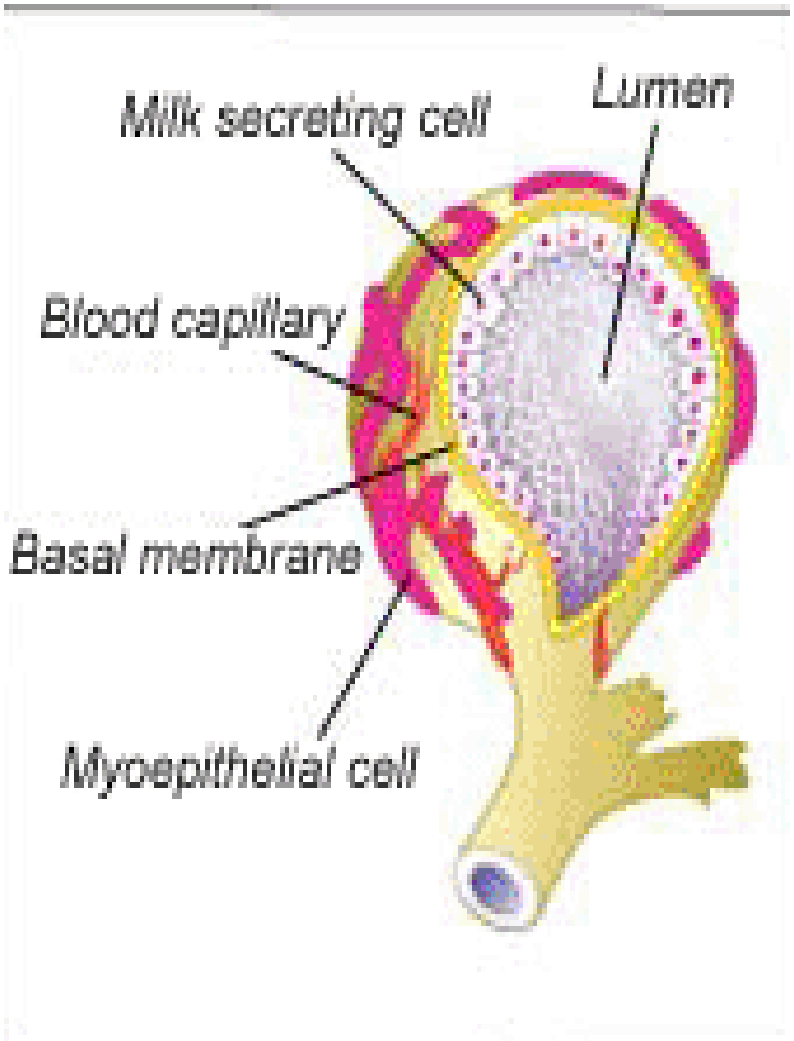
Ducts at the nipple: stratified squamous keratinizing ep.

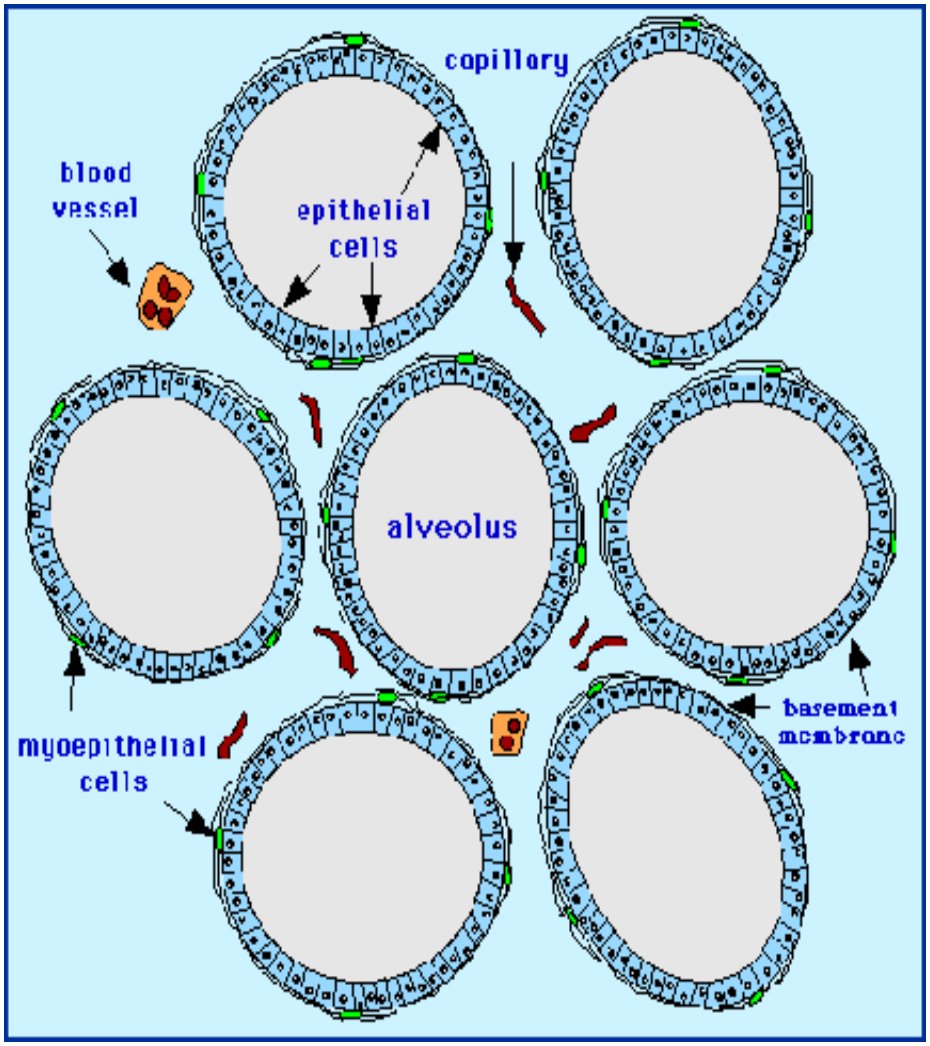
Lactiferous sinus and the lactiferous ducts: simple/stratified cuboidal/cylindrical ep.

Smaller ducts: simple cuboidal ep.

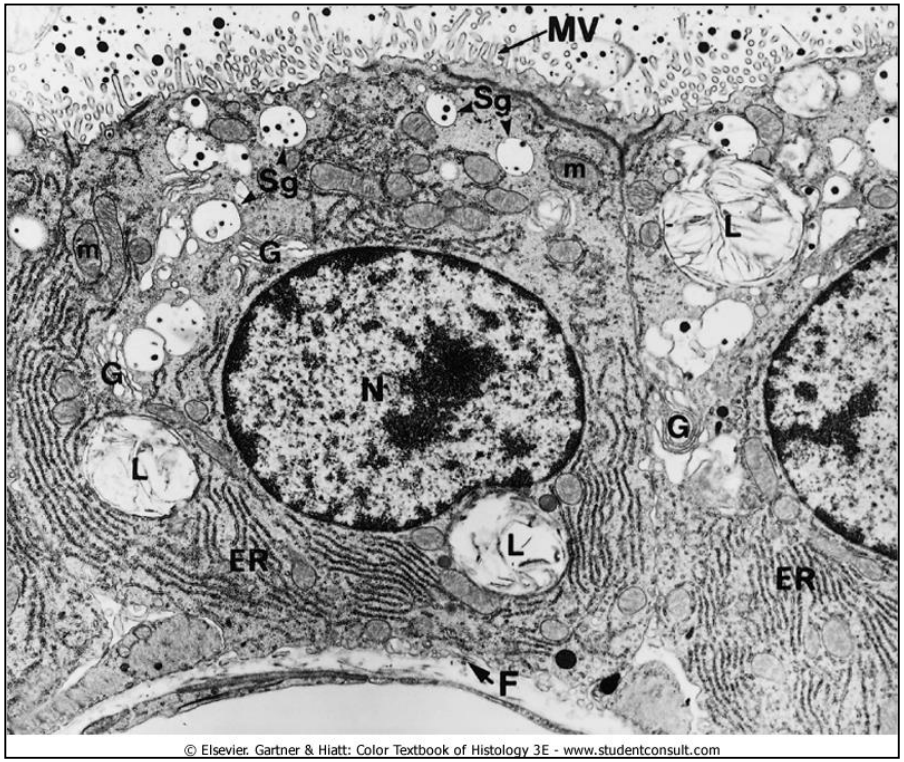


Mammary Gland – Lactating 3





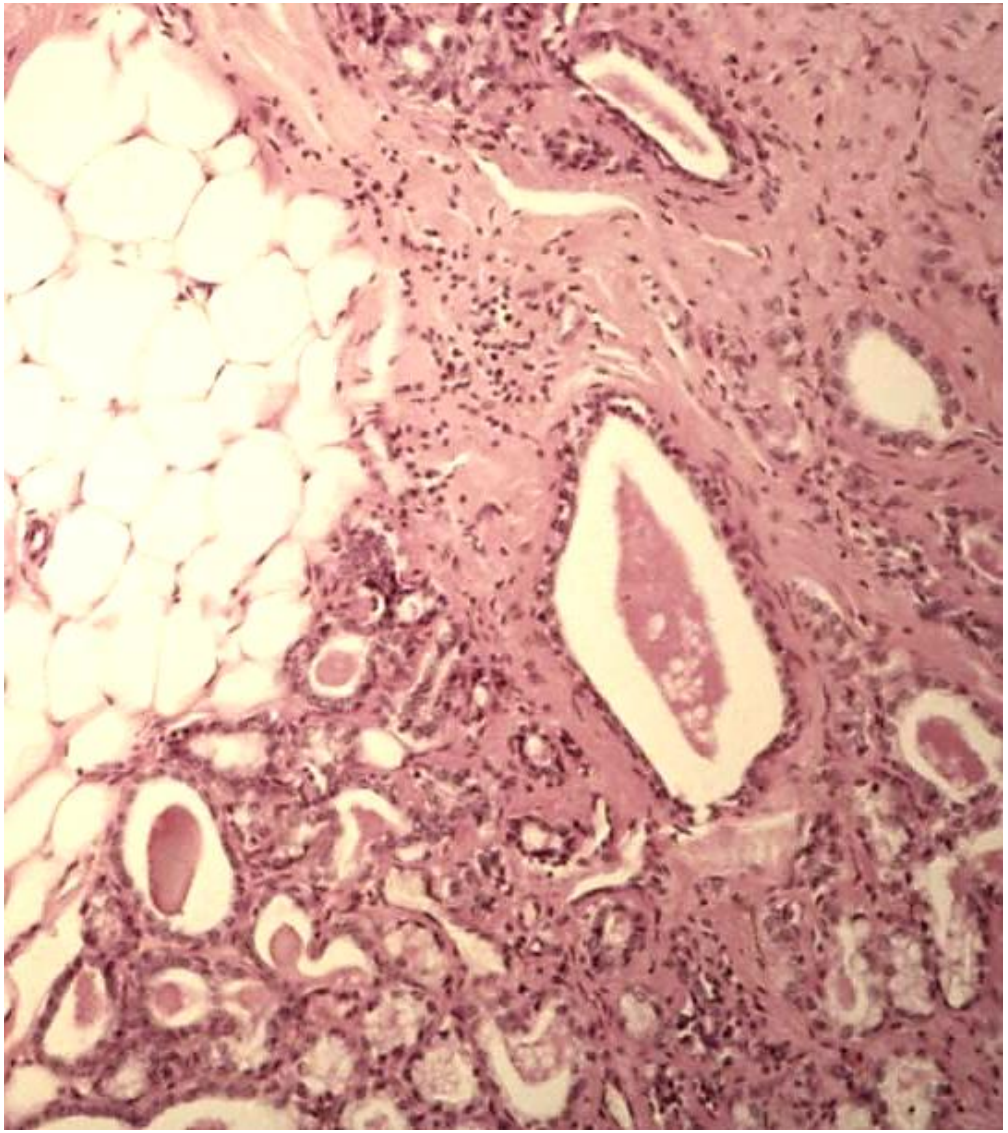
Mammary Gland – Lactating 4

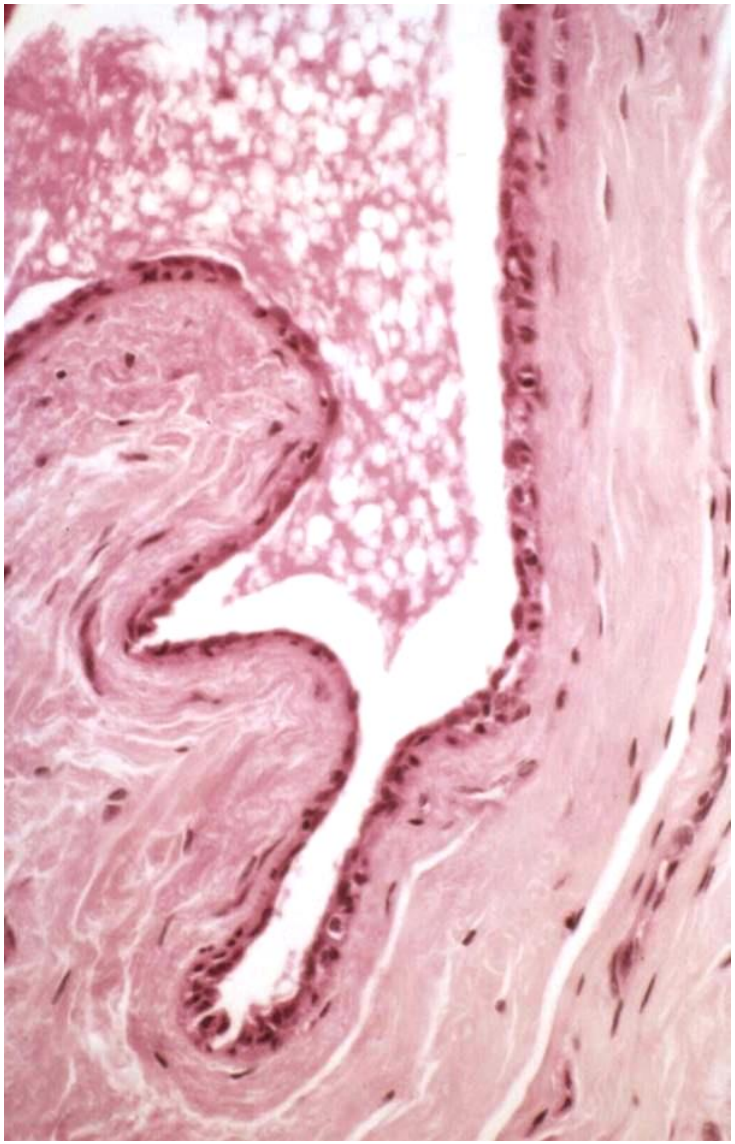


Electron micrograph of an acinar cell

- The **alveoli** are composed of cuboidal cells partially surrounded by a meshwork of myoepithelial cells.
- These secretory cells possess abundant RER and mitochondria, several Golgi complexes, many lipid droplets, and numerous vesicles containing caseins (milk proteins) and lactose.
- Not all regions of the alveolus are in the same stage of production, because different acini display varying degrees of preparation for synthesis of milk substances.

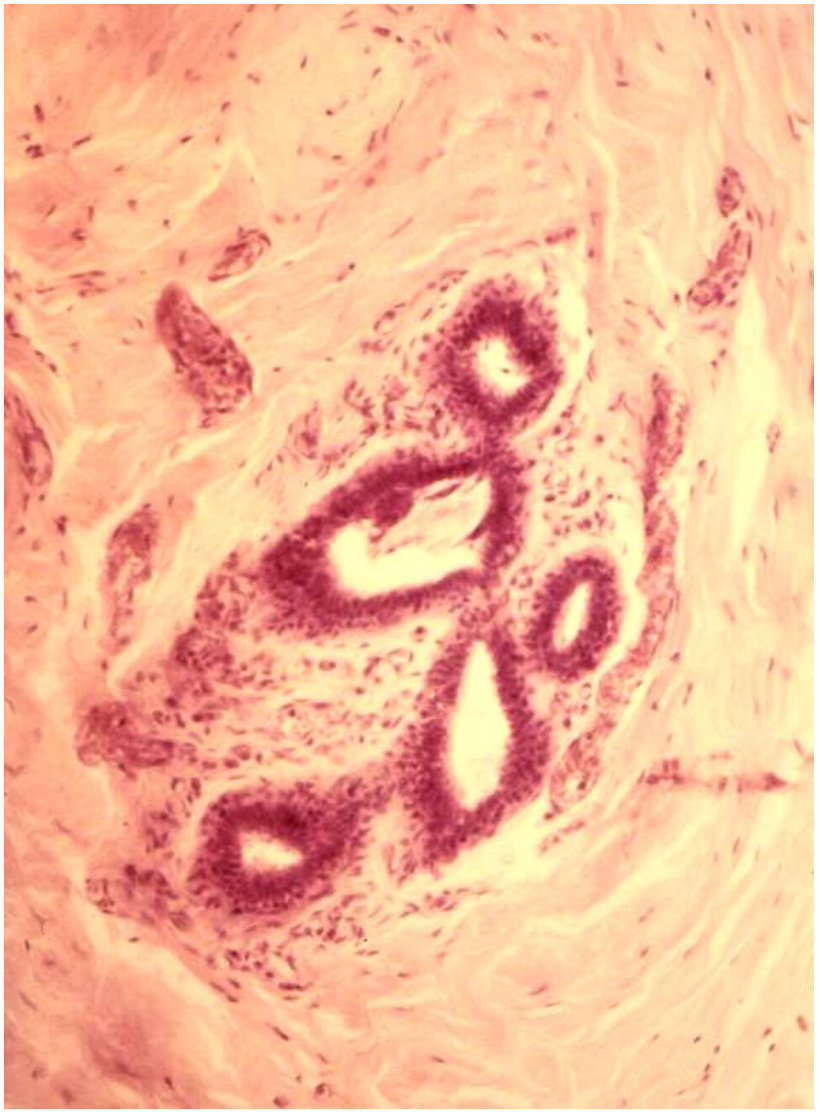
Mammary Gland – Lactating 5



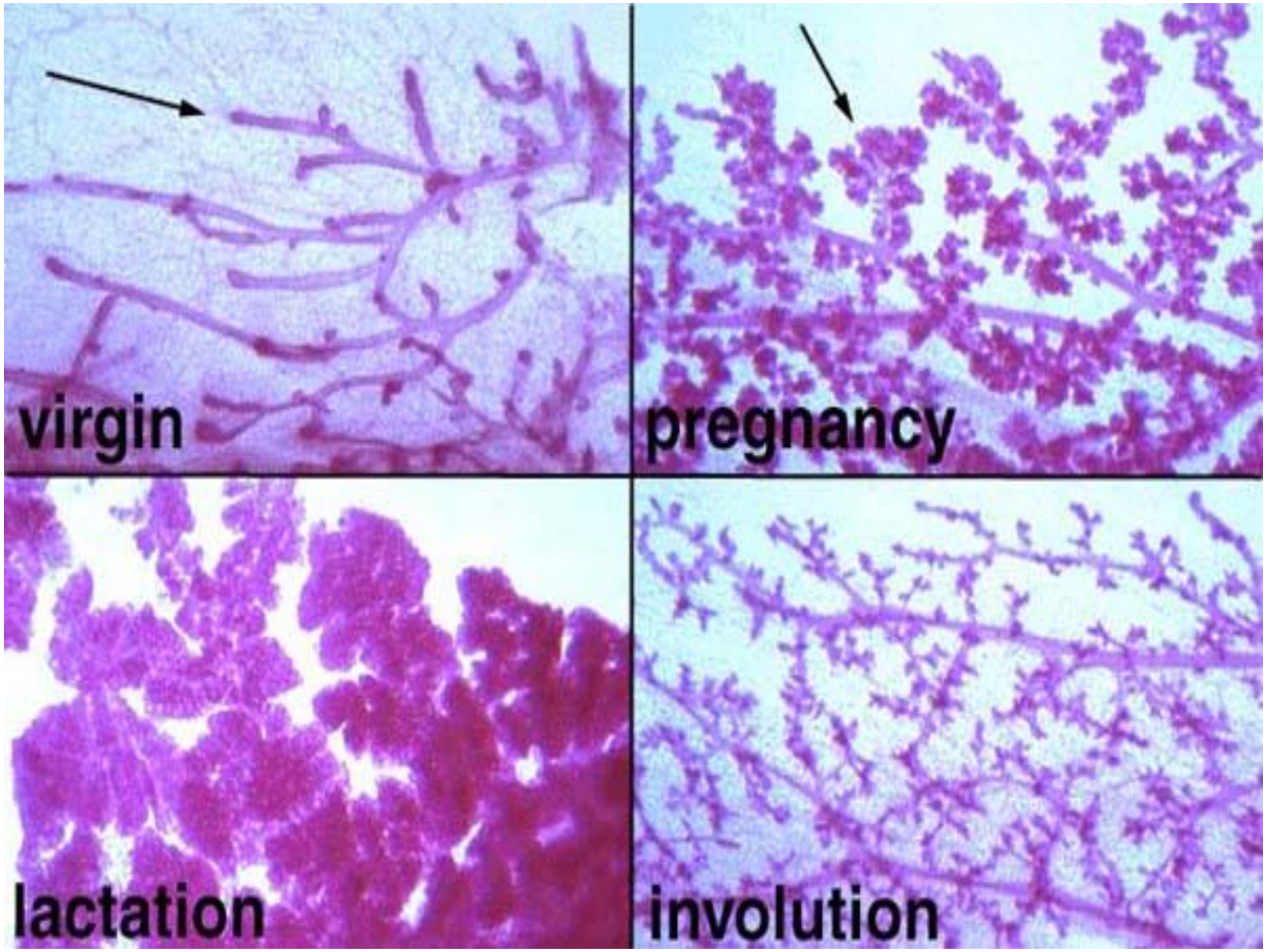


Mammary Gland – Involuting 1

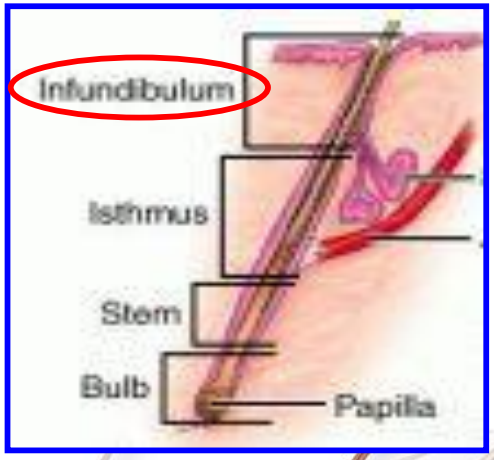
- atrophy and degeneration of the secretory cells
- milk biosynthesis ceases
- adipose cells occupy the empty space
- the duct system remains
- this process continues throughout menopause



Mammary Gland – States of development



Hair – Overall compostition



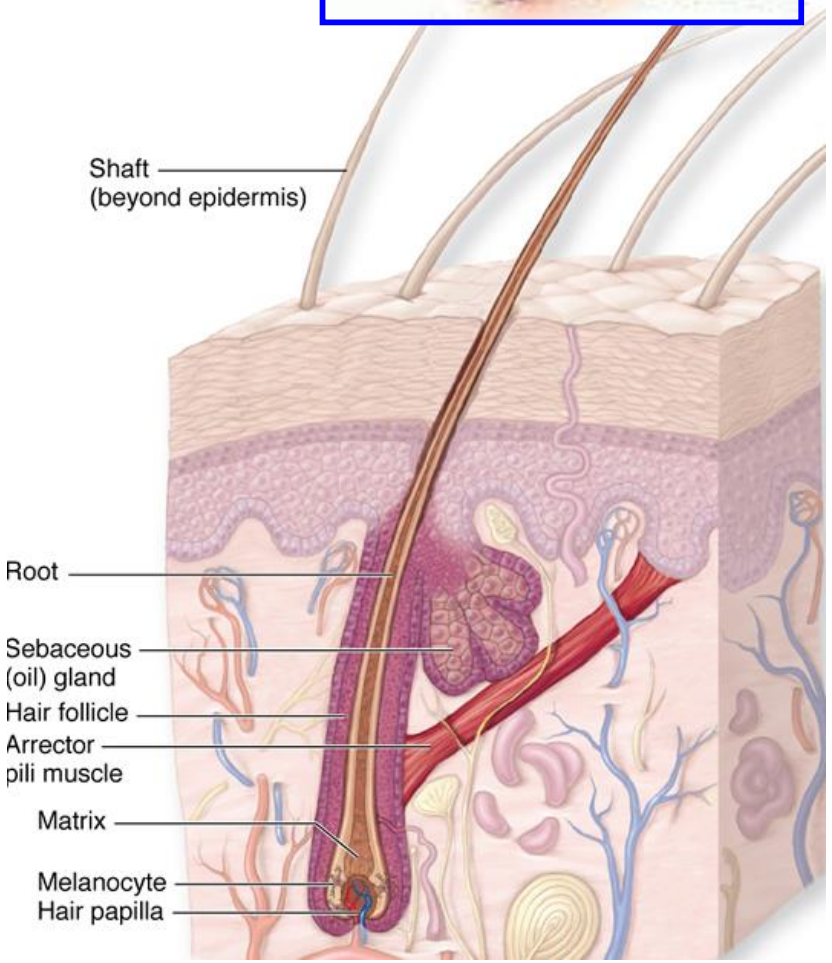
Shaft: portion of hair above surface
Root: portion of hair below surface
Cuticle: outermost layer of hair

Hair follicle: invagination of epidermis (to dermis / hypodermis)

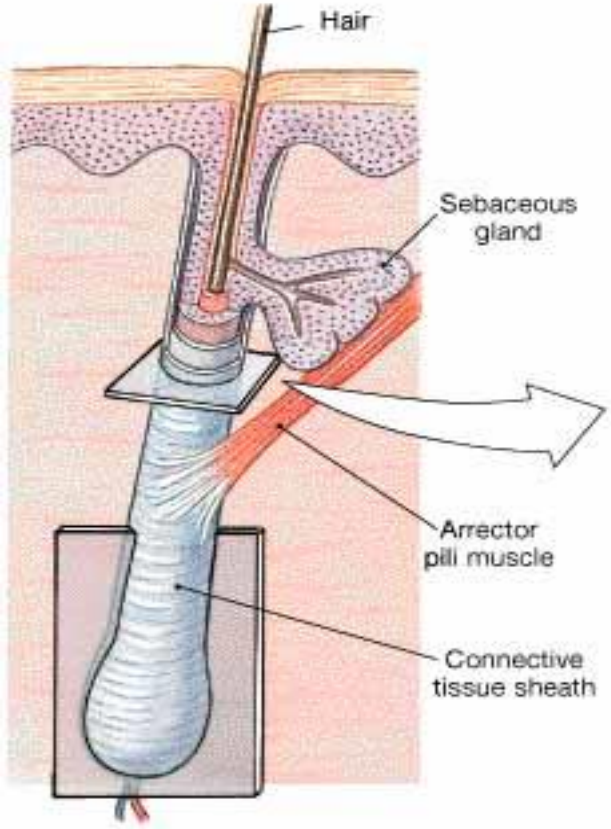
Hair bulb: at the base of the follicle (matrix - epithelial cells + melanocytes)

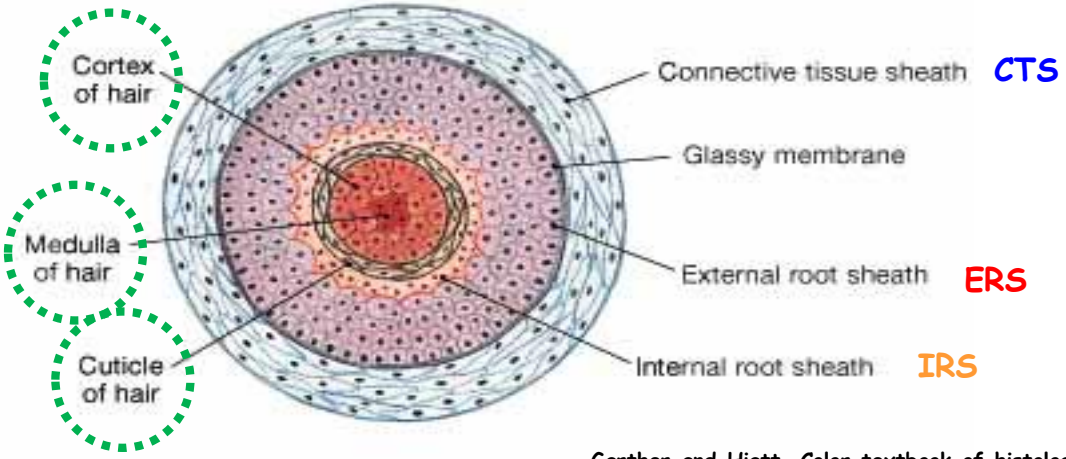
Hair papilla: projection of dermal connective tissue into bulb - contains blood vessels and nerves

Vellus x Terminal hairs

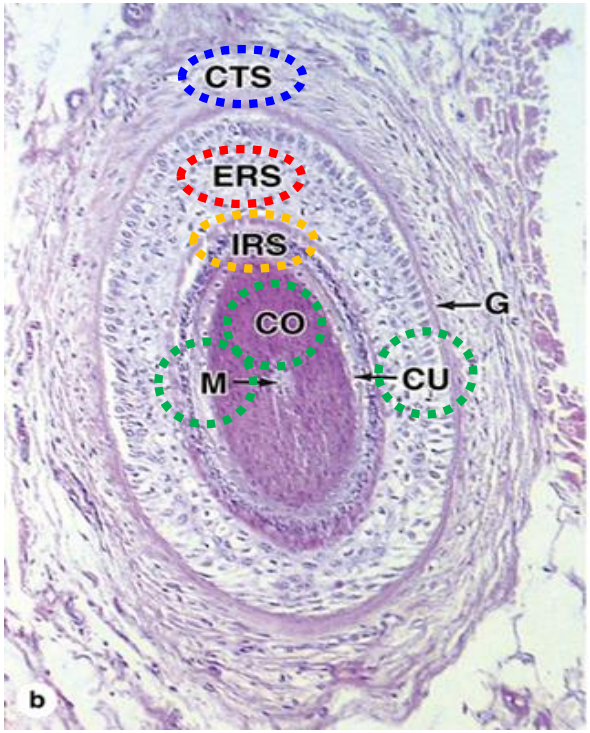


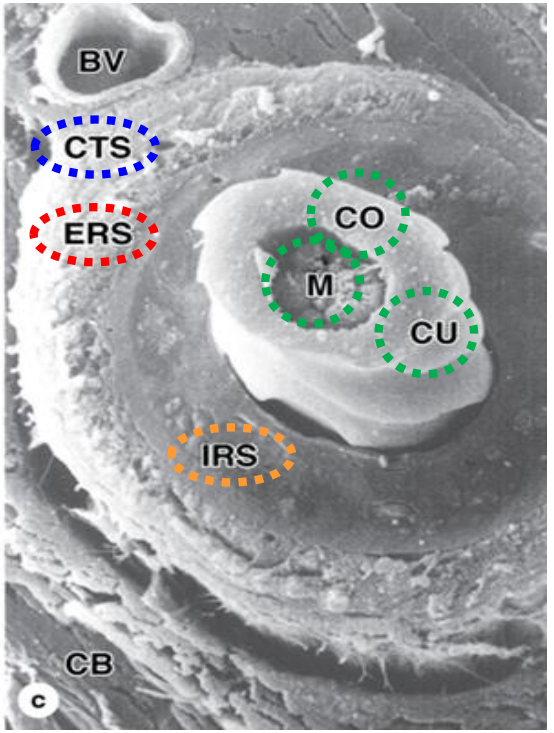
Hair structure 1



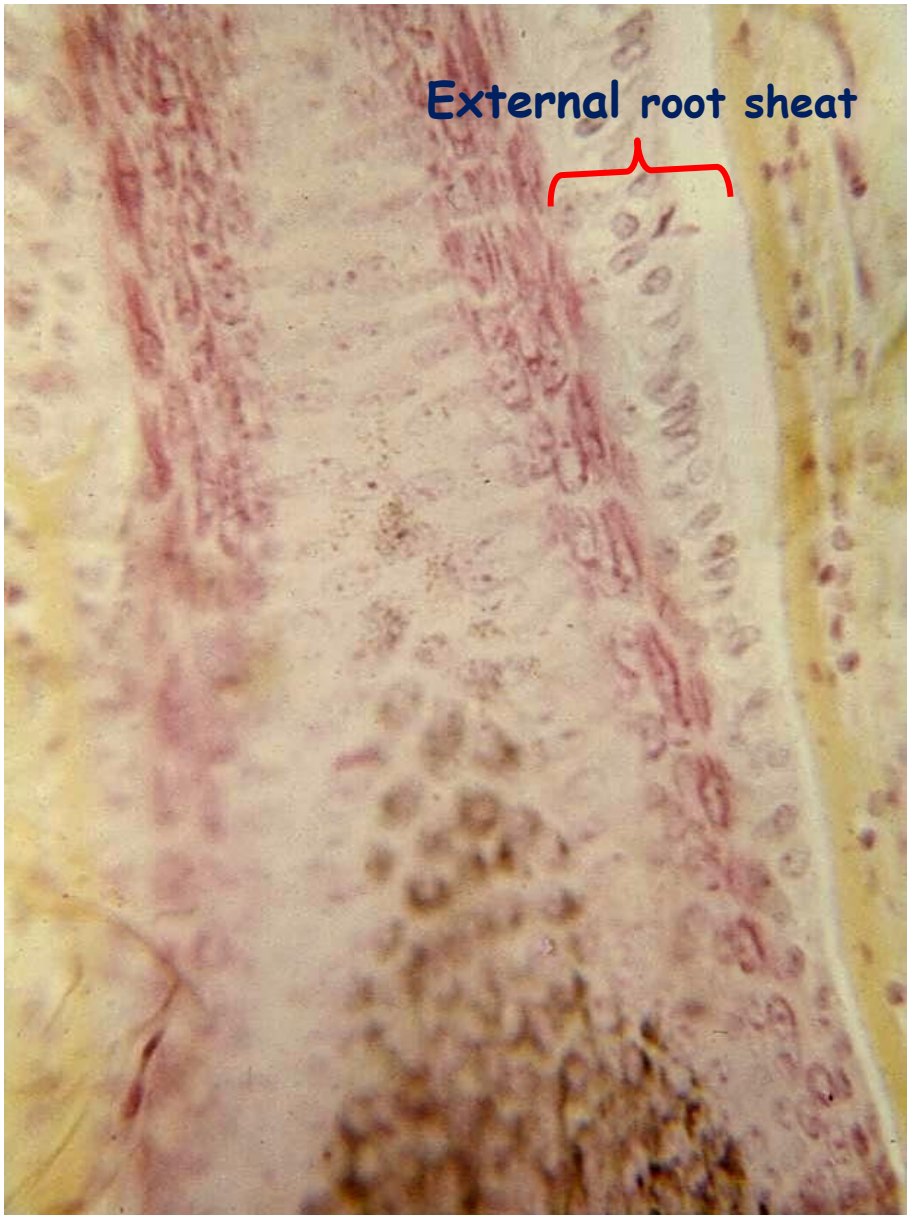


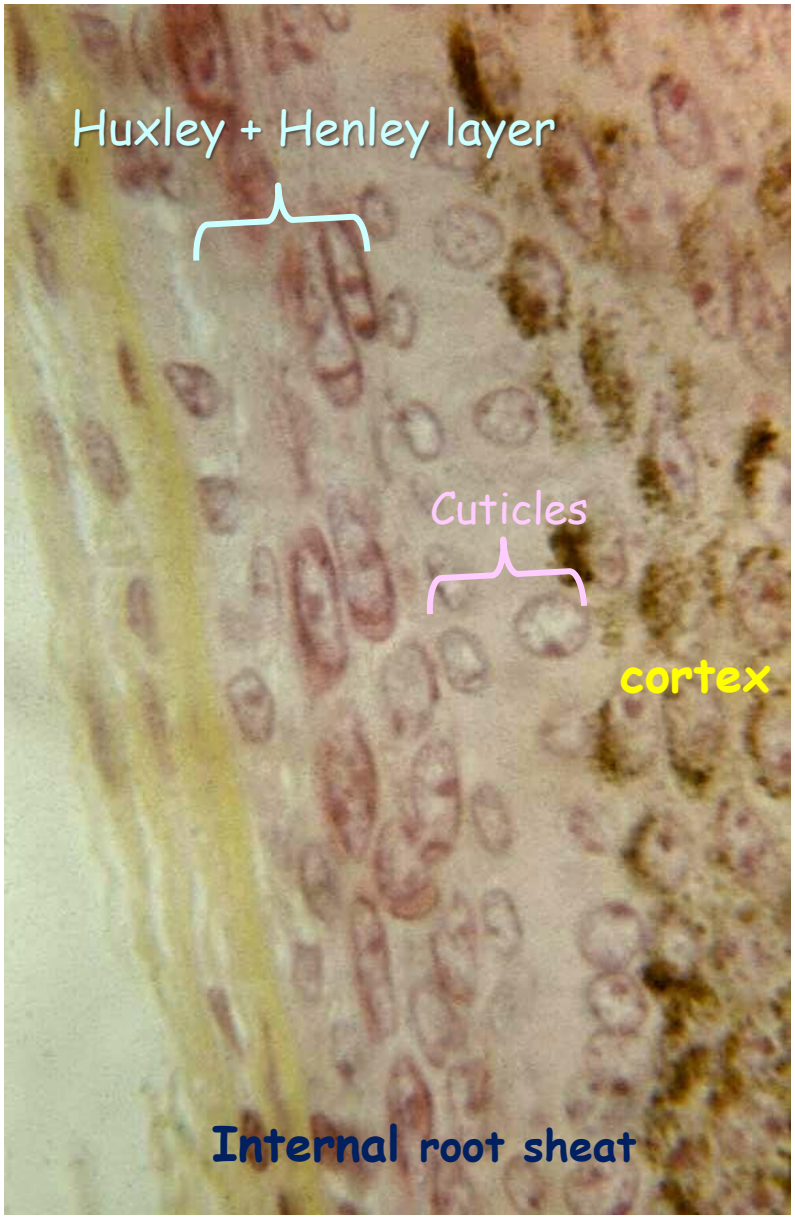
Garther and Hiatt, Color textbook of histology, Elsevier



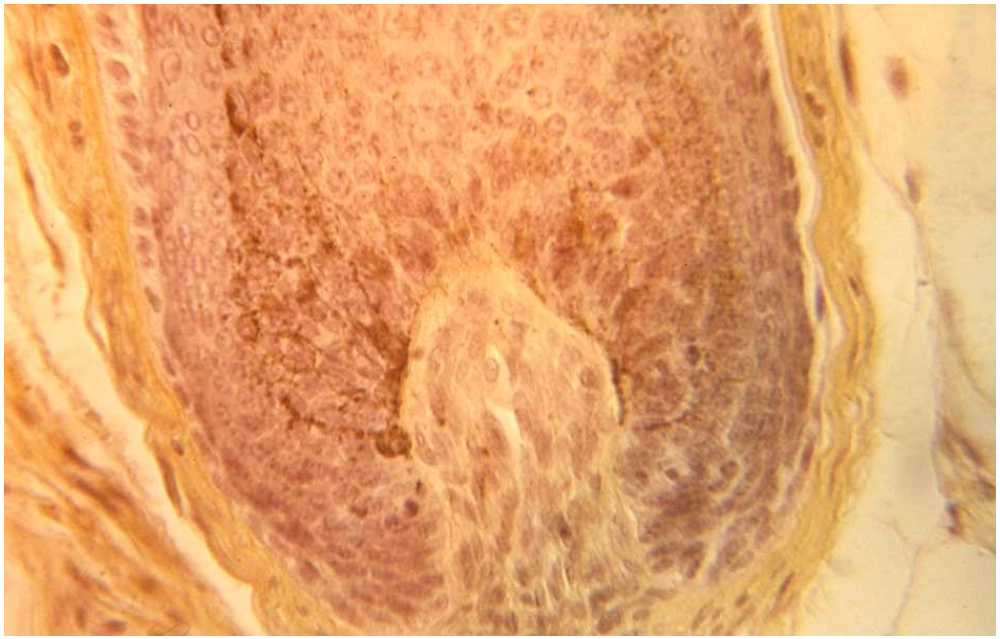


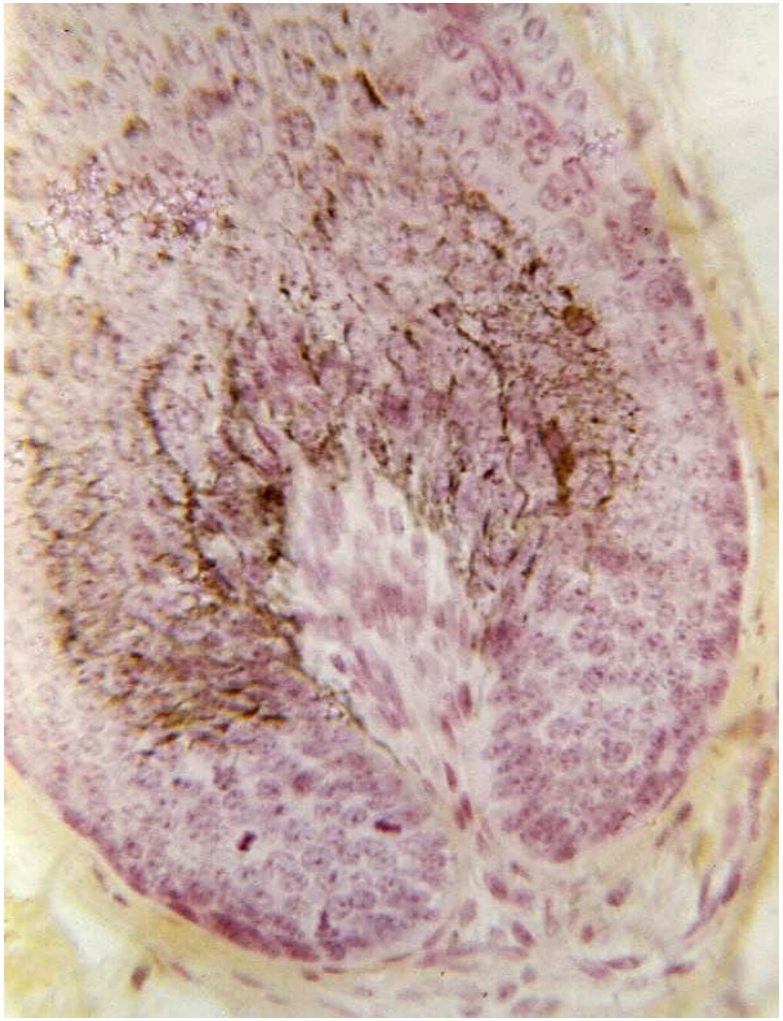
Hair structure 2



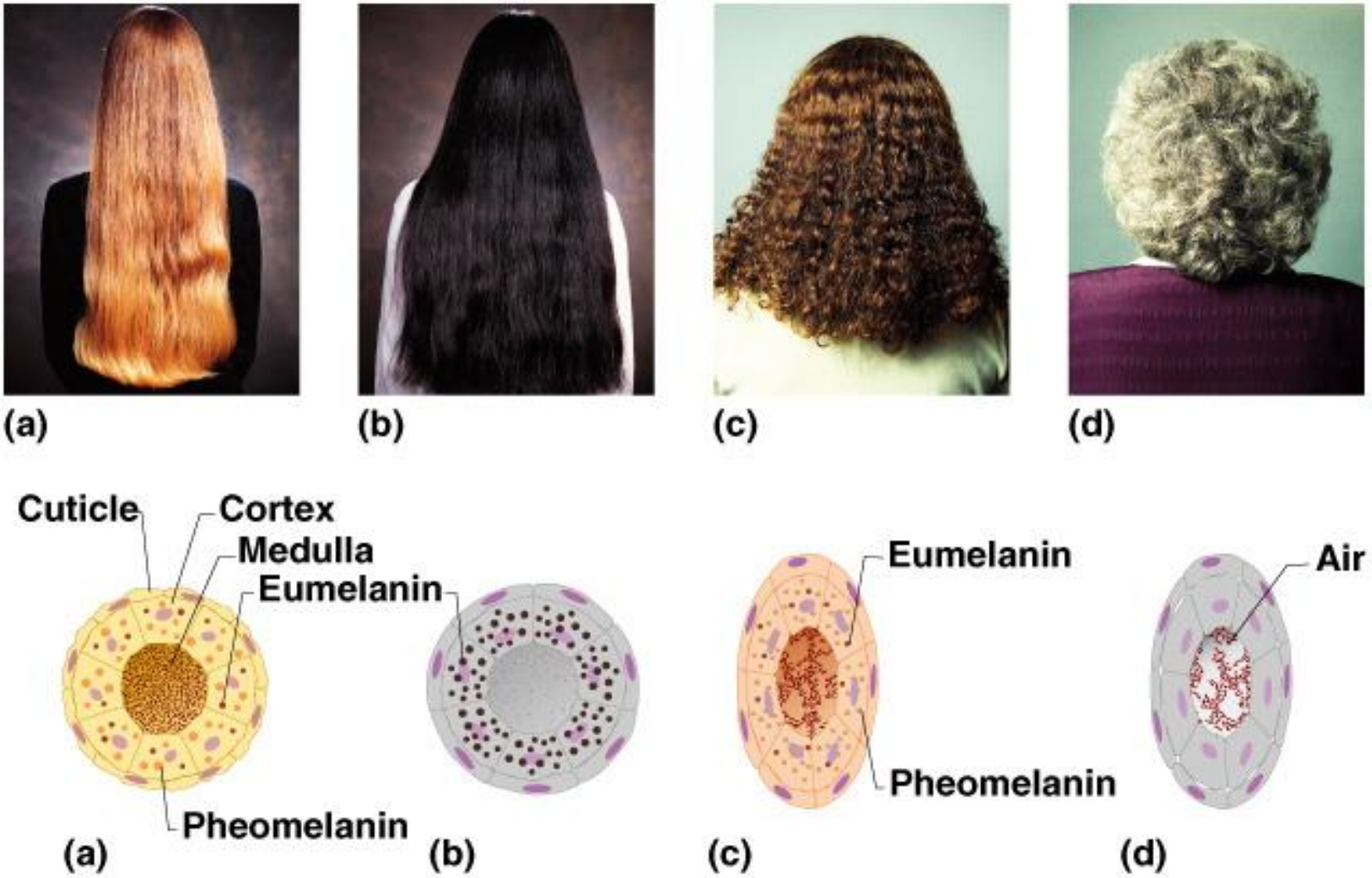


Hair bulb and papilla

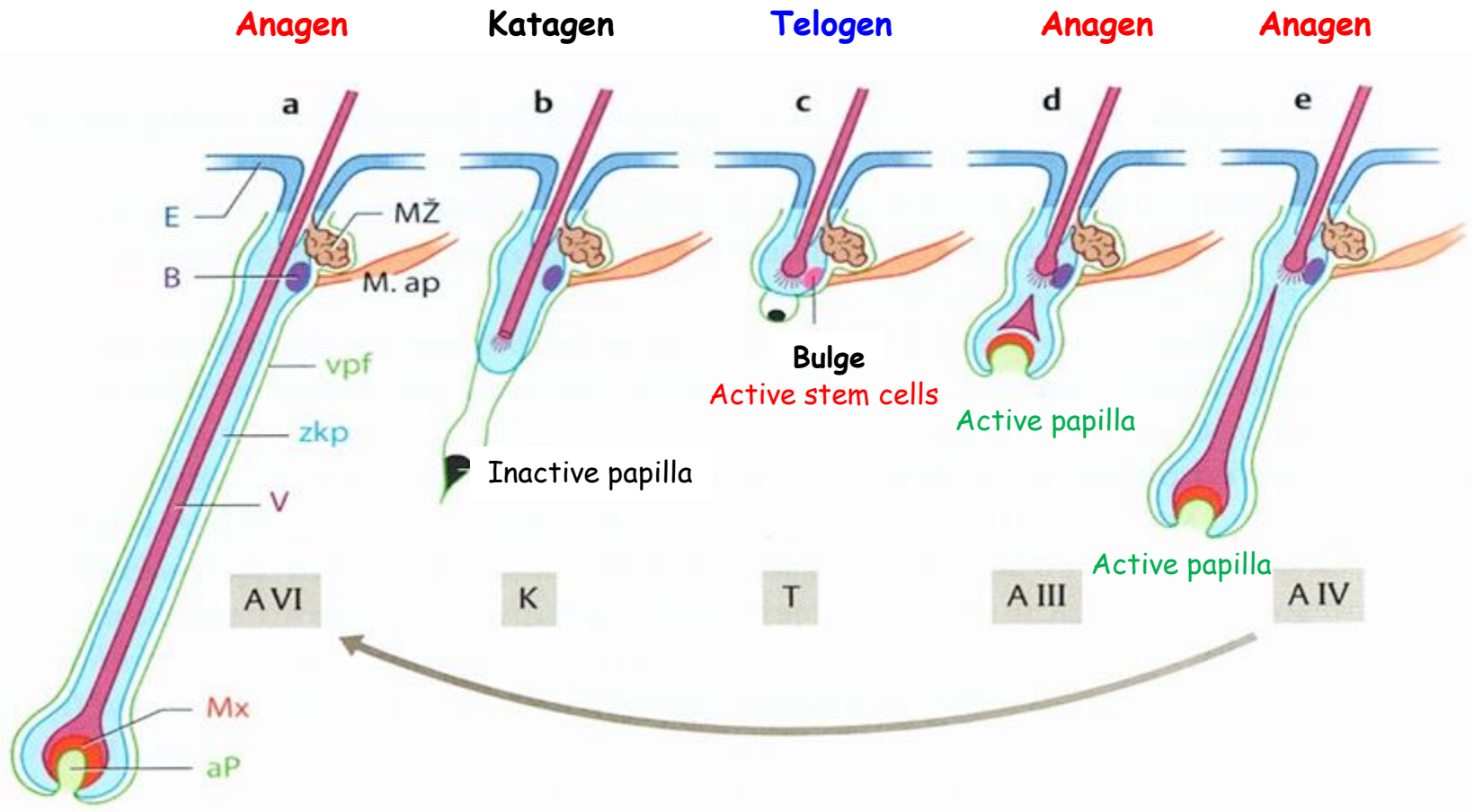




Hair – Color and Shape



Hair growth cycle

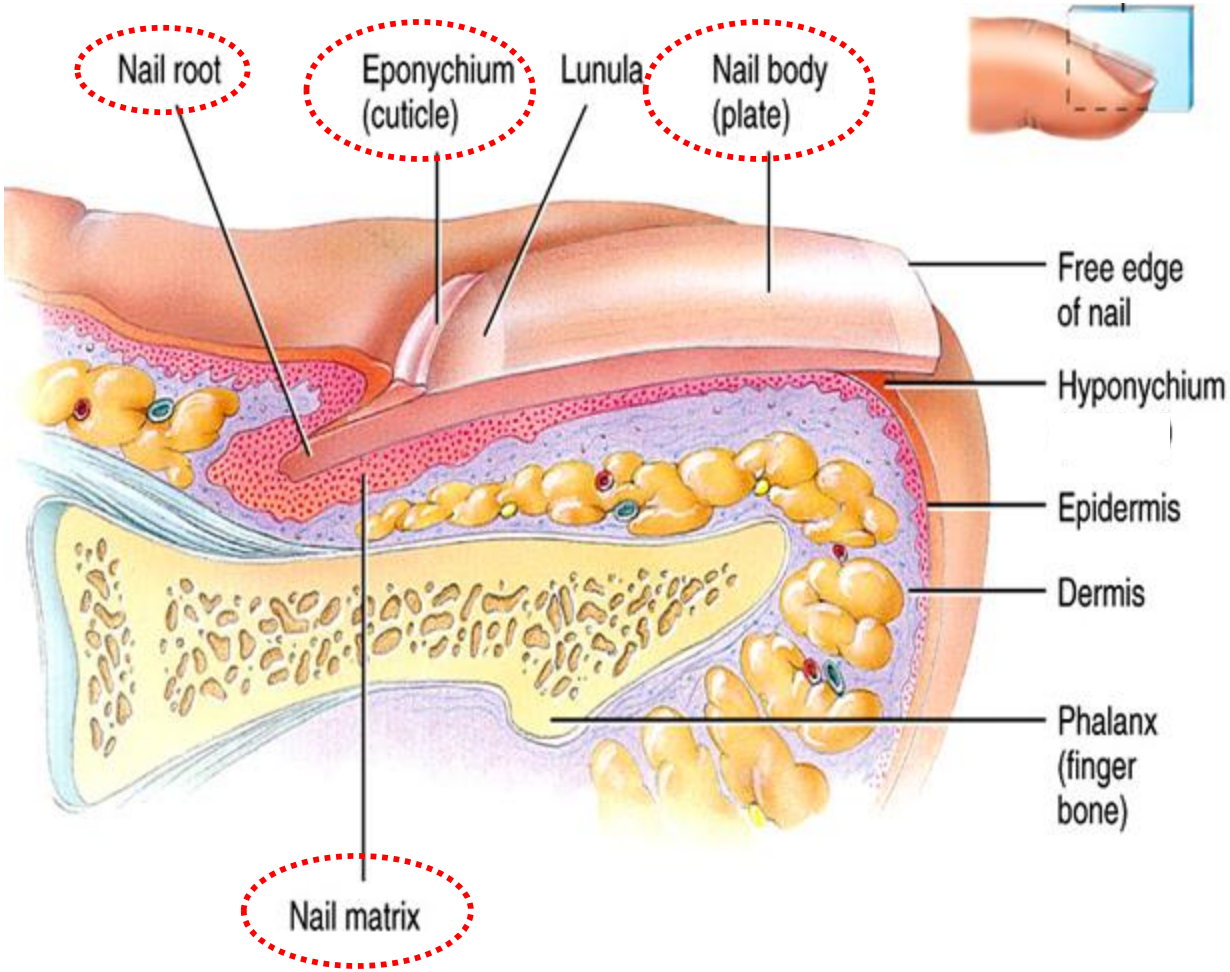


Active papilla

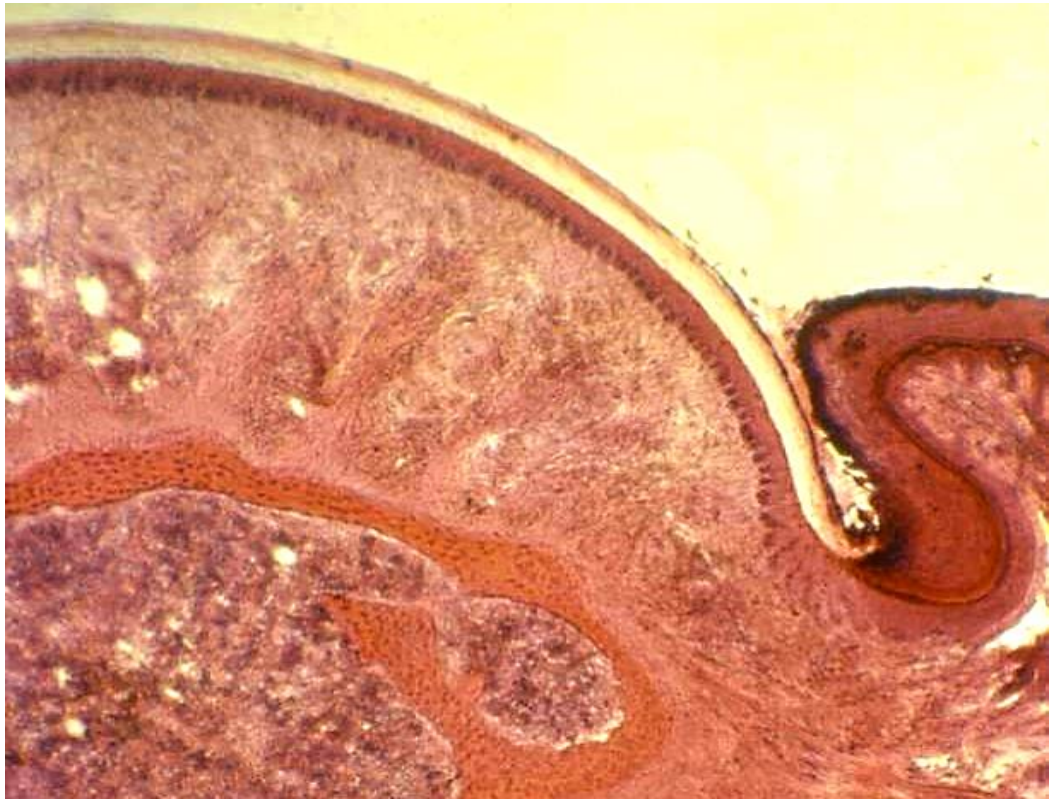
Anagen – months to years
Katagen – 3 weeks (involution)
Telogen – 3 months (resting)

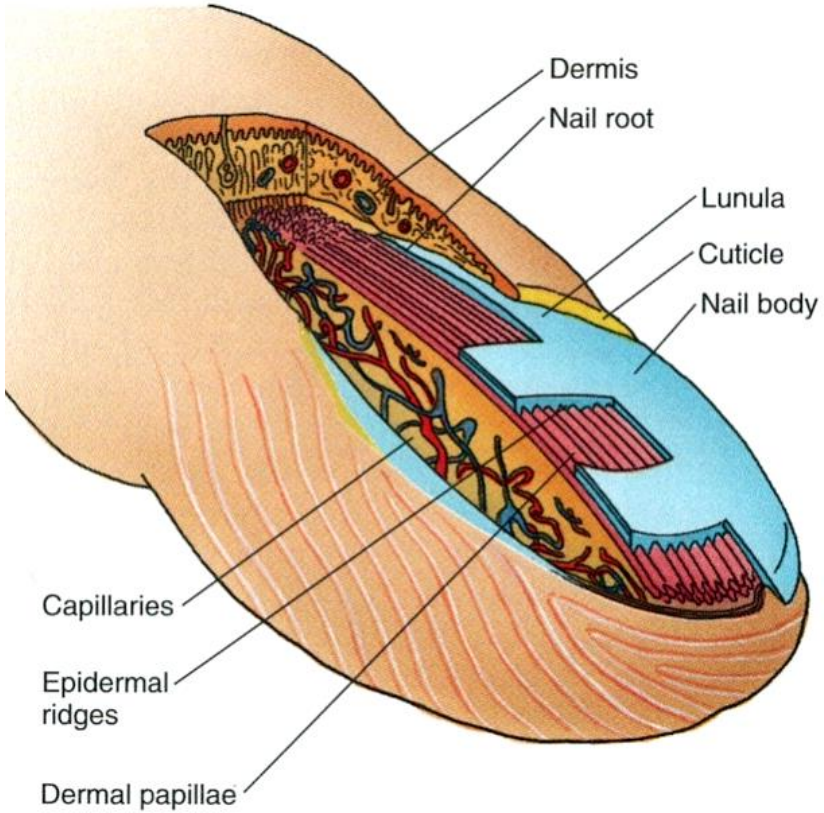
Nail 1

Nail plate (body) – „str. corneum"
Nail root – proximal part of the nail plate
Nail matrix - str. basale + spinosum (dividing)
Nail bed – str. basale + spinosum



Nail 2

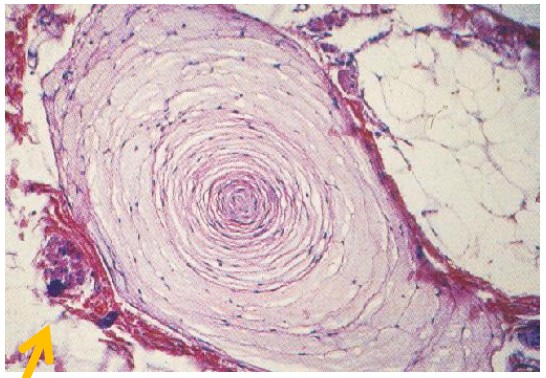



Dermis
Nail root
Lunula
Cuticle
Nail body
Capillaries
Epidermal ridges
Dermal papillae

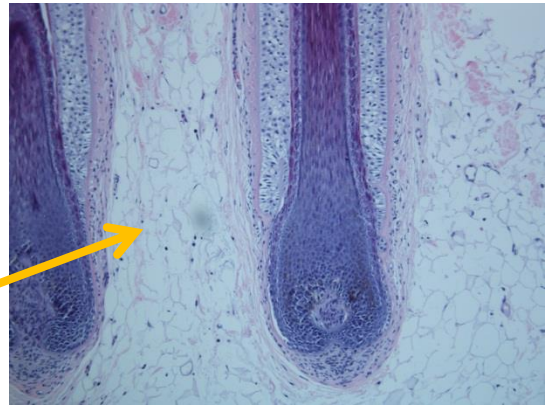
Subcutis - Hypodermis

Area deep to the dermis

- Loose connective tissue containing adipocytes, nerves, sensory receptors, arteries and veins (deep rete cutaneum)
- Provides a flexible attachment to the underlying muscle and fascia



Pacinian Corpuscle



Adipocytes

Hair bulb in the subcutis of the scalp

Skin development

Ectoderm

- Epidermis
- Accessory structures

Mesenchyme

(from mesoderm-dermatomes + unsegmented mesoderm-somatopleura)

- Dermis
- Hypodermis

A – Month 1 – simple surface ektoderm

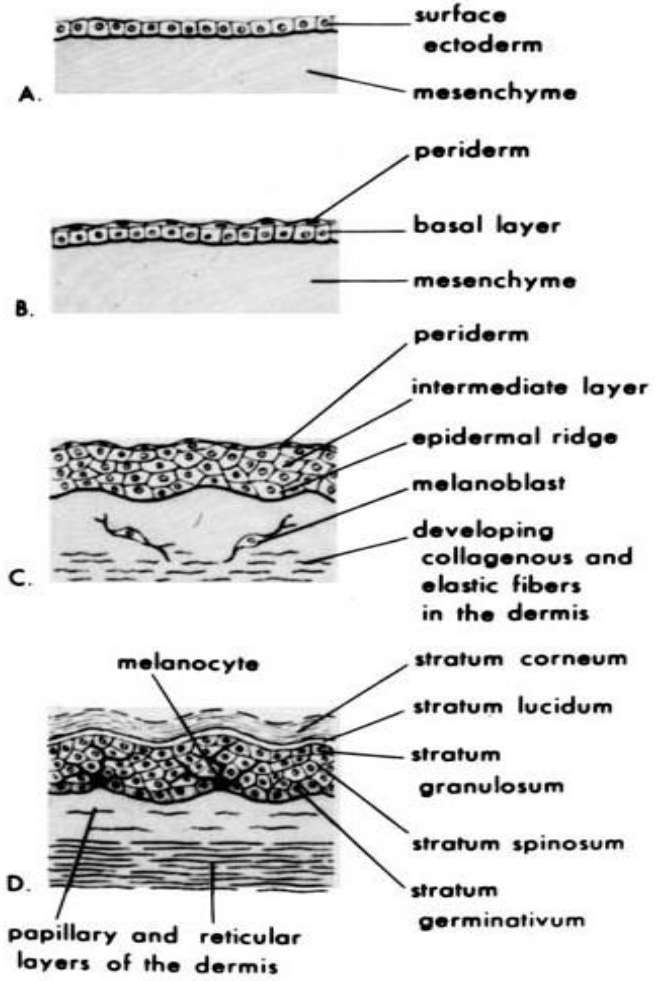
B – Month 2 – two layered epithelium:

basal layer + periderm (epitrichium)

C – Month 3 – basal + intermediary + periderm layers

(week 10-17 – formation of dermal ridges)

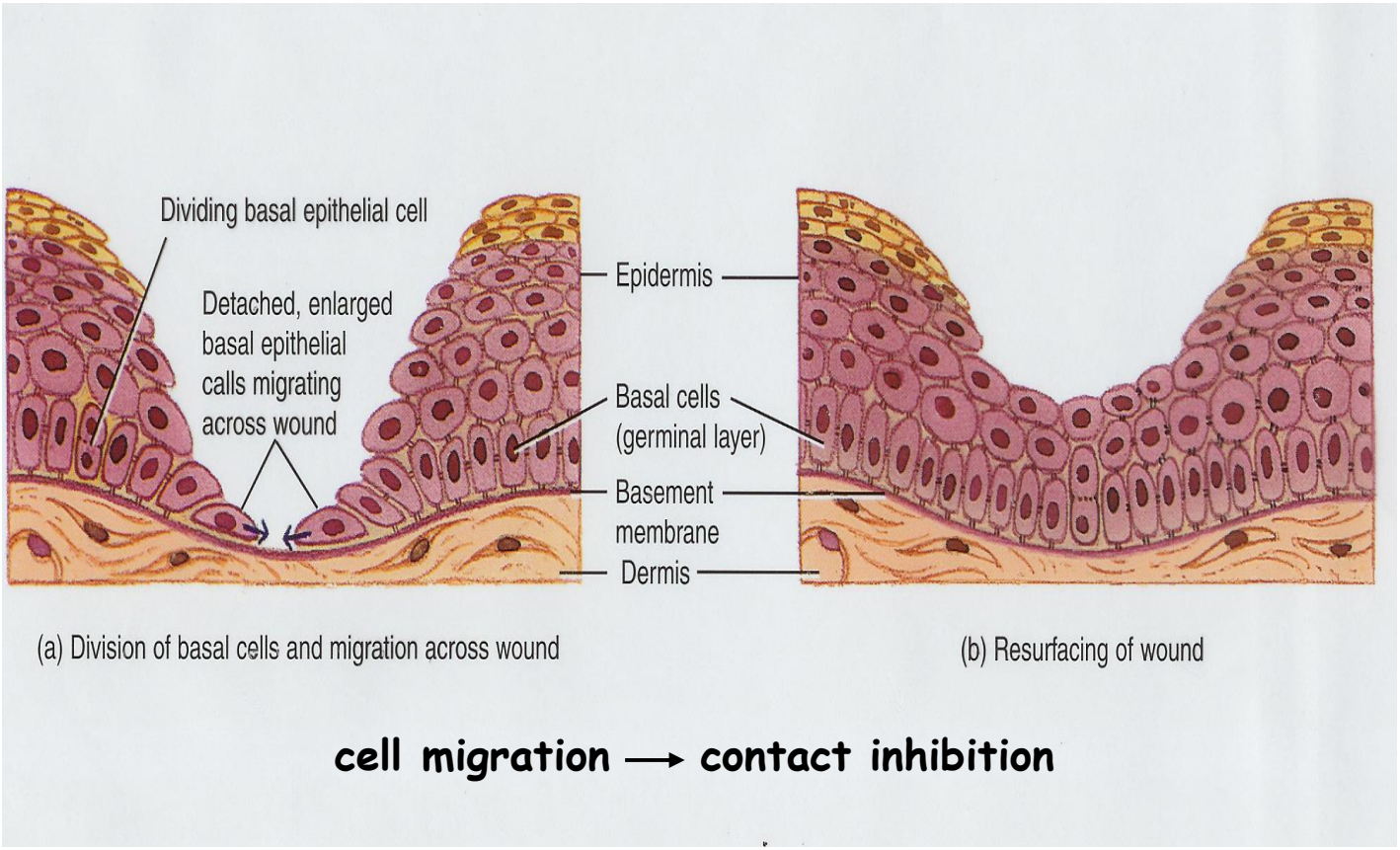
D – Month 5 (end) – periderm replaced by stratum corneum



Skin wound healing 1

Shallow cuts

Deeper wounds

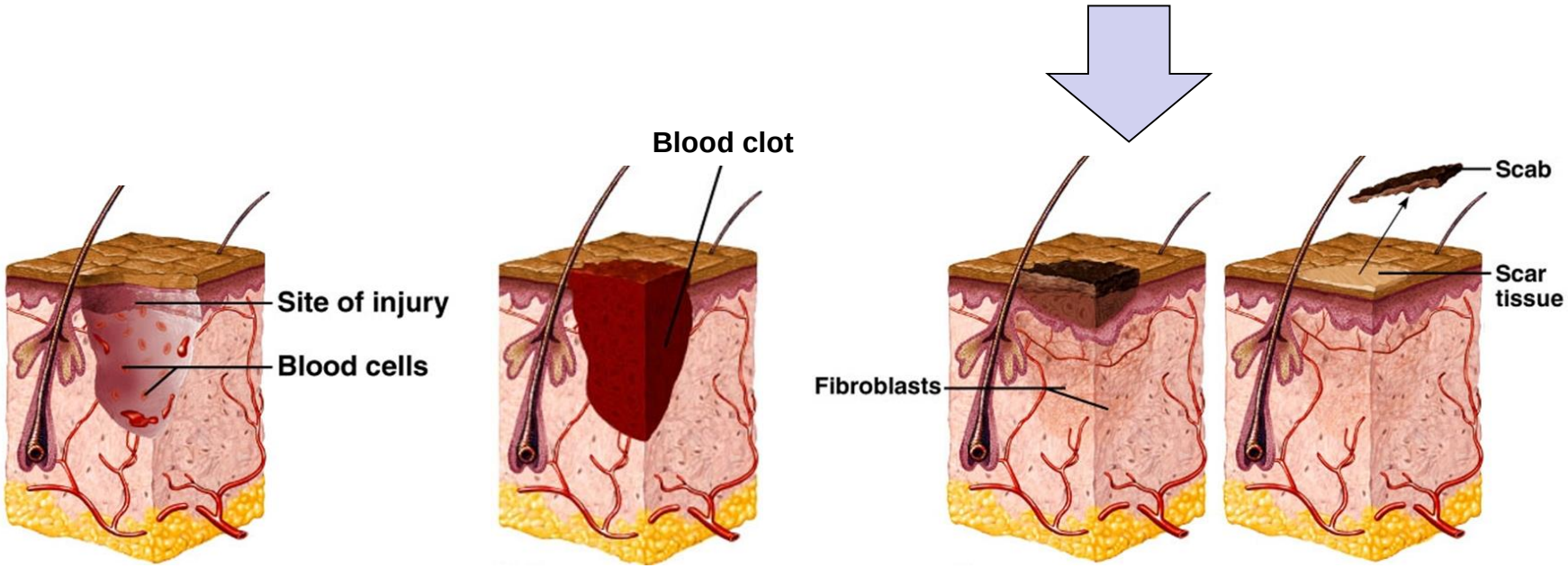


cell migration → contact inhibition

Skin wound healing 2

Shallow cuts

Deeper wounds



Inflammatory phase → **Migratory phase** → **Maturation phase**
+
Proliferative phase

Fibrin forms clot

Fibroblasts make granulation tissue

hypertrophic scar = keloid

Thak you for your attention!

Questions and comments at:
ahampl@med.muni.cz