

INTRODUCTION

Concept

1. Body's covering

a. Continuous with mucous membranes of all openings

- Nostrils
- Mouth
- Anus
- Urethra
- Vagina

b. Within depressions

- External ear canals
- Umbilicus

2. Organ vs. System

a. Integument as an organ

- Outdated concept
- Reasons for concept
 - flat, continuous over body
 - layered, as many organs appear

b. Integumentary system

- Current concept
- Reasons for concept
 - much more than just a covering
 - parts perform as separate organs
 - functions have systemic implications

Functions

[*Many same as epithelial*]

1. Protection

- a. Mechanical -- against trauma
- b. Chemical
- c. Osmotic
- d. Microbial
- e. Ultraviolet radiation

2. Mobility

- Permits varying degrees of freedom of movement
- Ex. highly modified over joints

3. Sensations

- Its position is ideal for awareness
- Sensations from various receptors (sense organs)
 - a. Pain
 - b. Touch
 - c. Pressure
 - d. Thermal

4. Temperature regulation

- a. Sweating
 - Eccrine sudoriferous glands
 - Wet skin carries away more heat
- b. Extra blood vessels
 - Papillary layer
 - Blood optionally circulated through

- closer to surface radiates more heat
- deeper retains heat
- Controlled by nervous system

c. Insulation from subcutaneous adipose

5. Blood pressure regulation

- Extra blood vessels -- different from temperature set
- Blood optionally circulated through
 - Through more vessels -- pressure dissipated
 - Through fewer vessels -- pressure enhanced
- Controlled by nervous system

6. Excretion

a. Sweat

- Water
 - utilized for cooling
 - waste metabolic substance, however
- Dissolved substances
 - in excess (Na & Cl ions)
 - toxic (ammonia)

b. Sebum

- Sebaceous gland secretion
- Ingredients are wastes, however

c. Heat -- from temperature regulation

7. Synthesis

- Vitamin D

- Within stratum basale & spinosum
- Converted cholesterol derivative + UV energy
- Benefit to entire body

8. Storage -- fat within adipocytes

9. Scent -- apocrine sudoriferous glands

Structural Plan

1. General

- Basically layered
 - Organs scattered within
- [*details later*]

2. Surface

a. Pitted

- Ducts
- Hair follicle openings

b. Furrowed

- Intersecting lines
- Geometric patterns -- on smoother surfaces
- Cobblestone look
 - over joints
 - analogous to transitional epithelium

c. Ridges/grooves

- Palms and soles
- Unique -- genetically determined
- Use & damage lines appear after birth

-- Functions

-- enhance grip

-- enhance tactile sensitivity

3. Thickness

a. Thinnest -- 1.5 - 2 mm (joints)

b. Thickest -- about 4 mm (dorsal cervical)

c. Thicker in men than women

EPIDERMIS

General

1. Relative thickness

-- Always thinner than dermis

-- Range -- 0.08 - 0.5 mm

2. Keratinization

-- Unique (excepting hard palate)

-- Only fully functional dead cells in body

-- Keratin

-- Fibrous protein

-- Very tough, flexible, water resistant

3. Receptors -- for light touch (e.g. free nerve endings)

Layers / Cell Replacement

1. Replacement

a. Reason

- Mechanical
- Upper keratinized layers worn away at high rate

b. Basic scheme

- Basal cells multiply
- Daughter cells ascend
- Synthesis of keratin occurs
- Reach stratum corneum
 - about 2 weeks
 - keratin synthesis completed
- Reach surface in about 2 weeks

c. Variability

- Faster with excess wear
- Under one week from base to free surface

2. Layers

a. Stratum basale

- Mitotic cell division
- Pigment cells -- melanocytes [*details later*]
- Nourished by underlying dermis

b. Stratum spinosum

- Intercellular cytoplasmic strands -- gives name
- Variable number of layers
- Mitotic cell division if required -- excess wear

c. Stratum granulosum

- Indistinct layer in thin skin
- Granules of keratohyalin -- keratin precursor

d. Stratum lucidum

- Absent in thin skin
- Contains eleidin -- keratin precursor

e. Stratum corneum

- Only several layers in thinnest skin
- 50 or more layers in palms & soles

DERMIS

General

1. Overall concept

a. Thickness compared with epidermis

- Generally 20 times thicker
- Palms & soles -- 8 times thicker

b. Connective tissue

- Dense irregularly arranged collagenous
- Tangled, intricate net-like

2. Importance

a. Responsible for most variations

- Thickness
- Toughness
- Flexibility

- b. Controls epidermis
 - Nourishment
 - Physical support

Layers

1. Papillary

- a. Less dense than reticular
- b. Extra blood vessels
 - Nourish epidermis
 - Body temperature regulation
 - Blood pressure regulation
- c. Serves as basement membrane for epidermis
- d. Papillae
 - 65,000 per square inch
 - Largest -- palms, soles, lips, nipples, penis & clitoris
 - Smallest & least numerous -- face & trunk
 - Provide surface area to aid interlocking with epidermis
 - Cause friction ridges
 - epidermis passively follows pattern
 - double row under each ridge
- e. Receptors -- e.g. Meissner's corpuscle for touch

2. Reticular

- a. Much thicker, coarser & denser than papillary
- b. Structure
 - Collagenous bundles -- parallel surface
 - Elastic fibers intermingled
 - Less vascular than papillary

- Cells -- mostly fibrocytes & macrophages (fewer)

c. Contains numerous organs

- Hairs

- Glands

- Receptors -- e.g. pressure

SUBCUTANEOUS (HYPODERMIS)

A. Adipose

1. Functions

- Insulation

- Protection – padding

- Storage

2. Variable distribution

- Men -- more neck, upper arms, lower back

- Women -- more breasts, buttocks, hips, thighs

- Anyone -- abdominal

B. Areolar

- Also termed superficial fascia

- More beneath adipose -- intermingled as well

- Provides flexibility over underlying muscles

PIGMENTATION

General

1. Melanin

a. Function

- Protection from ultraviolet radiation
- Color not a function; just a consequence of pigments

b. Structure

- Amino acid derivative
- Varies from yellow-brown to nearly black

c. Locations

- Epidermis
- Dermis -- sometimes
- Adrenal medulla
- Eye -- several locations (e.g. retina, iris)

2. Carotenes

a. Function -- ? -- definitely no UV protection

b. Lipid-related

c. Most common orange-yellow

3. Hemoglobin

a. Function -- oxygen transport in red blood cells

b. Skin color role

- Shows through to variable extent
- Depends upon other pigment types and amounts

Formation & Distribution

1. Formation

- Within melanocytes (-blasts)
- Between cells of stratum basale & spinosum (less often)
- Synthesize melanin
 - Always occurring at a basic level
 - Accelerated by increased UV exposure

2. Distribution

- Dendrites project from melanocytes
- Melanin injected into surrounding epidermal cells
- Melanin surrounds nucleus -- absorbs UV energy

3. Variations

a. Melanocytes

- Number fairly constant in everyone
- More or less basic activity
- More or less capable with more UV exposure
- Both amount & depth of distribution vary
- Albinism
 - no melanin
 - pinkish skin from hemoglobin
 - blue eyes

b. Freckles -- uneven distribution/activity of melanocytes

c. Trichosiderin

- Orange-red carotene
- Only in skin of "red headed" people

HAIR

Concept

- Considered to be an organ
- Function -- protection
- Epidermal origin
 - Mostly located within dermis -- sometimes into hypodermis
 - Homology of parts with epidermal strata

Formation

1. Origin -- from stratum basale
2. Growth & development
 - Column of new cells
 - Grow down, invading dermis
 - Keratinization process
 - Development towards hollow center of column
 - Keratinized cells form hair shaft
 - Shaft pushes up and out
 - Oldest part of shaft at distal end
 - Grows about 0.33 mm per day
 - Follicle wall layers equivalent to living epidermal strata
 - Accessory structures
 - Sebaceous glands [*details later*]
 - Arrector pili -- smooth muscle; no use

Changes

1. Resting follicle

- Follicle ceases growing
- Bulb shrivels -- it provided nourishment

2. Reactivation

- Germinal follicle layer begins new growth
- New bulb develops -- outgrowth of old bulb
- New root and shaft develops
- Old follicle pushed out
- Cycle is several months to several years long

3. Age changes

- Reactivation ceases for some follicles
- Hair amount decreases

Variations

1. Color

- a. Amount & distribution of melanin in shaft
 - Reflects light variably
 - Different from skin color
 - Gray / white -- air spaces
- b. Trichosiderin -- produces red hair

2. Texture

- a. Curly -- follicle & shaft very flattened (ribbon-like)
- b. Wavy -- follicle & shaft ovoid
- c. Straight -- follicle and shaft cylindrical

3. Sex

- Both sexes -- same number & distribution
- Texture & size vary in males & females

NAILS

A. Functions

1. Protection
2. Grasping

B. Structure

1. General

- Epidermal derivative
- More solid stratum corneum -- extracellular keratin
- Growth rate
 - about 1 mm / week
 - toenails much slower

2. Distinctive parts

a. Nail root

- proximal end, unexposed
- active growth area

b. Nail fold

- covers root
- eponychium (cuticle) its stratum corneum

c. Body

- exposed part
- hyponychium (quick) is skin attached beneath
- lunule (white) is more opaque / less vascular beneath

d. Nail bed

- beneath nail
- large dermal ridges; basale & spinosum follow
- growing nail slides over this, pushed from root

GLANDS

General -- *Entire Body*

1. Concept

- Organ [usually, but sometimes individual cells]
- Produces secretion and/or excretion

2. Secretion vs. Excretion

a. Secretion

- Synthesis & release of useful product

[*primary consideration at this time*]

- b. Excretion -- separation & elimination of metabolic waste products from body

3. Formation

- Epithelial origin -- begin in embryo
- Scheme
 - Localized extra cell division
 - Cells grow in column downward into connective tissue

- Develops lumen
- Distal portion becomes primary secretory area
- Upper portion varies [*details later*]

Classification (Types) -- *Entire Body*

1. Site of discharge

- a. Exocrine -- upper portion retained as duct
- b. Endocrine
 - Upper portion degenerates
 - Ductless -- hormone secretion into blood

2. Size

- a. Unicellular -- goblet cell
- b. Organs
 - Microscopic -- e.g. gastric
 - Macroscopic -- e.g. pancreas
 - typically subdivided into similar lobes
 - largest further subdivided into lobules

3. Structure

- a. Basic shapes
 - Tubular
 - Saccular (alveolar)
 - Acinar
- b. Complexity
 - 1. Simple -- 1 duct
 - single type has only one tube (e.g.)
 - branched has several tubes (e.g.)

2. Compound -- >1 duct

-- one main duct

-- >one main duct

4. Kind of secretion

a. Mucous -- e.g. goblet or esophageal

b. Serous

-- Watery, with dissolved substances

-- e.g. pancreas

c. Sero-mucous

-- Both, from different gland regions

-- e.g. salivary

d. Lipid -- e.g. sebaceous

e. Cellular

-- Live -- sperm or ova

-- Dead -- sebaceous

5. Method of secretion [*examples later*]

a. Merocrine (eccrine)

-- Specific type of exocytosis (reverse pinocytosis)

-- Secretion within vesicles

-- Vesicles fuse with inner cell membrane

-- Released by membrane rupture

-- Vesicle membrane simultaneously closes opening

b. Apocrine

-- Secretion accumulates at free end of cell

-- Secretion-containing free end pinches off

-- Cell regenerates lost portion

c. Holocrine

-- Secretion accumulates within entire cell which dies and disintegrates

-- Not a substance – living cells (e.g. sperm & ova)

Integumentary Glands

1. Sebaceous (oil)

a. Structure

-- Associated with hairs -- simple, branched alveolar

-- Independent -- compound alveolar

b. Functions

-- Soften stratum corneum surface and hair shafts

-- Bacteriostatic

-- Excretion

c. Secretion -- sebum (oily, but not true oil)

-- Fatty acids -- various

-- Glycerides -- di- and mono-

-- Cholesterol

-- Waxes -- various

-- Cellular debris -- due to holocrine method

d. Variations

-- Most numerous & largest, non-hair associated -- face, back, chest, nipples

-- Meibomian glands -- eyelashes

-- Acne -- blocked, inflamed ducts from overactivity

2. Sudoriferous ("sweat")

a. "Apocrine"

1. Misnamed -- really secrete by merocrine method
2. Structure
 - simple, branched tubular
 - empty into hair follicles
3. Do not produce true sweat
 - slight secretion, sticky
 - mostly proteins
4. Scent primary (only ?) function
 - secretion mixes with sweat
 - bacterial breakdown products cause aroma
5. Restricted locations
 - axillae
 - areolae
 - umbilicus
 - genital
 - anal
 - external ear (ceruminous glands, ear wax)

b. Eccrine -- true sweat glands

1. Structure -- single coiled tube
2. Function
 - body temperature regulation
 - excretion

3. Secretion

- water (about 99%)
- excess ions (Na, K, Mg, Cl, HCO₃, etc.)
- urea (much, from amino acid metabolism)
- ammonia (some, from amino acid metabolism)
- lactic acid (much, from muscle metabolism)
- excess amino acids (some)
- excess proteins (slight)
- excess lipids (slight)

4. Variations

- 200-300 / cm²
- more in hairless skin
- insensible sweat always occurs (300-700 ml/day)
- in high temperatures/activity (10-14 L/day)

3. Mammary

a. Structure

- Very complicated compound alveolar
- 15-20 lobes (per breast) -- each with lactiferous duct
- Each lobe subdivided into lobules
- Reduced or absent until pregnancy

b. Function -- infant nutrition

c. Secretion -- apocrine method

- Water (88%)
- Proteins -- caseins & lactalbumins
- Lactose -- disaccharide (glucose + galactose)
- Lipids -- fats, phospholipids & cholesterol
- Vitamins -- complete, with variable amounts
- Ions -- Ca, P, Na, Cl, K, Fe, I, Zn, Mg, S, & many trace
- Enzymes -- significance-?
- Antibodies
- Bifidus factors -- promote normal intestinal bacteria