The following module contains hyperlinked information which serves to offer more information on topics you may or may not be familiar with. We encourage that you read all the hyperlinked information.
Structure and Function of Skin
The basic science description in this module will assist you in understanding diseases seen in clinic and in future modules.

If you know how the skin works you know how to make it better when it is broken (it’s the same as biomechanics and gait).
Basic Science

- The skin is composed of 3 layers:
  - A. Epidermis
  - B. Dermis
  - C. Subcutaneous tissue (fat)
Epidermis

- **Structure of epidermis**: the epidermis is the outer layer of skin that is constantly replaced
  - Keratinocytes (squamous cells): make up the epidermis and produce keratin
  - Melanocytes: pigment producing cells at the basal layer
  - Langerhans’ cells: immune cells responsible for antigen presentation and phagocytosis
  - Hair and sweat glands: specialized structures derived from the epidermis
- **Function**: protect against the environment and infection and prevent excess water loss
  - **Burn victims who lose large amounts of epidermis become dehydrated and develop infections**
Epidermis

- The epidermis is composed of multiple layers:
  - 1. Basal Layer: Source of replacement cells
  - 2. Spinous Layer: Center of epidermis where keratinocytes make keratin
  - 3. Granular Cell Layer: Site of water barrier
  - 4. Stratum Corneum: Thick keratinized outer layer providing anti-trauma and anti-infectious barrier
Epidermis on Histology

- **Stratum Corneum**
- **Granular layer** (contains purple keratinohyaline granules)
- **Stratum spinosum** (spiny processes separate keratinocytes)
- **Basal layer**
The type of epidermis produced is determined in part by the type of keratin protein that skin makes. This is the reason some diseases are confined only to the palms and soles.

The granular layer and stratum spinosum are thick in the palms and soles (~1mm) and virtually absent on the abdomen and thin skin surfaces (~0.1mm).
Melanocytes

- Melanocytes are specialized neural crest cells that produce melanin, a protective pigment designed to absorb UV rays
  - They are found in the basal layer at a rate of 1 for every 10 keratinocytes
- The purpose of melanin is not currently known
  - It does help prevent skin cancer and UV damage, but may have additional functions
Melanocytes

- **All tanning is a reaction to skin (DNA) damage!**
  - In tanning, melanocytes begin to produce more melanosomes as a response to UV damage but retain the same number of melanocytes
- **Some skin lesions affect melanocyte number, others melanosome density**
  - Vitiligo has decreased melanocytes from autoimmune attack whereas albinism has a normal number of melanocytes with decreased melanosomes due to an enzyme defect
  - Freckling is a result of an increase in melanosomes whereas nevi result from an increase in melanocytes
Langerhans’ Cells

- Langerhans’ cells are immune (antigen presenting) cells in the stratum spinosum that present antigens to T cells
  - They are derived from the monocyte-macrophage lineage
- They initiate the immune response to antigens passing through the epidermis (such as poison oak resin) or arising within the epidermis (such as early skin cancers)
- Langerhans’ cells are damaged by sun light
Langerhans’ cell

Steps in immune cascade:
1. Antigen taken up by LC
2. LC enters lymphatic vessel
3. LC enters a lymph node to become dendritic cell expressing B7
4. B7 then stimulates helper T cells via CD28 receptor
Basement Membrane Zone (BMZ)

- The BMZ holds the epidermis to the dermis
  - It is porous allowing for transmission of cells and fluid
- Many blistering diseases occur through this region
  - Ex. Bullous Pemphigoid where the hemidesmosomes of the BMZ are targeted
Hair Follicles

- A hair follicle is a specialized structure of the epidermis producing a unique keratin structure called HAIR
  - The hair bulb divides to make a hair shaft and melanocytes in the bulb are responsible for producing hair color
- Hair follicles cycle continuously growing a new hair every 3-6 years, but this is variable among people as some can grow longer hair than others
  - The length of hair is determined by the length of the growth cycle
    - Typically growth rate of hair is ~1 cm per month → 12 cm per year → 72 cm (30 inches) over a 6yr growth cycle
Phases of Hair Growth

- **Anagen** is the growth phase, typically 3-6 yrs, 85-90% of hairs are in anagen at any one time.
- **Catagen** is a 3 wk transitional stage between anagen and telogen.
  - Typically no hairs on biopsy will be in catagen. Catagen hairs are seen in pathologic processes such as trichotillomania.
- **Telogen** is the shedding phase where the hair falls out, typically telogen is approximately 3 months. At any time 10-15% of hair is in telogen.
  - This is why it is normal to lose 100 or so hairs each day.
  - Typical human has ~100,000 hairs. If you lose 100 per day, you would go through an entire hair cycle in 1000 days or approximately 3 years.
- The “pull test” is used to diagnose abnormal hair loss.
  - Hairs are gently tugged and no more than 10-15% should come out as no more than this should be in telogen. (ex. If 20 are pulled, 2 should come out)
  - Alopecia areata, a condition causing patchy hair loss, has an abnormal “pull test” at active sites as a large percentage of hairs are in telogen.
Sebaceous Glands

- Sebaceous glands are a component of the hair follicle and after puberty secrete oil (sebum) which is driven by ANDROGENS.
- Sebum is one of the components in the pathogenesis of acne vulgaris.
- Function: Unknown except to make your skin shiny, give you zits, and make your hair stick together if you don’t shampoo.
Nails

- Nails function to grasp small objects and protect the fingertip from trauma
- The nail plate is composed of keratin produced by special cells and surrounded by specially evolved skin
- The whole complex is called a nail unit
- Nails grow ~0.1 mm per day (~3 mm per month)
- It takes 4-5 months to regrow a fingernail, however toenails grow slower requiring up to 12-18 mo to regrow the hallux, or big toe, nail
Sweat Glands

- There are two types of sweat glands: eccrine and apocrine.

- Eccrine glands produce sweat and cool you down (and make your clothes disgusting, and your palms and soles sweaty).
  - Mainly found in palms, soles, forehead, axilla.

- Apocrine glands in your armpits and groin make BO (Body Odor) from bacteria breaking down the apocrine sweat.
  - Only found in axilla, areolae, and anogenital region.
Dermis

- The dermis forms the firm part of your skin, above the fat
  - Dermis is made up of 2 layers:
    1. Papillary dermis, which is loosely arranged
    2. Reticular dermis, which is tightly organized
- The dermis contains proteins (collagen (97%) and elastin (3%))
  - Type I collagen is the predominant collagen type
  - Type IV collagen makes up the basement membrane
  - Type VII collagen makes anchoring fibrils
- The dermis ranges from very thin (eyelids ~1mm) to very thick (chest and back ~4mm)
- It contains the nerves and blood vessels of the skin
- It has receptors for touch, temperature, pain, and itch
Blood Vessels of the Dermis

- The blood vessels in the dermis have two functions:
  1. Delivering nutrients
  2. Temperature regulation
- The vessels are organized into two horizontal plexi, one in the papillary dermis and one in the reticular dermis at the dermal-subcutaneous junction
- Shunting blood through the upper dermal vessels leads to more heat loss, and through the deeper dermis conserves heat
Blood Vessel Organization

- Dermal Papillary Loop
- Deep Horizontal Plexus
- Superficial Horizontal Plexus
- Perforating Arteriole
Mast Cells

- Arranged along dermal blood vessels
- Contain histamine, heparin and other products that are either preformed or produced which act on blood vessels as well as release inflammatory cytokines
- Very important in allergic disease and itching

Mast Cell Granules
Examination of Skin
Components of Dermatological Evaluation

- History (Subjective)
- Physical Examination (Objective)
- Diagnosis (Assessment)
- Plan
- SOAP note
A dermatologic history is similar to other fields of medicine and includes:

- Chief Complaint
- History of Present Illness: Onset and evolution, Symptom (itch, pain), Current Treatments
- Past Medical History (PMH)
- Allergies
- Medications
- Family History (especially psoriasis, atopic dermatitis, allergic rhinitis, asthma, and skin cancer, particularly melanoma)
- Social History: Occupation, living state (may become important in the case of allergic skin reactions)
- Review of Systems
Physical Examination

- Be complete, examining both places that the patient indicates there may be a lesion as well as places the patient may not be obvious to the patient
  - For example, it is important to examine the cleft of the buttock in a patient with psoriasis
- For skin cancer patients, a complete examination of all sun exposed areas is essential (full body skin exam)
- Adequate illumination is essential for seeing skin lesions
- Magnification may help in identifying lesions
- Palpate lesions (with gloves)
Describing Skin Lesions

- Carefully describe ALL skin lesions
- Indicate the distribution of lesions (where they are on the body)
- Indicate configuration of lesions (shape and grouping)
- Indicate the color of lesions
Types of Skin Lesions

- **Primary Lesions**: these lesions represent the early stage of the lesion, how they look when they start, prior to evolving.

- **Secondary Lesions**: these lesions represent a later stage after the lesion has evolved or been altered.

- This may help you to determine where in the skin the process is occurring (epidermis, dermis, fat).
Types of Primary Skin Lesions

- **Macule**: <1 cm flat non-palpable lesion
- **Patch**: >1 cm flat non-palpable lesion
- These lesions only represent a change in color
- The color displayed helps localize the pathology
  - Red: from blood vessels in the dermis
  - White: from loss of melanin in the epidermis
  - Brown: from melanin in the epidermis or dermis
More Primary Skin Lesions

- **Papule**: elevated “bump” < 0.5 cm
- **Nodule**: elevated “bump” > 0.5 cm, frequently in the dermis or fat and deeper than a plaque
  - Large nodules, >2cm are often referred to as tumors
- **Plaque**: Plateau-like lesion > 0.5 cm
- **Wheal**: Special plaque composed only of fluid (a hive)
- **Cyst**: Papule or nodule filled fluid or semisolid material
More Primary Skin Lesions

- **Vesicle**: Fluid filled “blister” <0.5 cm
- **Bulla**: Fluid filled “blister” >0.5 cm
- **Pustule**: Cloudy fluid filled lesion containing many inflammatory cells (pus in it!!)
- **Telangiectasia**: Dilated superficial vessels (not “broken” blood vessels)
Secondary Lesions

- **Crust**: Dried fluid and keratinocytes arising from broken vesicles and bullae
- **Scale**: thickened stratum corneum (scale occurs in the epidermis)
- **Induration**: Increased firmness and thickening of the dermis (need to feel to determine this)
Secondary Lesions

- **Erosion**: Loss of the epidermis
- **Ulcer(ation)**: Loss of the epidermis and some or all of the dermis and sometimes subcutaneous tissue
- **Atrophy**: Loss of dermis or fat (sunken in) or thinning of the epidermis (finely wrinkled translucent skin)
Shapes and Configurations

- **Annular**: Making a circle, clear in the center
- **Round or oval**
- **Grouped (herpetiform)**: occurring in crops
- **Linear**: Making a line
- **Dermatomal**: Going along the nerves
Directions

A series of pictures displaying various morphologies and patterns will follow, try to think about how you should describe these lesions to your residents and attendings and then see how these lesions are appropriately described.
How would you describe this lesion?

- Which morphologies are present?

  a. macule  i. bulla
  b. patch   j. pustule
  c. papule  k. telangiectasia
  d. nodule  l. crust
  e. plaque  m. scale
  f. wheal   n. induration
  g. cyst    o. erosion
  h. vesicle p. ulcer
  q. atrophy
How would you describe this lesion?

On exam, the patient has large white patches of depigmentation with some surrounding depigmented macules without overlying scale.
How would you describe this lesion?

- Which morphologies are present?
  
  a. macule   i. bulla  
  b. patch  j. pustule  
  c. papule  k. telangiectasia  
  d. nodule  l. crust  
  e. plaque  m. scale  
  f. wheal  n. induration  
  g. cyst  o. erosion  
  h. vesicle  p. ulcer  
  q. atrophy
How would you describe this lesion?

Exam: 10-20 scattered flesh colored papules intermixed with 5-10 blue plaques

Papule

Plaque
How would you describe this lesion?

- Which morphologies are present?

a. macule  i. bulla
b. patch  j. pustule
c. papule  k. telangiectasia
d. nodule  l. crust
e. plaque  m. scale
f. wheal  n. induration
g. cyst  o. erosion
h. vesicle  p. ulcer
q. atrophy
How would you describe this lesion?

Exam: large circumscribed plaque with flesh colored center and erythematous border (wheal and flare)
How would you describe this lesion?

- Which morphologies are present?
  
a. macule  
b. patch  
c. papule  
d. nodule  
e. plaque  
f. wheal  
g. cyst  
h. vesicle  
i. bulla  
j. pustule  
k. telangiectasia  
l. crust  
m. scale  
n. induration  
o. erosion  
p. ulcer  
q. atrophy
How would you describe this lesion?

Exam: numerous scattered bullae with some ruptured bullae with overlying crust as well as some erosions at sites of ruptured bullae.
How would you describe this lesion?

- Which morphologies are present?

  a. macule  
  b. patch  
  c. papule  
  d. nodule  
  e. plaque  
  f. wheal  
  g. cyst  
  h. vesicle  
  i. bulla  
  j. pustule  
  k. telangiectasia  
  l. crust  
  m. scale  
  n. induration  
  o. erosion  
  p. ulcer  
  q. atrophy
How would you describe this lesion?

Exam: grouped pustules and inflammatory papules on the abdomen, thighs, and genital region.
How would you describe this lesion?

- Which morphologies are present?

  a. macule       i. bulla
  b. patch        j. pustule
  c. papule       k. telangiectasia
  d. nodule       l. crust
  e. plaque       m. scale
  f. wheal        n. induration
  g. cyst         o. erosion
  h. vesicle      p. ulcer
  i. bulla
  j. pustule
  k. telangiectasia
  l. crust
  m. scale
  n. induration
  o. erosion
  p. ulcer
  q. atrophy
Exam: diffuse telangiectasia on the cheek as well as a large well circumscribed tan/brown plaque at the jaw.
How would you describe this lesion?

- Which morphologies are present?
  a. macule  i. bulla
  b. patch  j. pustule
  c. papule  k. telangiectasia
  d. nodule  l. crust
  e. plaque  m. scale
  f. wheal  n. induration
  g. cyst  o. erosion
  h. vesicle  p. ulcer
  q. atrophy
How would you describe this lesion?

Exam: Large ulceration with defined borders on the medial ankle
How would you describe this lesion?

- Which morphologies are present?

  - a. macule
  - b. patch
  - c. papule
  - d. nodule
  - e. plaque
  - f. wheal
  - g. cyst
  - h. vesicle
  - i. bulla
  - j. pustule
  - k. telangiectasia
  - l. crust
  - m. scale
  - n. induration
  - o. erosion
  - p. ulcer
  - q. atrophy
How would you describe this lesion?

Exam: large atrophic hypopigmented patch with interspersed tan/brown macules and a tan/brown border

Epidermal Atrophy
- looks like cigarette paper

Macule
How would you describe this lesion?

- Which morphologies are present?

  a. macule  
b. patch  
c. papule  
d. nodule  
e. plaque  
f. wheal  
g. cyst  
h. vesicle  
i. bulla  
j. pustule  
k. telangiectasia  
l. crust  
m. scale  
n. induration  
o. erosion  
p. ulcer  
q. atrophy
How would you describe this lesion?

Exam: well defined annular plaque with erythematous border and flesh colored center
How would you describe this lesion?

- Which morphologies are present?
  - a. macule
  - b. patch
  - c. papule
  - d. nodule
  - e. plaque
  - f. wheal
  - g. cyst
  - h. vesicle
  - i. bulla
  - j. pustule
  - k. telangiectasia
  - l. crust
  - m. scale
  - n. induration
  - o. erosion
  - p. ulcer
  - q. atrophy
How would you describe this lesion?

Exam: region of grouped vesicles that coalesce into bullae at the periphery of the lesion.
Dematologic Therapy
Principles of Dermatologic Therapy

- The efficacy of any topical medication is related to:
  - 1. The concentration of the medication
  - 2. The vehicle (the mode in which it is transported)
  - 3. The active ingredient (inherent strength)
  - 4. Anatomic location
Drug Costs

- Topical Medications can be very expensive
- They are not all covered by insurance
- Over the counter (OTC)’s are generally cheaper than name brands
- Know the costs of the medications you prescribe and tell the patient in advance what they should expect to pay
Vehicles

- Ointment (like Vaseline): Greasy, moisturizing, messy, most effective in penetrating the skin.
- Creams (vanish when rubbed in): Less greasy, can sting, more likely to cause allergy (preservatives/fragrances).
- Lotions (liquid): Cooling, liquids that pour
Vehicles

- **Solutions (liquids that are greasy or alcoholic):** Can sting, good for hairy areas
- **Gels (semi solid alcohol-based):** Can sting, good for hairy areas or wet lesions
- **Foams (cosmetically elegant):** Good for hairy areas
- **Sprays: Aerosols (rarely used)**
Amount of Medication to Prescribe

- **Rule of 9’s**: Each whole leg is 18% of the Body Surface Area.

- It takes 30 grams of medication to cover the whole body. A large tube of topical medication is 60 grams.

- Whole body x percentage needing medication = amount necessary per application
  - Ex. For one leg: $30g \times 0.18 = 5.4g$

- The sole is 1% of body surface area (BSA), requiring 0.3 grams ($30g \times 0.01$) per treatment.
A patient comes in with a large rash on her left calf. If she must apply her topical medication BID how much should you prescribe for the month? Refer to BSA diagram for assistance.

**ANSWER:** 30 days/month x 2 times/day x 30g/body x 0.065 = 120 grams (4 oz)
Amount of Medication to Prescribe

How much would you prescribe for the month if someone needed to medicate both soles once a day? Refer to BSA diagram for assistance.

a. 1.8g
b. 18g
c. 180g
d. 1800g
Amount of Medication to Prescribe

Answer: b

- How much would you prescribe for the month if someone needed to medicate both soles once a day?
  a. 1.8g
  b. 18g
  c. 180g
  d. 1800g

Explanation: 30 days/month x 1 time/day x 30g x 0.01/sole x 2 soles = 18g (1/2 oz)
Topical Corticosteroids

- Topical steroids are classified based on potency. Potency is inherent to the molecule, not the concentration.
- The CLASS of the steroid is the strength.
- Steroids within any class are equivalent in strength.
- In practice, it is important to know one steroid from each class.
Topical Corticosteroids

- Super-High Potency: Clobetasol (Temovate) 0.05% cream, ointment, solution, foam
- High Potency: Fluocinonide (Lidex) 0.05% cream, gel, ointment, solution
- Medium Potency: Triamcinolone (TAC) 0.1% cream, ointment, solution
- Mid-Low: Aclometasone (Aclovate) 0.05% cream or ointment, Desonide 0.05% cream or ointment
- Lowest Potency: Hydrocortisone 1% or 2.5% cream or ointment

NOTE: Clobetasol 0.05% is STRONGER than hydrocortisone 1%. Look at class not percentage.
Applying Corticosteroids

- There are many ways that corticosteroids are applied.
- The topical steroid can also be applied to spot lesions.
- **Soak and smear**: this involves the patient soaking in a tub for 15 min (to open pores) and then "smearing" the topical steroid on the skin.
  - Sometimes, occlusion is used which is the placing of saran wrap or vinyl suit over the topical steroid to increase penetration.
- Typically mid-low/lowest potency topical steroids are used on the face with a stronger one for the body as a stronger steroid on the face may cause atrophy as a result of thin skin and strong steroid!
Side Effects of Topical Steroid Treatment

- Acne (perioral dermatitis/rosacea) can result when a greater than low potency steroid is applied to the face.
- Atrophy and striae (stretch marks) can result when steroid is used in the groin or arm pits.
- Petechiae and telangiectasia is possible from skin atrophy.
- Increased Fungal infections: For example, Lotrisone’s (betamethasone and clotrimazole) does not kill fungus as the betamethasone is too strong and suppresses the immune response from killing the fungus.
- Systemic side effects are rare due to low absorption, however with full body high potency steroid it is possible.

**NOTE: THE HIGHER THE POTENCY THE MORE LIKELY SIDE EFFECTS ARE TO OCCUR!**
Topical Antifungals

- There are several classes of topical antifungal medications
- Some classes are Fungistatic (stop fungi from growing), others are Fungicidal (they kill the fungi)
- Not all conditions are treatable with topical antifungals (hair infections and nail infections do not respond to topical treatment and require systemic treatment)
Topical Antifungals

- The following are some examples of topical antifungals:
  - Imidazoles (fungistatic): Ketoconazole, Econazole, Oxiconazole, Sulconazole, Clotrimazole (OTC), Miconazole (OTC)
  - Allylamines (fungicidal): Naftifine, Terbinafine (OTC), Butenifine
  - Ciclopirox (may have both fungistatic and fungicidal properties)
- Ketoconazole (Nizoral) shampoo is often used in seborrheic dermatitis
- NOTE: most frequently prescribed anti-fungals are in yellow
This module contains key morphology and descriptions used in dermatology. Please review this information as it is fundamental to dermatologic diseases. The following links will help you.

- Distribution
- Primary Lesions
- Secondary Lesions
- Shape and arrangement of lesions
- Dermatology lexicon
END OF MODULE