



**Nails**



# Nail Biology:

## The Nail Apparatus

- Nail plate
- Proximal nail fold
- Nail matrix
- Nail bed
- Hyponychium

Figure 1: Mary Albury-Noyes

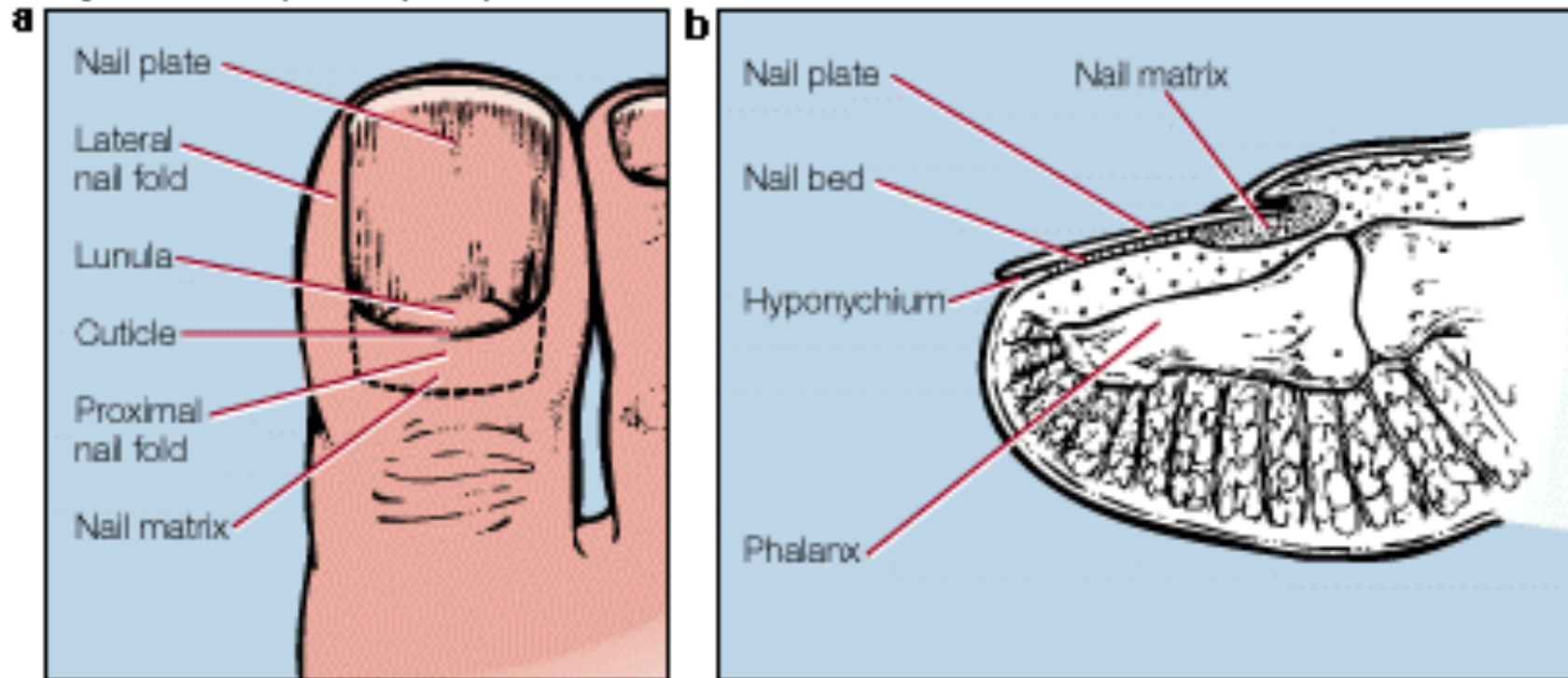


Figure 1. A dorsal view of the nail unit (a) shows the proximal extension of the nail matrix (dotted lines). A sagittal view (b) demonstrates the structure of the nail unit and the underlying tissue and bone. When any portion of the matrix is damaged, permanent nail deformity may result.





# Nail Biology:

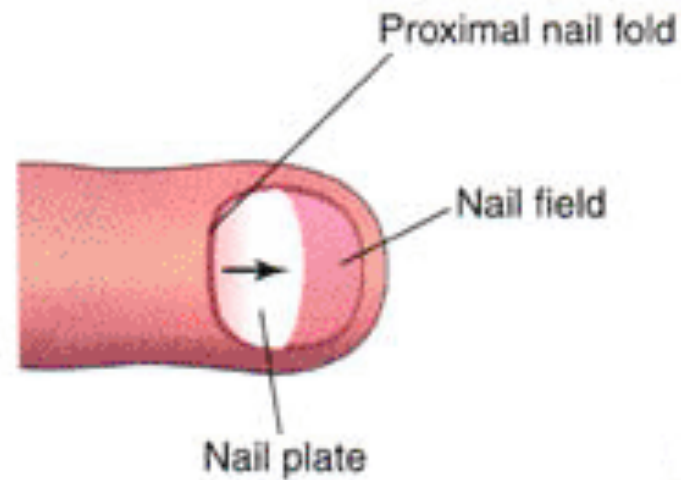
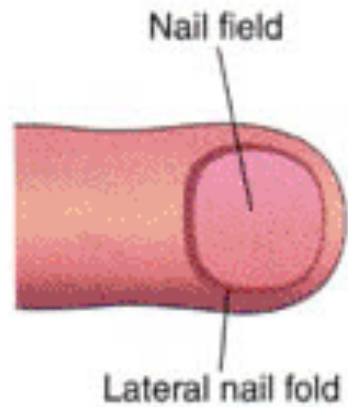
## The Nail Apparatus

- Lies immediately above the periosteum of the distal phalanx
- The shape of the distal phalanx determines the shape and transverse curvature of the nail
- The intimate anatomic relationship between nail and bone accounts for the bone alterations in nail disorders and vice versa

# Nail Apparatus:

## Embryology

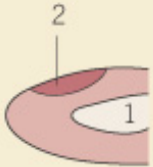
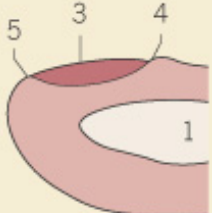
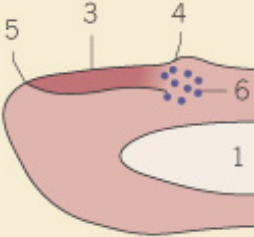
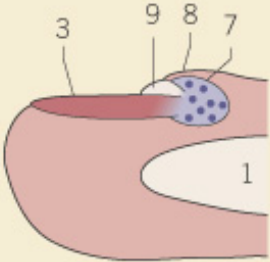
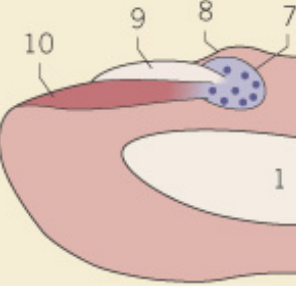
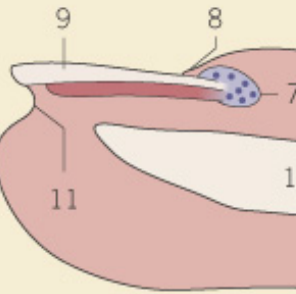
- *Nail field* develops during week 9 from the epidermis of the dorsal tip of the digit
- Proximal border of the nail field extends downward and proximally into the dermis to create the *nail matrix primordium*
- By week 15, the nail matrix is fully developed and starts to produce the nail plate



Nails develop from thickened areas of epidermis at the tips of each digit called **nail fields**. Later these nail fields migrate onto the dorsal surface surrounded laterally and proximally by folds of epidermis called **nail folds**.



## EMBRYOLOGICAL DEVELOPMENT OF THE NAIL APPARATUS

① 9th week	② 10th week	③ 12th week
		
④ 15th week	⑤ 16th week	⑥ 17th week
		
<p>1 Developing cartilage/bone                  2 Nail anlage                  3 Nail field with its proximal (4) and distal (5) fold                  6 Primordial matrix                  7 (Fully developed) nail matrix                  8 Proximal nail fold                  9 Nail plate                  10 Nail bed                  11 Hyponychium</p>		





# Nail Function

- Protect the distal phalanx
- Enhance tactile discrimination
- Enhance ability to grasp small objects
- Scratching and grooming
- Natural weapon
- Aesthetic enhancement
- Pedal biomechanics



# The Nail Plate

- Fully keratinized structure produced throughout life
- Results from maturation and keratinization of the nail matrix epithelium
- Attachments:
  - Lateral: lateral nail folds
  - Proximal: proximal nail fold (covers 1/3 of the plate)
  - Inferior: nail bed
  - Distal: separates from underlying tissue at the hyponychium



# The Nail Plate

- Rectangular and curved in 2 axes
  - Transverse and horizontal
- Smooth, although longitudinal ridging ↑ with age
  - Ridge pattern used for forensic identification
- Homogeneously pink due to underlying vessels
- Free edge is white



# The Nail Plate

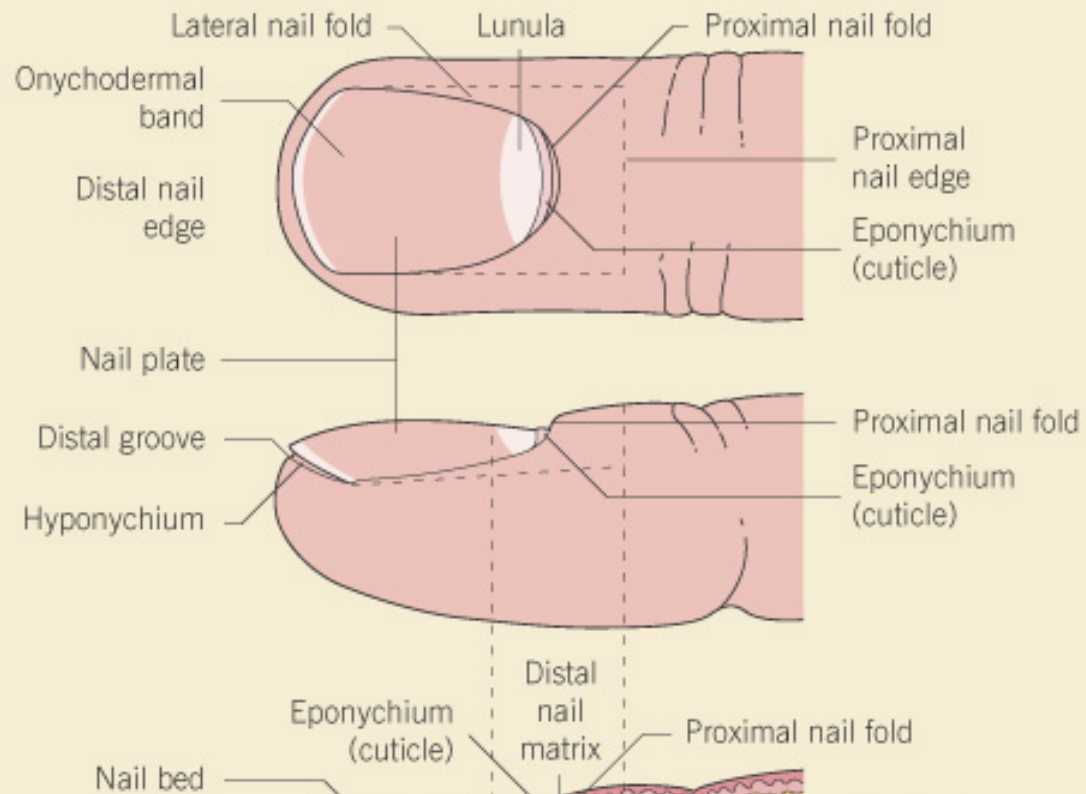
- Lunula:
  - visible portion of the nail matrix
  - white, half-moon shaped area
  - plate loosely attached to underlying epithelium



# The Nail Plate

- Onychocorneal Band
  - Thin, distal transverse white band
  - Marks distal portion of attachment of plate to bed
  - Anatomic barrier against environmental hazards
  - Disruption allows plate detachment (onycholysis)
- Onychodermal Band
  - Thin, distal pink band separating onychocorneal band from the free edge of the plate

## ANATOMICAL STRUCTURE OF THE NAIL APPARATUS





# The Nail Plate:

## Transverse Anatomy

- Nail plate consists of three portions:
  - Dorsal, intermediate, and ventral plates
  - Dorsal and intermediate plates are produced by the nail matrix
  - The ventral plate is produced by the nail bed
- Above the lunula, the plate consists only of the dorsal and intermediate portions



# Nail Plate Thickness

- Plate progressively thickens from point of emergence to distal tip
  - Mean thickness distal toenail: 1.65mm/1.38mm (m/f)
  - Mean thickness distal fingernail: 0.6mm/0.5mm (m/f)
- Thickness ↑ with age, esp. in 1<sup>st</sup> two decades
- Thickness depends on the length of the nail matrix and the nail bed



# Nail Plate Thickness

- Thinning of the nails is usually a matrix disorder
- Thickening of the nails is usually a consequence of nail bed disorders



# Proximal Nail Fold

- Consists of dorsal and ventral portions
- The dorsal portion is continuous with and anatomically similar to the skin of the dorsal digit but thinner and devoid of pilosebaceous units



# Proximal Nail Fold

- The ventral portion is invisible from the exterior and is continuous proximally with the germinative nail matrix
- It adheres to and covers  $\frac{1}{4}$  of the nail plate and keratinizes with a granular layer
- The limit between the proximal nail fold and the nail matrix can be histologically established at the site of disappearance of the granular layer

# Proximal Nail Fold:

## Cuticle

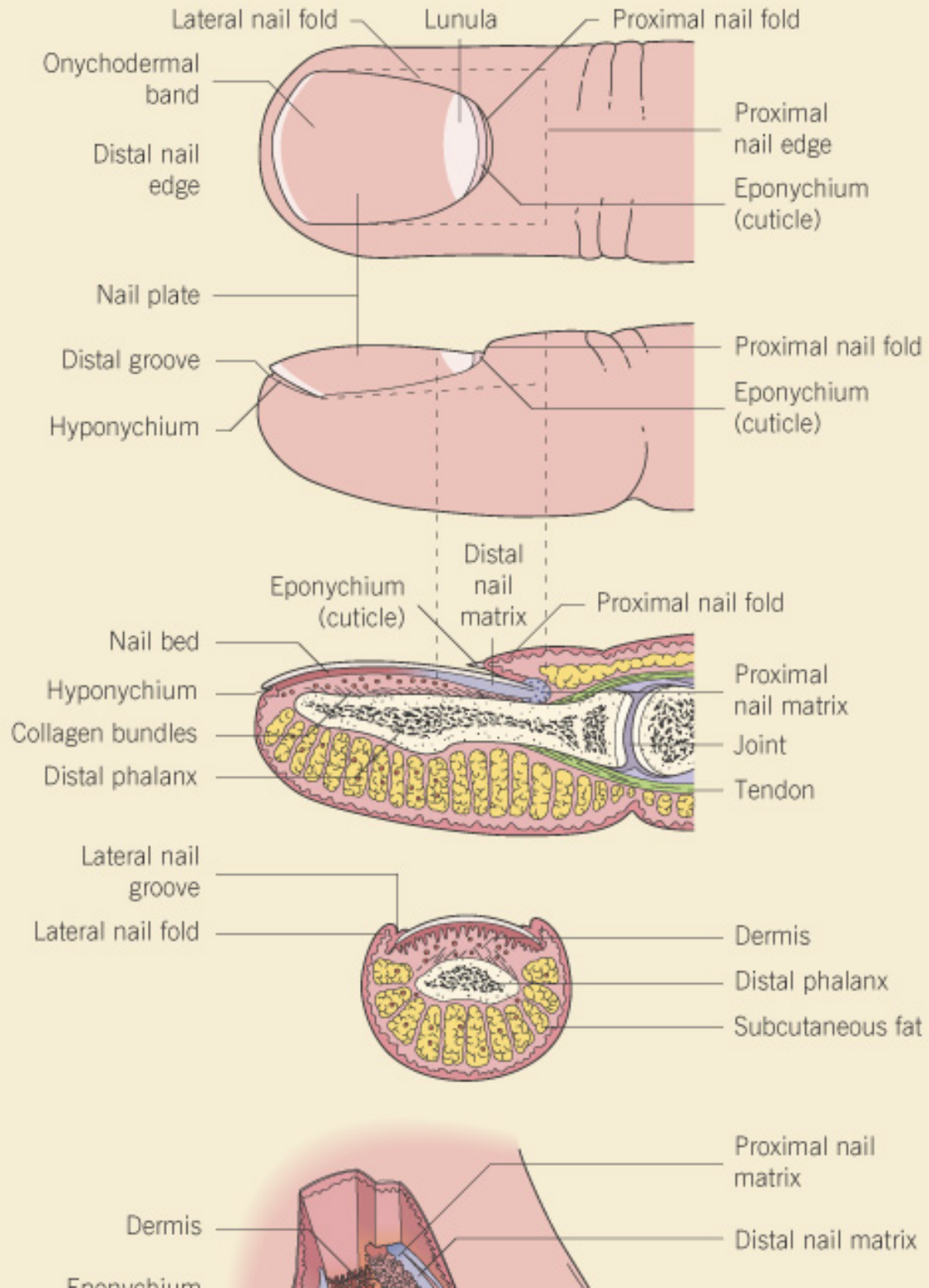
- Formed by the horny layer of the proximal nail fold
- Attached to the superficial nail plate
- Prevents separation of the plate from the fold
- Integrity of the cuticle is essential for nail homeostasis in this region





# Proximal Nail Fold

- Dermis of the proximal fold contains capillaries that run parallel to the surface
- Arterial and venous limbs of the capillaries are arranged in parallel rows and appear as fine regular loops
- Proximal nail fold capillary morphology is altered in connective tissue diseases





# Nail Matrix

- Specialized epithelial structure that lies above the midportion of the distal phalanx
- Consists of a proximal (dorsal) and a distal (ventral) portion
- Nail matrix keratinocytes keratinize *in the absence of a granular layer* to form the nail plate



# Nail Matrix Keratinization

- Maturation and differentiation of nail matrix keratinocytes occurs in a distally oriented diagonal axis (unlike the epidermis)
- Keratinization of the proximal (dorsal) nail matrix cells produces the dorsal nail plate
- Keratinization of the distal (ventral) nail matrix cells produces the intermediate nail plate



# Nail Matrix

- Cornified onychocytes are composed mainly of keratin filaments, high sulfur matrix proteins, and the marginal band, which consists of precipitated cytoplasmic proteins
- During keratinization of onychocytes, DNases and RNases degrade nuclear fragments. Incomplete degradation of nuclear material results in transient leukonychia spots



# Nail Matrix Melanocytes

- Usually quiescent but can become activated and synthesize melanin, which is transferred to surrounding keratinocytes
- Distal migration of melanin-containing keratinocytes gives rise to a diffuse or banded nail pigmentation (physiologic or pathologic)
- Nail matrix melanocytes of Caucasians do not contain mature melanosomes which are normally found in the nails of Asians and blacks





# Nail Bed

- Extends from the distal margin of the lunula to the onychodermal band
- Nail bed epithelium is thin (2-5 cell layers) and firmly attached to the nail plate
- Nail bed keratinization produces a thin, horny layer that forms the ventral nail plate
- No granular layer and sparse melanocytes



# Hyponychium

- Marks the anatomic area between the nail bed and the distal groove, where the nail plate detaches from the distal digit
- Anatomy is similar to plantar and volar skin (a granular layer is present)
- Normally covered by the distal nail plate



# Basement Membrane Zone

- Antigenic structure is identical to that of the epidermis and is consistent throughout all portions of the nail apparatus
- Thus, the nails are commonly involved in diseases associated with attack on BMZ components



# Blood and Nerve Supply

- Nail Apparatus: lateral digital arteries and nerves
- Nail Bed: encapsulated neurovascular structures called *glomus bodies* contain one to four AV anastomoses and nerve endings
  - regulate blood supply to the digits in cold weather

# Chemical Properties of the Nail Plate

- Low-sulfur keratins embedded in an amorphous matrix of high-sulfur proteins rich in cystine.
- Water (20%)
  - <18% = brittle; >30% = opaque and soft
- Lipid (<5%): mainly cholesterol
- Trace inorganic elements: iron, zinc, calcium
  - Do not contribute to nail hardness



# Chemical Properties

- Nail keratins:
  - 80% hard “hair-type” keratins
    - Acidic Ha 1-4 and basic Hb 1-4 keratins
  - 20% soft “skin-type” keratins
    - Epithelial keratins 5, 6, 14, 16, 17





# Nail Growth

- Proceeds from 15 weeks IUL until death
- Fingernails:
  - 3mm per month
  - 3-6 months for replacement
- Toenails:
  - 1mm per month
  - 12-18 months for replacement



# Nail Growth

- Decreased Growth

- Age > 50
- Systemic illness
- Malnutrition
- Vascular disease
- Peripheral neuropathy
- Antimitotic drugs
- Onychomycosis
- Yellow nail syndrome

- Accelerated Growth

- Pregnancy
- Finger trauma
- Psoriasis
- Oral retinoids
- Itraconazole

# Nail Clippings Can Be Evaluated For...

- Drugs, chemicals and toxins
- DNA analysis
- Blood group typing
- Individual identification



# Nail Signs

3 categories based on site of pathology:

- 1. Nail matrix
- 2. Nail bed
- 3. Nail plate (deposition of pigment)

**Table 71.1 Correlation of nail findings with anatomical site of nail damage.**

<b>CORRELATION OF NAIL FINDINGS WITH ANATOMICAL SITE OF NAIL DAMAGE</b>	
<b>Affected site</b>	<b>Clinical manifestation</b>
Proximal matrix	Beau's lines Pitting Longitudinal ridging Longitudinal fissuring Trachyonychia
Distal matrix	True leukonychia
Proximal + distal matrix	Onychomadesis Koilonychia Nail thinning
<b>Nail bed</b>	Onycholysis Subungual hyperkeratosis Apparent leukonychia Splinter hemorrhages

# Nail Signs due to Abnormal Matrix Function

- Beau's Lines
- Pitting
- Onychorrhexis
- Trachyonychia
- Onychomadesis
- Koilonychia

# Beau's Lines

- Transverse depressions due to disruption of proximal matrix mitotic activity
- Depth: extent of damage
- Width: duration of insult
- Mechanical trauma
- Proximal nail fold dz
- Systemic insult (all nails)





# Beau's Lines





# Onychomadesis (nail shedding)

- Proximal detachment of the nail plate from the proximal nail fold
- Due to a severe insult that produces complete arrest of matrix activity
- Causes are the same as for Beau's Lines

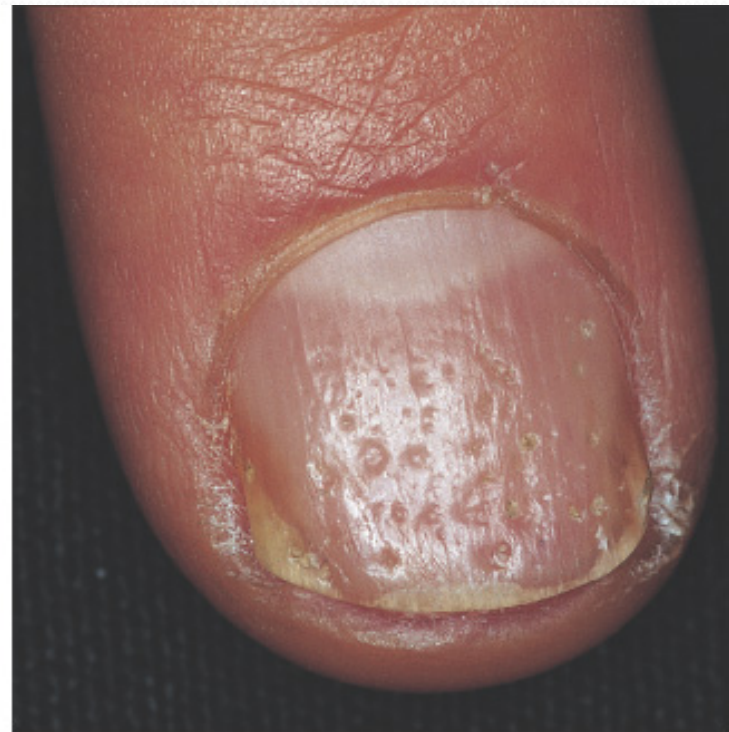


# Onychomadesis



# Pitting

- Punctate depressions of the nail plate surface
- Foci of abnormal keratinization of the proximal matrix results in clusters of parakeratotic cells in the dorsal plate
- Clusters easily detach, leaving pits





# Pitting





# What diseases produce pitting?

- Psoriasis- deep and irregular
- Alopecia areata- superficial and geometric
- Eczema

# Pitting



# Onychorrhexis

- Longitudinal ridging and fissuring of the plate
- Diffuse thinning
- Indicates diffuse damage to the nail matrix
  - Lichen planus
  - Vasculopathy/ischemia
  - Trauma, Tumors
  - Normal aging





# Trachyonychia (20 Nail Dystrophy)

- Nail roughness due to excessive longitudinal ridging
- Proximal nail matrix damage by:
  - Alopecia areata
  - Lichen planus
  - Psoriasis
  - Eczema





**Nail Disorder due to Distal  
Matrix Abnormality  
True Leukonychia**



# True Leukonychia

- Nail plate has a normal surface but loses its transparency and appears white because of *parakeratotic cells within the ventral portion*
- Caused by diseases that disturb *distal nail matrix keratinization*

# True Leukonychia:

## 3 Morphologic Variants

- Punctate:
  - opaque white spots, move distally with nail growth
  - Due to trauma, common in kids
- Transverse:
  - Multiple opaque white parallel lines, traumatic
  - Women: matrix trauma from manicures
- Diffuse / Total
  - Rare. Sometimes hereditary. May be assoc. w/ keratoderma and other congenital defects such as deafness

# Partial/Punctate Leukonychia



# Transverse Leukonychia





# Leukonychia Totalis

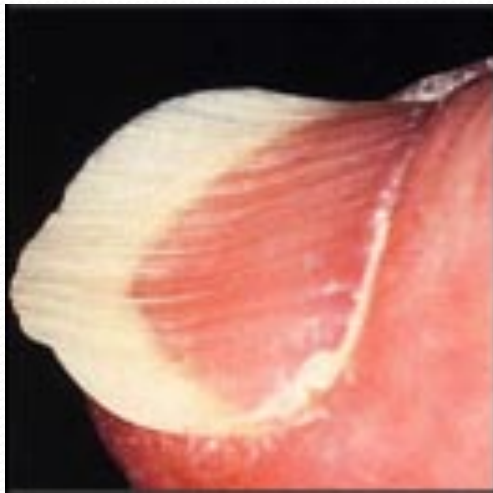


# Koilonychia (Spoon Nails)

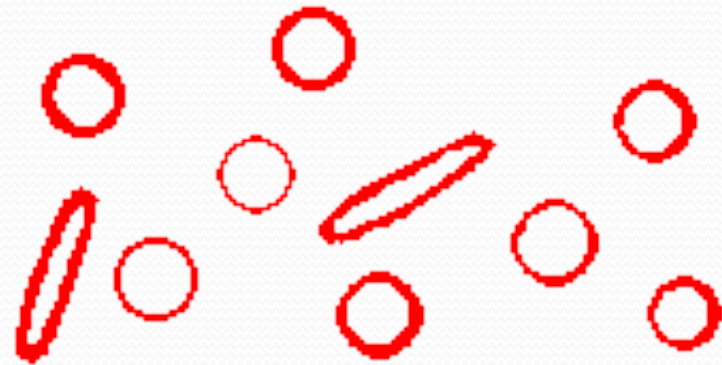
- Thinned, concave nail plate due to upward eversion of the lateral edges
- Physiologic in kids
- Iron deficiency anemia
- Plummer-Vinson
- Hemochromatosis



# What is this disease?



## Iron Deficiency





# Plummer-Vinson Syndrome

Esophageal webs, iron deficiency anemia, and  
koilonychia.

# Nail Signs due to Nail Bed Disorders

- Onycholysis
- Onychauxis
- Apparent Leukonychia
- Splinter hemorrhages

# Onycholysis

- Distal nail plate detachment from bed
  - Environmental exposure
  - Psoriasis
  - Infection
  - UVR +/- TCN
  - Hyperthyroidism
  - Subungual tumor





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# Onycholysis





## CAUSES OF ONYCHOLYSIS

Onycholysis						
Most common etiology	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Environmental</div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="border: 1px solid black; padding: 2px; font-size: 8px;">Exposures Irritants Water</div> <div style="border: 1px solid black; padding: 2px; font-size: 8px;">Trauma</div> <div style="border: 1px solid black; padding: 2px; font-size: 8px;">UV (photo- onycholysis in the absence of medications)</div> </div>	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Primary skin disorders</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">Psoriasis</div>	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Infections</div> <div style="border: 1px solid black; padding: 5px; font-size: 8px; margin: 10px auto;"> <ul style="list-style-type: none"> <li>• <i>Candida</i> spp. (may be secondary invaders)</li> <li>• Dermatophytes</li> <li>• HPV</li> </ul> </div>	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Drugs</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">Tetracyclines</div>	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Metabolic/ systemic disorders</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">Hyperthyroidism</div>	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Tumors</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">Subungual exostoses SCC</div>
Clues to diagnosis	<ul style="list-style-type: none"> <li>• History</li> <li>• Fingernails vs. toe nails</li> <li>• Minimal, if any, nail bed changes</li> <li>• Associated hemorrhage</li> </ul>	<ul style="list-style-type: none"> <li>• Additional nail findings e.g. oil drop changes, pits</li> <li>• Nail bed changes e.g. scale</li> <li>• Cutaneous lesions</li> </ul>	<ul style="list-style-type: none"> <li>• Additional nail findings e.g. chronic paronychia, yellow color, thickening</li> <li>• Nail bed changes e.g. scale, verrucous lesions</li> <li>• Green discoloration 2° to pyocyanin</li> <li>• Fungal and bacterial cultures</li> <li>• KOH/nail plate PAS</li> </ul>	<ul style="list-style-type: none"> <li>• History</li> <li>• Multiple nails</li> <li>• Minimal, if any, nail bed changes</li> <li>• Wood's lamp examination</li> </ul>	<ul style="list-style-type: none"> <li>• Multiple nails</li> <li>• Minimal, if any, nail bed changes</li> <li>• Additional cutaneous findings</li> <li>• TFTs</li> </ul>	<ul style="list-style-type: none"> <li>• Single nail</li> <li>• Nail bed findings</li> <li>• Radiograph</li> <li>• Biopsy specimen</li> </ul>
Less common etiologies	Allergens, e.g. formaldehyde, mono(meth)acrylates, cyanoacrylates	<ul style="list-style-type: none"> <li>• Lichen planus</li> <li>• Eczema</li> <li>• Lichen striatus</li> <li>• Blistering diseases (epidermolysis bullosa, pemphigus vulgaris, pompholyx)</li> <li>• Other disorders (ectodermal dysplasias, sarcoidosis, Langerhans cell histiocytosis, Darier's disease, keratosis lichenoides chronica)</li> </ul>	<ul style="list-style-type: none"> <li>• Saprophytes</li> <li>• Scabies</li> </ul>	<ul style="list-style-type: none"> <li>• Fluoroquinolones</li> <li>• Taxanes</li> <li>• Psoralens</li> <li>• NSAIDs</li> <li>• Other drugs (anthracyclines, captopril, chlorazepate, etoposide, gemcitabine, mycophenolate, phenothiazines, quinine, retinoids, sodium valproate, thiazides, 5-fluorouracil)</li> </ul>	<ul style="list-style-type: none"> <li>• Yellow nail syndrome</li> <li>• PCT</li> <li>• Pseudo PCT (drugs, dialysis)</li> <li>• EPP</li> </ul>	<ul style="list-style-type: none"> <li>• Melanoma</li> <li>• Fibromas</li> </ul>

# Onychauxis

- Nail plate appears thickened due to subungual scales (nail bed hyperkeratosis)
- Nail bed involvement by:
  - Psoriasis
  - Onychomycosis
  - eczema



# Onychauxis

“Ram’s Horn Nails”







# Apparent Leukonychia

- Nails are white because of abnormalities in the color of the nail bed
- Nail plate transparency is maintained and the leukonychia does not move distally with nail growth
- White color fades with pressure



# Apparent Leukonychia

- **Terry's Nails: cirrhosis**
  - Whole nail is white except 2mm distal red band
- **Muehrcke's Nails: hypoalbumin; chemotherapy**
  - Multiple transverse white bands parallel to lunula
- **Half and Half Nails: chronic renal disease**
  - Leukonychia of the proximal half of the nail

# Terry's Nails

(cirrhosis)





# Splinter Hemorrhages

- Dark-red, longitudinal, distal subungual lines
  - Trauma
  - Psoriasis
  - Onychomycosis
- Proximal splinters
  - Endocarditis
  - Vasculitis
  - Trichinosis
  - APA Syndrome

# Nail Signs due to Deposition of Pigment

- Exogenous- convex proximal border
  - Opposite of lunula
- Endogenous- concave proximal border
  - Parallels lunula
- Subungual- onycholysis