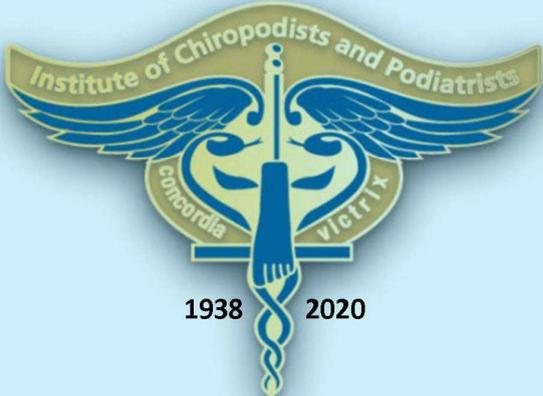


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Nails, nails, nails.

- ▶ A window on physiology
- ▶ An indicator of disease
- ▶ An indicator of toxicity



“The nail is an opalescent window”

Dawber, Baran and de Berker – *Science of the nail apparatus* (2001)

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Medical care of the feet



- ▶ “Within a science that has cutaneous medicine at its very heart, the less than optimal study and understanding of the human nail is akin to a dentist ignoring teeth.”



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Much in little(1)



- ▶ **Nail Plate (NP)** – a trilaminar structure; ventral, intermediate and dorsal laminae.
 - avascular, durable keratinised structure
- ▶ **Lateral nail folds (LNF)**
 - cutaneous borders of nail
- ▶ **Proximal nail fold (PNF)**
 - visible border continuous with Eponychium
- ▶ **Eponychium (cuticle)**
 - Epidermal seal extending from PNF to NP
- ▶ **Matrix** – differentiated parts originate dorsal, intermediate and ventral laminae.

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Much in little (2)



- ▶ **Lunula**–
Convex margin of the intermediate matrix
- ▶ **Nail bed** –
Vascular bed on which nail rests
- ▶ **Onychodermal band** –
Distal margin of nail bed
- ▶ **Hyponychium (Inc.' the solenhorn)**–
Cutaneous margin underlying free edge of nail
- ▶ **Distal groove (limiting furrow)**
–cutaneous ridge demarcating border between subungual structures and finger pulp

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Constituents of 'Nail'



- ▶ **Hard and soft keratins 1,5, 6, 10, 14,16,17,19** –
Arising from the tri-laminar matrix / nail bed**

** Various formation theories abound –

- Lewis (1954) : Matrix / ventral PNF, nail bed
- Zaias & Alvarez (1968), Norton (1971) : Matrix
- Johnson et al (1991,1993) : Matrix / nail bed
- de Berker & Angus, de Berker et/al (1996): Matrix

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In short



- ▶ Sheets of flattened keratinocytes expressed by various parts of the matrix
- ▶ Pushed forward along subungual ridges of vertical collagen fibres
- ▶ Matrix is protected from pathogen etc ingress ventrally by the eponychium 'seal'
- ▶ As keratinocytes move distally their nuclei fragment and cytoplasm condenses to compact into the nail plate layers
- ▶ Voila - we have a nail !

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What can affect the nail?



- ▶ Toxins
- ▶ Trauma
- ▶ Congenital pathologies
- ▶ Occupational factors
- ▶ Fungal infections
- ▶ Bacterial infections
- ▶ Systemic Disease
- ▶ Neoplasms, tumours, benign/malignant
- ▶ Dermatopathology including

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Toxins



- ▶ Due to their slow growth nail, structures can form a reservoir of past factors affecting their host. Probably to a greater extent in toenails due to slower growth than fingernails.

Nail growth and formation is affected by the ingestion of various xenobiotics, such as heavy metals, antibiotics or chemotherapeutic drugs. Prime example is Mee's lines which can demonstrate Arsenic or Thallium poisoning weeks or months prior to death from such cause**

** Kintz P. Toxicological Aspects of Drug-Facilitated Crime. Kintz P (Ed.). Elsevier, London, UK (2014)

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Mee's line



Aknowledgement: Yannick Trottier – Own work, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=20266791>

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Drugs – Rx or abuse



Fingernails and toenails are suitable for retrospective monitoring for a time frame of:

- ▶ up to 5 months (fingernail)
- ▶ 14 months (toenail)

before the collection of the nail sample.

Substances detectable include: Clozapine, Ethyl Glucoramide (binge drinking), citalopram and desmethylcitalopram, cortisone and cocaine amongst numerous others

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Skin conditions



- ▶ Psoriasis
- ▶ Scleroderma and other CTD's including, lupus, dermatomyositis, primary Sjogren syndrome*
- ▶ Occupation related dermatopathology – from plants, glass fibres, chemicals, food particles under nail plate – (*victuallers thumbnail* **)

* Elmansour, Imane et al. "Nail changes in connective tissue diseases: a study of 39 cases." *The Pan African medical journal* vol. 18 150. 17 Jun. 2014

** Head S. *Victualler's thumbnail*—a condition of subungual osmotrauma. *J R Coll Gen Pract.* 1984 Feb;34(259):118. PMID: 6471018; PMCID: PMC1959590

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My doctor/google/granny/dog said I have nail fungus.



All forms of trauma are a well known mimic of nail fungus (amongst podiatrists at least) and frequently misdiagnosed as fungus.



Musicians nail – microtrauma to fingernails of pianists, harpists, guitarists (anybody play these with toes?)

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Systemic disease



Clubbing - Inflammatory bowel disease, pulmonary malignancy, asbestosis, chronic bronchitis, COPD, cirrhosis, congenital heart disease, endocarditis, atrioventricular malformations, fistulas

Koilonychia - Iron deficiency anaemia, hemochromatosis, Raynaud's disease, SLE, trauma, nail-patella syndrome

Onycholysis - Psoriasis, infection, hyperthyroidism, sarcoidosis, trauma, amyloidosis, connective tissue disorders

Pitting - Psoriasis, Reiter's syndrome, alopecia areata

Beau's lines - Any severe systemic illness that disrupts nail growth, Raynaud's disease, pemphigus, trauma

Yellow nail - Lymphedema, pleural effusion, immunodeficiency, bronchiectasis, sinusitis, rheumatoid arthritis, nephrotic syndrome, thyroiditis, tuberculosis, Raynaud's disease

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Onychomycosis



We can conveniently divide organisms potentially affecting nails (and skin) into moulds and yeasts.

- ▶ **Moulds** sexually and asexually reproduce into multi-cellular forms termed Hyphae, which form a mat-like structure called a mycelium.
- ▶ **Yeasts** are unicellular and reproduce asexually by 'budding'.

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Moulds



More than twenty species of dermatophyte mould exist but only three predominantly cause infections of the nail structure:

- ▶ **Trichophyton Rubrum** : a complex of species that comprises multiple, geographically patterned morphotypes
- ▶ **Trichophyton Mentagrophytes**: the second-most commonly isolated fungus causing tinea infections in humans, and the most common or one of the most common fungi that cause zoonotic skin disease
- ▶ **Epidermophyton Floccosum**: The fungus was first isolated in 1870 from a tinea cruris patient in Germany by Carl Otto Harz, who named it *Acrothecium floccosum*

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Moulds



- ▶ *T. Rubrum*, *T. Mentagryphotes* and *E. Floccosum* all have the ability to produce enzymes that break down the four major classes of biological macromolecules (carbohydrates, lipids, proteins, and nucleic acids)
- ▶ The protein of the nail plate structures is a rich source of nourishment for the invading organisms

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Typical mould presentations



- ▶ Distal and Lateral Subungual Mycosis (DLSO)



As the name implies primarily affects the end and side of the nail. Initially features subungual hyperkeratosis. Some sources claim this to be the commonest presentation of onychomycosis *

* Summerbell R.C. Epidemiology and ecology of onychomycosis. *Dermatology*. 1997;194:S32–S36.

Illustration: dermnetnz.org/topics/fungal-nail-infections

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Typical mould presentations



▶ Superficial White Onychomycosis (SWO)



Commonest cause *T. Mentagryphotes*. Less frequently encountered than DLSO and affects the dorsal surface of the nail plate rather than the bed. Characterised by flaky patches and a 'dappling' pattern of discolouration.

Illustration: dermnetnz.org/topics/fungal-nail-infections

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Typical yeast presentations



▶ Proximal Subungual Onychomycosis (PSO)



PSO commences from the proximal portion of the nail apparatus. It is often intercurrent with infections of *Candida* in the periungual border area causing chronic paronychia. Is common in people with AIDS and other immune deficiency situations. It produces a white discoloration of the ventral plate without obvious thickening

Illustration: dermnetnz.org/topics/fungal-nail-infections

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End game



▶ Total Dystrophic Onychomycosis (TDO)



The potential sequelae of any chronic onychomycosis that has proved refractory to treatment. TDO is the most severe stage of onychomycosis, and it can result from a long-standing DLSO or PSO. The nail plate is diffusely thickened, friable and yellowish. It entirely lacks structure.

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Diagnosis



- ▶ **Differentiation** of the organism may only be reliable if based on Laboratory Histopathology.
- ▶ **Point of care** testing does exist using test strip kits but no personal experience of use. Does not appear to differentiate.
- ▶ **Ultra-violet illumination** (woods lamp) can be suggestive of different skin/nail pathogens (many of them bacterial) by chromofluorescence. In 1903, a simple method of artificially producing ultraviolet light was developed by the Physicist Robert Wood (1868 - 1955) which led to the term 'woods lamp' being used to describe the device. Wood used a nickel oxide and barium silicate coated glass filter to block visible light emanating from an incandescent filament

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UV diagnosis



- ▶ The human eye is typically able to visualise light falling within the 390 – 750 nm band of the electromagnetic spectrum.
- ▶ The wavelength known as ultraviolet (UV) falls below this at 300 – 400 nm.
- ▶ Although virtually invisible to humans, some animals such as birds can see the ultraviolet wavelength as can bees who use this ability as part of their means of detecting pollen in a flower head

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Examples of diagnostic Fluorescence



- *Pityriasis versicolor-Malassezia furfur* which exhibits a Yellowish-White or Copper-Orange colour.
- Pathogenic *pseudomonas* show Green fluorescence as does *Microsporum distortum* and *Microsporum ferrugineum*.
- *Erythrasma- Corynebacterium minutissimum* shows an often very striking deep Coral Red
- *Propionibacterium acnes*, a bacterium implicated in acne causation fluoresces orange
- Interestingly, *Tinea Pedis* does not UV Fluoresce but SWO, TDO and DLSO do, as does dermal hyperkeratosis and amelanotic sun-damaged skin..
- MORE INFO: Perspectives on in vitro fungal diagnosis with UV light. Revista Brasileira de Engenharia Biomédica, v. 23, n. 1, p. 25-30, abril 2007 (Rativa, Diego et al)



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Skin – visible light spectrum



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Skin – UV wavelength



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Tumors – benign



▶ Many epithelial tumours can effect the nail:

- Warts
- Syringoma
- Eccrine poroma
- Chondroid Syringoma
- Distal digital keratoacanthoma



Eccrine syringofibroadenoma.
(Courtesy of B Fouilloux)

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Keratoacanthoma



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Eccrine poroma.



(Courtesy of B Goettmann.)

A **poroma** is a benign adnexal neoplasm composed of epithelial cells that show tubular (usually distal ductal) differentiation. The malignant counterpart of a **poroma** is referred to as porocarcinoma

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Malignant Melanoma



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Treatments



- ▶ Debridement
- ▶ Topical agents (OTC and Rx)
- ▶ Systemic medication (Rx)
- ▶ Laser
- ▶ Microwave
- ▶ Surgery : PNA, TNA, Frosts, Symes etc

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Safety



- ▶ Fungal nails may seem simple but there is a potential danger to health if any fungal particles are inhaled.
- ▶ Some other fungi such as *Aspergillum. fumigatu* and *Blastomyces. dermatitidis* can cause severe nasal and pulmonary problems including pneumonia and in some cases death (esp. if not promptly diagnosed).
- ▶ In debriding suspected fungal nails, even if using a vacuum drill, an FFP3 mask is strongly recommended.

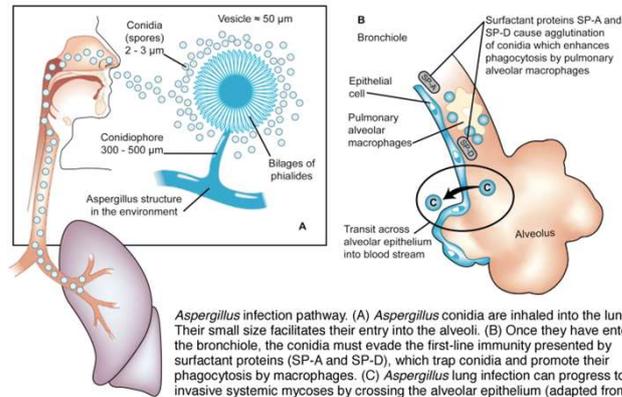


A Mating Pair of *Aspergillus fumigatus* with progeny. PLOS <https://doi.org/10.1371/journal.ppat.1004834>

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Safety



Aspergillus infection pathway. (A) *Aspergillus* conidia are inhaled into the lung. Their small size facilitates their entry into the alveoli. (B) Once they have entered the bronchiole, the conidia must evade the first-line immunity presented by surfactant proteins (SP-A and SP-D), which trap conidia and promote their phagocytosis by macrophages. (C) *Aspergillus* lung infection can progress to invasive systemic mycoses by crossing the alveolar epithelium (adapted from Williams (2000)).

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So, as always, Hot Dog Advises:



Hey! lets be vigilant out there.



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