KAMINSKI'S DIGITAL IMAGE LIBRARY OF MEDICAL MYCOLOGY

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Dedicated to
Geraldine Kaminski OAM
1918-1985

Preface

In 1975, Geraldine Kaminski produced sets of 100 colour teaching slides on the subcutaneous and systemic mycoses, which were distributed by the Australian Society for Microbiology. Gerry was an eminent Australian and mycologist who worked at the Adelaide Children's Hospital from 1937 to 1985 where she established the present day Mycology Reference Laboratory in 1960. She was a meticulous investigator, a gifted teacher and a person of rare humility. As a memorial to Gerry, this collection was upgraded in 1987 by one of us [DHE] to include a collection 480 colour 35mm slides covering the mycoses and pathogenic fungi likely to be encountered in Australasia, South East Asia and Oceania. We have now further enhanced this collection by the addition of over a 120 new slides to produce a set of 500 high quality digital [JPEG] images covering the clinical and mycological features of most pathogenic fungi encountered in the world.

The aim of this collection is to provide a library of high quality digital images as a teaching resource for medical mycology. The legends accompanying the slides in this collection have by necessity been kept brief. For further information regarding any of the mycoses or pathogenic fungi covered in this set, the reader is referred to Rippon's (1988) or Kwon-Chung and Bennett's (1994) texts on Medical Mycology. For the precise definitions of the mycology terminology used in the legends, the reader is referred to Ainsworth & Bisby's Dictionary of the Fungi (1995).

Finally, we sincerely thank all those who have contributed photographs. The source of these is acknowledged where known. However, over the years and with the passing of Gerry Kaminski, the original source of some of these may have been lost. For this we apologize.

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General Mycology

001. Five kingdom system of classifying living things showing that both fungi and animals may have evolved from a common ancestor.

002. Electron micrograph showing eukaryote cell architecture typical for a fungal cell. Note nucleus, mitochondria, endoplasmic reticulum, plasmalemma, vacuoles and cell wall (opaque in this slide).

003. Identification of medically important fungi. Summary slide showing taxonomic groups relevant to medical mycology.

Zygomycota - Class Zygomycetes: These are fast growing, terrestrial, largely saprobic fungi with non-motile cells; cosmopolitan (665 species). Hyphae coenocytic and mostly aseptate. Asexual spores include chlamydoconidia, conidia and sporangiospores contained in sporangia, borne on simple or branched sporangiophores. Sexual reproduction is isogamous producing a thick-walled sexual resting spore called a zygospore. Medically important orders and genera include:

1. Entomophthorales (Entomophthoromycosis) causative agents of subcutaneous zygomycosis - *Basidiobolus* and *Conidiobolus*.
2. Mucorales (Mucormycosis) causative agents of subcutaneous and systemic zygomycosis - *Absidia, Apophysomyces, Cunninghamella, Mortierella, Mucor, Rhizomucor, Rhizopus* and *Saksenaea*.

004. A peach which has been colonized by *Rhizopus* sp.

005. Non-septate (coenocytic) hyphal strand characteristic of the fungi belonging to the Zygomycetes. Note occasional septa are found in these fungi; however when these septa occur they are solid cross walls with no pores and there is no flow of cytoplasmic material between cells.

006. Zygospores of *Rhizopus sexualis*. Sexual reproduction in the Zygomycetes is isogamous, i.e. reproduction usually involves two gametes of similar size (see the two suspensor cells either side of the black, rough-walled zygospores).

007. Scanning electron micrograph of a zygospore of *Rhizopus homothallicus* showing two suspensor cells either side of a rough-walled zygospore.

008. Mature sporangium of *Rhizopus microsporus* showing a globose columella supporting a mass of sporangiospores. Asexual reproduction in the Zygomycetes is by the production of non-motile sporangiospores in a sporangium.

009. Collapsed "umbrella shaped" columella of *Rhizopus stolonifer* following sporangiospore dispersal.

010. Scanning electron micrographs showing striate sporangiospores of *Rhizopus stolonifer.*

Basidiomycota (mushrooms and toadstools): Saprobes and parasites (especially of plants), terrestrial; cosmopolitan (16,000 species). Hyphae septate with complex septal pores called dolipores which allow cytoplasmic but not nuclear migration. Hyphae are dikaryotic and can often be distinguished by the presence of clamp connections over the septa. Sexual reproduction is by the formation of exogenous basidiospores, typically four, on a basidium. Occasional species produce conidia but most are sterile.

Four classes may be distinguished: Hymenomycetes (mushrooms), Gasteromycetes (puff balls), Urediniomycetes (rusts) and Ustilaginomycetes (smuts). Genera of medical importance include:

1. Teleomorphs of known pathogenic fungi, e.g. *Filobasidiella*.
2. *Coprinus* and *Schizophyllium* agents of basidiomycosis.
3. Mushroom poisoning by *Amanita, Lepiota, Coprinus* and *Psilocybe* etc.

011. Transmission electron micrograph of a section through a "complex" septal pore, called a dolipore, of a basidiomycetous fungus. Hyphal compartments of Basidiomycetes are dikaryotic and "dolipores" have evolved to allow cytoplasmic but not nuclear migration. In this section the swollen lip of the dolipore is clearly seen (a) with the suspended parenthesome adjacent to it (b). (Courtesy Dr S. Flegler, Michigan State University, U.S.A.).

012. Basidiomycetous fungi can often be recognized by the presence of characteristic hyphal clamp connections over the septa. Clamp connections are specialized hyphal bridges that allow the simultaneous mitosis of two nuclei to occur in such a position that the dikaryons of compatible nuclei are duplicated in the proper relationship to each other.

013. Basidiocarp of the common commercially cultivated mushroom *Agaricus bisporus* showing cap, stripe and gills.

014. Scanning electron micrograph of a small cross section of a gill from the common field mushroom *Agaricus campestris* showing typical basidia in various developmental stages. Note basidia typically produce four basidiospores supported on fine peg-like structures called sterigmata.

015. Scanning electron micrograph showing a typical basidium of *Agaricus campestris* with four sterigmata and three remaining mature basidiospores.

Ascomycota (common moulds): Saprobes, parasites (especially of plants), or lichen forming, mostly terrestrial; cosmopolitan (28,650 species). Hyphae septate with simple septal pores, cytoplasmic and nuclear migration not inhibited. Asexual reproduction is by conidia. Sexual reproduction is by the formation of endogenous ascospores, typically eight, in an ascus. Asci are often housed in a fruiting body or ascocarp e.g. cleistothecia or perithecia.

No classes are now recognized; although in the past they have often been grouped according to how the asci were arranged (Hemiascomycetes, Plectomycetes, Pyrenomycetes, Discomycetes, Laboulbeniomycetes and Loculoascomycetes).

Medically important genera include the teleomorphs of known pathogenic fungi e.g. *Arthroderma, Nannizzia, Ajellomyces, Pseudallescheria, Eurotium* etc., agents of mycetoma, such as *Leptosphaeria* and *Neotestudina*, and of black piedra, such as *Piedraia hortae*.

016. Scanning electron micrograph showing fungal hyphae the basic vegetative growth form of fungi.

017. Transmission electron micrograph of a section through hyphae showing typical septa and septal pores of an ascomycetous fungus (*Chaetomium globosum*).

018. Transmission electron micrographs of sections through "simple" septal pores of an Ascomycete showing characteristic Woronin bodies which can plug the pore in the event of injury to the hyphal segment.

019. Viable hyphal fragments of a dermatophyte in a skin scraping, demonstrating the evolutionary advantage of septate hyphae (fluorescence microscopy using Calcofluor White as a stain.).

020. A linear, cylindrical, eight-spored ascus of *Sordaria fimicola*. Note ascosporogenesis (sexual reproduction in the Ascomycotina) involves the formation of ascospores, typically eight, by "free cell formation" within an ascus.

021. Clavate shaped, eight-spored asci of the Loculoascomycete, *Leptosphaerulina* showing multicellular ascospores.

022. Globose, so called "naked" asci, containing eight ascospores of *Pseudoarachniotus*. Note the asci are not housed in a fruiting body or ascocarp and in the past this fungus would have been classified as a Hemiascomycete (i.e. ascocarps absent).

023.	Culture of *Aphanoascus flavescens* on Sabouraud's dextrose agar showing numerous cleistothecia (non-ostiolate ascocarps). *A. flavescens* is a soil keratinophilic ascomycete which occasionally causes dermatomycosis in man and animals.

024. A cleistothecium of *Aphanoascus flavescens* formed on sterile human hair bait cultures. In the past this fungus would have been classified as a Plectomycete (i.e. ascocarps typically a cleistothecium).

025. The *Chrysosporium* anamorph of *Aphanoascus flavescens*. Note the typical pyriform to clavate shaped conidia with truncated bases which are formed either intercalary, laterally or terminally.

026. Scanning electron micrograph showing a perithecium (an ostiolate ascocarp) of *Gelasinospora*. Note the apical ostiole. Ascomycetes typically producing perithecia were once classed as Pyrenomycetes.

027. Scanning electron micrograph showing ascospore discharge through the apical ostiole of a perithecium of *Gelasinospora*.

Hyphomycetes (conidial moulds): A class of mycelial moulds, which reproduce asexually by conidia on hyphae or aggregations of hyphae but not within discrete conidiomata. No sexual state is present; cosmopolitan (l7,000 species). Hyphae are septate, having simple ascomycetous septal pores. This class contains the majority of medically important fungi.

Dematiaceous Hyphomycetes are those conidial fungi that produce dark brown, green-black, or black colonies and are the causative agents of **phaeohyphomycosis**. Hyaline Hyphomycetes include those conidial fungi which are not darkly pigmented, colonies may be colourless or brightly coloured. These include the agents of **hyalohyphomycosis**, aspergillosis, dermatophytosis and the dimorphic pathogens, like *Histoplasma capsulatum*.

Identification of the hyphomycetes is primarily based on microscopic morphology including; (a) conidial morphology, especially septation, shape, size, colour and cell wall texture; (b) the arrangement of conidia as they are borne on the conidiogenous cells, for example whether they are solitary, arthrocatenate, blastocatenate, basocatenate or gloiosporae etc., (c) the type of conidiogenous cell, for example non-specialized or hypha-like, phialide, annellide or sympodial etc., and (d) other additional features such as the presence of sporodochia or synnemata.

Culture characteristics, although less reliable may also be useful. These include surface texture, topography and pigmentation, reverse pigmentation and growth at 37^{o}C. For identification, potato dextrose agar and cornmeal agar are two of the most suitable media to use, and exposure to daylight is recommended to maximize culture colour characteristics.

028. Riddell's slide culture technique. Because Mycologists rely so heavily on the microscopic morphology of fungi to identify them it is essential to have a good microscopic preparation. One has to observe the precise arrangement of the conidiophores and the way in which the conidia are produced (conidial ontogeny). Riddell's simple method of slide culture (Mycologia 42: 265, 1950) permits fungi to be studied virtually in situ with little disturbance.

Aspergillosis.

Aspergillosis is a spectrum of diseases of humans and animals caused by members of the genus *Aspergillus*. These include (1) mycotoxicosis due to ingestion of contaminated foods; (2) allergy and sequelae to the presence of conidia or transient growth of the organism in body orifices; (3) colonization without extension in preformed cavities and debilitated tissues; (4) invasive, inflammatory, granulomatous, necrotizing disease of lungs, and other organs; and rarely (5) systemic and fatal disseminated disease. The type of disease and severity depends upon the physiologic state of the host and the species of *Aspergillus* involved.
Distribution: World-wide.
Aetiological Agents: *Aspergillus fumigatus, A. flavus, A. niger, A. nidulans* and *A. terreus*.

029. Aspergilloma found at post-mortem in the lung of a child with leukaemia. Note fungus ball occupying cavity.

030, 031. Aspergilloma found at post-mortem in the lung of a child with leukaemia.

032. Aspergillosis in air sacs of a hen during an epidemic of aspergillosis in poultry. (Courtesy C.V.L. Weybridge, England).

033 Grocott's methenamine silver (GMS) stained tissue section of lung showing fungal balls of hyphae of *Aspergillus fumigatus.*

034. Grocott's methenamine silver (GMS) stained tissue section of lung showing dichotomously branched, septate hyphae of *Aspergillus fumigatus*.

035, 036. Grocott's methenamine silver (GMS) stained tissue sections showing *Aspergillus fumigatus* in lung tissue, note conidial heads forming in an alveolus.

037. *Aspergillus fumigatus* on Czapek dox agar showing typical blue-green surface pigmentation with a suede-like surface consisting of a dense felt of conidiophores.

038,039. Microscopic morphology of *Aspergillus fumigatus* showing typical columnar, uniseriate conidial heads. Conidiophores are short, smooth-walled and have conical shaped terminal vesicles, which support a single row of phialides on the upper two thirds of the vesicle. Conidia are produced in basipetal succession forming long chains (slide 038), however, during preparation of slides the conidial chains are usually disrupted giving the more typical microscopic appearance seen in slide 039. Conidia are globose to subglobose, green and rough-walled to echinulate.

040. *Aspergillus niger* on Czapek dox agar. Colonies consist of a compact white or yellow basal felt covered by a dense layer of dark-brown to black conidial heads.

041. Microscopic morphology of *Aspergillus niger* showing large, globose, dark brown conidial heads, which become radiate, tending to split into several loose columns with age. Conidiophores are smooth-walled, hyaline or turning dark towards the vesicle. Conidial heads are biseriate with the phialides borne on brown, often septate metulae. Conidia are globose to subglobose, dark brown to black and rough-walled.

042. *Aspergillus flavus* on Czapek dox agar. Colonies are granular, flat, often with radial grooves, yellow at first but quickly becoming bright to dark yellow-green with age.

043. Microscopic morphology of *Aspergillus flavus*. Conidial heads are typically radiate, later splitting to form loose columns, biseriate but having some heads with phialides borne directly on the vesicle. Conidiophores are hyaline and coarsely roughened, often more noticeable near the vesicle. Conidia are globose to subglobose, pale green and conspicuously echinulate. Some strains produce brownish sclerotia.

044. *Aspergillus nidulans* on Czapek dox agar showing typical plain green colony with dark red-brown cleistothecia developing within and upon the conidial layer. Reverse may be olive to drab-grey or purple-brown.

045. Microscopic morphology of *Aspergillus nidulans*. Conidial heads are short columnar and biseriate. Conidiophores are usually short, brownish and smooth-walled. Conidia are globose and rough-walled.

046. *Aspergillus terreus* on Czapek dox agar showing typical suede-like cinnamon-buff to sand brown colonies. Reverse yellow to deep dirty brown.

047. Conidial head of *Aspergillus terreus*. Conidial heads are compact, columnar and biseriate. Conidiophores are hyaline and smooth-walled. Conidia are globose to ellipsoidal, hyaline to slightly yellow and smooth-walled.

048. Immunodiffusion test showing precipitins against *Aspergillus*.

049. Antifungal susceptibility disk test showing the *in vitro* activity of voriconazole against *Aspergillus fumigatus* with *Candida krusei* as a control.

Blastomycosis.

Blastomycosis is a chronic granulomatous and suppurative disease having a primary pulmonary stage that is frequently followed by dissemination to other body sites, chiefly the skin and bone. Although the disease was long thought to be restricted to the North American continent, in recent years autochthonous cases have been diagnosed in Africa, Asia and Europe. All available clinical and epidemiological evidence indicates that humans and lower animals contract blastomycosis from some source in nature. However, the natural habitat of *B.* dermatitidis has yet to be clearly delineated, despite some reports of its isolation from soil.
Distribution: North America, some cases from Africa, Asia and Europe.
Aetiological Agent: *Blastomyces dermatitidis*

050. Ulcerated granuloma due to *B. dermatitidis*. (Courtesy of Dr. John Rippon, USA).

051 Cutaneous blastomycosis of 20 years duration showing loss of skin. Note advancing edge of lesion. (Courtesy of Dr. John Rippon, USA).

052, 053. Cutaneous blastomycosis from the same patient as in 051 showing loss of skin from the arm and fingers. Note advancing edge of lesion. (Courtesy of Dr. John Rippon, USA).

054, 055. Tissue sections showing large, broad-base, unipolar budding yeast-like cells, 8-15µm in diameter. Note: tissue sections need to be stained by Grocott's methenamine silver method to clearly see the yeast-like cells, which are often difficult to observe in Haematoxylin and eosin (H&E) stained preparations.

Candidiasis.

A primary or secondary mycotic infection caused by members of the genus *Candida*. The clinical manifestations may be acute, subacute or chronic to episodic. Involvement may be localized to the mouth, throat, skin, scalp, vagina, fingers, nails, bronchi, lungs, or the gastrointestinal tract, or become systemic as in septicaemia, endocarditis and meningitis.
Distribution: World-wide.
Aetiological Agents: *Candida albicans, C. glabrata, C. tropicalis, C. krusei. C. parapsilosis, C. guilliermondii* and *C. pseudotropicalis.* All are ubiquitous and occur naturally on humans.

056. Oral candidiasis in an infant showing characteristic patches of a creamy-white to grey pseudomembrane composed of blastoconidia and pseudohyphae of *C. albicans*. Note the mouth of normal newborn infants has a low pH which may promote the proliferation of *C. albicans*. The infections are usually acquired during the birth process from mothers who had vaginal thrush during pregnancy. Clinical symptoms may persist until a balanced oral flora has been established.

057. Chronic oral candidiasis of the tongue and mouth corners (angular cheilitis) in an adult with an underlying immune deficiency. Note characteristic white pseudomembrane composed of cells and pseudohyphae of *C. albicans*.

058. Angular cheilitis an intertrigo and fissuring caused by maceration of the corners of the mouth is frequently complicated by chronic infection with *C. albicans*. Note the white pseudomembrane-like colonies in the mouth corners of this adult patient. (Courtesy Dr G. Hunter, Adelaide, S.A.).

059. Solar cheilitis in a young boy showing colonization of the lip by *C. albicans*. (Courtesy Dr G. Hunter, Adelaide, S.A.).

060. *Candida* granuloma of the forehead and angular cheilitis of the mouth in a young girl with chronic mucocutaneous candidiasis. Note thick crusted lesions of the scalp and forehead. *C. albicans* was isolated.

061. Interdigital candidiasis of the hands may develop particularly in persons whose hands are subject to continuing wetting, especially with sugar solutions or contact with flour. *C. albicans* was isolated. (Courtesy Dr G. Hunter, Adelaide S.A.).

062. Interdigital candidiasis of the feet explains l% of cases of "athletes foot" and must be distinguished from tinea pedis caused by dermatophytes. *C. albicans* was isolated. Compare this slide with slide 251 showing *T. rubrum* infection of foot. (Courtesy Dr G. Hunter, Adelaide, S.A.).

063. Intertriginous or flexural candidiasis of the groin may also mimic tinea cruris caused by a dermatophyte. Note erythematous scaling lesions with distinctive border and several small satellite lesions. *C. albicans* was isolated. (Courtesy Dr D. Hill, Adelaide, S.A.).

064. Intertriginous or flexural candidiasis behind the knee showing an extensive erythematous scaling lesion and several smaller satellite lesions caused by *C. albicans*. (Courtesy Dr G. Hunter, Adelaide, S.A.).

065. Satellite lesions of cutaneous candidiasis showing typical collars of scale. *C. albicans* was isolated. Note the presence of satellite lesions usually differentiates candidiasis from dermatophytosis.

066. Candidiasis of the penis (balanitis) caused by *C. albicans*. (Courtesy Dr G. Hunter, Adelaide, S.A.).

067. Vaginal candidiasis caused by *C. albicans*. (Courtesy Dr J. McCloskey, Perth, W.A.).

068, 069. Chronic candidiasis (onychomycosis) of thumb nails showing destruction of nail tissue. *C. albicans* was isolated. (Courtesy Dr G. Hunter, Adelaide, S.A.).

070. Superficial candidiasis in an infant (nappy rash) secondary to seborrhoeic dermatitis. Usually occurs under unhygienic conditions of chronic dampness and irregularly changed, unclean nappies. In several cases this condition may spread to the axillae, face, conjunctiva and other areas (see slide 071).

071. Young infant with chronic superficial candidiasis showing spread to the mouth area and conjunctiva. Note erythematous scaling lesions with well marginated borders and small satellite lesions on the chin showing typical collar of scaling. *C. albicans* was isolated. (Courtesy Dr G. Hunter, Adelaide, S.A.).

072. Generalized candidiasis in a young infant secondary to seborrhoeic dermatitis caused by *C. albicans*. Note the particular involvement of body creases, e.g. groin, axillae, neck, cubital fossae and multiple small satellite lesions.

073. Generalised candidiasis in a young infant caused by *C. albicans.*

074. *Candida* endophthalmitis is often associated with candidemia, indwelling catheters or drug abuse, however it is rare in patients with severe neutropenia. Lesions are often localized near the macula and patients complain of cloudy vision. Exogenous *Candida* endophthalmitis is rare, but cases have been reported following ocular trauma or surgery. Similarly, conjunctival and corneal infections have also been recorded following trauma.

075. Chronic candidiasis of the scalp in a child with an underlying immune deficiency caused by *C. albicans*.

076. Skin scraping from superficial candidiasis showing clusters of budding yeast cells and branching pseudohyphae.

077. Direct smear of urine from a patient with candidiasis of the kidney showing *C. albicans* in mycelial or tissue phase with blastoconidia budding from the pseudohyphae.

078. Periodic Acid-Schiff (PAS) stained section of post-mortem oesophagus showing invasion of blood vessel by *C. albicans*. Note blastoconidia and branched pseudohyphae.

079. *C. albicans* on Sabouraud's dextrose agar showing typical cream coloured, smooth surfaced, waxy colonies.

080. Microscopic morphology of *C. albicans* showing budding spherical to ovoid blastoconidia.

081. Screening test for the identification of *C. albicans*. Production of germ tubes by *C. albicans* in serum or plasma after 2-3 hours incubation at 37^{O}C. Note characteristic germ tubes.

082. Germ tube negative *Candida* species showing no production of germ tubes in plasma after 3 hours incubation at 37^{O}C. Budding blastoconidia only are seen.

083. Confirmatory test for *C. albicans*. Production of large round, thick-walled vesicles (often incorrectly referred to as chlamydoconidia) on Difco chlamydospore agar. Trypan blue in the medium is absorbed strongly by these terminal vesicles. Numerous small blastoconidia and pseudohyphae are also present.

084. Uni-Yeast-Tek plate showing common assimilation tests and dalmau plate culture used for the identification of yeasts. Note morphological studies are essential for the satisfactory identification of yeasts. Also note the negative urease test indicating the ascomycetous nature of *Candida albicans*, the test organism.

085. API ID32C yeast identification strip showing the identification of *Candida*.

086. Auxacolor yeast identification strip showing the identification of *Candida.*

087. CHROMagar *Candida* plate showing chromogenic colour change for *C. albicans* (green), *C. tropicalis* (blue), *C. parapsilosis* (white) and *C. glabrata* (pink).

088. Sensititre YeastOne antifungal microbroth dilution plate showing MIC's to *Candida albicans* for Amphotericin B (0.125 ug/ml), Fluconazole (1.0 ug/ml), Itraconazole (0.125 ug/ml), Ketoconazole (0.125 ug/ml) and 5-Fluorocytosine (0.18 ug/ml).

089. Fungitest antifungal microbroth breakpoint test for *Candida krusei* for 5-Fluorocytosine, Amphotericin B, Miconazole, Ketoconazole, Itraconazole and Fluconazole.

090. Fluconazole Etest and disk test for *Candida albicans*.

091. Fluconazole Etest and disk test for *Candida albicans* showing end point trailing effect.

092. *Candida dubleniensis* and *Candida albicans* on CHROMagar.

093. *Candida dubleniensis* and *Candida albicans* on Bird Seed Agar.

Chromoblastomycosis.

A mycotic infection of the cutaneous and subcutaneous tissues characterized by the development in tissue of dematiaceous (brown-pigmented), planate-dividing, rounded sclerotic bodies. Infections are caused by the traumatic implantation of fungal elements into the skin and are chronic, slowly progressive and localized. Tissue proliferation usually occurs around the area of inoculation producing crusted, verrucose, wart-like lesions.
Distribution: World-wide but more common in bare footed populations living in tropical regions.
Aetiological Agents: Various dematiaceous hyphomycetes associated with decaying vegetation or soil, especially *Phialophora verrucosa, Fonsecaea pedrosoi, F. compacta* and *Cladophialophora carrionii*.

094. Chronic verrucose chromoblastomycosis of the foot due to *Phialophora verrucosa*. Note tissue hyperplasia characterized by the formation of verrucoid, warty cutaneous nodules raised 1 to 3cm above the skin surface. (Courtesy Dr R. Crosby, Adelaide, S.A.).

095, 096. Chronic verrucous chromoblastomycosis of the hand due to *Cladophialophora carrionii*. Note tissue hyperplasia forming a white verrucoid cutaneous lesion. In Australia, chromoblastomycosis due to *C. carrionii* occurs mostly on the hands and arms of timber and cattle workers in humid tropical forests. (Courtesy Mr J. Kennedy, Toowoomba, Qld.).

097. Skin scrapings from a patient with chromoblastomycosis mounted in 10% KOH and Parker ink solution showing characteristic brown pigmented, planate-dividing, rounded sclerotic bodies.

098, 099. Chromoblastomycosis - Haematoxylin and eosin (H&E) stained sections showing characteristic dark brown sclerotic cells, which divide by binary fission and not by budding. Note all agents of chromoblastomycosis form these sclerotic bodies in tissue.

100. *Cladophialophora carrionii* on Sabouraud's dextrose agar. Colonies are slow growing, reaching 3-4cm in diameter after l month, with a compact suede-like to downy surface. Colonies are olivaceous-black in colour and have well defined margins.

101. Microscopic morphology of *Cladophialophora carrionii* showing typical *Cladosporium* type conidial ontogeny with elongate conidiophores producing branched acropetal chains of smooth-walled conidia.

102. *Phialophora verrucosa* on Sabouraud's dextrose agar. Colonies are slow growing, initially dome-shaped, later becoming flat, suede-like and olivaceous to black in colour.

103. Microscopic morphology of *Phialophora verrucosa* showing typical *Phialophora* type conidial ontogeny with well-formed, flask-shaped or elliptical phialides having distinctive widely flaring, pigmented collarettes. The single-celled phialoconidia are produced in basipetal succession and aggregate in slimy heads at the apices of the phialide.

Coccidioidomycosis.

Initially, a respiratory infection, resulting from the inhalation of conidia, that typically resolves rapidly leaving the patient with a strong specific immunity to re-infection. However, in some individuals the disease may progress to a chronic pulmonary condition or as a systemic disease involving the meninges, bones, joints and subcutaneous and cutaneous tissues.
Distribution: Endemic in south-western U.S.A., northern Mexico and various centres in South America.
Aetiological Agent: *Coccidioides immitis*, a soil inhabiting fungus.

104. Coccidioidomycosis showing chronic lesions of the face. Active lesions are seen on the cheek. An atrophic, depigmented scar representing a healed lesion is on the forehead. (Courtesy of Dr J.W. Rippon, USA).

105. Chronic cutaneous coccidioidomycosis showing granulomatous lesions on face, neck and chin. (Courtesy of Dr J.W. Rippon, USA).

106. Extension of pulmonary coccidioidomycosis showing a large superficial, ulcerated plaque. (Courtesy of Dr J.W. Rippon, USA).

107. Direct microscopy of skin scrapings from a cutaneous lesion mounted in 10% KOH and Parker ink solution showing characteristic endosporulating spherules (sporangia) of *Coccidioides immitis*. The presence of spherules with endospores is diagnostic.

108, 109. Periodic Acid-Schiff (PAS) stained tissue section of viscera from an experimentally induced infection in a mouse showing typical endosporulating spherules of *Coccidioides immitis*. Young spherules have a clear centre with peripheral cytoplasm and a prominent thick wall. Endospores (sporangiospores) are later formed within the spherule by repeated cytoplasmic cleavage. Rupture of the spherule releases endospores into the surrounding tissue where they re-initiate the cycle of spherule development.

110, 111. Culture of *Coccidioides immitis* on Sabouraud's dextrose agar showing a suede-like to downy, greyish white colony with a tan to brown reverse.

112, 113 Microscopic morphology of *Coccidioides immitis* showing typical single-celled, hyaline, rectangular to barrel-shaped, alternate arthroconidia, separated from each other by a disjunction cell. This arthroconidial state has been classified in the genus *Malbranchea* and is similar to that produced by many non-pathogenic soil fungi, e.g. *Gymnoascus* sp.

Cryptococcosis

A chronic, subacute to acute pulmonary, systemic or meningitic disease, initiated by the inhalation of the fungus. Primary pulmonary infections have no diagnostic symptoms and are usually subclinical. On dissemination, the fungus usually shows a predilection for the central nervous system, however skin, bones and other visceral organs may also become involved.
Distribution: World-wide.
Aetiological Agent: *Cryptococcus neoformans*.

114. Primary cutaneous cryptococcosis on the forearm of an adult human *Cryptococcus neoformans* var. *gattii*. Note papule-like lesion, which is beginning to ulcerate. (Courtesy Dr G. Donald, Adelaide, S.A.).

115. "Molluscum contagiosum" like lesions caused by *Cryptococcus neoformans* var. *neoformans* in an HIV+ patient. (Courtesy Dr D. Marriott, Sydney, NSW).

116, 117. Ulcerated perianal skin lesion caused by *Cryptococcus neoformans* var. *neoformans* in an HIV+ patient (Courtesy Dr D. Marriott, Sydney, NSW).

118. Ulcerated skin lesion caused by *Cryptococcus neoformans* var. *neoformans* on the forearm of an HIV+ patient (Courtesy Dr D. Marriott, Sydney, NSW).

119. Ulcerated skin lesions caused by *Cryptococcus neoformans* var. *gattii* on the head of an FIV+ cat (Courtesy Dr R. Malik, Sydney, NSW).

120. Cryptococcal rhinitis caused by *Cryptococcus neoformans* var. *gattii* in an FIV+ cat (Courtesy Dr R. Malik, Sydney, NSW).

121. Cryptococcal rhinitis caused by *Cryptococcus neoformans* var. *gattii* in an African grey parrot from the Adelaide Zoo.

122. India ink preparation of cerebrospinal fluid from a patient with cryptococcal meningitis showing a budding yeast cell of *C. neoformans* surrounded by a characteristic wide gelatinous capsule.

123, 124. MRI scans showing multiple cryptococcomas [white masses] in the brain. (Courtesy Prof. Tania Sorrell, Sydney NSW).

125. X-ray showing pulmonary cryptococcal infection [right upper lobe]. (Courtesy Prof. Tania Sorrell, Sydney NSW).

126. Tissue section stained by haematoxylin and eosin (H&E) showing numerous encapsulated yeast cells. *C. neoformans* was isolated. (Courtesy Dr G. Hunter, Adelaide, S.A.).

127. Grocott's methenamine silver (GMS) stained tissue section of lung showing typical encapsulated yeast cells of *C. neoformans.*

128. Grocott's methenamine silver (GMS) stained tissue section of lung showing atypical non-encapsulated yeast cells of *C. neoformans.*

129. *C. neoformans* on Sabouraud's dextrose agar showing typical dark cream coloured, smooth, moist, shining and mucoid colonies.

130. Microscopic morphology of *C. neoformans* showing encapsulated budding, yeast cells. No pseudohyphae are produced.

131. Mixed culture of *C. neoformans* and *C. albicans* on bird seed agar (Guizotia seeds) showing the distinctive brown colonies of *C. neoformans*, due to the selective absorption of pigment from the media, compared to the white colonies of *C. albicans*.

132. Canavanine-glycine-bromothymol blue medium can be used to distinguish *C. neoformans* var. *neoformans* (medium remains yellow) from *C. neoformans* var. *gattii* (medium turns a deep blue in 2-3 days).

133. Accumulation of pigeon dung a natural habitat for *Cryptococcus neoformans* var. *neoformans*.

134. Basidiospores of *Cryptococcus neoformans* var. *neoformans* following mating of two compatible strains [MAT α and MAT a].

135. Iatron serotyping kit can be used to serotype isolates of *Cryptococcus neoformans*.

136. A positive cryptococcal antigen latex test. It should be noted that the detection of cryptococcal capsular polysaccharide antigen in spinal fluid is now the method of choice for diagnosing patients with cryptococcal meningitis. In AIDS patients, cryptococcal antigen can be detected in the serum in nearly 100% of cases. However, in non-AIDS patients antigen detection in serum is less sensitive with only about 60% of patients with cryptococcosis reported as being positive. Note, serum specimens should be pretreated with pronase to enhance detection of antigen and avoid false negative results.

137. Negative cryptococcal antigen latex test.

138. Uni-Yeast-Tek plate showing characteristic assimilation tests and dalmau plate culture used for the identification of *C. neoformans*. Note the urease positive test indicating the basidiomycetous nature of *C. neoformans.*

Dermatophytosis (Ringworm or Tinea)

Ringworm of scalp, glabrous skin, and nails caused by a closely related group of fungi known as dermatophytes which have the ability to utilize keratin as a nutrient source.
The disease process in dermatophytosis is unique for two reasons:

(a) No living tissue is invaded; the keratinised stratum corneum is simply colonized. However, the presence of the fungus and its metabolic products usually induces an allergic and inflammatory eczematous response in the host. The type and severity of the host response is often related to the species and strain of dermatophyte causing the infection.
(b) The dermatophytes are the only fungi that have evolved a dependency on human or animal infection for the survival and dissemination of their species.

139. Routine equipment for the collection of hair, skin and nail specimens.

140. Black collection cards showing a suitable amount of nail material for a good sample vs an insufficient sample.

141. Hyphal elements of *Epidermophyton floccosum* ramifying through skin scales mounted in 10% KOH and Parker ink solution.

142. Hyphal elements breaking up into arthroconidia ramifying through skin scales mounted in 10% KOH and Parker ink solution.

143. Conidia of *Scopulariopsis* in an infected nail mounted in 10% KOH.

144. Brown pigmented hyphae of *Scytalidium dimidiatum* [= *Nattrassia mangiferae*, synonym *Hendersonula toruloidea*] in an infected nail mounted in 10% KOH (Courtesy Dinah Parr, Auckland New Zealand).

145. Wood's ultra-violet light. Note simulated greenish-yellow fluorescence in small beaker.

Epidermophyton floccosum

An anthropophilic fungus often causing tinea pedis, tinea cruris, tinea corporis and onychomycosis. Not known to invade hair in vivo. May become epidemic among personnel using common shower or gym facilities, e.g. athletic teams, troops, ship crews and inmates of institutions.
Distribution: World-wide.
Key Features: Culture characteristics and microscopic morphology.

146. Severe tinea of the foot (tinea pedis) caused by *E. floccosum* showing extensive scaling.

147, 148. Tinea of the groin (tinea cruris) showing typical circular, erythematous lesions with raised advancing margins.

149. Submammary tinea corporis caused by *E. floccosum*.

150. Acute infection of the hand caused by *E. floccosum* showing inflammation and serious exudate from the ulcerative margins.

151, 152, 153. *E. floccosum* on mycobiotic agar. Colonies are usually greenish-brown or khaki coloured with a suede-like surface, raised and folded in the centre, with a flat periphery and submerged fringe of growth. Older cultures may develop white pleomorphic tufts of mycelium. A deep yellowish-brown reverse pigment is usually present.

154, 155. Microscopic morphology of *E. floccosum* showing characteristic smooth, thin-walled macroconidia, which are often produced in, clusters growing directly from the hyphae (slide 154). Numerous chlamydoconidia are formed in older cultures (slide 155). No microconidia are formed.

Microsporum audouinii

An anthropophilic fungus causing non-inflammatory infections of scalp and skin especially in children. Once the cause of epidemics of tinea capitis in Europe and North America but is becoming less frequent. Invaded hairs show an ectothrix infection and usually fluoresce a bright greenish-yellow under Wood's ultra-violet light.
Distribution: World-wide.
Key Features: Absence of conidia and poor or absence of growth on polished rice grains.

156. Typical *M. audouinii* infection of scalp showing hair loss and scaling.

157. Chronic *M. audouinii* scalp infection of 6 years duration showing minimal hair loss and scaling.

158, 159. Colony of *M. audouinii* on mycobiotic agar showing a flat, spreading, downy white surface with a salmon or peach-pink reverse pigment.

160. Microscopy morphology of *M. audouinii* showing a thick-walled intercalary chlamydoconidium. Note macroconidia and microconidia are only rarely produced.

161. Nutritional requirements. Growth of *M. audouinii* is enhanced by the presence of thiamine (Trichophyton agars No.1 and No.4, Difco).

162. Growth of *M. audouinii* on polished rice grains is very poor or absent, usually being visible only as a brown discoloration. This is one of the features, which distinguish *M. audouinii* from *M. canis*.

Microsporum canis

A zoophilic dermatophyte, which is a frequent cause of ringworm in humans, especially children. Invades hair, skin and rarely nails. Cats and dogs are the main sources of infection. Invaded hairs show an ectothrix infection and fluoresce a bright greenish-yellow under Wood's ultra-violet light.
Distribution: World-wide.
Key Features: Distinctive macroconidia and culture characteristics. Abundant growth and sporulation on polished rice grains.

163 Young boy showing numerous, circular scaling lesions with distinct erythematous borders following contact with kittens. *M. canis* was isolated.

164. Young girl showing *M. canis* lesions in chickenpox scars following contact with family cat.

165. A five week old baby showing typical *M. canis* lesions with raised, erythematous advancing borders following contact with several Siamese cats.

166. Early infection of the scalp showing hair loss, scaling and advancing erythematous border. *M. canis* was isolated.

167. Typical *M. canis* scalp lesion showing hair loss and scaling. Note small "broken off" infected hairs in the central part of the lesion.

168. Large kerion-type lesion consisting of crusts, matted hair, exudate, and scalp debris. *M. canis* was isolated. (Courtesy Dr D. Hill, Adelaide, S.A.).

169. Severe inflammatory kerion lesion and suppurative folliculitis produced by infection with *M. canis.* (Courtesy Dr T. Turner, Adelaide, S.A.).

170. Typical small-spored ectothrix hair invasion produced by *M. canis.*

171, 172. Culture of *M. canis* on mycobiotic agar showing a spreading whitish, cottony surface growth with a golden-yellow reverse pigment. Note non-pigmented strains may occur.

173. Slide culture of *M. canis* showing typical spindle-shaped, verrucose, thick-walled macroconidia (5-15 cells), often with a terminal knob. A few pyriform to clavate microconidia are also present.

174. Dysgonic type of *M. canis.* Cultures on mycobiotic agar are heaped and folded and yellow-brown in colour. Macroconidia are usually absent in these strains. However, typical colonies and macroconidia of *M. canis* are usually produced on polished rice grains. Note the dysgonic type colony of *M. canis* is similar to that of *Microsporum ferrugineum.*

175. *M. canis* showing good surface growth and sporulation on polished rice grains.

Microsporum ferrugineum

An anthropophilic fungus causing epidemic juvenile tinea capitis in humans. The clinical features are similar to those of infections caused by *M. audouinii.* Invaded hairs show an ectothrix infection and fluoresce a greenish-yellow under Wood's ultra-violet light.
Distribution: Asia (including China and Japan), USSR, Eastern Europe and Africa.
Key Features: Culture characteristics and distinctive "bamboo" hyphae.

176, 177. Culture of M. *ferrugineum* on mycobiotic agar showing a waxy, glabrous, convoluted thallus with a cream to buff coloured surface and no reverse pigment. Note surface pigmentation may vary from cream to yellow to deep red and a flatter white form sometimes occurs. Cultures rapidly become downy and pleomorphic.

178. Microscopic morphology of *M. ferrugineum.* No microconidia or macroconidia are produced, only irregular branching hyphae with prominent cross walls (“bamboo” hyphae) and occasional to numerous chlamydoconidia occur. The so-called "bamboo" hyphae are a characteristic of this species.

Microsporum gypseum

A geophilic fungus, which may cause infections in animals and humans, particularly children and rural workers during warm humid weather. Usually produces a single inflammatory skin or scalp lesion. Invaded hairs show an ectothrix infection but do not fluoresce under Wood's ultra-violet light.
Distribution: World-wide.
Key Features: Distinctive macroconidia and culture characteristics.

179. Young child showing a large circular erythematous scaly lesion with a raised border on the nose. *M. gypseum* was isolated.

180. An adult with a large, circular, erythematous pustular lesion on the wrist. *M. gypseum* was isolated.

181. Scalp infection in a young child showing hair loss and a circular erythematous kerion-like lesion. Note small broken-off infected hairs. *M. gypseum* was isolated.

182. Hair infected by *M. gypseum* showing large-spored ectothrix invasion of hair.

183, 184. Culture of *M. gypseum* on mycobiotic agar showing a flat, spreading suede-like to granular, tawny-buff cinnamon coloured surface. Many cultures develop a central white downy umbo (dome) or a fluffy white tuft of mycelium and some also show a narrow, white periphery. A yellow-brown pigment is usually produced on the reverse, however a reddish-brown reverse pigment may be present in some strains.

185. Microscopic morphology *M. gypseum* showing abundant, symmetrical, ellipsoidal, thin-walled verrucose 4-6 celled macroconidia. The terminal or distal ends of most macroconidia are slightly rounded, while the proximal ends (point of attachment to hyphae) are truncate. Numerous clavate shaped microconidia are also present, but these are not diagnostic.

186. Isolation of *M. gypseum* from soil by using prepubertal hair as bait. This technique can be used to determine the source of infection.

Microsporum nanum

A zoophilic fungus frequently causing chronic non-inflammatory lesions in pigs and a rare cause of tinea in humans. Also present in soil of pig-yards. Invaded hairs may show a sparse ectothrix or endothrix infection but do not fluoresce under Wood's Ultra-Violet light.
Distribution: World-wide.
Key Features: Distinctive macroconidia and culture characteristics.

187, 188, 189. Chronic non-inflammatory lesions in pigs caused by *M. nanum.* (Courtesy Mr D. Connoll, Brisbane, Q1d.)

190, 191. Culture of M. *nanum* on mycobiotic agar showing a flat, white to cream coloured, suede-like to powdery surface with brownish-orange reverse pigment.

192. Microscopic morphology of *M. nanum* showing numerous small ovoid to pyriform macroconidia with 1-3 cells but mostly 2 cells, with relatively thin, finely echinulate (rough) walls, and broad truncate bases. Many macroconidia are borne on conidiophores, which do not stain readily. Occasional clavate microconidia are present, which distinguishes *M. nanum* from some species of *Chrysosporium.*

Trichophyton concentricum

An anthropophilic fungus, which causes chronic widespread non-inflammatory tinea corporis known as tinea imbricata because of the concentric rings of scaling it produces. It is not known to invade hair. Infections among Europeans are rare.
Distribution: Pacific Islands of Oceania, South East Asia and Central and South America.
Key Features: Clinical disease, geographical distribution and culture characteristics.

193, 194. Chronic non-inflammatory lesions in inhabitants of Papua New Guinea caused by *T. concentricum* showing characteristic concentrically arranged imbricated rings of scaling. (Slide 193 courtesy Dr S. Reed, Papua New Guinea; Slide 194 courtesy Dr M. Tipping, Timor).

195. *T. concentricum* infection in a Caucasian from Papua New Guinea, of 30 years duration. Note the polymorphic patches of profuse scaling. (Courtesy Dr K. O'Grady, Adelaide, S.A.).

196, 197. Culture of *T. concentricum* on mycobiotic agar showing a slow growing, glabrous, deeply folded thallus ranging from cream to deep orange-brown in colour. Reverse is buff to brown in colour.

198. Microscopic morphology of *T. concentricum* consists of broad, much-branched, irregular hyphae, which may have "antler" tips resembling *T. schoenleinii*. Chlamydoconidia are often present in older cultures.

Trichophyton equinum

A zoophilic fungus causing equine ringworm and rare infections in humans. Most strains require nicotinic acid for growth except those from Australia and New Zealand, which are autotrophic (var. *autotrophicum).* Invaded hairs show an ectothrix infection but do not fluoresce under Wood's ultra-violet light.
Distribution: World-wide except for var. *autotrophicum* which is restricted to Australia and New Zealand.
Key Features: Microscopic morphology, culture characteristics, nicotinic acid requirement and clinical lesions in horses.

199. Horse ringworm showing multiple papular lesions. *T. equinum* var. *equinum* was isolated. (Courtesy C.V.L. Weybridge, England).

200. Plaques of horsehair infected by *T. equinum* var. *equinum.*

201. Horse ringworm showing multiple crusting lesions. *T. equinum* var. *autotrophicum* was isolated.

202. Horse ringworm showing raw plaques caused by *T. equinum* var. *autotrophicum.*

203. Clinical slide showing a large, circular, erythematous pustular lesion on the wrist of a female equestrian. *T. equinum* var. *autotrophicum* was isolated.

204. Granulomatous lesion with a crusting border of two years duration on the wrist of a male stable hand. *T. equinum* var. *autotrophicum* was isolated. (Courtesy Dr G. Donald, Adelaide, S.A.)

205. Typical sparse chains of relatively large ectothrix spores produced by *T. equinum* infection of hair. Hairs mounted in 10% KOH and Parker ink solution.

206, 207. *T. equinum* on Sabouraud's dextrose agar with 0.5% yeast extract. Cultures are usually flat, suede-like to downy in texture and white to buff in colour, similar to *T. mentagrophytes.* Cultures usually have a deep-yellow submerged fringe and reverse, which later becomes dark red in the centre.

208, 209, 210. Microscopic morphology of *T. equinum* showing abundant microconidia (slide 208), which may be sessile and pyriform or stalked and spherical. Macroconidia are only rarely produced, but when present are clavate, smooth, thin-walled and of variable size (slide 209). Occasional nodular organs (slide 210) may be present and the microconidia often undergo a transformation to produce abundant chlamydoconidia in old cultures.

211. *In vitro* perforations of human hair caused by the growth of *T. equinum* var. *autotrophicum.*

212. *T. equinum* var. *equinum* on Trichophyton Nos 1 and 5 agars (Difco) demonstrating a growth requirement for nicotinic acid.

213. *T. equinum* var. *autotrophicum* on Trichophyton Nos 1 and 5 agars (Difco) demonstrating that no special nutritional requirements are needed for growth.

Trichophyton mentagrophytes* var. *interdigitale

The anthropophilic form of *T. mentagrophytes* and a common cause of tinea pedis, particularly the vesicular type, tinea corporis and sometimes superficial nail plate invasion. Not known to invade hair *in vivo*, but produces hair perforations *in vitro.* Must be differentiated from the downy forms of *T. rubrum.*
Distribution: World-wide.
Key Features: Culture characteristics, microscopic morphology and *in vitro* perforation of human hair.

214, 215. Tinea pedis caused by *T. mentagrophytes* var. *interdigitale.* Note dry scaling lesions. (Slide 215 Courtesy Dr D. Hill, Adelaide, S.A.).

216, 217. Vesicular type tinea pedis caused by *T. mentagrophytes* var. *interdigitale.* Note vesicle showing serous exudate (slide 217). (Slides courtesy Drs D. Hill and G. Donald, Adelaide, S.A.).

218. Acute vesicular tinea pedis caused by *T. mentagrophytes* var. *interdigitale.*

219. An "id" reaction on the hand associated with acute vesicular tinea pedis caused by *T. mentagrophytes* var. *interdigitale.* Excessive treatment with topical preparations often exaggerates this condition. (Courtesy Dr D. Hill, Adelaide, S.A.).

220, 221. *T. mentagrophytes* var. *interdigitale* on mycobiotic agar. Cultures are white or cream coloured, fluffy or downy, later becoming suede-like due to the production of numerous microconidia. Reverse side of the thallus may be non-pigmented or yellow-brown to red-brown in colour.

222, 223, 224. Microscopic morphology of *T. mentagrophytes* var. *interdigitale.* Cultures usually produce numerous subspherical to pyriform microconidia, occasional spiral hyphae and spherical chlamydoconidia, the latter being more abundant in older cultures. Occasional slender clavate, smooth-walled multiseptate macroconidia may also be present in some cultures.

225. *In vitro* perforations of human hair caused by the growth of *T. mentagrophyles* var. *interdigitale.*

226. Hydrolysis of urea. (A) *T. rubrum* negative after 7 days; (B) *T. mentagrophytes* positive in less than 7 days; and (C) uninoculated control negative after 7 days.

227. Differentiation of *T. rubrum* and *T. mentagrophytes* using Lactritmel agar, a pigment stimulating medium (Kaminski, G.W. 1985. Mycopathologia 91:57-59). The majority of *T. rubrum* isolates produce a dark, wine-red reverse pigment where as isolates of *T. mentagrophytes* usually produce a yellow-brown pigment.

Trichophyton mentagrophytes* var. *mentagrophytes

The zoophilic form of *T. mentagrophytes* with a wide range of animal hosts including mice, guinea pigs, kangaroos, cats, horses, sheep and rabbits. Produces inflammatory skin or scalp lesions in humans, particularly in rural workers. Kerion of the scalp and beard may occur. Invaded hairs show an ectothrix infection but do not fluoresce under Wood's ultra-violet light.
Distribution: World-wide.
Key Features: Culture characteristics, microscopic morphology and clinical disease with known animal contacts.

228. *T. mentagrophytes* var. *mentagrophytes* infection in a Guinea pig showing hair loss and skin scaling of the nose.

229. A large, erythematous, pustular lesion on the wrist of an adult male farmer. *T. mentagrophytes* var. *mentagrophytes* was isolated. (Courtesy Dr G. Donald, Adelaide. S.A.).

230. Chronic scaly lesion on the ear caused by *T. mentagrophytes* var. *mentagrophytes* in an adult male dairy farmer, who leans against his cows while milking.

231. Widespread, chronic erythematous scaling lesions with extensive folliculitis in an eight year old boy. *T. mentagrophytes* var. *mentagrophytes* was isolated. (Courtesy Dr N. Grieve, Adelaide, S.A.).

232. Severe inflammatory kerion lesion and superlative folliculitis of the scalp caused by *T. mentagrophytes* var. *mentagrophytes.*

233. Infection of a laboratory technician's finger by *T. mentagrophytes* var. *mentagrophytes* following contact with mice.

234, 235. *T. mentagrophytes* var. *mentagrophytes* on Kaminski's Lactritmel agar (Mycopathologia 1985 91:57-59). Cultures are flat, white to cream in colour, with a powdery to granular surface. Some cultures develop raised central tufts

or pleomorphic downy areas. Reverse pigmentation is yellow-brown to pinkish brown.

236, 237. *T. mentagrophytes* var. *mentagrophytes* on mycobiotic agar isolated from a mouse. Cultures are flat, white to cream in colour, with a powdery to granular surface and have a red-brown submerged peripheral fringe and reverse pigment.

238, 239, 240. Microscopic morphology of *T. mentagrophytes* var. *mentagrophytes* showing predominantly spherical microconidia, often forming in dense clusters (slide 238), spiral hyphae (slide 239) and smooth, thin-walled, clavate, multiseptate macroconidia (slide 240).

Trichophyton mentagrophytes* var. *quinckeanum

A zoophilic form of *T. mentagrophytes* and the cause of "mouse favus" seen on mice as thick saucer-shaped yellow crusted lesions called scutula. Infections in humans are usually inflammatory and sometimes produce scutula. Invaded hairs are rarely seen but they may show either ectothrix or endothrix infection. Infected human hairs do not fluoresce under Wood's ultra-violet light, but very occasional hairs from experimental lesions in guinea pigs may show a pale yellow fluorescence.
Distribution: Difficult to establish but probably world-wide. Often associated with mice plagues in the Australian Wheat Belt.
Key Features: Culture characteristics, microscopic morphology, contact with mice, odour and rapid urease test.

241. Field mouse showing thick saucer-shaped yellow crusted lesions called scutula, under the eye and on the ear caused by *T. mentagrophytes* var. *quinckeanum.*

242. Human mouse favus (from Poland) showing thick saucer-shaped scutula caused by *T. mentagrophytes* var. *quinckeanum.*

243, 244, 245. Clinical slides showing raised erythematous lesions in young children caused by *T. mentagrophytes* var. *quinckeanum.* All infections were acquired following contact with contaminated materials during a mice plague on the West Coast of South Australia.

246. Experimental scutula induced by inoculating the back of the head of a laboratory mouse with *T. mentagrophytes* var. *quinckeanum.*

247, 248. *T. mentagrophytes* var. *quinckeanum* on mycobiotic agar. Cultures are white, downy and dome-shaped when young; becoming heaped, folded and powdery due to the production of numerous microconidia with age. Reverse pigmentation is usually yellow-brown in colour.

249. Microscopic morphology of *T. mentagrophytes* var. *quinckeanum* showing numerous microconidia, which are predominantly slender, clavate when young and borne laterally along the sides of the hyphae. With age the microconidia become broader and pyriform with some subspherical forms. Occasional to moderate numbers of smooth-walled, multiseptate, clavate macroconidia may be present in young cultures.

Trichophyton rubrum

An anthropophilic fungus, which has become the most common and widely distributed dermatophyte of humans. It frequently causes chronic infections of skin, nails and rarely scalp. Granulomatous lesions may sometimes occur. Invaded hairs show ectothrix or endothrix infection but do not fluoresce under Wood's ultra-violet light.
Distribution: World-wide.
Key Features: Culture characteristics, microscopic morphology and failure to perforate hair *in vitro.*

250, 251. Tinea pedis caused by *T. rubrum* showing scaling macerated skin between the toes. Note compare slide 250 with slide 062 showing candidiasis of the interdigital space (Slides courtesy Drs G. Donald and D. Hill, Adelaide, S.A.).

252. Atopic tinea pedis following treatment with betnovate, caused by *T. rubrum.* (Courtesy Dr D. Hill, Adelaide, S.A.).

253, 254. Tinea of the groin (tinea cruris) caused by *T. rubrum.* Note circular erythematous scaly lesions with advancing border (Slides courtesy Drs D. Hill and G. Donald, Adelaide, S.A.).

255. Erythematous, scaly perianal lesions caused by *T. rubrum.* (Courtesy Dr G. Hunter, Adelaide, S.A.).

256, 257. *T. rubrum* infection of finger nails (slide 256) and toe nails (slide 257). Note nails become discoloured and brittle. (Slide 257 courtesy Dr D. Hill, Adelaide, S.A.).

258, 259. Onychomycosis caused by *T. rubrum*.

260, 261. Chronic non-inflammatory tinea of a finger (260) and hand (261), caused by *T. rubrum.* (Courtesy Drs G. Donald and D. Hill, Adelaide, S.A.).

262. Facial lesion caused by *T. rubrum* showing distinctive, erythematous, advancing border. (Courtesy Dr G. Hunter, Adelaide, S.A.).

263. Tinea corporis caused by *T. rubrum* showing distinctive erythematous advancing border. (Courtesy Dr D. Hill, Adelaide, S.A.).

264. *T. rubrum* infection of the foot and calf.

265, 266. Tinea barbae caused by *T. rubrum.* (Slides courtesy Drs G. Hunter and J. Nicholson, Adelaide, S.A.).

267, 268. *T. rubrum* downy type on Kaminski's Lactritmel agar (Mycopathologia 1985; 91:57-59). Cultures are generally white, suede-like to downy with a characteristic deep wine-red reverse pigment. Note no reverse pigment is produced when these strains are grown on 1% peptone agar.

269, 270, 271. Microscopic morphology of *T. rubrum* showing the production of scanty to moderate numbers of slender clavate to pyriform microconidia. Macroconidia are absent, however closterospore-like projections may be present in some strains.

Trichophyton schoenleinii

An anthropophilic fungus causing favus in humans which is a chronic, scarring form of tinea capitis characterized by saucer-shaped crusted lesions or scutula and permanent hair loss. Invaded hairs remain intact and fluoresce a pale greenish yellow under Wood's ultra-violet light.
Distribution: Eurasia and Africa.
Key Features: Culture characteristics, microscopic morphology showing favic chandeliers and clinical disease.

272. Early infection of the scalp by *T. schoenleinii* showing the formation of small scutula.

273. Favus of the scalp showing extensive hair loss and numerous small scutula. *T. schoenleinii* was isolated.

274. The same lesion as in slide 273 following treatment. Note permanent hair loss and scarring of the scalp.

275, 276. *T. schoenleinii* on mycobiotic agar. Cultures are waxy or glabrous with a deeply folded honeycomb-like thallus with some sub-surface growth. The thallus is cream coloured to yellow to orange brown. Cultures are difficult to maintain in convoluted form and rapidly become flat and downy. No reverse pigmentation is present.

277, 278. Microscopic morphology of *T. schoenleinii* showing characteristic antler "nail head" hyphae also known as 'Flavic chandeliers". No macroconidia or microconidia are seen in routine cultures, however, numerous chlamydoconidia may be present in older cultures.

Trichophyton soudanense

An anthropophilic fungus, which is a frequent cause of tinea capitis in Africa. Invaded hairs show an endothrix infection but do not fluoresce under Wood's ultra-violet light.
Distribution: Africa with occasional isolates from Europe, Brazil and USA.
Key Features: Culture characteristics and microscopic morphology showing reflexive hyphal branching and endothrix invasion of hair.

279, 280. *T. soudanense* on mycobiotic agar. Cultures are slow growing with a flat to folded, suede-like surface. Often there is a broad fringe of submerged growth. Surface mycelium and reverse pigment are characteristically a deep apricot-orange in colour.

281. Microscopic morphology of *T. soudanense* showing reflex hyphae branching. Pyriform microconidia may occasionally be present and numerous chlamydoconidia are often found in older cultures.

Trichophyton tonsurans

An anthropophilic fungus causing inflammatory or chronic non-inflammatory finely scaling lesions of skin, nails and scalp. A common cause of tinea capitis in the Australian Aborigine and in the African-American population. Invaded hairs show an endothrix infection and do not fluoresce under Wood's ultra-violet light.
Distribution: World-wide.
Key Features: Microscopic morphology culture characteristics, endothrix invasion of hairs and partial thiamine requirements.

282 *T. tonsurans* infection of the scalp in an eight year old Aboriginal showing minimal hair loss and numerous small broken off endothrix infected hairs.

283. Tinea of the scalp caused by *T. tonsurans* showing minimal hair loss and scaling.

284. *T. tonsurans* infection of a nail (tinea unguium).

285. Circular, finely scaling lesion with distinct erythematous borders on the thigh of a seven year old Aborigine. *T. tonsurans* was isolated.

286. Circular, erythematous pustular lesion due to *T. tonsurans* in an adult Caucasian.

287. Typical large spored endothrix invasion of hair caused by *T. tonsurans* mounted in 10% KOH and Parker ink solution. Note the chains of arthroconidia..

288, 289,
290, 291. Cultures of *T. tonsurans* show considerable variation in texture and colour. They may be suede-like to powdery, flat with a raised centre or folded, often with radial grooves. The colour may vary from pale-buff (slide 288) to yellow, the so-called "sulfureum" form, which resembles *Epidermophyton floccosum* (slide 289), to dark-brown (slide 290). The reverse colour varies from yellow-brown to reddish-brown to deep mahogany (slide 291 is the reverse of slide 290). All cultures are on mycobiotic agar.

292, 293. Regional endemic colony types of *T. tonsurans* often occur, for example in Australia, isolates from Aborigines living in the Northern Territory (slide 292) are quite different from those recovered from Aborigines living in South Australia (slide 293), the latter isolates having minimal surface hyphae and darker pigmentation.

294, 295,
296, 297. Microscopic morphology of *T. tonsurans.* The hyphae are relatively broad, irregular and much branched with numerous septa. Numerous characteristic microconidia varying in size and shape from long-clavate to broad-pyriform are borne at right angles to the hyphae, which often remain unstained by lactophenol cotton blue (slide 294, 295). Very occasional smooth, thin-walled, irregular, clavate macroconidia may be present in some cultures (slide 296). Numerous swollen giant forms of microconidia and chlamydoconidia are produced in older cultures (slide 297).

298. *T. tonsurans* has a partial requirement for thiamine. Note the enhanced growth on Trichophyton No.4 agar (Difco) containing thiamine.

Trichophyton verrucosum

A zoophilic fungus causing ringworm in cattle. Infections in humans result from direct contact with cattle or infected fomites and are usually highly inflammatory involving the scalp, beard or exposed areas of the body. Invaded hairs show an ectothrix infection and fluorescence under Wood's ultra-violet light has been noted in cattle but not in humans. All strains require thiamine for growth and many strains also require inositol. Unlike other dermatophytes growth is enhanced at 37^{O}C.
Distribution: World-wide.
Key Features: Culture characteristics and requirements for thiamine and inositol, large ectothrix invasion of hair, clinical lesions and history.

299, 300. Cattle ringworm showing multiple crusting lesions. *T. verrucosum* was isolated. (Slide 299 Courtesy Dr Kral, University of Perugia, Italy; Slide 300 Courtesy C.V.L. Weybridge, England).

301. Tinea barbae showing severe crusting lesions caused by *T. verrucosum*.

302. An erythematous, pustular lesion on the forearm of a veterinarian following contact with cattle. *T. verrucosum* was isolated.

303. A circular, erythematous lesion with a raised advancing border on the thigh of an eight year old girl. Known contact with cattle and *T. verrucosum* was isolated.

304, 305. Extremely severe inflammatory kerion-type lesion of the scalp in a two year old child. *T. verrucosum* was isolated.

306. Typical chains of large ectothrix spores produced by *T. verrucosum* infection of hair. Hairs mounted in 10% KOH and Parker ink solution.

307. Primary isolation plate of *T. verrucosum* showing very slow growing colonies, usually only 5-10mm with a heaped up centre and flat or submerged periphery.

308, 309. Culture of *T. verrucosum* on mycobiotic agar showing the typical glabrous, heaped and folded white coloured colony with no reverse pigment.

310, 311. Microscopic morphology of *T. verrucosum*. When grown on thiamine enriched media occasional strains produce clavate to pyriform microconidia (slide 310). Macroconidia are only rarely produced, but when present have a characteristic rat tail or string bean shape (slide 311).

312. Microscopic examination of young cultures (five days) of *T. verrucosum* on Sabouraud's dextrose agar with 0.5% yeast extract show characteristic terminal vesicles (not chlamydoconidia) at the tips of hyphae.

313. All strains of *T. verrucosum* produce typical chains of chlamydoconidia when grown in brain heart infusion broth with para-amino benzoic acid (P.A.B) and agar at 37^{O}C.

314. *T. verrucosum* on Trichophyton No.1 and No.4 agars (Difco) demonstrating a growth requirement for thiamine.

Trichophyton violaceum

An anthropophilic fungus causing inflammatory or chronic non-inflammatory finely scaling lesions of skin, nails, beard and scalp, producing the so-called "black-dot" tinea capitis. Invaded hairs show an endothrix infection and do not fluoresce under Wood's ultra-violet light.
Distribution: World-wide, particularly in the near East, Eastern Europe, U.S.S.R. and North Africa.

Key Features: Culture characteristics, partial thiamine requirement and endothrix hair invasion.

315, 316. Endothrix tinea capitis in Australian Aborigines, showing minimal scaling and hair loss. *T. violaceum* was isolated.

317. "Black dot" endothrix tinea capitis in an Australian Aborigine showing numerous broken-off infected hairs and pustular lesions of the scalp.

318. Typical large spored endothrix invasion of hair caused by *T. violaceum* mounted in 10% KOH and Parker ink solution.

319. *T. violaceum* on mycobiotic agar. Cultures are very slow growing, glabrous or waxy, heaped and folded and a deep violet in colour. Cultures often become pleomorphic, forming white sectors and occasional non-pigmented strains may occur.

320. Microscopic morphology of *T. violaceum* showing broad, tortuous, much-branched, distorted hyphae and lack of conidia are typical of strains grown on the usual media. Although numerous chlamydoconidia are produced in older cultures.

321. *T. violaceum* has a partial requirement for thiamine. Note the enhanced growth on Trichophyton No. 4 agar (Difco) containing thiamine.

Histoplasmosis

An intracellular mycotic infection of the reticuloendothelial system caused by the inhalation of the fungus. Approximately 95% of cases of histoplasmosis are inapparent, subclinical or benign. Five percent of the cases have chronic progressive lung disease, chronic cutaneous or systemic disease or an acute fulminating fatal systemic disease. All stages of this disease may mimic tuberculosis.
Distribution: World-wide, especially U.S.A. Sporadic cases do occur in Australia.
Aetiological Agent: *Histoplasma capsulatum*, especially from soil enriched with excreta from chicken, starlings and bats.

322. Histoplasmosis of the lower gum showing ulcer around base of tooth.

323. Tissue section stained with haematoxylin and eosin from a biopsy of the mouth lesion shown in slide 322. Note macrophages containing numerous yeast cells of *Histoplasma capsulatum*. The basophilic cytoplasm of the fungal cells is retracted from the poorly stained cell wall, giving the false impression of a capsule. (Courtesy Dr G. Hunter, Adelaide, S.A.).

324. Tissue section stained by Grocott's methenamine silver (GMS) from a lung biopsy showing numerous yeast cells of *Histoplasma capsulatum* inside macrophages.

325, 326. Culture of *Histoplasma capsulatum* on Sabouraud's dextrose agar showing a white suede-like colony with a pale yellow-brown reverse.

327. Microscopic morphology of the saprophytic or mycelial form of *Histoplasma capsulatum* showing characteristic large, rounded, single-celled, tuberculate macroconidia formed on short, hyaline, undifferentiated conidiophores.

328. Yeast-like culture of *Histoplasma capsulatum* on blood agar incubated at 37^{o}C.

329. Microscopic morphology of the parasitic or yeast form of *Histoplasma capsulatum* cultured on brain heart infusion agar containing blood incubated at 37^{o}C. Note the small round to oval budding yeast-like cells.

Histoplasma capsulatum* var. *duboisii

330. Tissue section stained by Periodic Acid-Schiff (PAS) showing numerous yeast cells of *Histoplasma capsulatum* var. *duboisii*. This African variant differs by having larger (7-15μm) budding yeast cells *in vivo*.

331. Tissue section stained by Grocott's methenamine silver (GMS) showing numerous yeast cells of *Histoplasma capsulatum* var. *duboisii*. This African variant differs by having larger (7-15μm) budding yeast cells *in vivo*.

332. Immy exoantigen immunodiffusion test kit for the identification of *Histoplasma capsulatum*, *Coccidioides immitis* and *Blastomyces dermatitidis.*

333. Exoantigen immunodiffusion plate showing positive identification of *Histoplasma capsulatum.* Note H and M bands of identification; EX = culture filtrate; H = *Histoplasma* antibody and antigen, C = *Coccidioides* antibody and antigen; B = *Blastomyces* antibody and antigen.

Hyalohyphomycosis.

A mycotic infection of man or animals caused by a number of hyaline (non-dematiaceous) hyphomycetes where the tissue morphology of the causative organism is mycelial. This separates it from phaeohyphomycosis where the causative agents are brown-pigmented fungi. Hyalohyphomycosis is a general term used to group together infections caused by unusual hyaline fungal pathogens that are not agents of otherwise-named infections; such as *Aspergillosis*. Etiological agents include species of *Penicillium, Paecilomyces, Acremonium, Beauveria, Fusarium,* and *Scopulariopsis*.

The clinical manifestations of hyalohyphomycosis are many ranging from harmless saprophytic colonization to acute invasive disease. Predisposing factors include prolonged neutropenia, especially in leukaemia patients or in bone marrow transplant recipients, corticosteroid therapy, cytotoxic chemotherapy and to a lesser extent patients with AIDS. The typical patient is granulocytopenic and receiving broad-spectrum antibiotics for unexplained fever.

334. *Penicillium* sp. colonizing an orange showing typical green surface pigmentation with a suede-like surface consisting of a dense felt of conidiophores.

335. Culture of *Penicillium* sp. on Sabouraud's dextrose agar.

336. Microscopic morphology of a *Penicillium* sp. showing chains of single celled phialoconidia (ameroconidia) produced in basipetal succession from a specialized conidiogenous cell called a phialide. The term basocatenate is often used to described such chains of conidia where the youngest conidium is at the basal or proximal end of the chain. In *Penicillium* phialides may be produced singly or in groups or from branched metulae, giving a brush-like appearance, i.e. a penicillus.

337. Microscopic morphology of *Paecilomyces variotii* showing chains of single celled phialoconidia (ameroconidia) produced in basipetal succession from a phialide. Conidia formed in chains with the youngest at the base are termed basocatenate. Note phialides are swollen at their bases, gradually tapering towards their apices and may form a brush-like penicillus. *Paecilomyces* sp. are similar to *Penicillium* sp. except that the latter are always green or blue green. *Paecilomyces* are gold, green-gold, lilac or tan, but never blue or green.

338. Microscopic morphology of *Scopulariopsis brevicaulis* showing chains of single celled annelloconidia (ameroconidia) produced in basipetal succession following a series of short percurrent proliferations (annellations) by a specialized condiogenous cell called an annellide. Once again, the term basocatenate can be used to describe such chains of conidia where the youngest conidium is at the basal end of the chain. In *Scopulariopsis* annellides may be solitary, in groups, or organized into a distinct penicillus. Conidia are globose to pyriform, usually truncate, with a rounded distal portion, smooth to rough, and hyaline to brown in colour.

339. Microscopic morphology of *Beauveria bassiana* showing sympodial development of single celled conidia (ameroconidia) on a geniculate or zig-zag rachis. Conidiogenous cells are flask-shaped, rachiform, proliferating sympodially and are often aggregated into sporodochia or synnemata. Conidia are hyaline and globose or ovoid in shape.

340, 341. Microscopic morphology of *Trichothecium roseum* showing alternating 2-celled conidia (didymoconidia) produced retrogressively on essentially undifferentiated conidiophores. The term retrogressive describes the mechanism of conidiogenous cell development, which involves a gradual shortening of the fertile cell during basipetal formation of successive conidia. Conidia are ellipsoidal to pyriform in shape with an obliquely truncate basal scar, hyaline, smooth to delicately roughened and thick walled.

342. Microscopic morphology of *Trichoderma harzianum* showing repeatedly branched conidiophores, irregularly verticillate, bearing clusters of divergent, often irregularly bent, flask-shaped phialides. Conidia are mostly green, sometimes hyaline, with smooth or rough walls and are formed in slimy conidial heads (glioconidia) clustered at the tips of the phialides.

343. Microscopic morphology of *Sepedonium* sp. showing hyaline, nonspecialized conidiophores, resembling short branches of the vegetative hyphae. Conidia are terminal, solitary, or in clusters, one-celled, globose to ovoid, 7 to 17μm, hyaline to amber, smooth to verrucose and usually with a thick wall.

344. Microscopic morphology of *Verticillium* sp. well differentiated and erect conidiophores, verticillately branched over most of their length, bearing whorls of slender awl-shaped divergent phialides. Conidia are hyaline or brightly coloured, mostly one-celled, and are usually borne in slimy heads (glioconidia).

345. Microscopic morphology of *Geotrichum candidum* showing chains of single celled arthroconidia (ameroconidia) produced by the holoarthric fragmentation of undifferentiated hyphae. Arthroconidia are hyaline, smooth, subglobose to cylindrical, and are released by the separation of a double septum.

346. Microscopic morphology of the conidial state (anamorph) of a saprophytic *Gymnoascus* sp. showing the formation of alternate single celled arthroconidia (ameroconidia) by the enteroarthric fragmentation of undifferentiated hyphae. These arthroconidia are hyaline, rectangular to barrel-shaped and separated from each other by a disjunctor cell. Note this common soil fungus closely resembles *Coccidioides immitis* (see slides 112 to 113).

347. Microscopic morphology of *Gliocladium* sp., which is often described as a counterpart of *Penicillium* with slimy conidia. The most characteristic feature of the genus is the distinctive erect, often densely penicillate conidiophores with phialides, which bear slimy, one-celled hyaline to green, smooth-walled conidia in heads or columns. Although, some penicillate conidiophores are always present, *Gliocladium* species may also produce verticillate branching conidiophores, which can be confused with *Verticillium* or *Trichoderma.*

Lobomycosis.

Lobomycosis is a chronic, localized, subepidermal infection characterized by the presence of keloidal, verrucoid, nodular lesions or sometimes by vegetating crusty plaques and tumors. The lesions contain masses of spheroidal, yeast-like organisms tentatively referred to as *Loboa loboi.* There is no systemic spread. The disease has been found in humans and dolphins and is restricted to the Amazon Valley in Brazil. The aetiologic agent known as "*Loboa loboi*" remains to be cultured.

348. Lobomycosis showing extensive verrucoid lesions on the legs. The initial infection is thought to be caused by traumatic implantation such as an arthropod sting, snake bite, sting-ray sting, or wound acquired while cutting vegetation. The lesions begin as small, hard nodules resembling keloids and may spread slowly in the dermis and continue to develop over a period of many years. Older lesions become verrucoid and may ulcerate. The disease may be transferred to other areas of the skin by further trauma or autoinoculation. Thus the areas of involvement may become quite extensive. Lesions are usually found on the arms, legs, face or ears. 90% of cases are men, mostly in farmers and other high-risk groups exposed to various harsh conditions as well as aquatic habitats.

349. Grocott's methenamine silver (GMS) stained tissue section showing numerous darkly pigmented yeast-like cells, often in chains, 9-12μm in size typical of *Loboa loboi*.

Malassezia infections.

Pityriasis (tinea) versicolor: A chronic, superficial fungal disease of the skin characterized by well-demarcated white, pink, fawn, or brownish lesions, often coalescing, and covered with thin furfuraceous scales. The colour varies according to the normal pigmentation of the patient, exposure of the area to sunlight, and the severity of the disease. Lesions occur on the trunk, shoulders and arms, rarely on the neck and face, and fluoresce a pale greenish colour under Wood's ultra-violet light. Young adults are affected most often, but the disease may occur in childhood and old age.
Distribution: World-wide but more common in tropical than temperate climates.
Aetiological Agent: *Malassezia furfur* a lipophilic yeast forming part of the normal flora of human skin.

350, 351, 352. The most common form of the disease seen in Caucasians showing typical hyperpigmented lesions on the trunk.

353, 354, 355. Typical depigmented lesions seen in dark-skinned individuals, for example in Australian Aborigines. (Slide 355 courtesy Dr A. Green, Adelaide, S.A.).

356, 357. Depigmented lesions on the face of a young Aboriginal girl and young Caucasian boy respectively. Pityriasis versicolor of the face is a rare clinical presentation. (Slides courtesy Drs A. Green and G. Donald, Adelaide, S.A.).

358. Follicular pityriasis versicolor. Lesions are visible around the hair follicles and sebaceous glands. This is a more severe form of the disease. (Courtesy Dr G. Donald, Adelaide, S.A.).

359. Skin scrapings taken from patients with Pityriasis versicolor stain rapidly when mounted in 10% KOH, glycerol and Parker ink solution and show characteristic clusters of thick-walled round, budding yeast-like cells and short angular hyphal forms up to 8um in diameter (ave. µm diam.). These microscopic features are diagnostic for the causative agent *Malassezia furfur* and culture preparations are usually not necessary.

360. Colonies of *Malassezia furfur* on Dixon's agar. A specialized isolation medium containing glycerol-mono-oleate.

Mycetoma.

A mycotic infection of humans and animals caused by a number of different fungi and actinomycetes characterized by draining sinuses, granules and tumefaction. The disease results from the traumatic implantation of the aetiologic agent and usually involves the cutaneous and subcutaneous tissue, fascia and bone of the foot or hand. Sinuses discharge serosanguinous fluid containing the granules which vary in size, colour and degree of hardness, depending on the aetiologic species, and are the hallmark of mycetoma.
Distribution: World-wide but most common in bare-footed populations living in tropical or subtropical regions.
Aetiological Agents: Actinomycotic mycetoma:- *Nocardia, Actinomadura* and *Streptomyces*. Eumycotic mycetoma: - *Madurella, Acremonium, Pseudallescheria, Exophiala, Leptosphaeria, Curvularia, Fusarium, Aspergillus* etc.

361. Diagrammatic sketch of mycetoma of the foot showing the formation of suppurating abscesses and draining sinuses.

362. Actinomycotic mycetoma showing numerous draining sinuses. There is destruction of bone, distortion of the foot, and hyperplasia at the openings of the sinus tracts. (Courtesy John Rippon U.S.A.).

363. Excised mycetoma showing a draining sinus (cut open in this preparation) containing black grains.

364. Grains of *Madurella mycetomatis* (tissue microcolonies) are brown or black, 0.5 to 1.0 mm in size, round or lobed, hard and brittle, composed of hyphae which are 2 to 5μm in diameter, with terminal cells expanded to 12 to 15 (30)μm in diameter.

365. Haematoxylin and eosin (H&E) stained tissue section showing white grained actinomycotic mycetoma caused by Streptomyces somaliensis. (Original sections courtesy Prof. R. Vanbreuseghem, Antwerp, Belgium).

366. Haematoxylin and eosin (H&E) stained tissue section showing red grained actinomycotic mycetoma caused by *Streptomyces pelletierii.* (Original sections courtesy Prof. R. Vanbreuseghem, Antwerp, Belgium).

367. Haematoxylin and eosin (H&E) stained tissue section showing black grained eumycotic mycetoma caused by *Madurella mycetomatis*. (Courtesy Dr O'Keefe, School of Public Health and Tropical Medicine, N.S.W.).

368. Culture of *Madurella mycetomatis* showing the typical brown diffusible pigment in the agar. Colonies are slow growing, flat and leathery at first, white to yellow to yellowish-brown, becoming brownish, folded and heaped with age and the formation of aerial mycelia. A brown diffusible pigment is characteristically produced in primary cultures. *M. mycetomatis* can be distinguished from *Madurella grisea* by growth at 37^{O}C and its inability to assimilate sucrose.

369. Microscopic morphology of *M. mycetomatis* showing phialides (rarely seen as most isolates are sterile). Although most cultures are sterile, two types of conidiation have been observed, the first being flask-shaped phialides that bear rounded conidia, the second being simple or branched conidiophores bearing pyriform conidia (3-5μm) with truncated bases. The optimum temperature for growth of this mould is 37^{O}C.

370. Microscopic morphology of *Fonsecaea pedrosoi*. Primary sympodial blastoconidial formation. Initial sympodial development of primary conidia is similar to that seen in *Rhinocladiella* (raduliform), except that the conidiogenous zone is confined to the upper portion of the conidiophore. Raduliform sympodial development is where the elongating conidiogenous axis is relatively wide compared to the width of the conidial attachment and the axis tends to become clavate or somewhat inflated rather than zig-zag.

371. Microscopic morphology of *Fonsecaea pedrosoi.* Secondary sympodial blastoconidial formation. The primary conidia in turn, as the culture ages, also function as conidiogenous cells producing additional secondary blastoconidia also in a sympodial manner.

CAUSATIVE AGENTS OF MYCOTIC MYCETOMA INCLUDE: *Acremonium* sp. (see slide 381), *Pseudallescheria boydii* (see slides 424 to 430), *Curvularia* sp. (see slide 380), *Fusarium* sp. (see slides 374 to 377), *Aspergillus nidulans* (see slides 044 to 045) and *Exophiala jeanselmei* (see slides 404 to 407).

Mycotic Keratitis.

An opportunistic fungal infection of the eye that causes ulceration and inflammation, usually following trauma to the cornea by vegetative matter, soil or surgery. Prolonged treatment with corticosteroids may also be a predisposing factor.
Distribution: World-wide.
Aetiological Agents: Various saprophytic fungi, especially *Aspergillus fumigatus*, *A. flavus, A. niger, Fusarium solani* and *Candida albicans*. Others include species of *Alternaria, Curvularia, Pseudallescheria* and *Acremonium*.

372. Mycotic keratitis showing a central shaggy-edged corneal ulcer and satellite lesion with marked hypopyon caused by *Pseudallescheria boydii*. (Courtesy Dr J.W. Rippon, University of Chicago, U.S.A.).

373. Corneal scraping mounted in 10% KOH showing numerous hyphal elements and conidia characteristic of *Pseudallescheria boydii*. (Courtesy Dr J.W. Rippon, University of Chicago, U.S.A.).

374. *Fusarium* sp. on Sabouraud's dextrose agar. Cultures are usually rapidly growing, pale or bright coloured (depending on the species) with a felty aerial mycelium.

375, 376, 377. Microscopic morphology of *Fusarium solani*. Species of *Fusarium* typically produce both macro- and microconidia. In *F. solani*, microconidia are usually abundant, cylindrical to oval, 1- to 2-celled and formed from long lateral phialides (slide 375). Macroconidia are formed after 4-7 days from short multi-branched conidiophores, which may form sporodochia. They are 3- to 5- septate (usually 3- septate), fusiform, cylindrical, often moderately curved, with an indistinctly pedicellate foot cell and a short blunt apical cell (slide 376). Chlamydoconidia of *F. solani* are hyaline, globose, smooth to rough walled, borne singly or in pairs on short lateral hyphal branches or intercalary (slide 377).

378. *Alternaria* sp. isolated from a corneal ulcer on Sabouraud's dextrose agar showing typical darkly pigmented (dematiaceous) black to olivaceous-black, suede-like to floccose colony.

379. Microscopic morphology of *Alternaria alternata* isolated from a corneal ulcer showing branched acropetal chains (blastocatenate) of multicellular conidia (dictyoconidia) produced sympodially from simple, sometimes branched, short or elongate conidiophores. Conidia are obclavate, obpyriform, sometimes ovoid or ellipsoidal, often with a short conical or cylindrical beak, pale brown, smooth-walled or verrucose.

380. Microscopic morphology of *Curvularia lunata* showing pale brown multicelled conidia (phragmoconidia) formed apically through a pore (poroconidia) in a sympodially elongating geniculate conidiophore similar to *Drechslera*. Conidia are cylindrical or slightly curved, with one of the central cells being larger and darker.

381. Microscopic morphology of an *Acremonium* sp. showing long, hyaline, awl-shaped, simple, erect, phialides arising from hyphae or fascicles. Conidia are usually one-celled (ameroconidia), hyaline, globose to cylindrical, and mostly aggregated in slimy heads at the apex of each phialide.

382. Microscopic morphology of *Lasiodiplodia theobromae*, a rare cause of mycotic keratitis, showing characteristic 2-celled, pigmented, longitudinally striate pycnidioconidia. *L. theobromae* is a cosmopolitan, tropical saprophytic Coelomycete which forms pycnidia.

For *Aspergillus fumigatus* see slides 037 to 039.
For *Aspergillus flavus* see slides 042 to 043.
For *Candida albicans* see slides 079 to 093.
For *Pseudallescheria boydii* see slides 424 to 430.

Otomycosis

A chronic or sub-acute fungal infection of the external ear canal often following topical antibiotic therapy for bacterial infections. There may also be an underlying eczematous condition. Symptoms include scaling, pruritus, and pain.
Distribution: World-wide.
Aetiological Agents: Various saprophytic fungi, especially *Aspergillus niger* (90% of infections), *A. fumigatus, A. flavus, Candida* sp. and *Pseudallescheria boydii*. Dogs and cats *Malassezia pachydermatis*.

For *Aspergillus niger* see slides 040 to 041.
For *Aspergillus fumigatus* see slides 037 to 039.
For *Aspergillus flavus* see slides 042 to 043.
For *Candida albicans* see slides 079 to 093.
For *Pseudallescheria boydii* see slides 424 to 430.

Paracoccidioidomycoses

Paracoccidioidomycosis is a chronic granulomatous disease that characteristically produces a primary pulmonary infection, often inapparent, and then disseminates to form ulcerative granulomata of the buccal, nasal and occasionally the gastrointestinal mucosa. The disease in its inception and development is similar to blastomycosis and coccidioidomycosis. The only

etiological agent, *Paracoccidioides brasiliensis* is geographically restricted to areas of South and Central America.

383. Mucocutaneous paracoccidioidomycosis showing extensive destruction of facial features. (Courtesy Dr John Rippon, USA).

384. Mucocutaneous paracoccidioidomycosis showing an ulcerated lesion on the lips and loss of teeth. (Courtesy Dr John Rippon, USA).

385. Mucocutaneous paracoccidioidomycosis showing an ulcerated lesion on the pharyngeal mucosa. (Courtesy Dr John Rippon, USA).

386. Grocott's methenamine silver (GMS) stained lung tissue section showing multiple, narrow base, budding yeast cells "steering wheels" of *P. brasiliensis.*

387. Microscopic morphology of *Paracoccidioides brasiliensis* showing multiple, narrow base, budding yeast cells "steering wheels" of *P. brasiliensis.*

***Penicillium marneffei* infection.**

Penicillium marneffei exhibits thermal dimorphism by growing in living tissue or in culture at 37^{O}C as a yeast-like fungus or in culture at temperatures below 30^{O}C as a mould. It has a propensity to cause disease in the normal host, as well as in immunosuppressed patients, but significantly, it has now become a major opportunistic pathogen in HIV positive patients in Indochina. Over 300 cases have been reported with the majority of these coming from Chiang Mai in northern Thailand. Other predisposing factors include lymphoproliferative disorders, bronchiectasis and tuberculosis, autoimmune diseases and corticosteroid therapy. To date, all naturally occurring infections have been in residents of, or travelers to, southeast Asia; especially northern Thailand, Vietnam, Hong Kong, Taiwan and southern China. Imported cases of *P. marneffei* infections have been reported from Australia, France, Italy, Netherlands, UK and USA.

388. Typical papules often with a central necrotic umbilication "Molluscum contagiosum" like lesions caused by *P. marneffei* in an HIV+ patient. (Courtesy Dr P. Jones, Sydney, N.S.W.).

389. "Molluscum contagiosum" like lesions caused by *P. marneffei* on the neck of an HIV+ patient. (Courtesy Dr P. Jones, Sydney, N.S.W.).

390. "Molluscum contagiosum" like lesions caused by *P. marneffei* in the buccal cavity of an HIV+ patient. (Courtesy Dr P. Jones, Sydney, N.S.W.).

391. "Molluscum contagiosum" like lesions caused by *P.* marneffei below the eye and on the cornea of an HIV+ patient. (Courtesy Dr P. Jones, Sydney, N.S.W.).

392. Typical papules "Molluscum contagiosum" like lesions caused by *P. marneffei* on the back of an HIV+ patient. (Courtesy Dr B. Curry, Darwin N.T.).

393. Papule like lesions caused by *P. marneffei* that have been scratched in an HIV+ patient. (Courtesy Dr P. Jones, Sydney, N.S.W.).

394. Grocott's methenamine silver (GMS) stained tissue section showing numerous small yeast-like cells of *P. marneffei* that closely resemble those seen in Histoplasmosis. (Courtesy Dr P. Jones, Sydney, N.S.W.).

395. A Giemsa stained touch smear showing the typical septate yeast-like cells of *P. marneffei*. (Courtesy Dr B. Curry, Darwin N.T.).

396. Culture of *P. marneffei* showing distinctive red diffusible pigment. On Sabouraud's dextrose agar at 25^{O}C, colonies are fast growing, suede-like to downy, white with yellowish-green conidial heads. Colonies become greyish-pink to brown with age and produce a diffusible brownish-red to wine red-pigment.

397. Microscopic morphology of *P. marneffei* showing hyaline, smooth-walled conidiophores bearing terminal verticils of 3 to 5 metulae, each bearing 3 to 7 phialides. Conidia are globose to subglobose, 2 to 3μm in diameter, smooth-walled and are produced in basipetal succession from the phialides.

398. Scanning electron micrograph showing phialides and conidia of *P. marneffei.*

Phaeohyphomycosis

A mycotic infection of humans and lower animals caused by a number of dematiaceous (brown-pigmented) fungi where the tissue morphology of the causative organism is mycelial. This separates it from other clinical types of disease involving brown-pigmented fungi where the tissue morphology of the organism is a grain (mycotic mycetoma) or sclerotic body (chromoblastomycosis). Clinical forms of the disease range from localized superficial infections of the stratum corneum (tinea nigra) to subcutaneous cysts (phaeomycotic cyst) to invasion of the brain.
Distribution: World-wide.
Aetiological Agents: Various dematiaceous hyphomycetes especially *Cladophialophora bantiana, Curvularia* sp., *Bipolaris* sp. and *Exophiala jeanselmei.*

399. *Alternaria* sp. colonizing a tomato showing typical darkly pigmented (dematiaceous) lesions.

400. Clinical slide showing cutaneous phaeohyphomycosis of the face caused by *Wangiella dermatitidis*. (Courtesy of Dr. J.W. Rippon, University of Chicago, USA).

401. Clinical slide showing cutaneous phaeohyphomycosis of the forearm caused by *Exophiala jeanselmei*. (Courtesy of Dr. J.W. Rippon, University of Chicago, USA).

402. Clinical slide of subcutaneous phaeohyphomycosis following a non-penetrating injury. The lesion, on the dorsum of the right thumb, was fluctuant, tender, blue-grey and had no connection to the surface. *Wangiella dermatitidis* was isolated. (Courtesy of Dr. J.W. Rippon, University of Chicago, USA).

Phaeohyphomycosis - Haematoxylin and eosin (H&E) stained section showing characteristic, brown-pigmented, septate hyphal elements of *Exophiala jeanselmei*. The hyphae may be short to elongate, distorted or swollen, regularly shaped, or any combination of the above.

403. Phaeohyphomycosis - Periodic Acid-Schiff (PAS) stained smear of pus from a subcutaneous abscess of the toe showing septate hyphal elements of *Exophiala moniliae*.

404. *Exophiala jeanselmei* on Sabouraud's dextrose agar showing black mucoid, yeast-like streaked colonies producing, with age, greenish-grey suede-like aerial mycelium. Reverse is olivaceous-black.

405, 406, 407. Microscopic morphology of *Exophiala jeanselmei*. Numerous ellipsoidal, yeast-like, budding cells are usually present, especially in young cultures (slide 405). Scattered amongst these yeast-like cells are larger, inflated, subglobose to broadly ellipsoidal cells (germinating cells) which give rise to short torulose hyphae that gradually change into unswollen hyphae (slide 406). Conidia are formed on lateral pegs either arising apically or laterally at right or acute angles from essentially undifferentiated hyphae or from strongly inflated detached conidia (slides 406 and 407). Conidiogenous pegs are 1-2 (-3) μm long, slightly tapering and imperceptibly annellate (slides 406 and 407). Conidia are hyaline, smooth, thin-walled, broadly ellipsoidal, 3.2 - 4.4 x l.2 - 2.2μm and with inconspicuous basal scars (slide 406).

408. Microscopic morphology of *Exophiala spinifera* showing pigmented spine-like conidiophores and clusters of single-celled annelloconidia produced in basipetal succession from an annellide.

409. Microscopic morphology of *Cladophialophora bantiana* (= *Xylohypha bantiana*) showing conidia formed in long, sparsely branched, flexuous, acropetal chains from undifferentiated conidiophores. Conidia are one-celled (very occasionally two-celled), pale brown, smooth-walled, ellipsoid to oblong-ellipsoid and are 2-3 x 4-7μm in size. *Cladophialophora bantiana* may be distinguished from *Cladosporium* species by the absence of conidia with distinctly pigmented hila, the absence of characteristic shield cells and by growth at 42°C (compared with *Cladophialophora carrionii* which has a

maximum growth temperature of 35-36^{O}C and *Cladosporium* species which have a maximum of less than 35^{O}C.

410. Microscopy morphology of *Cladosporium cladosporioides* showing branching chains of single-celled conidia (ameroconidia) produced in an acropetal manner from simple erect, pigmented conidiophores. The term blastocatenate is often used to describe chains of conidia where the youngest conidium is at the apical or distal end of the chain. Conidia are pale brown to dark brown and have a distinct dark hilum. Note the conidia closest to the conidiophore, and where the chains branch, are usually "shield-shaped". The presence of shield-shaped conidia, a distinct hilum, and chains of conidia that readily disarticulate, are diagnostic for the genus *Cladosporium*.

411. Microscopy morphology of a *Phialophora* sp. showing clusters of single-celled phialoconidia (ameroconidia) produced in basipetal succession from a phialide. Note conidia are not formed in chains but aggregate in slimy heads at the apices of the phialides, which show distinctive collarettes.

412. Microscopic morphology of *Wangiella dermatitidis* showing flask-shaped to cylindrical phialides without distinctive collarettes. Conidia are hyaline to pale brown, one-celled, round to obovoid, 2.0-4.0 x 2.5-6.0 μm smooth-walled and accumulate in slimy balls (glioconidia) at the apices of the phialides or down their sides. Cultures grow at 42^{O}C

413. Microscopic morphology of *Epicoccum nigrum* showing a cluster of darkly pigmented (phaeo), globose to pyriform, rough walled multicellular conidia (dictyoconidia). Conidia are formed holoblastically on nonspecialized, determinant, slightly pigmented conidiophores, which are grouped in aggregates called sporodochia.

414. Microscopic morphology of a *Stemphylium* sp. showing solitary, darkly pigmented (phaeo), terminal, multicellular conidia (dictyoconidia) formed on a distinctive conidiophore with a darker terminal swelling. Note the conidiophore proliferates percurrently through the scar where the terminal conidium (poroconidium) was formed. *Stemphylium* should not be confused with *Ulocladium*, which produces similar dictyoconidia from a sympodial conidiophore, not from a percurrent conidiogenous cell as in *Stemphylium*.

415. *Ulocladium* sp. Colonies are rapid growing, brown to olivaceous-black or greyish and suede-like to floccose. Microscopically, numerous, usually solitary, multicelled conidia (dictyoconidia) are formed through a pore (poroconidia) by a sympodially elongating geniculate conidiophore. Conidia are typically obovoid (narrowest at the base), dark brown and often rough-walled. Seven species have been described all being saprophytes.

416,417. Microscopic morphology of *Bipolaris australiensis* (= *Drechslera australiensis*) showing sympodial development of darkly pigmented, multicellular conidia (phragmoconidia) on a geniculate or zig-zag rachis. Conidia are produced through pores in the conidiophore wall (poroconidia) and are fusiform to ellipsoidal, germinating only from the ends (bipolar). The genera *Drechslera, Bipolaris, Curvularia* and *Exserohilum* are all closely related.

418, 419. Microscopic morphology of *Exserohilum* sp. Conidia are straight, curved or slightly bent, ellipsoidal to fusiform and are formed apically through a pore (poroconidia) on a sympodially elongating geniculate conidiophore. Conidia have a strongly protruding, truncate hilum and the septum above the hilum is usually thickened and dark. The end cells are often paler than the other cells and the walls are often finely roughened. Conidial germination is bipolar. The genus *Exserohilum* may be differentiated from the closely related genera *Bipolaris* and *Drechslera* by forming conidia with a strongly protruding truncate hilum (i.e. exserted hilum). The hilum is defined as "a scar on a conidium at the point of attachment to the conidiophore". In *Drechslera* species, the hilum does not protrude whereas in *Bipolaris* species the hilum protrudes only slightly.

420. Microscopic morphology of *Veronaea botryose*. Conidiophores are erect, straight or flexuose, occasionally branched and are usually geniculate, due to the sympodial development of the conidia. Conidia are pale brown, 2-celled, cylindrical with a truncated base, smooth-walled or slightly verrucose [5-12 X 3-4μm].

421. Microscopic morphology of *Pithomyces chartarum* showing darkly pigmented, multicellular conidia (phragmo- or dictyoconidia) formed on small peg-like branches of the vegetative hyphae. Conidia are broadly elliptical, pyriform, oblong, and commonly echinulate or verrucose. *Pithomyces chartarum* is often involved with facial eczema of sheep.

422. Microscopic morphology of *Aureobasidium pullulans* showing chains of 1- to 2-celled, darkly pigmented arthroconidia commonly called chlamydoconidia. These arthroconidia actually represent the *Scytalidium* anamorph of *Aureobasidium* and are only of secondary importance in recognizing members of this genus. Also note the presence of hyaline, septate hyphae, some undergoing holothallic transformation to arthroconidia, giving rise to numerous hyaline, single-celled, ovoid-shaped conidia (ameroconidia) which are produced on short denticles.

423. Microscopic morphology of the *Scytalidium* anamorph of the Coelomycete *Hendersonula toruloidea* showing chains of 1- to 2-celled, darkly pigmented arthroconidia produced by the holothallic fragmentation of undifferentiated hyphae. *Hendersonula toruloidea* is a recognized agent of onychomycosis and superficial skin infections, especially in tropical regions.

Pseudallescheriasis and *Scedosporium.*

A spectrum of diseases similar in terms of variety and severity to those caused by *Aspergillus*. The vast majority of infections are mycetomas, the remainder include infections of the eye, ear, central nervous system, internal organs and more commonly the lungs.
Distribution: World-wide.
Aetiological Agent: *Pseudallescheria boydii* (anamorph *Scedosporium apiospermum*), a common soil inhabiting fungus.

424. *Pseudallescheria boydii* (anamorph *Scedosporium apiospermum*) on Sabouraud's dextrose agar showing typical greyish-white, cottony colony with a greenish-black reverse.

425. Microscopic morphology of the anamorphic state *Scedosporium apiospermum* showing numerous, single-celled, pale-brown, broadly clavate to ovoid conidia, borne singly or in small groups on elongate, simple or branched conidiophores or laterally on hyphae.

426. Synnemata and conidia of *Graphium eumorphum* a synanamorph of *Pseudallescheria boydii.*

427. Ascocarps of the teleomorphic state *Pseudallescheria boydii* are yellow-brown to black, spherical cleistothecia (non-ostiolate ascocarps) which are mostly submerged in the agar and consist of irregularly interwoven brown hyphae. When crushed cleistothecia release numerous, faintly brown, ellipsoidal ascospores.

428, 429. Microscopic morphology of *Scedosporium prolificans.* Conidia are borne in small groups on distinctive basally swollen, flask-shaped annellides, which occur singly or in clusters along the vegetative hyphae. Conidia are single-celled, hyaline to pale-brown, ovoid to pyriform, 2-5 x 3-13µm (average 3.4-5.3µm) in size, and have smooth thin walls. *Scedosporium prolificans* is distinguished from other members of the genus, in particular, the human pathogen *S. apiospermum*, by having basally swollen (inflated), flask-shaped annellides, slower colony development on nutrient agar media, and by not growing on media containing cycloheximide (actidione).

430. Antifungal susceptibility disk test showing the *in vitro* activity of voriconazole against *Scedosporium apiospermum* and *Scedosporium prolificans.*

Rhinosporidiosis.

Rhinosporidiosis is an infection of the mucocutaneous tissue caused by Rhinosporidium seeberi, an as yet unisolated and unclassified fungus. It

causes a chronic granulomatous disease characterised by the production of large polyps, tumours, papillomas, or wart-like lesions. The nose is the most commonly affected site.

431. Numerous spherules of varying sizes typical of rhinosporidiosis.

432. Mature spherule with endospores typical of rhinosporidiosis.

Sporotrichosis.

Primarily a chronic mycotic infection of the cutaneous or subcutaneous tissues and adjacent lymphatics characterized by nodular lesions which may suppurate and ulcerate. Infections are caused by the traumatic implantation of the fungus into the skin, or very rarely, by inhalation into the lungs. Secondary spread to articular surfaces, bone and muscle is not infrequent, and the infection may also occasionally involve the central nervous system, lungs or genitourinary tract.
Distribution: World-wide particularly tropical and temperate regions.
Aetiological Agents: *Sporothrix schenckii*, commonly found in soil and on decaying vegetation.

433. Lymphocutaneous sporotrichosis showing typical elevated subcutaneous nodules developing along the regional lymphatics of the forearm. (Courtesy Professor D. Weedon, Brisbane, Qld.).

434, 435. Lymphocutaneous sporotrichosis showing more advanced, ulcerating lesions developing along the lymph system of the forearm. (Courtesy Professor D. Weedon, Brisbane, Qld.).

436. Fixed cutaneous sporotrichosis showing an ulcerating lesion on the leg. (Courtesy Professor D. Weedon, Brisbane, Qld.).

437. Fixed cutaneous verrucous-type sporotrichosis of the wrist and hand, looking remarkably similar to chromoblastomycosis. (Courtesy Professor D. Weedon, Brisbane, Qld.).

438. Section from a fixed cutaneous lesion on the face of a child with sporotrichosis showing round Periodic Acid-Schiff (PAS) positive yeast-like cells, one with an elongated bud. *Sporothrix schenckii* is a dimorphic fungus and this is the typical parasitic or yeast-like form seen in tissue. (Courtesy Professor D. Weedon, Brisbane, Qld.).

439. *Sporothrix schenckii* on Sabouraud's dextrose agar grown at 25^{o}C colonies are moist and glabrous, with a wrinkled and folded surface. Pigmentation may vary from white to cream to black.

440. Microscopic morphology of the saprophytic or mycelial form of *Sporothrix schenckii* when grown on Sabouraud's dextrose agar at 25^{o}C. Note clusters of ovoid conidia produced sympodially on short conidiophores arising at right angles from the thin septate hyphae.

441. Microscopic morphology of the parasitic or yeast form of *Sporothrix schenckii* when grown on brain heart infusion agar containing blood and incubated at 37^0C. Note budding yeast cells.

Tinea nigra.

Tinea nigra is a superficial fungal infection of skin characterized by brown to black macules, which usually occur on the palmar aspects of hands and occasionally the plantar and other surfaces of the skin. Lesions are non-inflammatory and non-scaling.
Distribution: World-wide, but more common in tropical regions of Central and South America, Africa, South-East Asia and Australia.
Aetiological Agent: *Exophiala werneckii* a common saprophytic fungus believed to occur in soil, compost, humus and on wood in humid tropical and sub-tropical regions. Familial spread of infection reported.

442. Typical brown to black, non-scaling macules on the palmar aspect of the hands. Note there is no inflammatory reaction. (Courtesy of Dr J. W. Rippon, University of Chicago, U.S.A.).

443. Tinea nigra plantaris of three years duration in a 50 year old man from South America. Note the typical darkly-pigmented, non-scaling macules. (From E. Haneke and B. Kienlein-Kletschka. l983. Light and electron microscopic investigation of tinea nigra. Mykosen 26 :5l4-520).

444. Skin scrapings mounted in 10% KOH showing pigmented brown to dark olivaceous (dematiaceous) septate hyphal elements and 2-celled yeast cells producing annelloconidia typical of *Exophiala werneckii*. (Courtesy of Dr J.W. Rippon, University of Chicago, U.S.A.).

445. *Exophiala werneckii* on Sabouraud's dextrose agar. Initially colonies are mucoid, yeast-like and shiny black. However with age they develop abundant aerial mycelia and become dark olivaceous in colour.

446. Microscopic morphology of *Exophiala werneckii* showing the typical 2-celled, pale brown yeast cells, with prominent darkly-pigmented septa, which act as annellides. Annellides may also arise from the hyphae. Annelloconidia are l to 2-celled, cylindrical to spindle-shaped, hyaline to pale brown and usually occur in aggregated masses.

Zygomycosis (Entomophthoromycosis).

Entomophthoromycosis caused by *Conidiobolus*

A chronic inflammatory or granulomatous disease that is typically restricted to the nasal submucosa and characterized by polyps or palpable restricted subcutaneous masses. Clinical variants, including pulmonary and systemic infections have also been described. Human infections occur mainly in adults with a predominance in males (80% of cases). Infections also occur in horses usually producing extensive nasal polyps and the causative agent *Conidiobolus coronatus* is a recognised pathogen of termites, other insects and spiders.
Distribution: World-wide, especially tropical rain forests of Africa.
Aetiological Agent: *Conidiobolus coronatus*, commonly present in soil and decaying leaves.

447. Entomophthoromycosis caused by *Conidiobolus coronatus* showing bilateral distortion of the subcutaneous tissue of the nasal region. (Courtesy of Dr. J.W. Rippon, University of Chicago, USA.).

448, 449. Entomophthoromycosis caused by *Conidiobolus coronatus* in a patient seen at the Pasteur Institute in Paris in 1972 from the then French Camaroons. Note the massive swelling and distortion of the subcutaneous tissue of the nasal and perioral regions, with a large polypoid protrusion on the inner aspect of the lower lip. (Courtesy Dr R. Garrison, V.A. Medical Centre, Kansas City, U.S.A.).

450. Haematoxylin and eosin (H&E) stained section of tissue from the patient shown in slides 448 and 449 showing broad sparsely septate hyphae surrounded by an eosinophilic sheath (Splenodore-Hoeppli phenomenon) typical of Entomophthoromycosis (also see slide 457). (Courtesy Dr R. Garrison, V.A. Medical Centre, Kansas City, U.S.A.).

451. *Conidiobolus coronatus* on Sabouraud's dextrose agar showing a flat, cream coloured, glabrous, radially folded colony covered by a fine, powdery, white surface mycelium.

452, 453. Microscopic morphology of *Conidiobolus coronatus* showing several mature, spherical sporangiola (conidia) with hair-like appendages, called villae and prominent papillae, marking the site of former attachment to the sporangiophore.

Entomophthoromycosis caused by *Basidiobolus*

A chronic inflammatory or granulomatous disease generally restricted to the limbs, chest, back or buttocks primarily occurring in children with predominance in males. Initially, lesions appear as subcutaneous nodules, which develop into massive, firm, indurated, painless swellings, which are freely movable over the underlying muscle but are attached to the skin which is hyperpigmented but not ulcerated.
Distribution: Tropical Africa, India, Indonesia and South East Asia including the Northern Territory of Australia.
Aetiological Agent: *Basidiobolus ranarum* (= *B. haptosporus*) commonly present in decaying fruit and vegetable matter, and as a commensal in the intestinal tract of frogs, toads and lizards.

454. Entomophthoromycosis caused by *Basidiobolus ranarum* showing a subcutaneous lesion involving the entire thigh and buttock of an Indonesian boy. There was a secondary bacterial infection following a biopsy. (Courtesy of Dr J.W. Rippon, University of Chicago, USA).

455, 456. Entomophthoromycosis caused by *Basidiobolus ranarum* showing an ulcerated subcutaneous lesions on the abdomen of a young boy from Darwin.

457. Haematoxylin and eosin (H&E) stained section of tissue from a lesion on a child's arm showing broad septate hyphae surrounded by an eosinophilic sheath (Splenodore-Hoeppli phenomenon) typical of Entomophthoromycosis.

Note there are two major histological differences between subcutaneous zygomycosis caused by *Basidiobolus* and *Conidiobolus* (Entomophthoromycosis) and zygomycosis caused by members of the Mucorales (mucormycosis). Firstly, in Entomophthoromycosis the hyphae are surrounded by an eosinophilic sheath and there is a lack of vascular invasion, which is so characteristic of infections caused by the Mucorales. Secondly, the hyphal elements of Mucorales are sparsely septate in tissue, where as frequent septation is seen in tissue hyphae of *Basidiobolus* or *Conidiobolus*.

458. *Basidiobolus ranarum* on Sabouraud's dextrose agar after 17 days incubation at 26^{O}C showing a flat, yellowish-grey, glabrous, radially folded colony covered by a fine, powdery, white surface mycelium. Note the satellite colonies formed by germinating conidia ejected from the primary colony.

459. Microscopic morphology of *Basidiobolus ranarum* showing globose, one-celled conidia that are forcibly discharged from a sporophore. The sporophore has a distinct swollen area just below the spore that actively participates in the discharge of the spore.

460. Microscopic morphology of *Basidiobolus ranarum* showing numerous round, smooth, thick-walled zygospores.

Subcutaneous zygomycosis (Mucormycosis)

Primary cutaneous and subcutaneous infections usually the result of a "barrier break" or traumatic implantation of fungal elements. Lesions vary considerably in morphology but include plaques, pustules, ulcerations, deep abscesses and ragged necrotic patches. Most heal with little treatment (debridement and amphotericin B) and they are not usually associated with dissemination.
Distribution: World-wide.
Aetiological Agents: Cosmopolitan members of the Mucorales including species of *Rhizopus, Mucor, Rhizomucor, Absidia, Cunninghamella, Saksenaea* and *Mortierella*.

461, 462, 463. An Australian Aborigine from the Northern Territory recovering from extensive burns (461) developed a subcutaneous lesion on his ankle (see slide 462), caused by *Apophysomyces elegans*, which subsequently underwent debridement (463).

464. Direct mount in KOH of aspirated material from the lesion described in 462 showing distinctive infrequently septate thin walled hyphae with focal bulbous dilations and irregular branching, typical for those species belonging to the Mucorales.

465, 466. Young sporangium (465) and mature sporangium (466) of *Apophysomyces elegans* showing distinctive funnel-shaped apophyses and a conspicuous pigmented sub-apical thickening below the apophysis.

467. Culture of *Apophysomyces elegans* on Sabouraud's dextrose agar.

468. Primary isolation of *Apophysomyces elegans* from soil on Sabouraud's dextrose agar at 45^{O}C.

469, 470. An ulcerated, erythematous plaque on a tattooed area of the left forearm of an otherwise healthy 25 year old male. This lesion had begun 15 months previously as a papule, which he thought, resulted from a scratch received whilst installing insulation. Slow enlargement had occurred despite several courses of antibiotics and two attempts at excision. *Saksenaea vasiformis* was isolated. (Courtesy Dr D. Hill, Adelaide, S.A.).

471. The forearm of the same patient in slides 469 and 470 following treatment with amphotericin B. Overall, this lesion developed slowly, remained localized and was successfully treated.

472. An extensively debrided leg of a 60 year old debilitated patient showing visible mycelial growth (dark staining area) on the uppermost margin. *Saksenaea vasiformis* was isolated. Briefly, an obese, non-diabetic, 60 year old woman who had had radiotherapy for carcinoma of the bladder some years previously, presented with a 36 hour history of a painful lesion below her left knee. The lesion when first noticed, was a small erythematous macule which progressed to an enlarging necrotic ulcer with visible mycelial growth at the margins. Despite extensive debridement and amphotericin B treatment the lesion progressed and her leg was amputated. There was no evidence of a systemic focus. Unfortunately the patient concomitantly suffered from complications associated with her previous radiotherapy and these eventually led to her death a month later. At post-mortem there was no evidence of zygomycosis or of malignant disease. (Courtesy Dr G. Nimmo, Princess Alexandra Hospital, Brisbane, Qld.).

473. Direct microscopy of a skin scraping from the lesion seen in slides 469 and 470 mounted in 10% KOH and Parker ink solution showing broad, sparsely septate hyphae typical of a zygomycete.

474. Haematoxylin and eosin (H&E) stained section of tissue from the leg seen in slide 472 showing broad, infrequently septate, thin-walled hyphae with focal bulbous dilations and irregular, non-dichotomous, often right-angled, branching. *Saksenaea vasiformis* was isolated.

475. *Saksenaea vasiformis* on Sabouraud's dextrose agar. Fungal cultures of biopsy material from the lesions seen in slides 469 and 472 yielded white downy colonies with no reverse pigment made up of broad, non-septate hyphae typical of a zygomycetous fungus.

476. Microscopic morphology of *Saksenaea vasiformis* showing typical broad, sparsely septate hyphae. Note the septa in zygomycetous fungi are solid cross walls with no pores and there is no flow of cytoplasmic material between cells. Therefore, if a hyphal strand is damaged the whole segment perishes (see upper left hand section of slide). This is why zygomycetous fungi are often difficult to isolate from clinical specimens, i.e. during the biopsy procedure or in "chopping up" the specimen in the laboratory, all the hyphal elements become damaged and are non viable.

477. Microscopic morphology of *Saksenaea vasiformis* showing a typical flask-shaped sporangium arising from darkly pigmented rhizoids. Note the oblong shaped sporangiospores filling the long neck of the sporangium.

478. Agar block method to induce sporulation of *Saksenaea vasiformis* and *Apophysomyces elegans* Briefly, a small block of agar is cut from a well established culture grown on PDA and is placed in the centre of petri dish

containing 1% agar in distilled water. After 21 days at $26^{O}C$ look for sporangium formation at the periphery of the petri dish.

Systemic Zygomycosis (Mucormycosis)

An acute and rapidly developing, less commonly chronic, infection of debilitated patients. Depending on the portal of entry, the disease involves the rhino-facial-cranial area, lungs, gastrointestinal tract, skin or less commonly other organ systems. The infecting fungi have a predilection for invading vessels of the arterial system, causing embolization and subsequent necrosis of surrounding tissue. A suppurative, pyrogenic reaction is elicited; granuloma formation is not frequently encountered.
Distribution: World-wide.
Aetiological Agents: Cosmopolitan members of the Mucorales, including species of *Rhizopus, Mucor, Rhizomucor Absidia, Cunninghamella, Saksenaea* and *Mortierella*.

479. Rhinocerebral zygomycosis showing involvement of the palate caused by *Apophysomyces elegans*.

480. MRI scan from the same patient in 479 showing extensive tissue destruction.

481. Rhinocerebral zygomycosis caused by *Rhizopus oryzae*.

482, 483. Rhinocerebral zygomycosis caused by *Rhizopus oryzae* extensive involvement of the orbit and associated MRI image.

484. Zygomycotic ulceration in a calf abomasum. (Courtesy C.V.L. Weybridge, England).

485. Haematoxylin and eosin (H&E) stained section of lung tissue showing the broad, infrequently septate, thin-walled hyphae of *Absidia corymbifera*.

486. *Rhizopus oryzae* on Sabouraud's dextrose agar. Colonies are very fast growing at 25^{o}C, about 5-8mm high, with some tendency to collapse, white cottony at first becoming brownish grey to blackish-grey depending on the amount of sporulation.

487, 488. Microscopic morphology of *Rhizopus oryzae*. Sporangiophores up to l500μm in length and l8μm in width, smooth walled, non-septate, simple or branched, arising from stolons opposite rhizoids usually in groups of 3 or more. Sporangia are globose, often with a flattened base, greyish black, powdery in appearance, up to l75um in diam. and many spored. Columellae and apophysis together are globose, subglobose or oval, up to l30μm in height and soon collapsing to an umbrella-like form after spore release. Sporangiospores are angular, subglobose to ellipsoidal, with ridges on the surface, and up to 8μm in length. No growth at 45^{O}C; good growth at 40^{O}C.

489. Microscopic morphology of *Absidia corymbifera* showing a typical pyriform shaped sporangium with a characteristic conical shaped columella and pronounced apophysis. i.e. a swelling of the sporangiophore below the columella.

490. Grocott's methenamine silver (GMS) stained tissue section from a lung showing typical zygomycete hyphae and by chance a sporangium of *Absidia corymbifera.*

491, 492, 493. Microscopic morphology of a *Mucor* sp. showing erect, simple sporangiophores forming a terminal, globose sporangium, packed with sporangiospores and with a well developed subtending columella visible (slide 491). The sporangial wall then dissolves allowing the release of the sporangiospores which exposes the columella (slide 492). A collarette (remnants of the sporangial wall) is usually visible at the base of the columella following spore dispersal (slide 493). Stolons and rhizoids are not produced by *Mucor* sp.

494. Microscopic morphology of *Rhizomucor pusillus* showing sympodially branched sporangiophores with a septum below the sporangium. Sporangia are generally globose with an oval or pear-shaped columella. A collarette (remnants of the sporangial wall) is usually visible at the base of the columella following spore dispersal. Sporangiospores are globose to subglobose and are often mixed with crystalline remnants of the sporangial wall. *Rhizomucor* species are thermophilic and differ from species of *Mucor* by the development of primitive rhizoids.

495. Primitive rhizoids of *Rhizomucor pusillus.*

496, 497. Microscopic morphology of *Cunninghamella bertholletiae* showing simple sporangiophores forming a swollen, terminal vesicle around which single-celled, globose to ovoid, sporangiola develop on swollen denticles.

498. Microscopic morphology of *Syncephalastrum racemosum* showing terminal vesicle, finger-like merosporangia and sporangiospores.

499. Mature merosporangia of *Syncephalastrum racemosum* showing sporangiospores arranged in rows.

500. Microscopic morphology of *Mortierella wolfii* showing a typical erect, delicate sporangiophore, wide at its base, with a compact cluster of short acrotonous (terminal) branches. On dehiscence of the sporangia a conspicuous collarette is usually present. Columella are generally lacking and sporangiospores are single-celled, short-cylindrical, with a double membrane.

FOR ADDITIONAL SLIDES ON THE ZYGOMYCETES SEE SLIDES 004 TO 010.

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