

Microbial Diseases of the Skin and Eyes

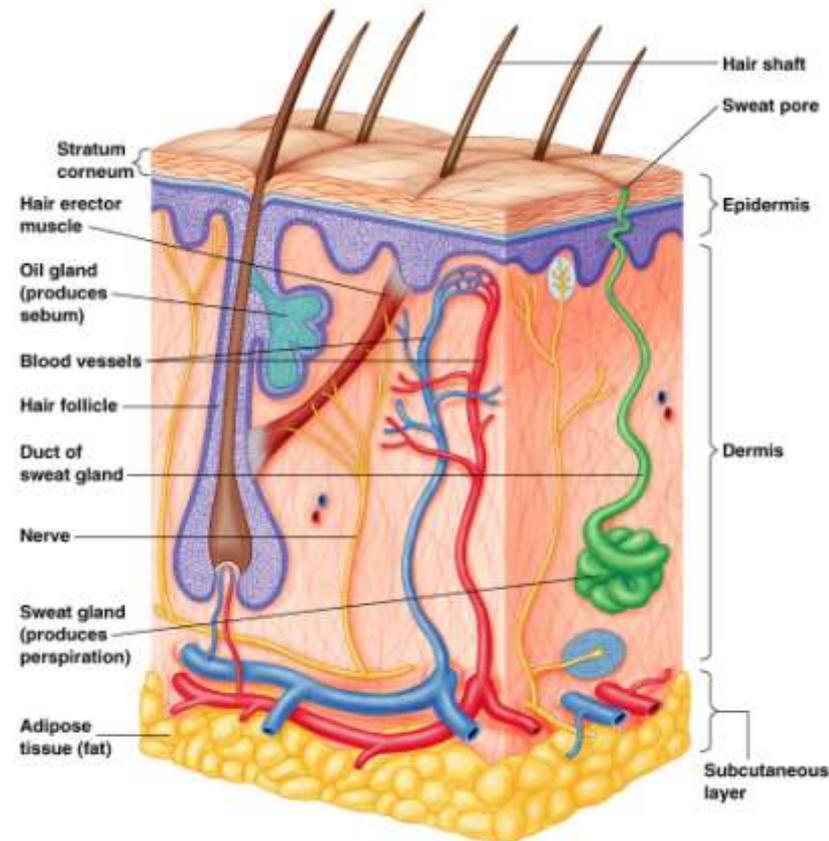
Chapter 21

I. Introduction

- A. Skin is a physical barrier against microorganisms
- B. Moist areas of skin, e.g. axilla, skin folds, support larger populations of microorganisms than dry ones (e.g. scalp).

II. Structure and Function of the Skin

- A. Outer layer, epidermis, contains keratin, a waterproof coating.
- B. Inner layer, dermis, contains hair follicles, sweat glands, and oil glands that may allow entry of microorganisms.
- C. Sebum and perspiration are secretions that may inhibit growth of microbes.
- D. Body cavities lined with epithelium may secrete mucous and constitute a mucous membrane.

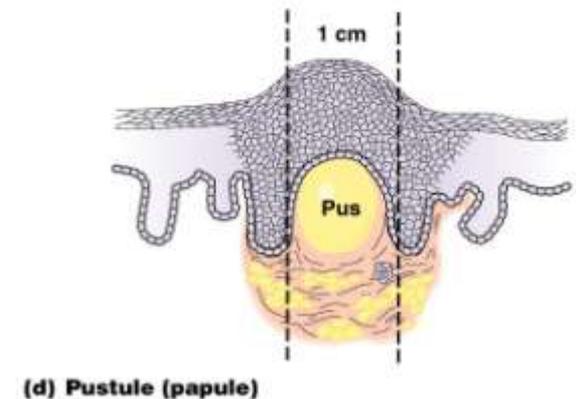
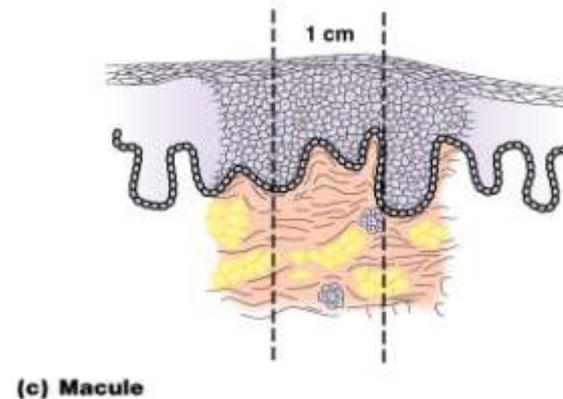
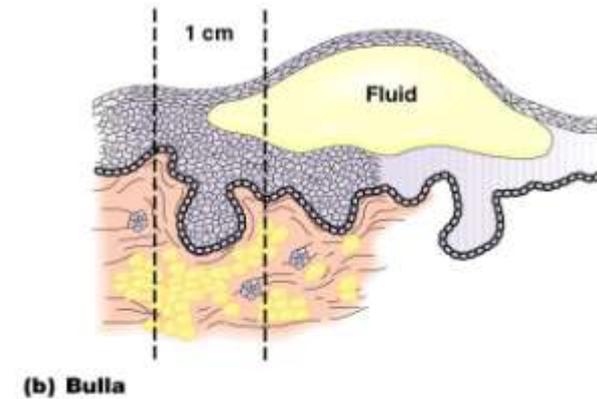
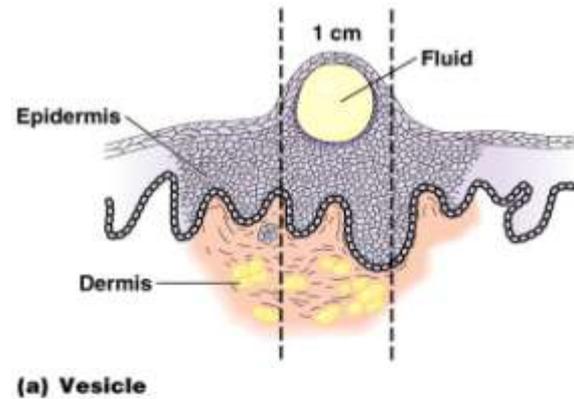


III. Normal Microbiota of the Skin

- A. Microbes that live on the skin are resistant to desiccation and high concentrations of salt.
- B. Gram positives predominate on the skin (e.g. *Staph epidermidis*, diphtheroids). These are not totally removed by hand washing.
- C. *Propionibacterium sp.* colonize oil glands and hair follicles where they metabolize oil and produce acid end products. This lowers the pH to 3-5, creating a bacteriostatic condition.
- D. Lysozyme from tears destroys many organisms.
- E. *Pitysporium ovale* (a yeast) grows on oily secretions and may cause dandruff.

IV. Microbial Diseases of the Skin

- A. Skin Lesions
 - Vesicles- small fluid filled lesion
 - Bulla- vesicles > 1 cm
 - Macule- flat reddened lesion
 - Pustule- raised lesion with pus



IV. Microbial Diseases of the Skin

- B. Bacterial Diseases of the Skin
 - 1. Staphylococcal Skin Infections
 - a. Staphylococci are gram positive bacteria that grow in clusters.
 - b. The majority of skin microbiota are coagulase negative *S. epidermidis*.
 - c. Almost all pathogenic strains of *S. aureus* produce coagulase.
 - d. Pathogenic *S. aureus* can produce enterotoxin and leukocidins. Toxemia occurs when toxins enter the blood stream as with exfoliative toxin (scalded skin syndrome) and toxic shock toxin (TSST-1) causing toxic shock syndrome.
 - e. Many strains of *S. aureus* produce penicillinase (beta-lactamase positive) and may be treated with vancomycin.
 - f. Staph impetigo of the newborn is a highly contagious superficial skin infection.



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Lesions of Scalded Skin Syndrome
Caused by a Toxin



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Staph Impetigo



62 - Infectious Disease **Scaled Skin Syndrome** - Some strains of Staph produce an exfoliative toxin. Multiple superficial areas are seen with a strong resemblance to scalding. The impetiginous lesion at the root of the nose was the original site of staphylococcal infection.



25 Impetigo of leg and arm in child



B&S Fig. 28-2C Folliculitis caused by *Staph aureus* showing numerous pustules.

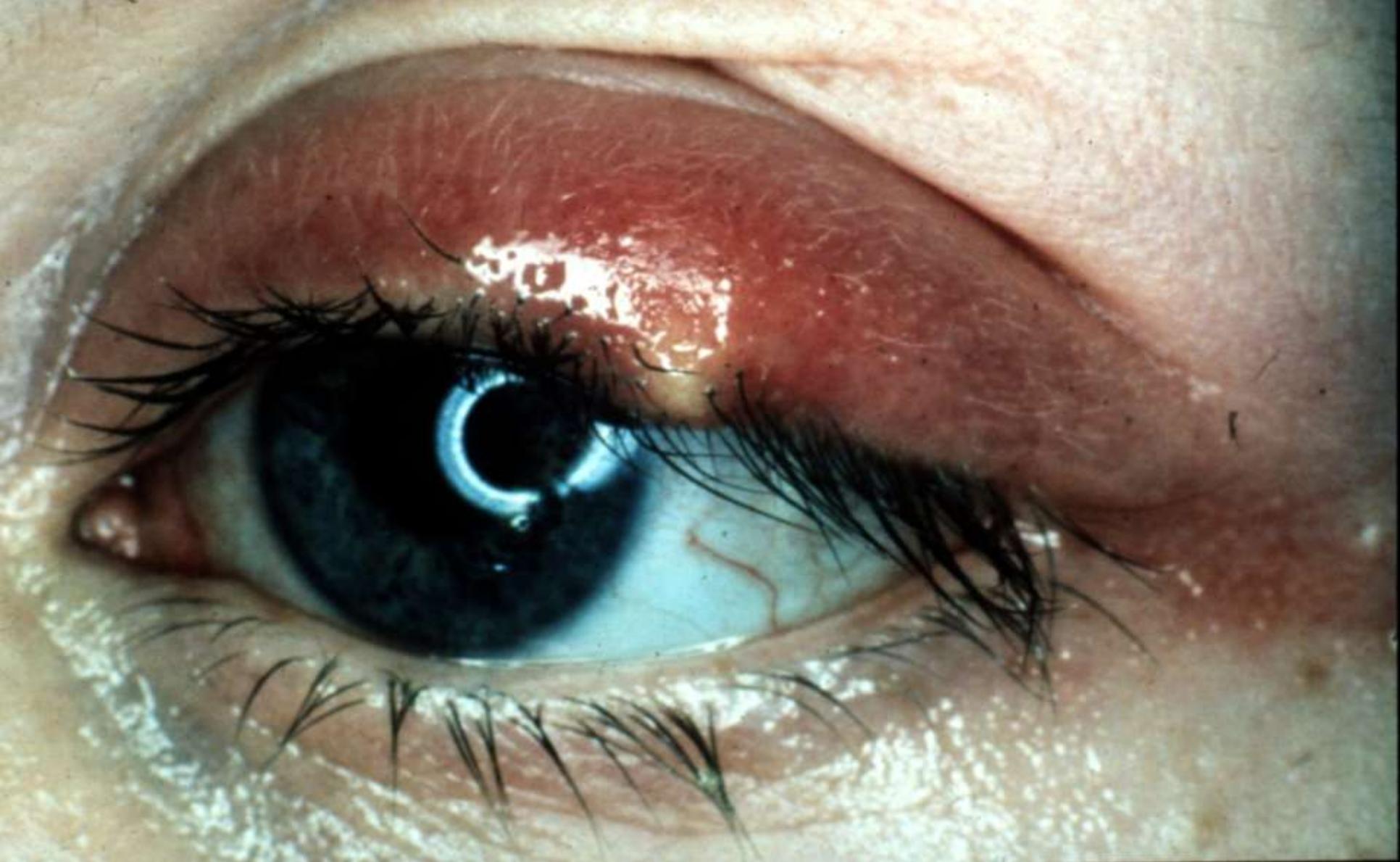


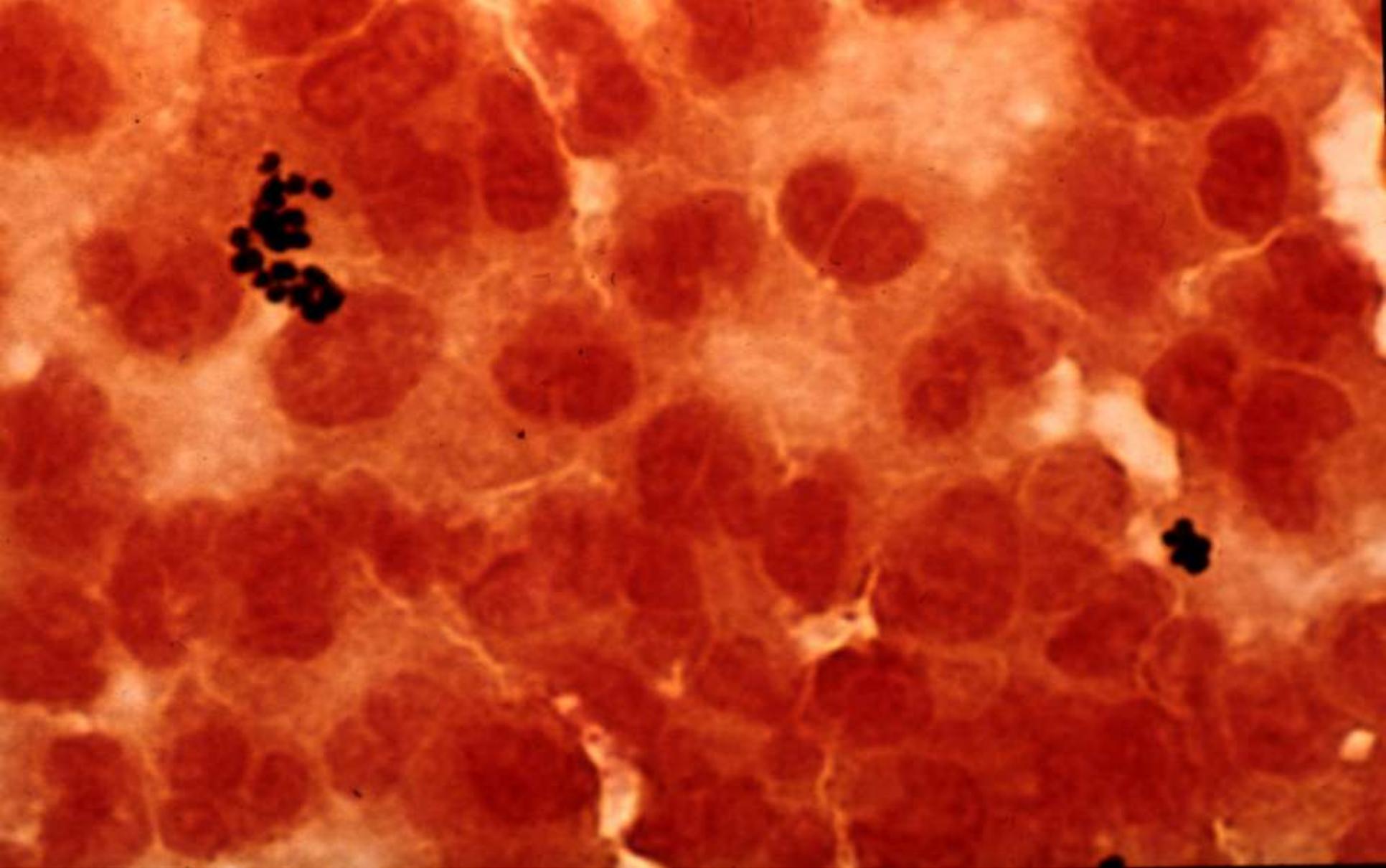
Fig 111 Inf Dis Sty - This is a localized infection of the eyelid, usually caused by *Staphylococcus aureus*. This patient has generalized swelling and redness of the upper lid with a localized collection of pus near the lid margin. Infected follicle of eyelash.



63 Inf Dis **Toxic Shock** Many of the manifestations of this disease (fever, hypotension, generalized erythematous rash, nausea and vomiting, diarrhea) are non-specific, but the characteristic desquamation, which commonly involves the hands and feet, is rarely seen in other conditions.



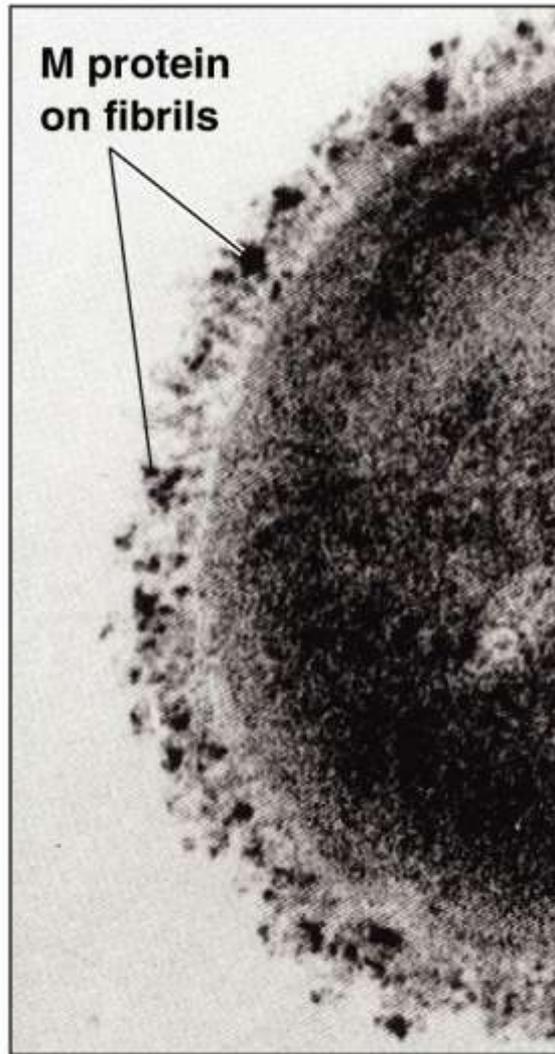
Figure 5-11. The coagulase tube test. Coagulase (-) *Staphylococcus epidermidis* above, coagulase (+) *S. aureus* below. This test was run for 24 hours.



428 Plate II. G Abscess aspirate, smear, Gram stain, light microscopy, MPV. Purulence heavy. Gram-positive cocci, groups, extracellular. Impression: Staphylococcal disease.

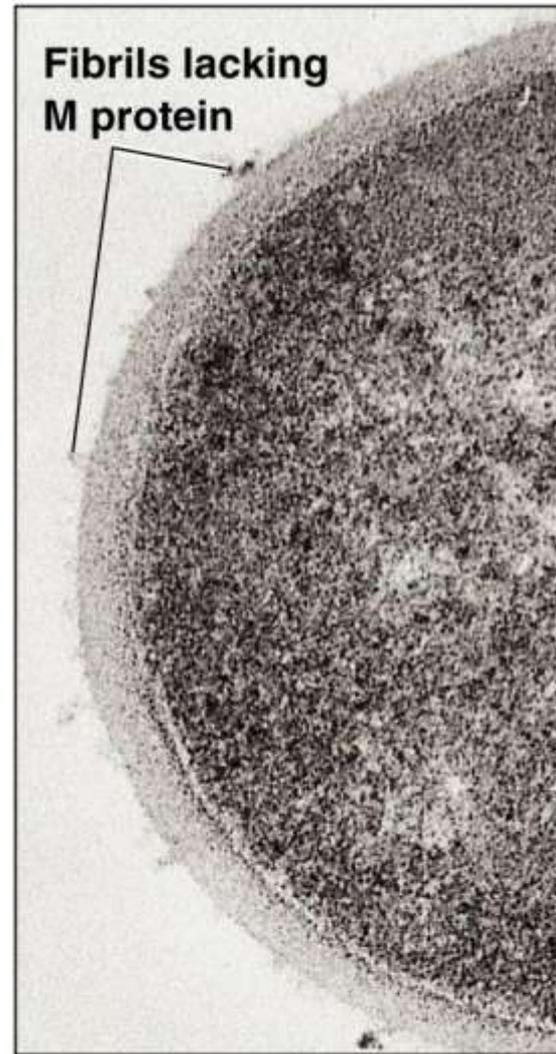
IV. Microbial Diseases of the Skin

- B. Bacterial Diseases of the Skin
 - 2. Streptococcal Skin Infections
 - a. Streptococci are gram positive cocci that often grow in chains and are aerotolerant anaerobes.
 - b. Streptococci are classified according to their hemolysins and serologic antigenic carbohydrates (groups A-T).
 - c. Group A beta-hemolytic *Strep pyogenes* are the pathogens most important to humans.
 - d. Group A produces a number of virulence factors: M protein (over 80 immunological types), erythrogenic toxin (scarlet fever rash), deoxyribonuclease, streptokinase, hyaluronidase.
 - e. Erysipelas (red patches) and impetigo (isolated pustules) are commonly caused by *S. pyogenes*.
 - f. Invasive *S. pyogenes* cause severe and rapid skin destruction (cellulites, myositis, necrotizing fasciitis, flesh-eating).



(a)

TEM | 0.1 μm



(b)

TEM | 0.1 μm

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M protein of group A beta-hemolytic streptococci. It provides several pathogenic qualities to GAB.

Figure 21.5 - Overview



Fig 66 Inf Dis Erysipelas due to *S. pyogenes*. The raised red indurated area of inflammation has spread rapidly to give a butterfly distribution with blistering on affected areas. The eyes are closed by edema, but are unaffected.



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Lesion of erysipelas caused by Group A strep toxins



Fig 61 Inf Dis **Impetigo** This is a superficial infection caused by streptococci, staphylococci or a combination of both. Clusters of superficial vesicles rapidly become purulent and form yellow adherent crusts. New lesions develop at other sites and, if untreated, the lesions may slowly enlarge and multiply over weeks or months. The boy's face shows several infected areas, some of which have scabbed.



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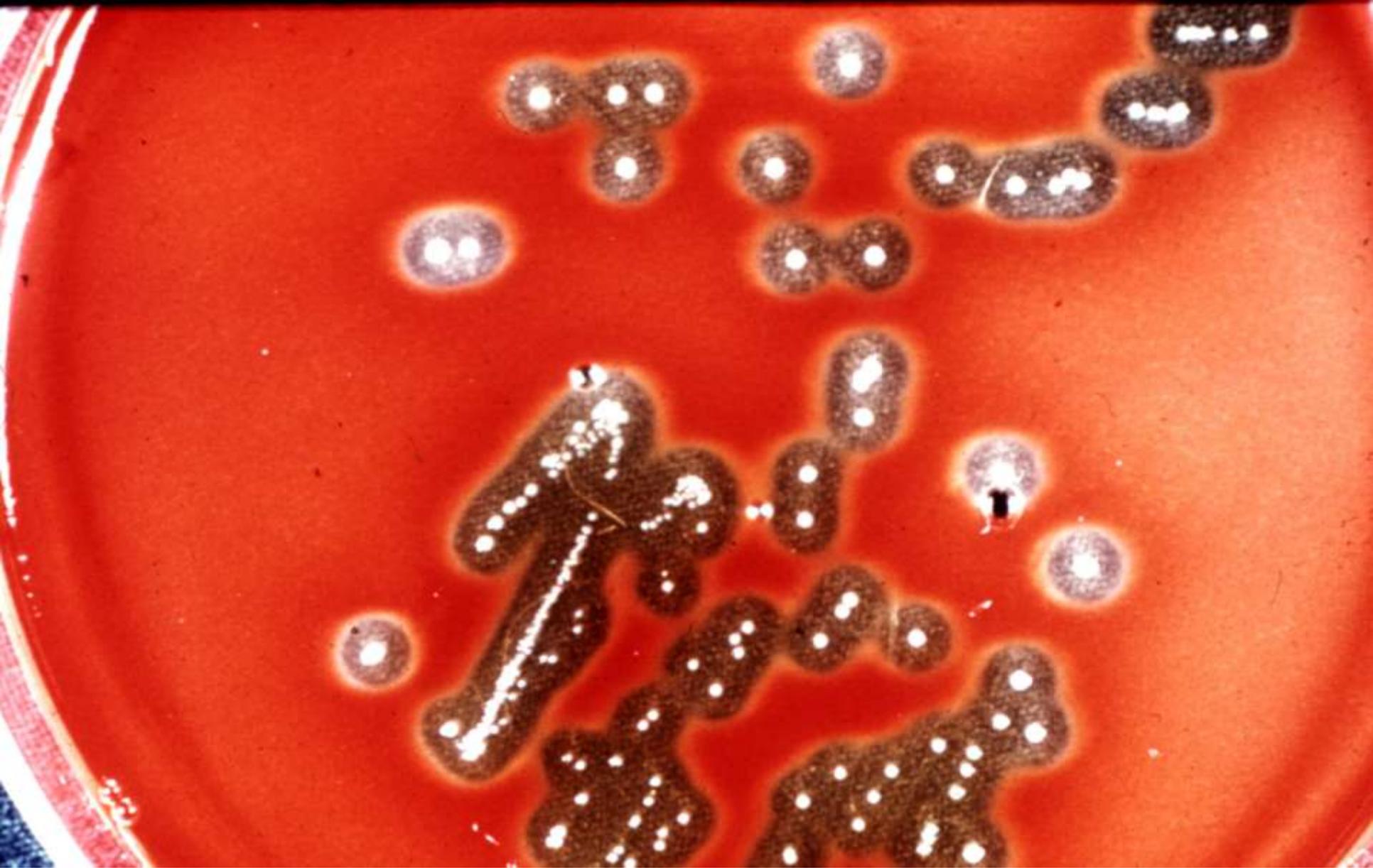
Lesions of Impetigo: isolated pustules that become crusted.



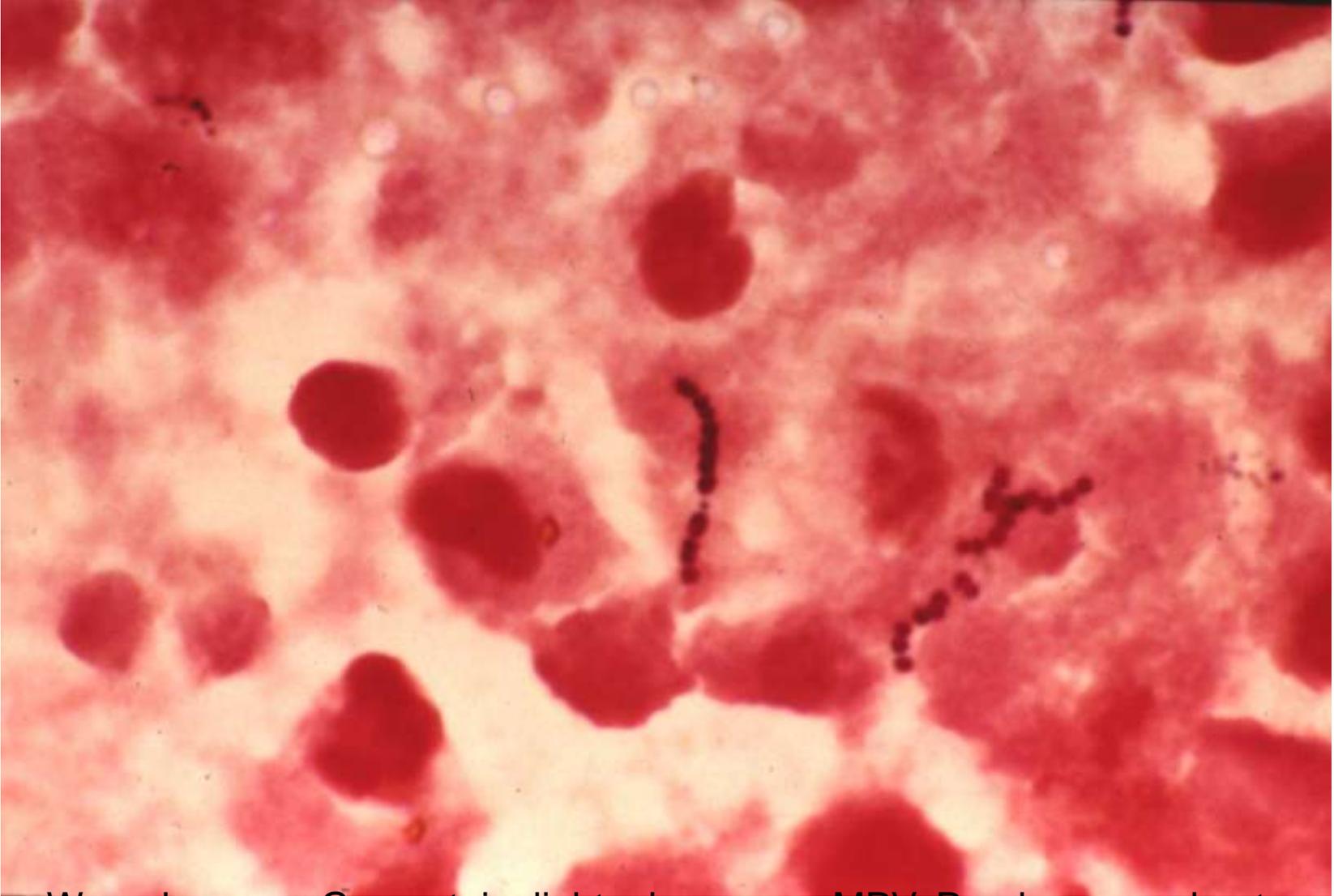
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Necrotizing fasciitis due to Group A strep

Figure 21.8



#8 Blood Agar Plate – *Strep pyogenes* - Beta-hemolytic



427 Plate II. D Wound, smear, Gram stain, light microscopy, MPV. Purulence moderate. Amorphous debris moderate. Gram-positive cocci, chains, extracellular. Impression: Streptococcal disease. The presence of typical chains of *Streptococcus* on a background showing purulence with poorly preserved "polys" and amorphous debris is suggestive of hemolytic streptococci with tissue cytotoxicity. Routine bacterial culture yielded a pure growth of *Streptococcus pyogenes*.

IV. Microbial Diseases of the Skin

- B. Bacterial Diseases of the Skin

- 3. Pseudomonas skin infections

- a. Pseudomonads are gram negative rods that are aerobes (non-fermenters). They live primarily in soil and water that are resistant to many disinfectants and antibiotics.
 - b. *Pseudomonas aeruginosa* is the most prominent species and produces endotoxin and several exotoxins.
 - c. Skin diseases include otitis externa, burn infections, dermatitis, serious eye infections.
 - d. Infections may show a characteristic blue-green pus caused by pyocyanin pigment.
 - e. Common cause of nosocomial infections and may be treated with fluoroquinolones.

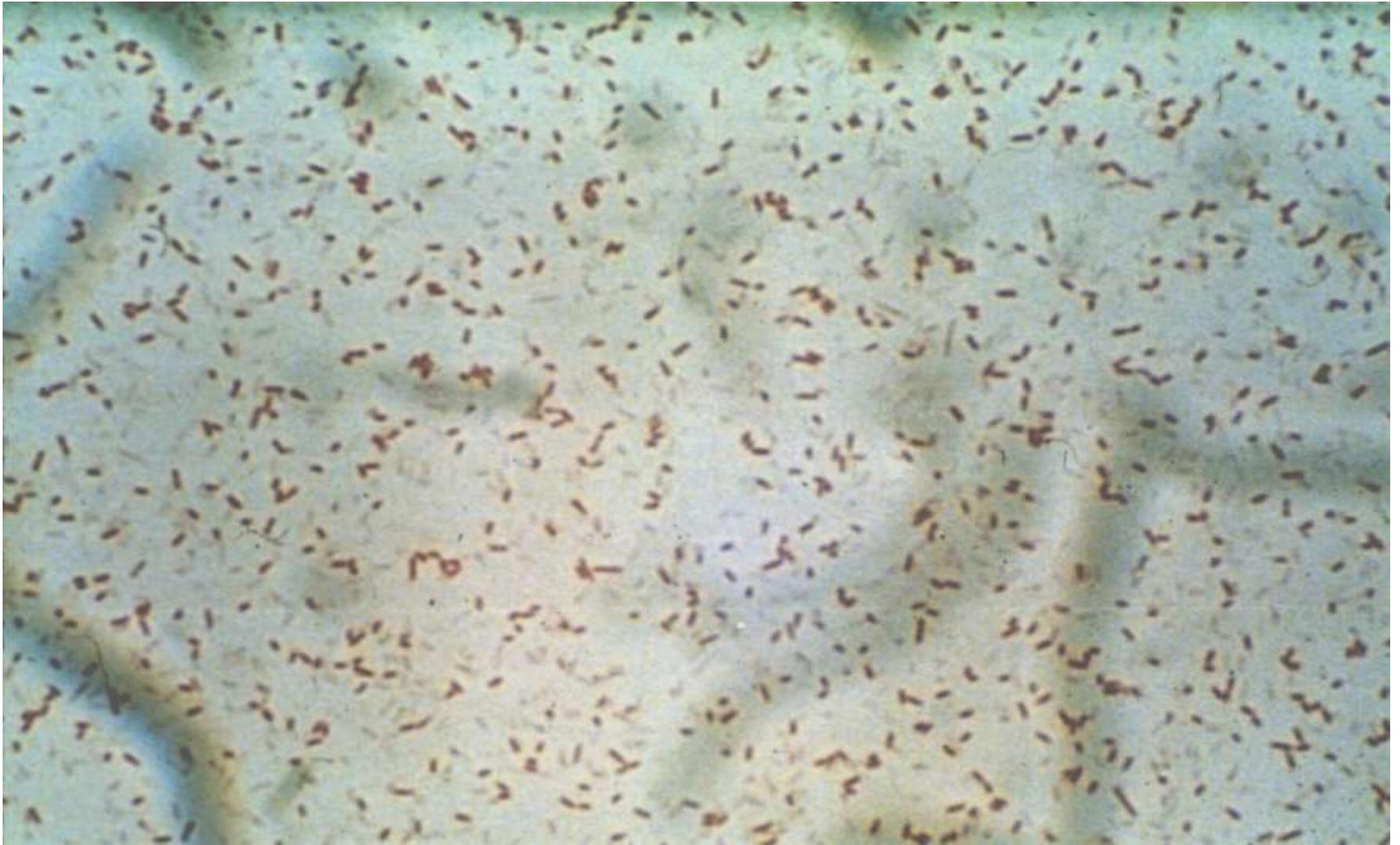


Fig 38. - Microbiology of Infectious Diseases

Pseudomonas aeruginosa

Gram stain showing long, slender Gram-negative rods.



71 Infectious Diseases

Lesion in an immunodeficient child. Later developed *Ps. aeruginosa* septicemia.

IV. Microbial Diseases of the Skin

- B. Bacterial Diseases of the Skin
 - 4. Acne: the most common skin infection, about 85% of all teenagers.
 - a. *Propionibacterium acnes* can metabolize sebum trapped in hair follicles, releasing metabolic end-products (fatty acids) that cause an inflammatory response known as acne. Can be mild to severe in presentation.
 - b. Benzoyl peroxide, tetracycline, and isotretinoin (Accutane), blue light (405-420 nm) may be used to treat acne. Accutane is associated with severe birth defects.



189 Figure 19-22

Gram-stained appearance of *Propionibacterium acnes*, illustrating the term diphtheroid.

IV. Microbial Diseases of the Skin

- C. Viral Diseases of the Skin
 - 1. Warts – Papillomavirus
 - a. Papillomaviruses (> 50 types) cause skin cells to proliferate and produce a benign growth called a wart or papilloma.
 - b. Warts are spread by direct contact. Incubation period is several weeks.
 - c. Warts may regress spontaneously or be removed chemically or physically.



Fig 145 - Pediatrics

Warts - (Papillomavirus) Flattened, hyperkeratotic lesions are present on the hands. They are very common in children and adolescents and the majority resolve spontaneously. An effective treatment is freezing with liquid nitrogen.

IV. Microbial Diseases of the Skin

- C. Viral Diseases of the Skin
 - 2. Smallpox – Variola virus
 - a. Variola virus causes two types of skin infections:
 - variola major (mortality >20%) and
 - variola minor (mortality <1%).
 - A major killer in the Middle Ages. Devastated Native Americans after the arrival of European colonists.
 - b. Smallpox is transmitted by the respiratory route, and the virus is moved to the skin via the bloodstream where it causes lesions that become pustular.
 - c. The only host for smallpox is humans.
 - d. Smallpox has been eradicated as a result of a vaccination effort by the WHO. Now is presented as a potential bioterrorism weapon.



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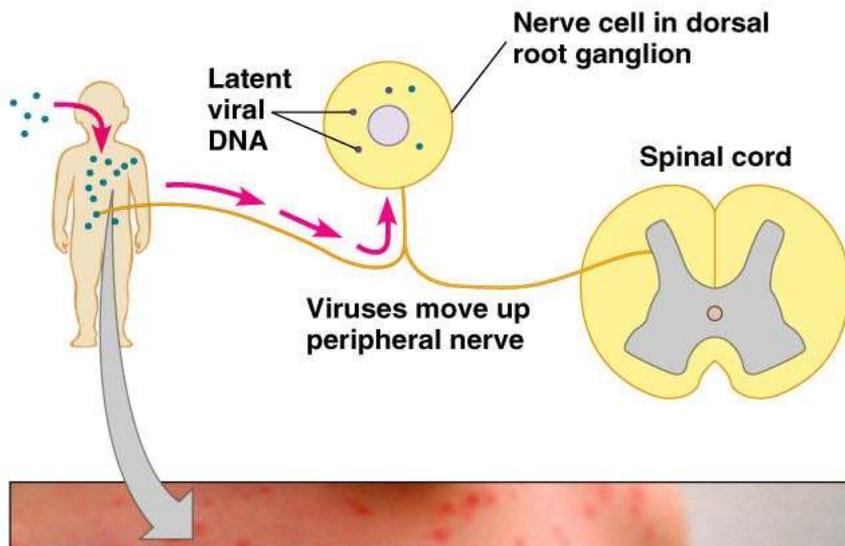
Smallpox lesions

IV. Microbial Diseases of the Skin

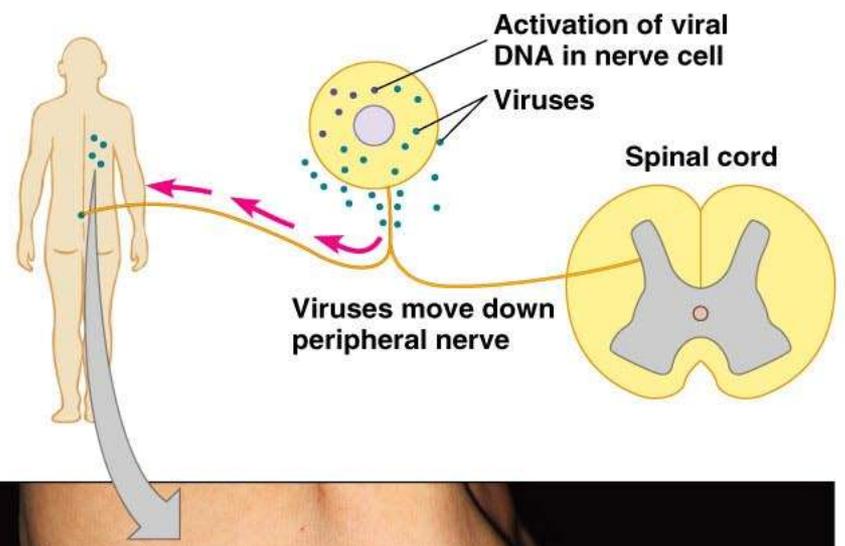
C. Viral Diseases of the Skin

– 3. Chickenpox – Varicella-zoster virus, and Shingles – Herpes Zoster

- a. Chickenpox (varicella) is caused by initial varicella-zoster virus infection.
- b. Varicella-zoster virus is transmitted by the respiratory route and is localized in skin cells, causing a vesicular rash. Two weeks incubation period.
- c. Complications of chickenpox include encephalitis and Reye's syndrome.
- d. Reye's Syndrome: Occasional severe complications of chickenpox, influenza and sometimes other viral diseases in children. Brain damage or death may result from brain swelling, which prevents blood circulation. Use of aspirin may increase chances of attack.
- e. After chickenpox, the virus can remain latent in sensory nerve cell bodies and subsequently activate shingles.
- f. Shingles (herpes zoster) is characterized by a vesicular rash along the affected cutaneous sensory nerves (dermatome).
- g. The virus can be treated with acyclovir. An attenuated live vaccine is available. A booster is available for adults.



(a) Initial infection: chickenpox (varicella)



(b) Recurrence of infection: shingles (herpes zoster)

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a) Chickenpox (varicella) and b) shingles (herpes zoster)



Fig 50 Infectious Diseases

The eruption is discrete, each lesion starting as a macule which rapidly becomes papular and then vesicular. The eruption develops in crops and is denser on trunk and face than on the limbs. The lesions are superficial and soon crust over or are scratched, so that vesicles may not easily be seen.



Fig. 51 - Infectious Diseases

This general view of severe varicella shows the characteristic distribution with superficial lesions at different stages of development. The rash is most dense centrally, on the face and trunk, and grades off towards the periphery.



Fig. 53 - Infectious Diseases

Herpes zoster of the ophthalmic division of the trigeminal nerve. This is the division most commonly affected, although maxillary mandibular herpes are occasionally seen. Lesions of the nose to the tip indicate that the naso-ciliary branch is involved and that the eye may be affected.

IV. Microbial Diseases of the Skin

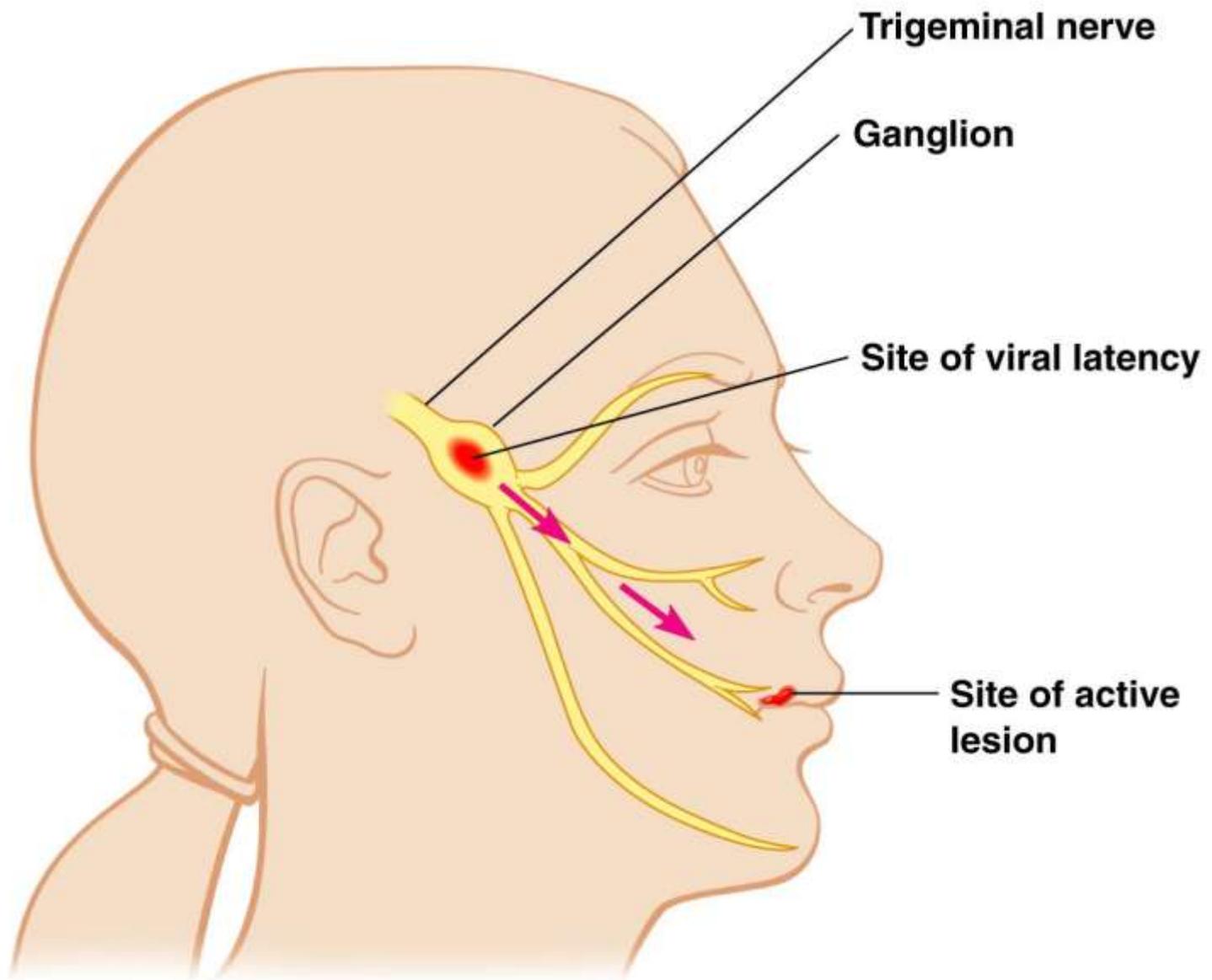
- C. Viral Diseases of the Skin
 - 4. Herpes Simplex – HSV-1 and HSV-2
 - a. Herpes simplex infection of mucosal cells results in cold sores and occasionally encephalitis.
 - b. The virus remains latent in trigeminal nerve cell ganglia, and cold sores can recur when the virus is activated by UV, emotions, hormonal changes.
 - c. Herpes simplex virus type 1 is transmitted primarily by oral and respiratory routes. Can be contracted by dental workers (fingers = herpetic whitlow) and wrestlers (herpes gladiatorum). HSV-2 primarily by sexual contact (Ch. 26)
 - d. Herpes encephalitis occurs when herpes simplex viruses infect the brain.
 - e. Acyclovir has proven successful in treating herpes encephalitis.



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Cold sores or fever blisters caused by herpes simplex virus

Figure 21.11



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Figure 21.12

Site of latency of herpes simplex type 1 in the trigeminal nerve ganglion



Fig. 44 - Infectious Diseases

The most common manifestations of recurrent infection is the cold sore, seen on the mucocutaneous margin. Sometimes recurrent herpes simplex is found at other sites. The early appearance, seen in this photograph, is of a localized swelling which soon reveals itself as a cluster of closely packed vesicles.



Fig. 45. Infectious Diseases

Here, in more fully developed form than in the previous slide, is the characteristic irregularly grouped cluster of small vesicles.



Fig 48 - Infectious Diseases

Herpes Simplex - Patients with immunosuppression are at special risk from the virus. This patient with leukemia developed severe lesions with necrosis of the skin. Common also in doctors and nurses who put fingers in patients mouth.



Fig. 49 - Infectious Diseases

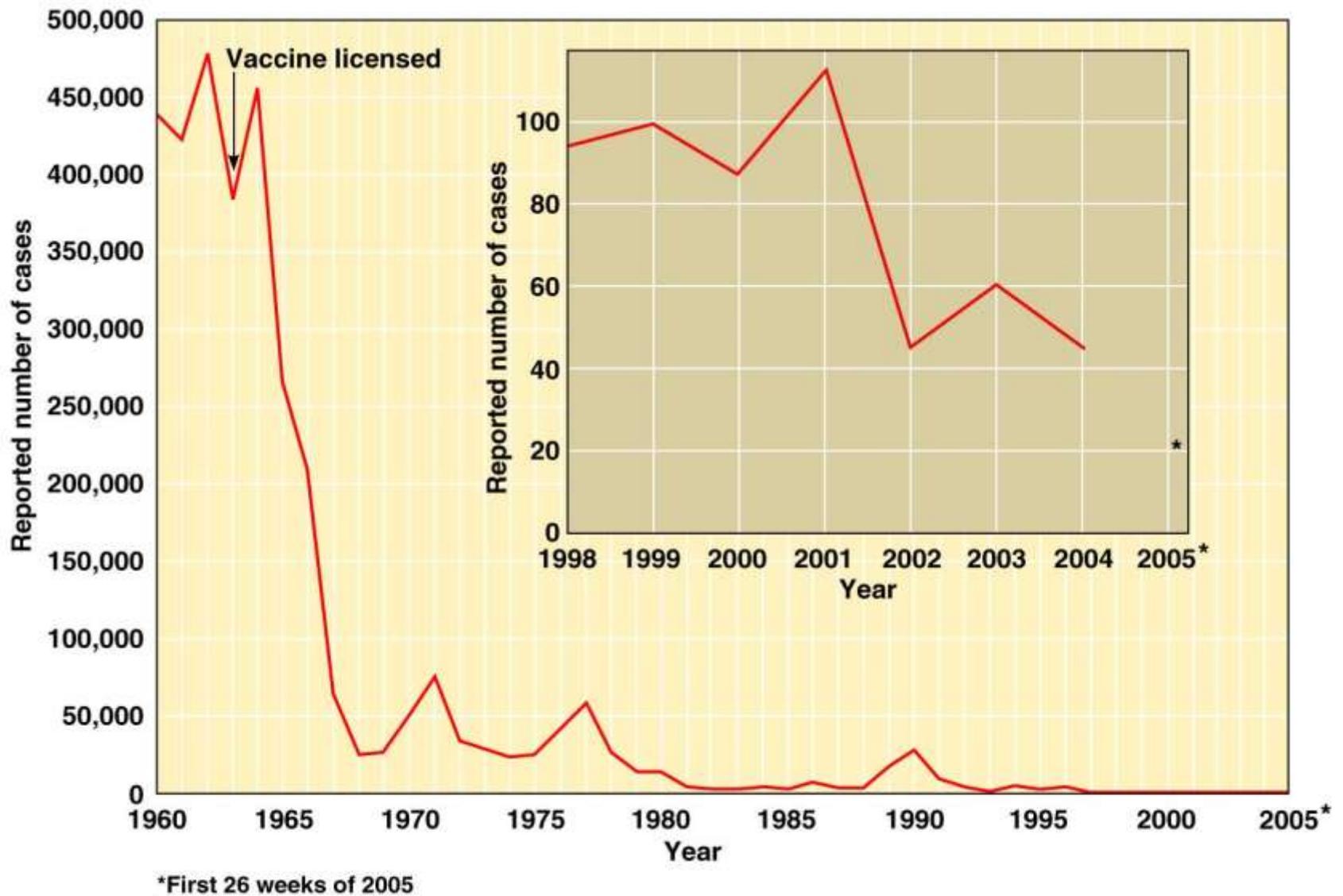
Herpetic whitlow. This is seen after accidental inoculation with herpes simplex virus, and thumb-sucking children sometimes develop herpetic paronychia when they have oral herpes. The lesion may look just like a staphylococcal infection but, as in this picture, there may be multiple superficial pustules suggestive of a herpetic origin.

IV. Microbial Diseases of the Skin

- C. Viral Diseases of the Skin

- 5. Measles (Rubeola)

- a. Measles is caused by measles virus and transmitted by the respiratory route.
 - b. Vaccination provides effective long-term immunity (Usually given as MMR – measles, mumps, rubella).
 - c. After the virus has incubated in the upper respiratory tract, macular lesions appear on the skin, and Koplik's spots (red patch with a central white spot) appear on the oral mucosa opposite molars.
 - d. Complications of measles include middle ear infections, pneumonia, encephalitis (occur in 1:1000 cases and 1:3,000 is fatal), and secondary bacterial infections.



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Reported cases of measles cases in the United States

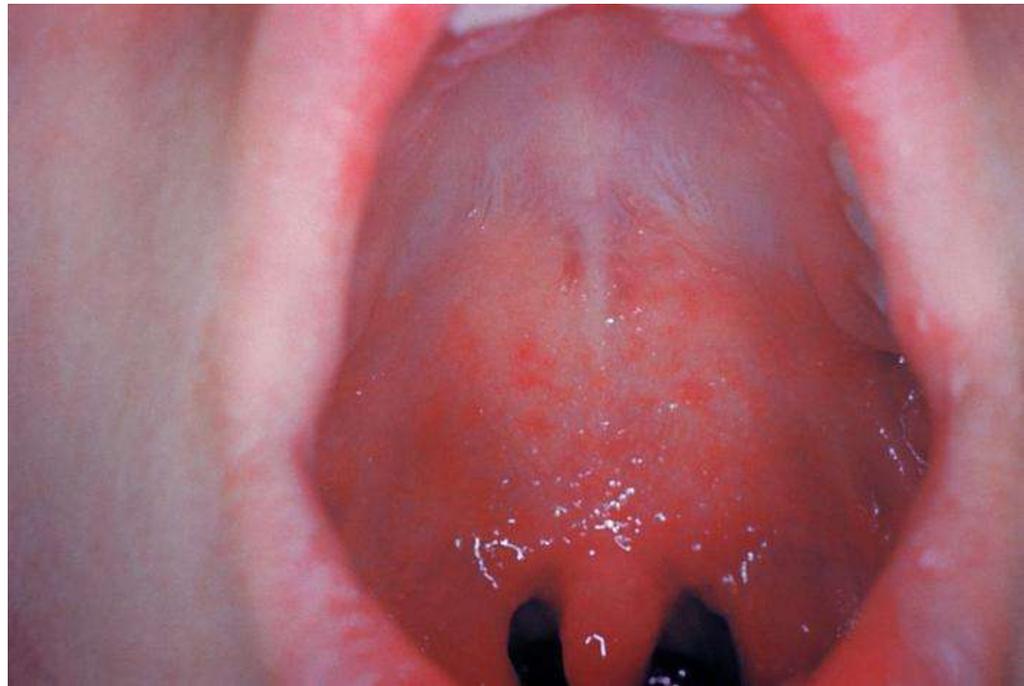
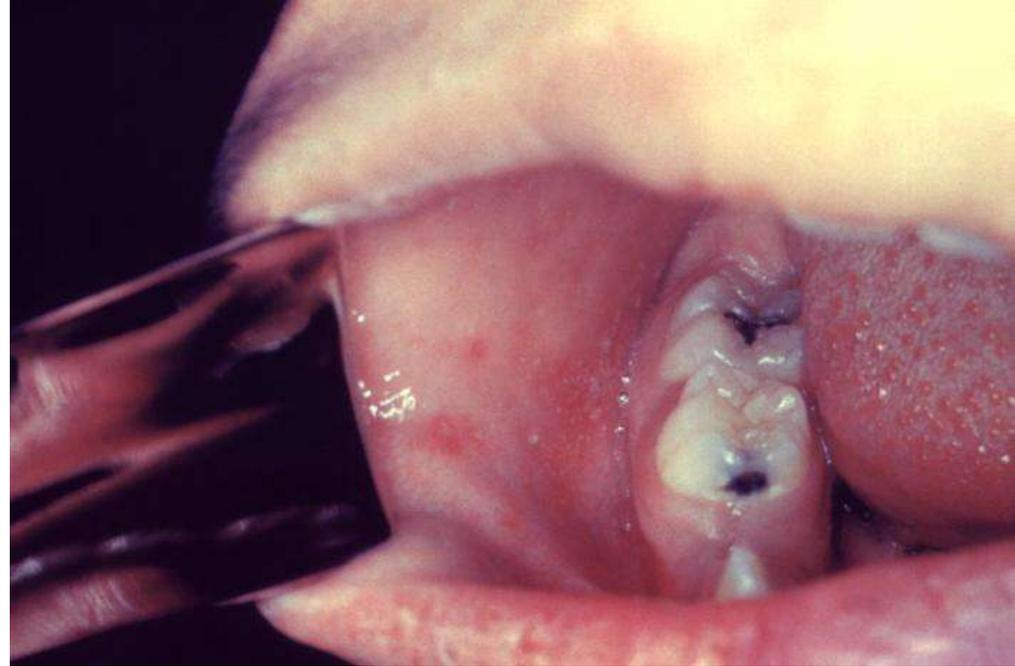


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The rash of small raised spots typical of measles (rubeola)

Koplik's spots (kop'liks) are spots found on the mucosa which are often associated with measles. They are small, irregular red spots, each with a minute bluish white speck in the center, seen on the buccal mucosa and lingual mucosa (mucous membrane of the inside of the cheek and tongue) and are pathognomonic of early stage measles. They often appear a few days before the rash arrives and can be a useful sign to look for in children known to be exposed to the measles virus.

Wikipedia



IV. Microbial Diseases of the Skin

- C. Viral Diseases of the Skin
 - 6. Rubella (German measles) – Rubella virus
 - a. The rubella virus is transmitted by the respiratory route.
 - b. A macular rash of small red spots and light fever might occur in an infected individual; the disease can be asymptomatic.
 - c. Congenital rubella syndrome can affect a fetus when a woman contracts rubella during the first trimester of her pregnancy. 35% chance of serious effects.
 - d. Damage from congenital rubella syndrome includes stillbirth, deafness, eye cataract, heart defects, and mental retardation. Live vaccine introduced in 1969, must be given 3 months before or 3 months after conception.
 - e. Serum antibodies are measured to determine immune status to rubella.



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The rash of red spots characteristic of rubella

IV. Microbial Diseases of the Skin

- D. Fungal Diseases of the Skin
 - 1. Cutaneous Mycoses – *Microsporum*, *Trichophyton*, and *Epidermophyton*
 - a. Fungi that colonize the outer layer of the epidermis cause dermatomycoses.
 - b. Fungi can resist high osmotic pressure and low moisture so can grow on the skin.
 - c. *Microsporum*, *Trichophyton*, and *Epidermophyton* cause dermatomycoses called ringworm, or tinea.
 - Tinea corporis – Body
 - Tinea capitis – Scalp (May cause bald patches. Spread by contact among children and by contact with fomites, dogs, and cats.
 - Tinea cruris – Groin (Jock itch)
 - Tinea pedis – Feet (Athlete's foot)

IV. Microbial Diseases of the Skin

- D. Fungal Diseases of the Skin
 - 1. Cutaneous Mycoses – Microsporum, Trichophyton, and Epidermophyton (cont.)
 - d. These fungi grow on keratin-containing epidermal structures: hair, skin, and nails.
 - e. Ringworm and athlete's foot are usually treated with topical antifungal chemicals. Hair and nails with systemic agents for weeks/months.
 - f. Diagnosis based on the microscopic examination of skin scrapings or fungal culture.
 - g. Dermatophyte test agar – turns red when positive



(a) Ringworm



(b) Athlete's foot

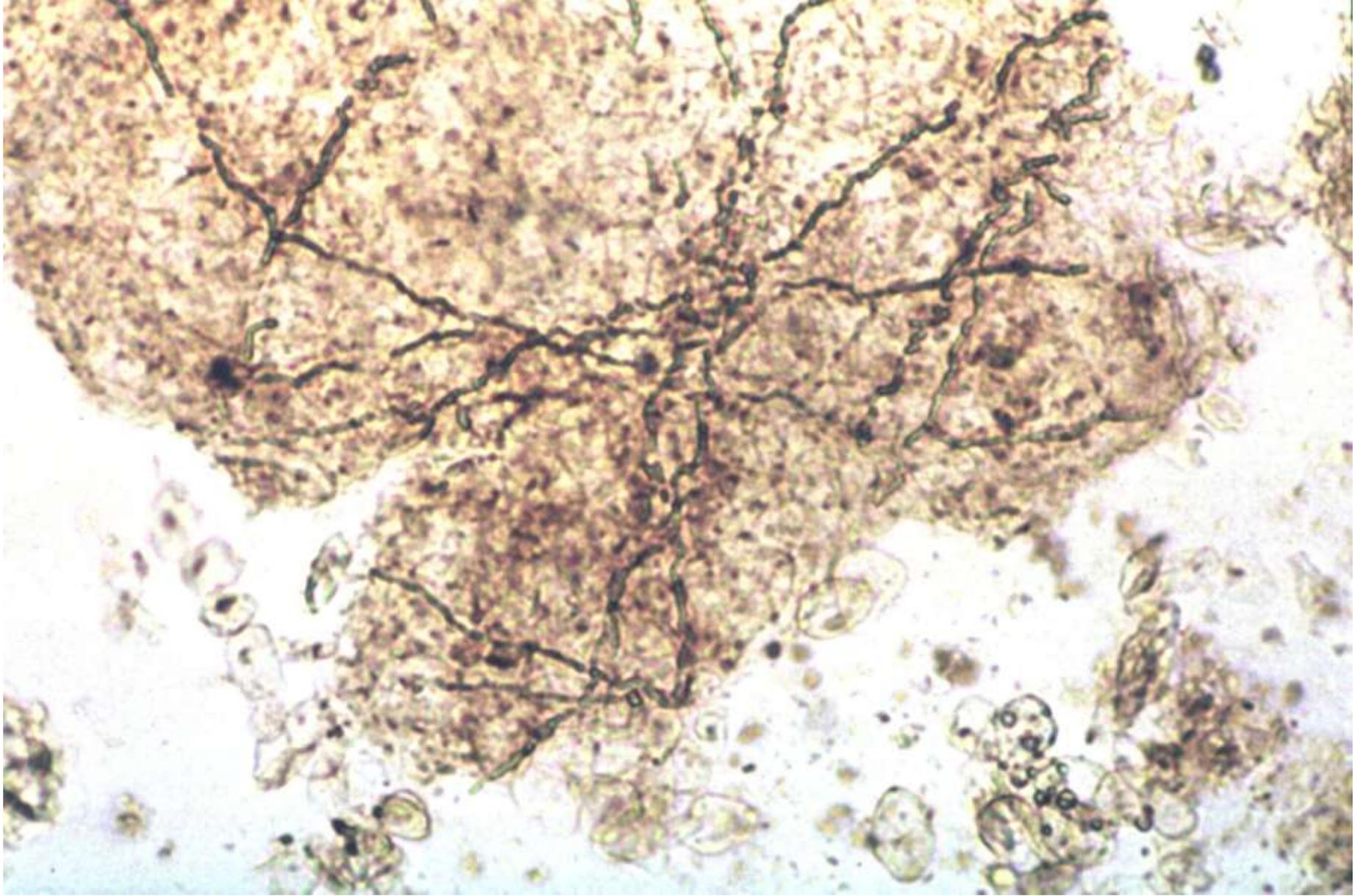
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Dermatomycosis



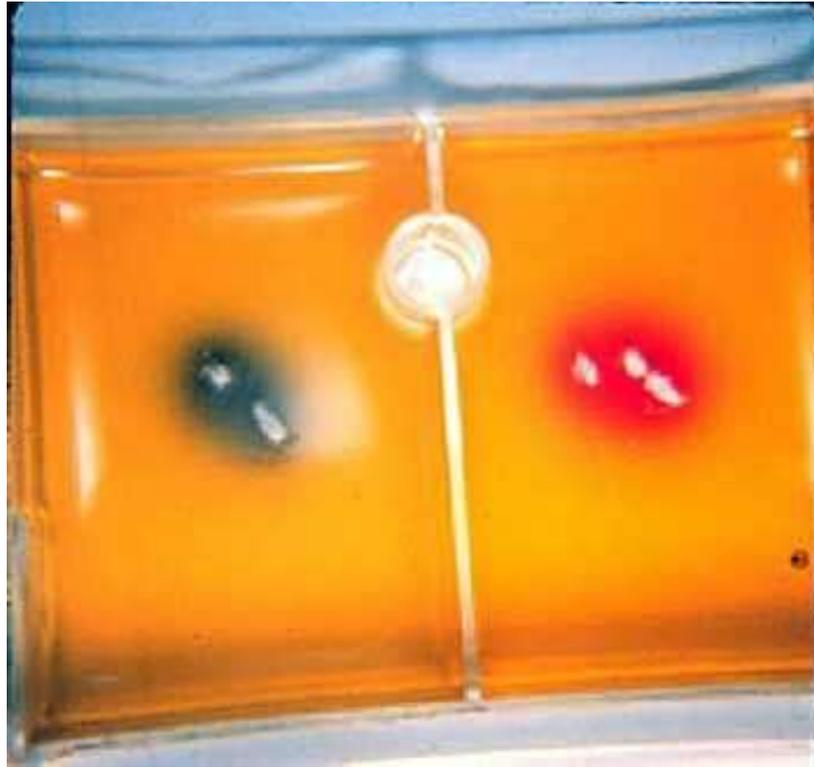
421 Figure 27-13

Tinea corporis (ringworm) - A slowly spreading scaly, erythematous lesion is present on the arm, due to a fungal infection. The spreading edge of the lesion is inflamed and the center of the lesion is clearing giving a characteristic ringed appearance.



433 Plate XI A

Skin scales, scrapings, KOH wet preparation, light microscopy, HPV. Hyphae present, septate, thin. Morphology suggests dermatophyte.



DTM plate on the right showing color change after two day's growth; *Microsporum canis*. It is based on Sabouraud's dextrose agar with added cyclohexamide to inhibit saprotrophic growth, antibiotic to inhibit bacterial growth and phenol red a pH indicator. The pH indicator is useful in distinguishing a dermatophyte fungus, which utilizes nitrogenous material for preferred metabolism, producing alkaline by-products, imparting a red color change to the medium. Typical saprotrophic fungi utilized carbohydrates in the medium producing acidic by-products and no red color change.

IV. Microbial Diseases of the Skin

- D. Fungal Diseases of the Skin
 - 2. Subcutaneous Mycoses – *Sporothrix schenckii*
 - a. Sporotrichosis results from a soil fungus that penetrates the skin through a wound, especially in gardeners and soil workers.
 - b. The fungi grow and produce subcutaneous nodules along the lymphatic vessels.



66 Mycology Atlas

Sporotrichosis - Primary lesion on hand.



67 Mycology Atlas

Classic lymphocutaneous form of sporotrichosis. A linear chain of secondary subcutaneous nodules is seen along the course of lymphatic drainage from a primary skin lesion. The primary nodular-ulcerative lesion on the extensor surface of the hand.



250 Figure 23-24. B

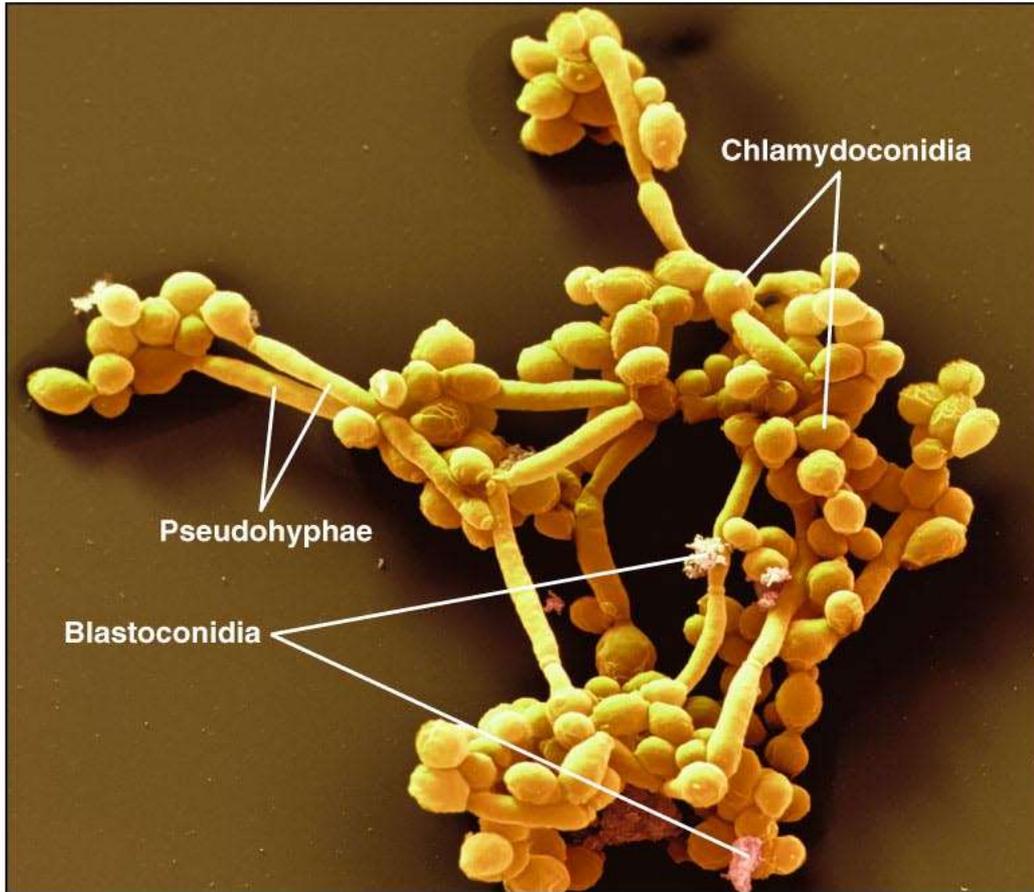
Yeast phase of *Sporothrix schenckii*, showing cigar-shaped yeast cells typical of the species.

IV. Microbial Diseases of the Skin

- D. Fungal Diseases of the Skin

- 3. Candidiasis – *Candida albicans*

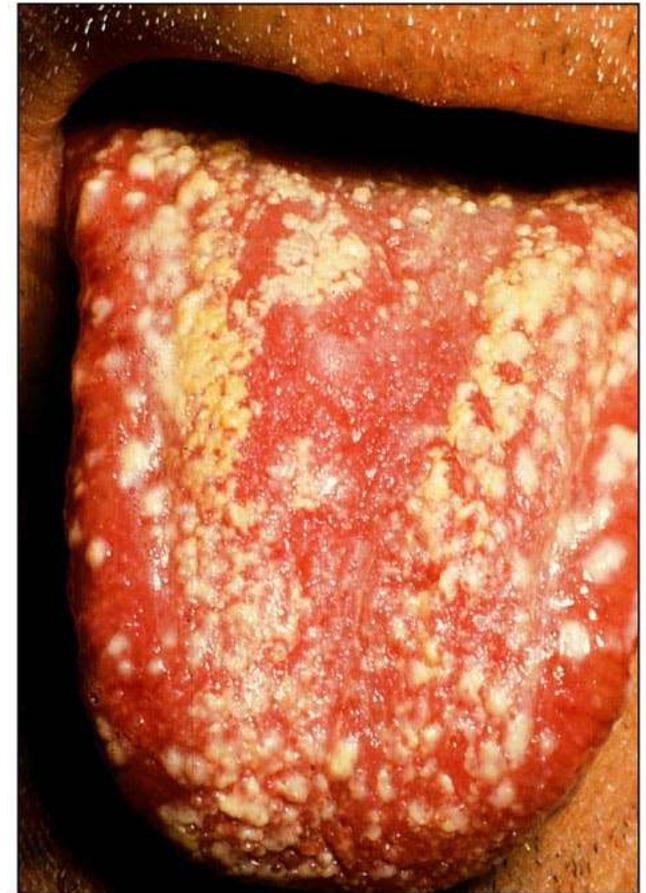
- a. *Candida albicans* causes infections of mucous membranes and is a common cause of thrush (in oral mucosa) and vaginitis.
 - b. *C. albicans* is an opportunistic pathogen that may proliferate when the normal bacterial microbiota are suppressed (e.g. antibiotics, pH, moisture, newborns, immunosuppression).
 - c. Topical antifungal chemicals may be used to treat candidiasis: Clotrimazole or Miconazole. Oral ketoconazole for systemic infections.



(a) *Candida albicans*

SEM

20 mm



(b) Oral candidiasis, or thrush

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Candidiasis



Fig. 124 - Microbiology of Infectious Diseases

Growth of *Candida albicans* on Sabourauds Agar.

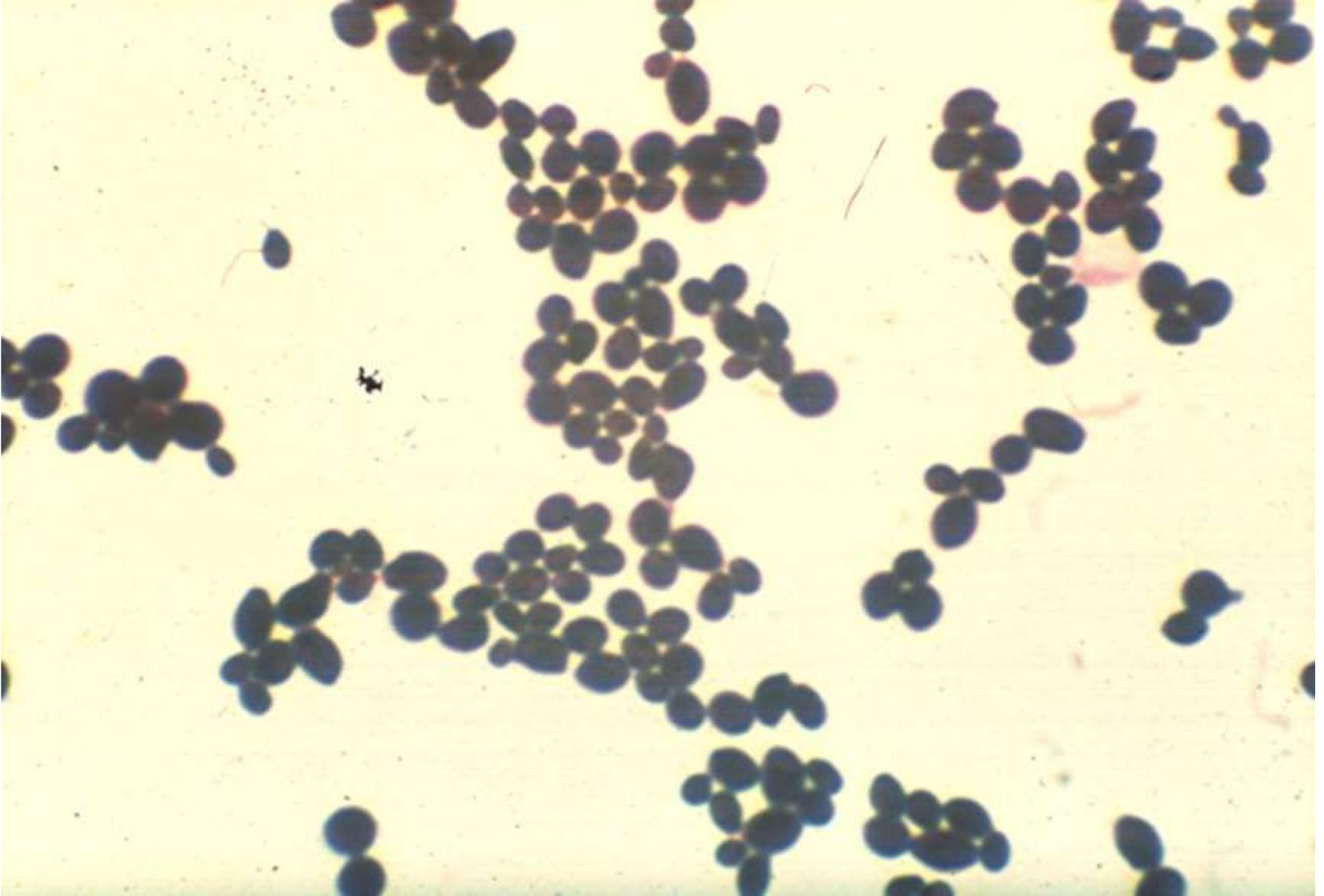
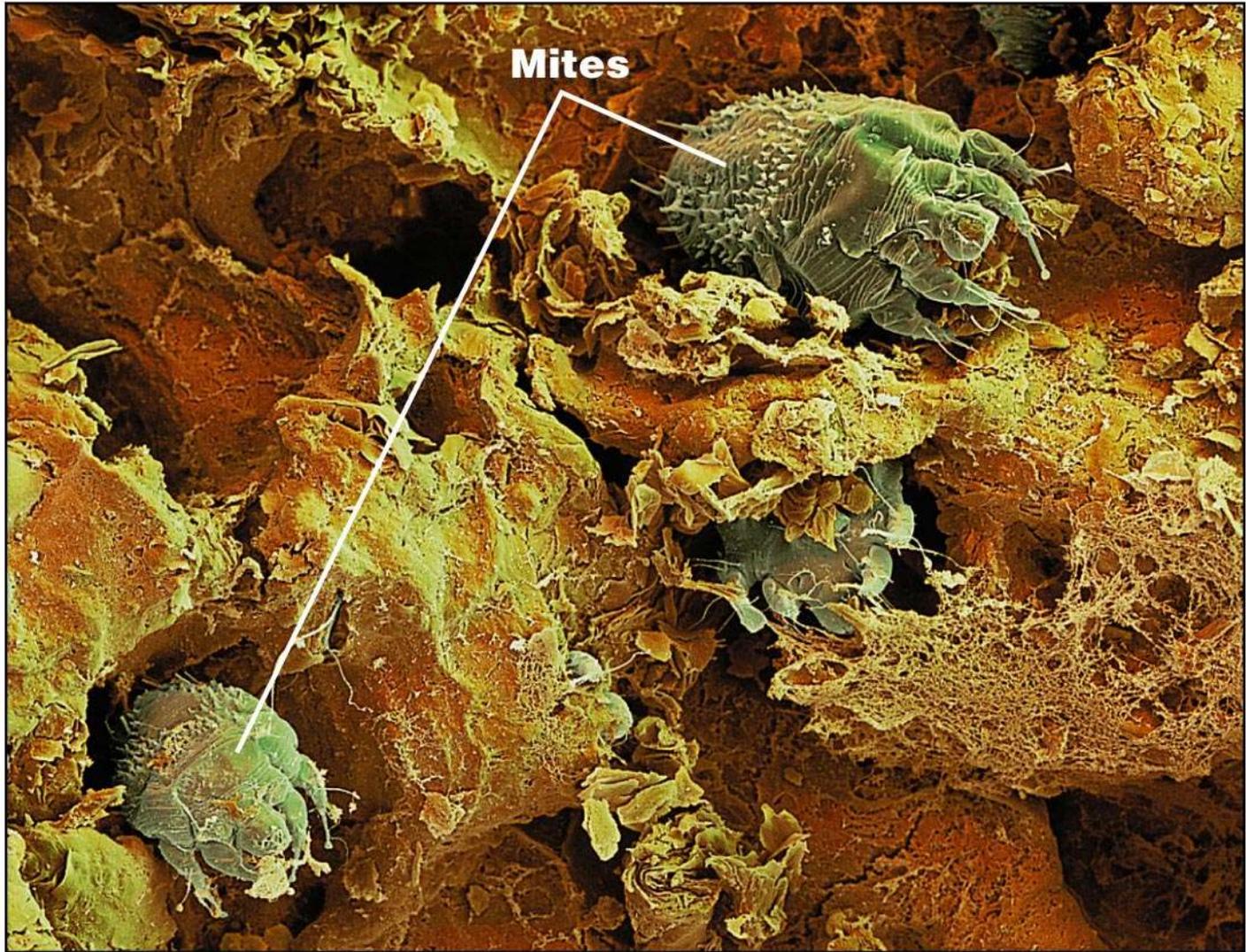


Fig. 126 - Microbiology of Infectious Diseases

Gram stained film of *Candida albicans* showing yeast cells of various sizes.

IV. Microbial Diseases of the Skin

- E. Parasitic Infestation of the Skin
 - 1. Scabies – *Sarcoptes scabiei*
 - a. Scabies is caused by a mite burrowing and laying eggs in the skin. Lives about 25 days, but eggs hatch within this time.
 - b. *Sarcoptes scabiei* causes intense itching. Passed by intimate contact.
 - c. Topical application of (insecticides) gamma benzene hexachloride (lindane) or permethrin is used to treat scabies.



SEM

1 mm

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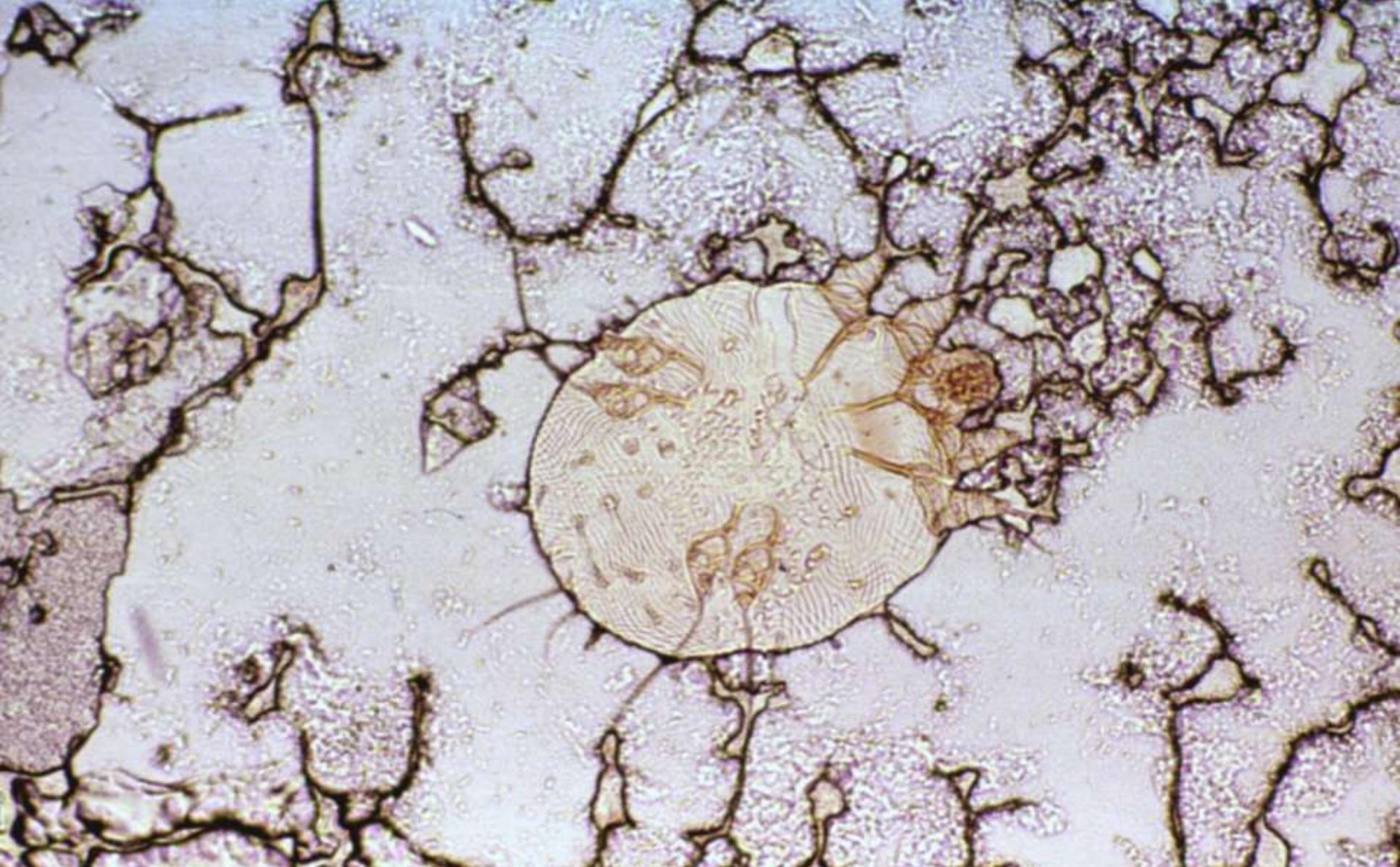
Scabies mites in skin

Figure 21.18



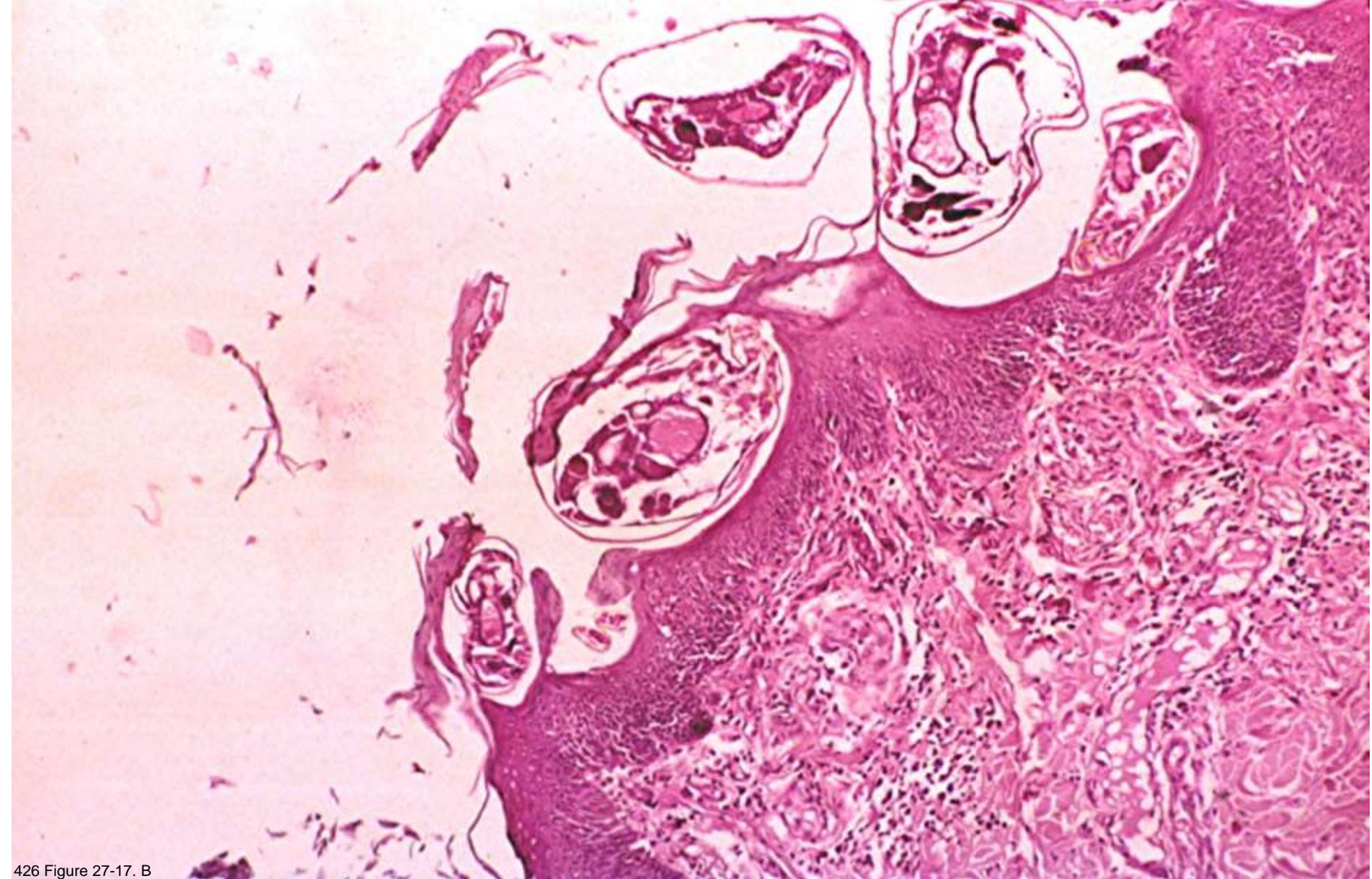
Fig. 76 - Scabies

The hands and wrists are common sites of infestation with *Sarcoptes scabiei*. The rash is often complicated by secondary infection, the effects of scratching and by allergic reactions. Although the rash is often most prominent on other body parts - not head and neck - mites can usually be found only on the hands and wrists, in the short linear burrows.



425 Figure 27-17. A

Sarcoptes scabiei adult showing short legs and conical spines.



426 Figure 27-17. B

Tissue cross-section of scabies lesion showing larvae burrowed into the epidermal layer of the skin.

IV. Microbial Diseases of the Skin

- E. Parasitic Infestation of the Skin
 - 2. Pediculosis: Lice infection caused by two subspecies: *Pediculus humanus capitis* (head) or *P. h. corporis* (body).
 - a. Outbreaks among school children is common, spread by close contact. Itching is the first sign of infection.
 - b. Life span is about a month with eggs (nits) laid every day and cemented to hairs. Adapted to grasp hair shafts.
 - c. Treatment can be topical, but resistance has emerged or removal by fine tooth comb.

(a) Adult louse grasping hair.



SEM 1 mm



(b) This egg case (nit) contains the nymphal stage of the louse, which is in the process of exiting through the cap (operculum). It does this by gulping air and forcing it out the anus until it pops free, much like a champagne cork.

SEM 0.2 mm



P. h. capitis



Pediculus humanis adult louse

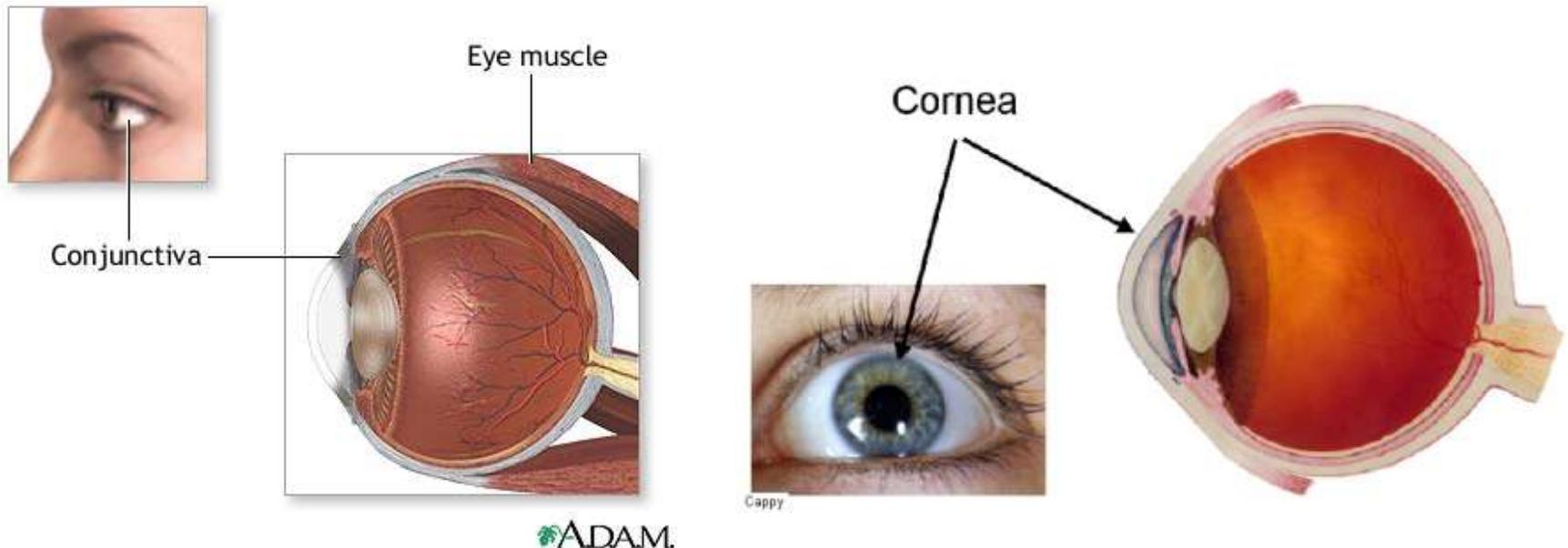
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a) Louse and b) louse egg case

Figure 21.19 - Overview

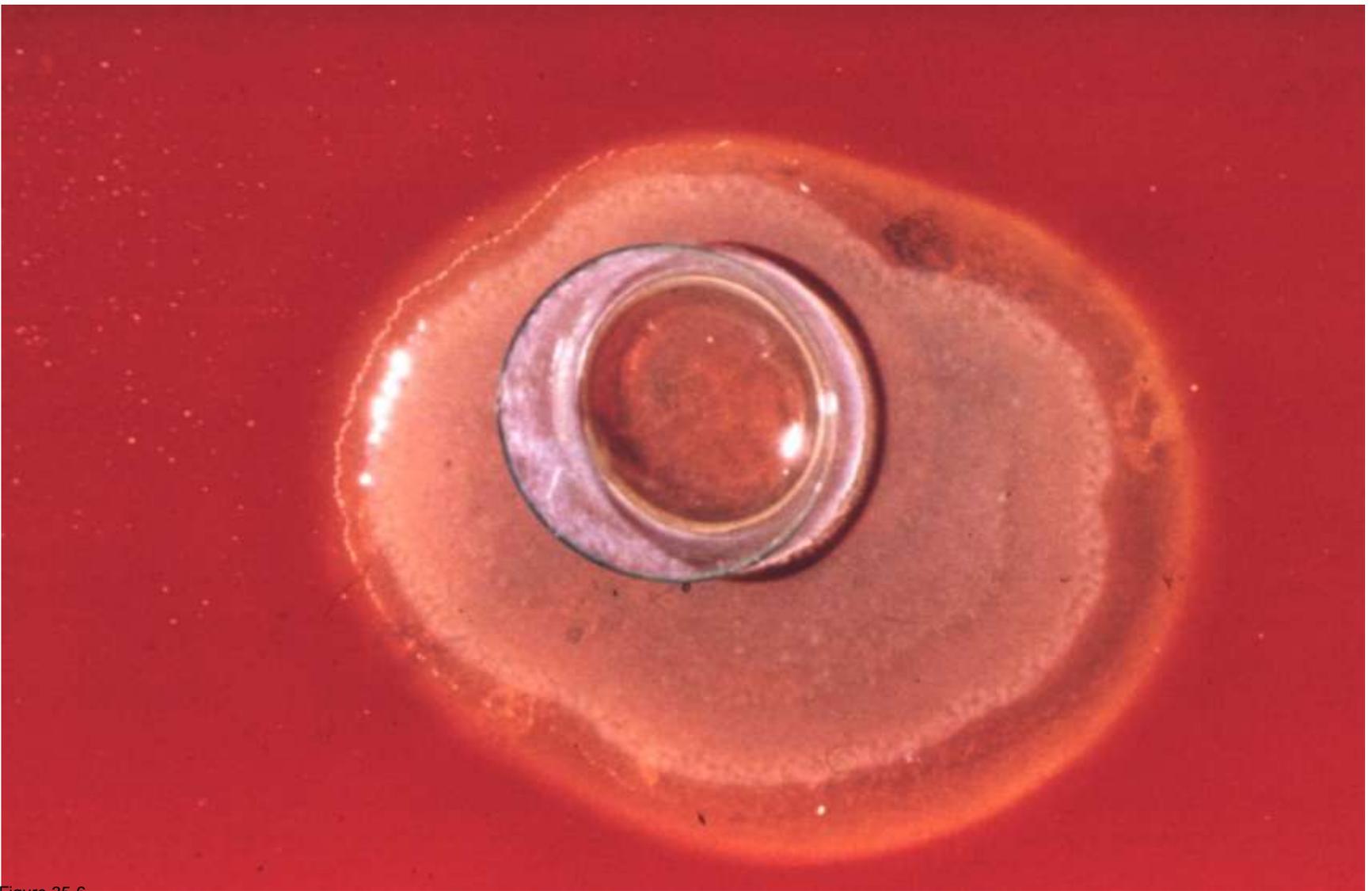
V. Microbial Diseases of the Eye

- A. Eye Anatomy commonly involved with infection
 - 1. Conjunctiva
 - The mucous membrane lining the eyelid and covering the eyeball is the
 - 2. Cornea
 - The transparent, fibrous outer layer of the anterior outer layer of the eye



V. Microbial Diseases of the Eye

- B. Infections of the Eye
 - 1. Bacterial infections of the eye usually originate from the skin and upper respiratory tract microbial flora.
 - 2. Conjunctivitis (membrane lining the eye and covering the eyeball) is caused by several bacteria, viruses, or Chlamydia.
 - It can be transmitted by improperly disinfected contact lenses.



489 Figure 35-6

Growth of *Pseudomonas aeruginosa* from daily-wear (soft) contact lens. Patient had an ulcerative keratitis. The corneal culture also grew *P. aeruginosa*.

V. Microbial Diseases of the Eye

- C. *Neisseria gonorrhoeae*
 - 1. Neonatal gonorrhoeal ophthalmia is caused by the transmission of *Neisseria gonorrhoeae* from an infected mother to an infant during its passage through the birth canal.
 - 2. At an earlier time, all newborn infants were treated with 1% silver nitrate to prevent the growth of *Neisseria*. Now replaced by an antibiotic that also prevents *Chlamydia* infection.

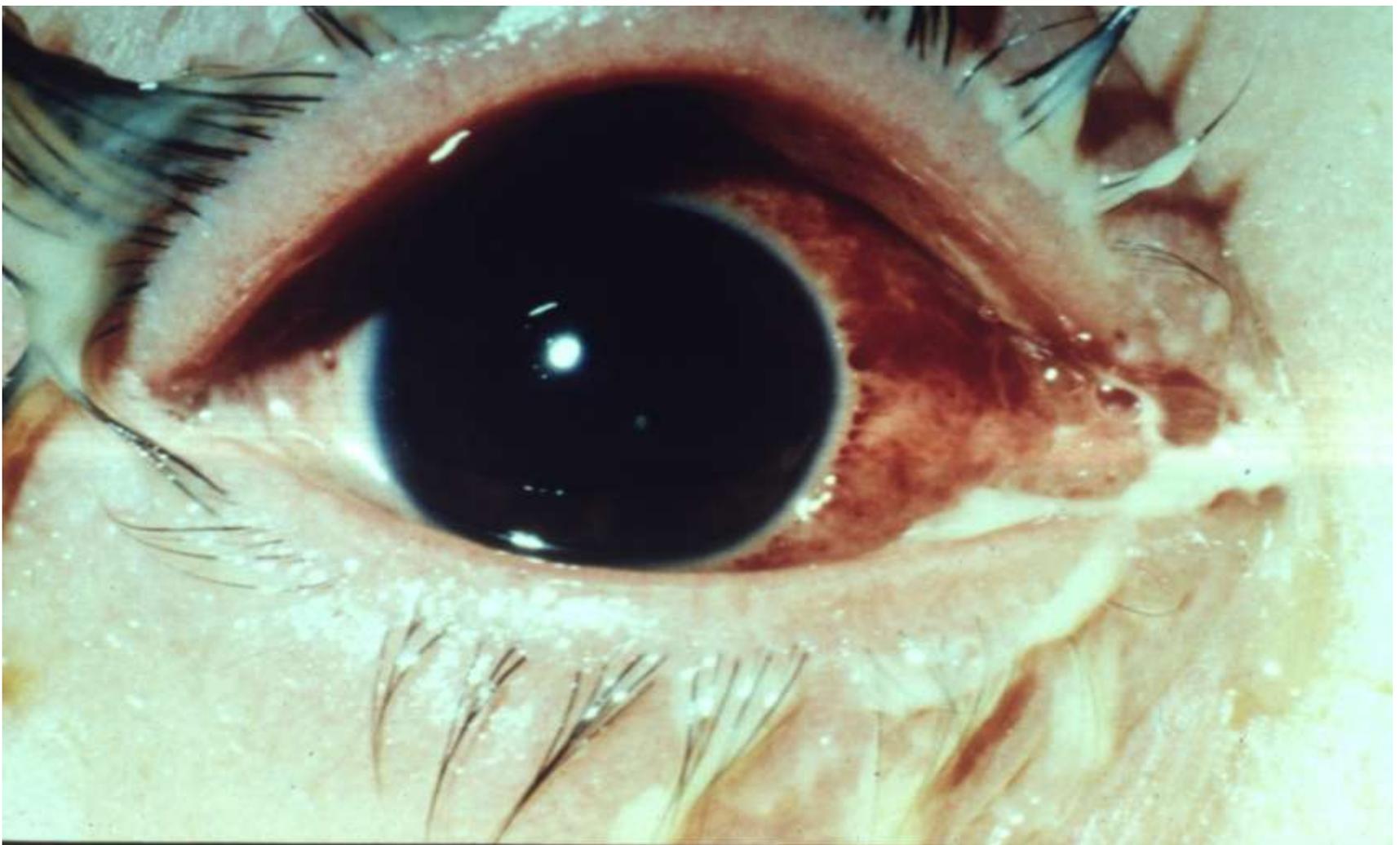


Fig. 114 - Infectious Diseases

Purulent conjunctivitis. In bacterial conjunctivitis, a purulent discharge is typically present, as in this patient. The bacteria most commonly involved are *Streptococcus pneumoniae*, *Staphylococcus aureus*, *Haemophilus influenzae*, *Moraxella lacunata* (pink-eye) and *Neisseria gonorrhoea*.

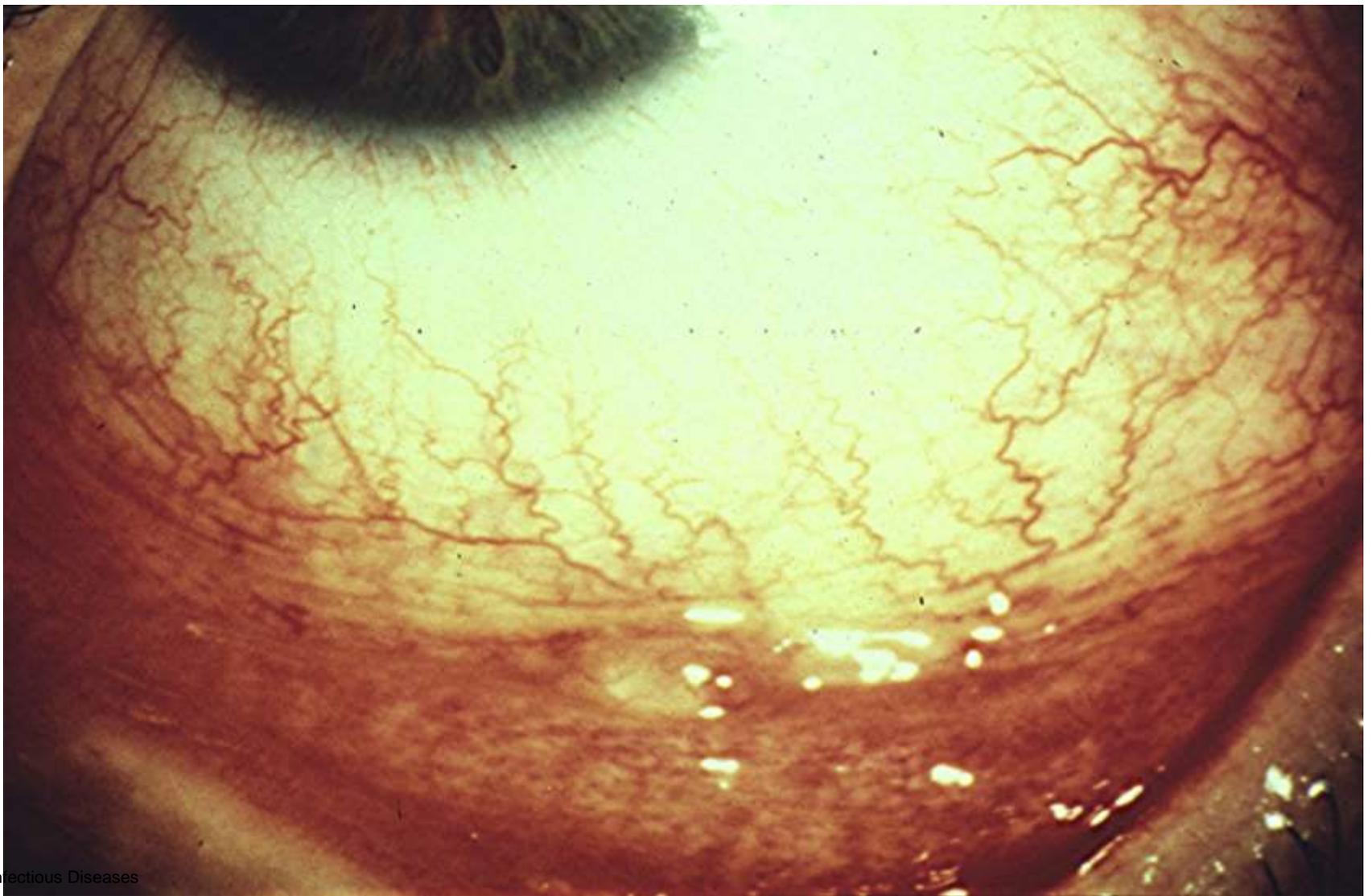


Fig 113 - Infectious Diseases

Acute infection of the conjunctiva may be caused by viruses, bacteria, or Chlamydia. All forms of conjunctivitis are accompanied by itching, excessive lacrimation and more or less severe conjunctival infection. Typically the degree of hyperaemia diminishes in severity towards the cornea; in iritis the hyperaemia is greatest at the limbus (border).

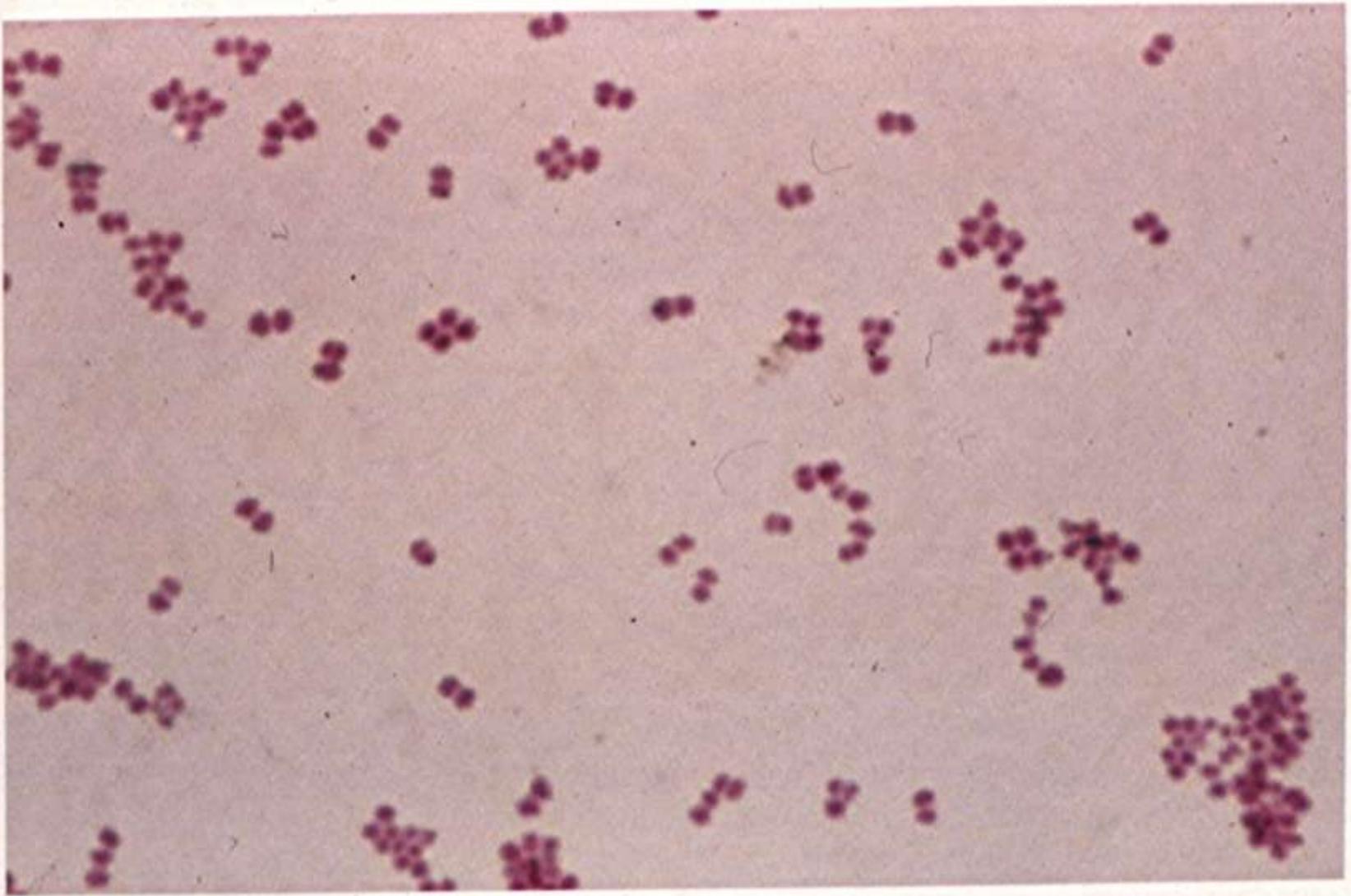


Figure 3-13. *Neisseria gonorrhoeae* is a diplococcus that causes gonorrhoea in humans. Members of this genus produce diplococci with adjacent sides flattened (X2640).

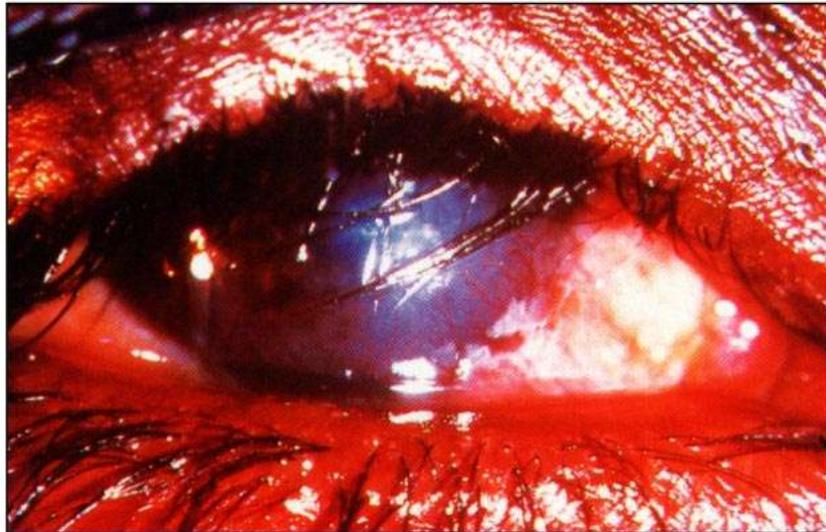
V. Microbial Diseases of the Eye

- D. Trachoma
 - 1. Inclusion conjunctivitis is an infection of the conjunctiva caused by *Chlamydia trachomatis*. It is transmitted to infants during birth, may be transmitted in unchlorinated swimming water.
 - 2. In trachoma, which is caused by *C. trachomatis*, scar tissue forms on the cornea due to abrasion by the eyelashes.
 - 3. Trachoma is transmitted by hands, fomites, and perhaps flies.
 - 4. Greatest single cause of blindness in the world. 500 million cases with 7 million blinded.
 - 5. Treatment used is ophthalmic tetracycline or azithromycin (an erythromycin derivative) orally, sanitary practices and education.

Trachoma



(a) Chronic inflammation of the eyelid



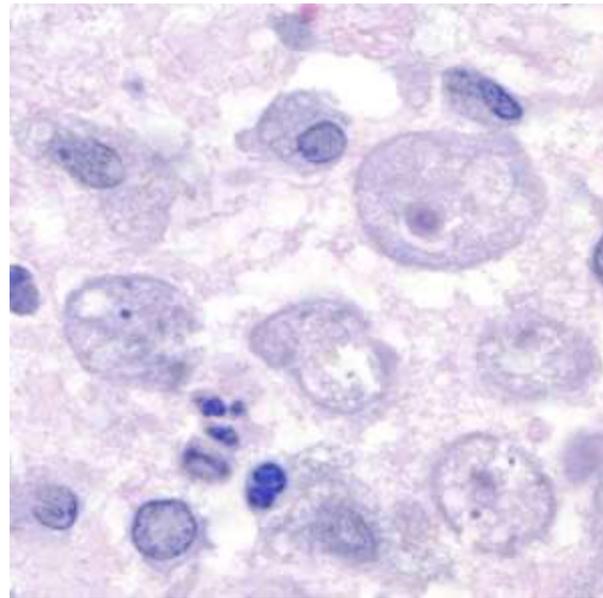
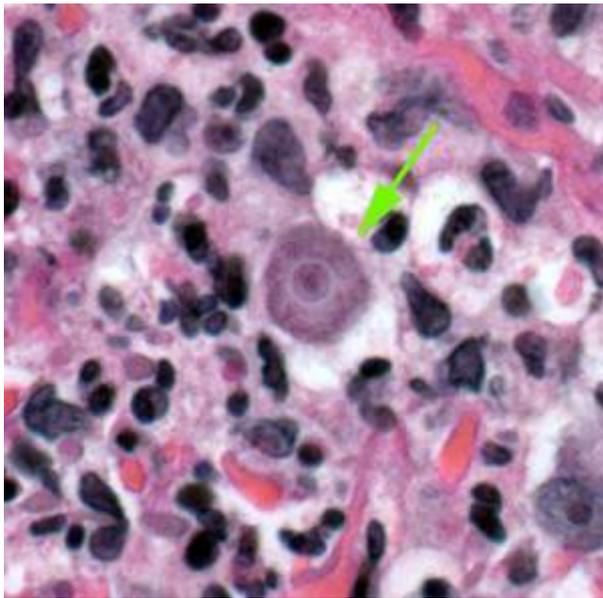
(b) Trichiasis, inturned eyelids, abrading the cornea

V. Microbial Diseases of the Eye

- E. Herpetic keratitis
 - 1. Inflammation of the cornea is called keratitis.
 - 2. Herpetic keratitis causes corneal ulcers. The etiology is HSV-1 that also causes cold sores. Common cause of blindness in US.
 - 3. Trifluridine is an effective treatment of herpes keratitis.
- F. *Acanthamoeba*, an amoeba, transmitted via water, can cause a serious form of keratitis.
 - Many cases are associated with wearing contact lenses
 - Especially with unsanitary practices, wearing too long, and use while swimming.



Early inflammation due to *Acanthamoeba* keratitis.
(CDC: Photo courtesy of Dan B. Jones, M.D.)



Left: Trophozoite of *Acanthamoeba* sp. in tissue, stained with H&E.
Right: Trophozoites of *Acanthamoeba* sp. in a corneal scraping, stained with H&E.