

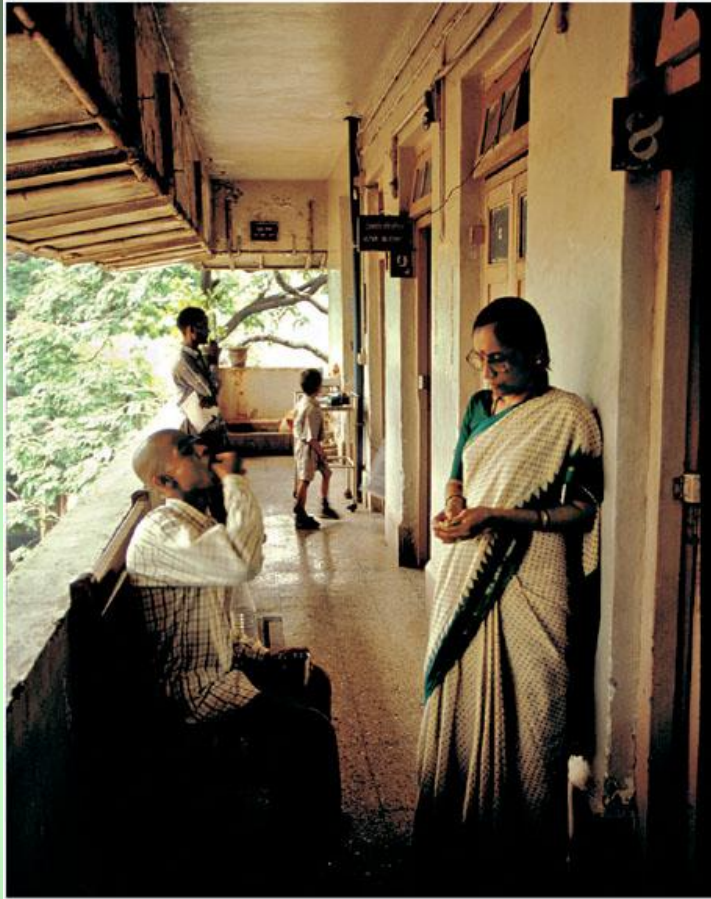
Foundations in Microbiology

Fifth Edition

Talaro

Chapter

19

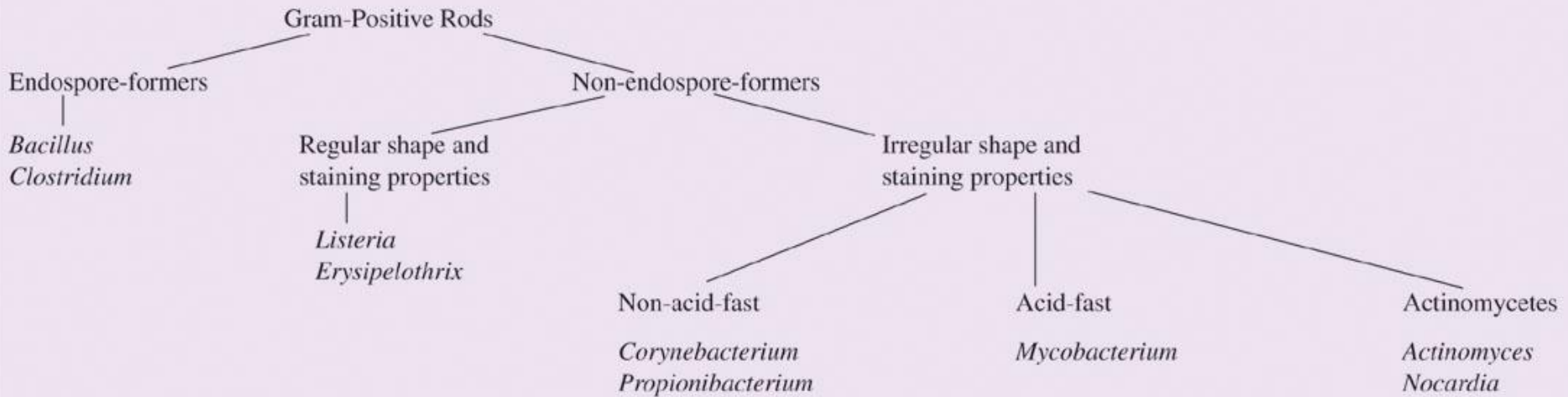


The Gram-Positive Bacilli of Medical Importance

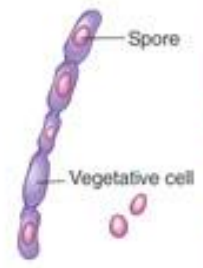
Chapter 19

TABLE 19.1

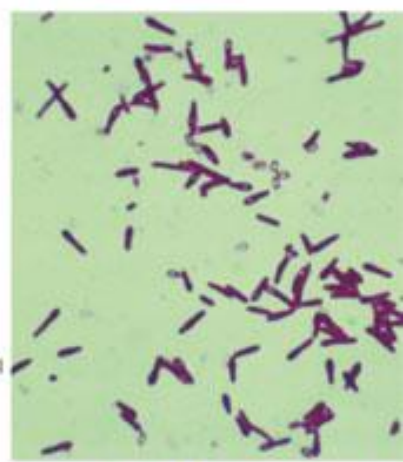
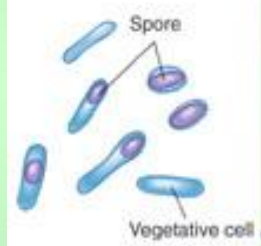
Gram-Positive Bacilli



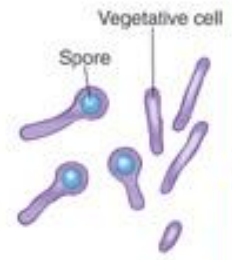
(a)



(b)



(c)

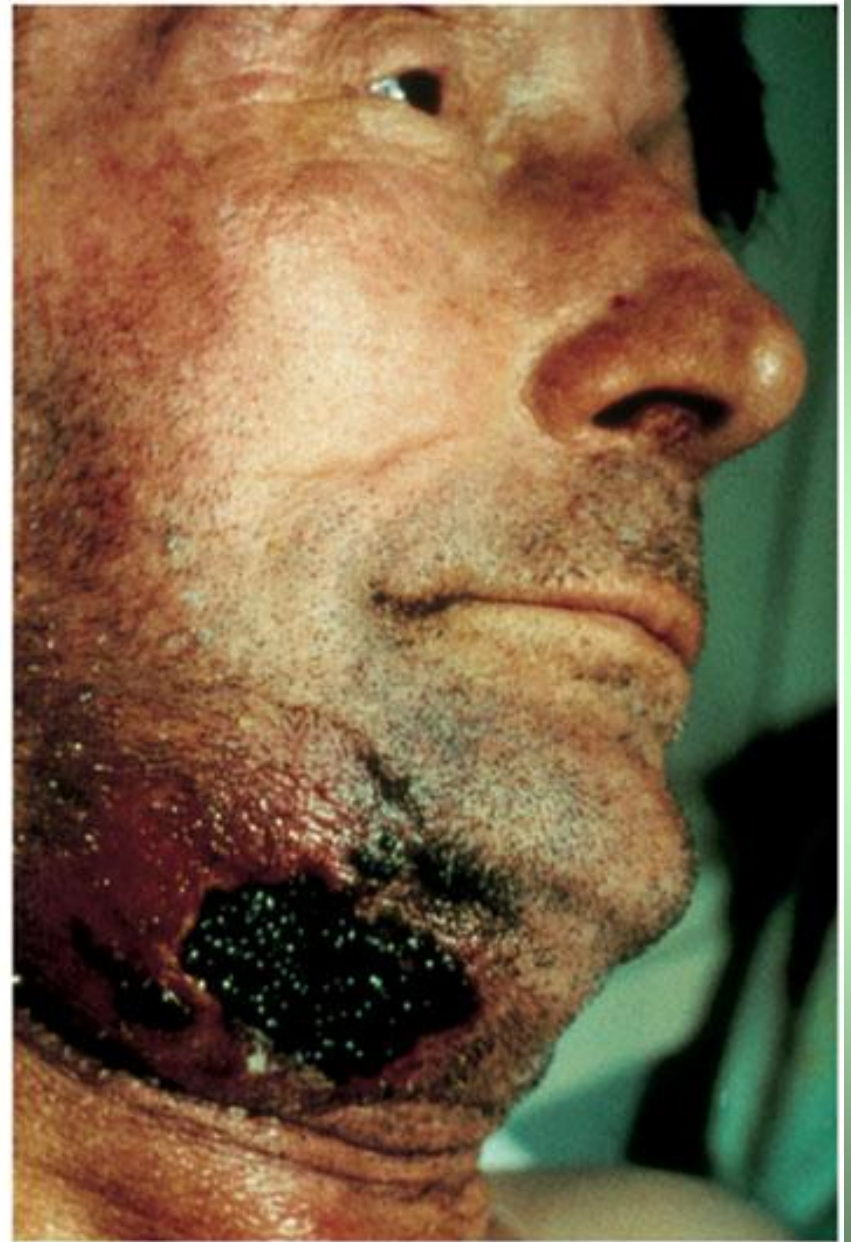


Bacillus

- gram-positive, endospore-forming, motile rods
- mostly saprobic
- aerobic & catalase positive
- versatile in degrading complex macromolecules
- source of antibiotics
- primary habitat is soil
- 2 species of medical importance
 - *Bacillus anthracis*
 - *Bacillus cereus*

Bacillus anthracis

- large, block shaped rods
- central spores that develop under all conditions except in the living body
- virulence factors – capsule & exotoxins
- 3 types of anthrax
 - **Cutaneous – spores enter through skin, black sore-eschar; least dangerous**
 - **Pulmonary –inhalation of spores**
 - **Gastrointestinal – ingested spores**
- treated with penicillin or tetracycline
- vaccine – toxoid 6X over 1.5 years; annual boosters



(a)

(b)

Bacillus cereus

- common airborne & dustborne
- grows in foods, spores survive cooking & reheating
- ingestion of toxin-containing food causes nausea, vomiting, abdominal cramps & diarrhea; 24 hour duration
- no treatment
- spores abundant in the environment



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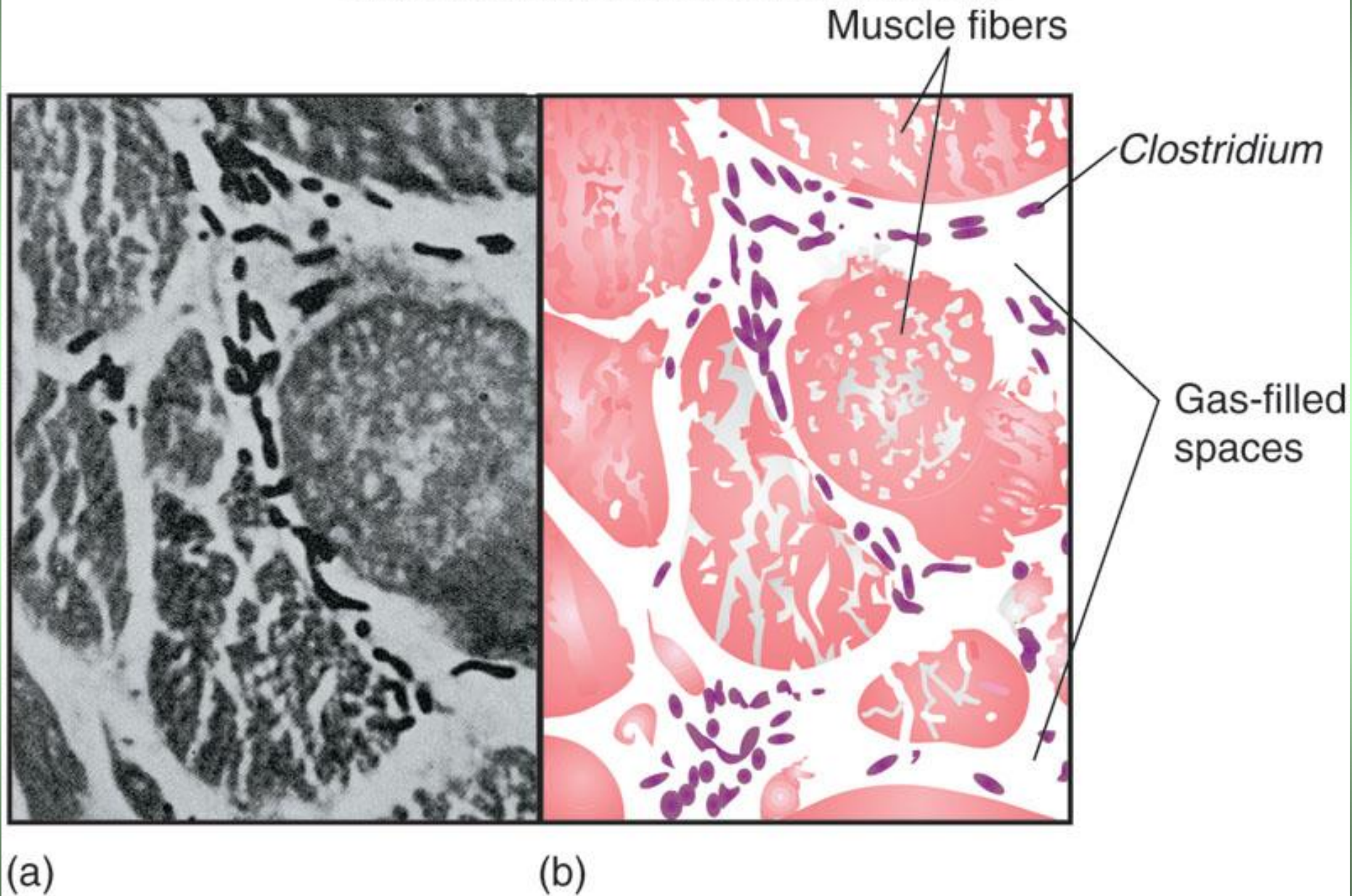
"Gross! This isn't anthrax, it's an envelope full of dandruff."

Clostridium

- gram-positive, spore-forming rods
- **anaerobic** & catalase negative
- 120 species
- oval or spherical spores produced only under anaerobic conditions
- synthesize organic acids & alcohols & exotoxins
- cause wound & tissue infections & food intoxications

Clostridium perfringens

- causes gas gangrene in damaged or dead tissues
- 2nd most common cause of food poisoning, worldwide
- virulence factors
 - toxins – alpha toxin – causes RBC rupture, edema & tissue destruction
 - collagenase
 - hyaluronidase
 - DNase





Clostridium perfringens

- treatment of gangrene – debridement of diseased tissue
 - large doses of cephalosporin or penicillin
 - hyperbaric oxygen

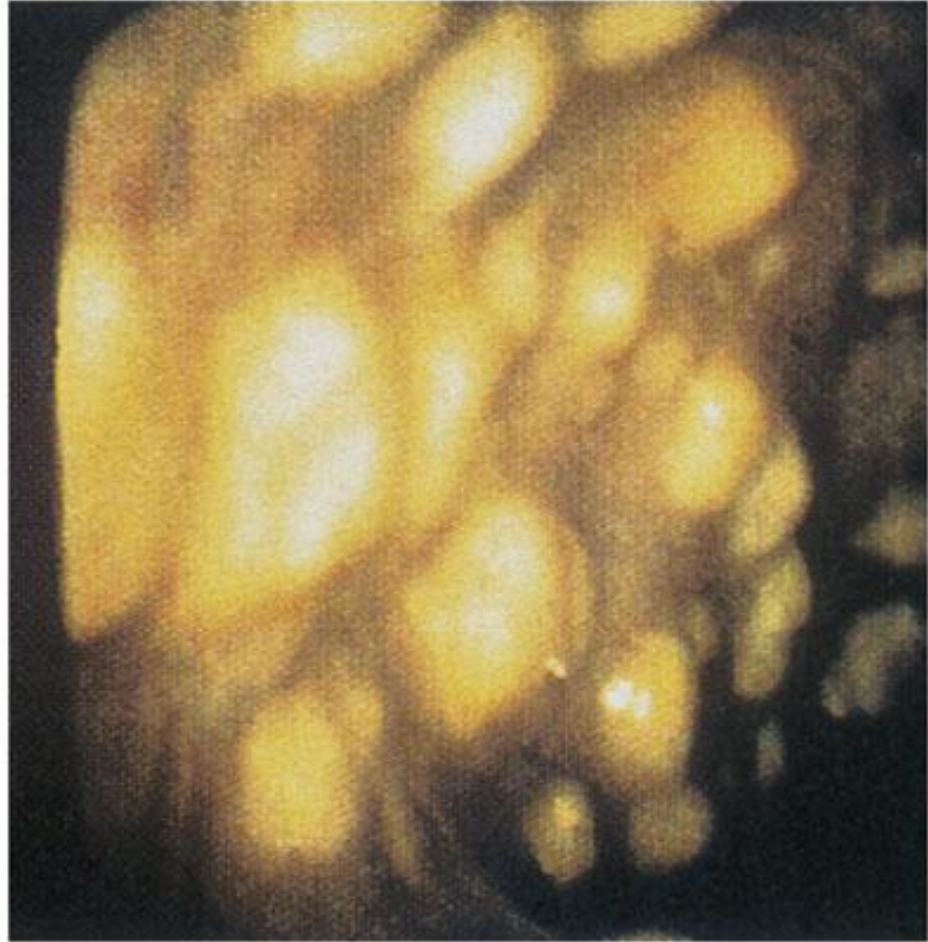


Clostridium difficile

- normal resident of colon, in low numbers
- causes antibiotic-associated colitis
 - treatment with broad-spectrum antibiotics kills the other bacteria, allowing *C. difficile* to overgrow
- produces enterotoxins that damage intestine
- major cause of diarrhea in hospitals



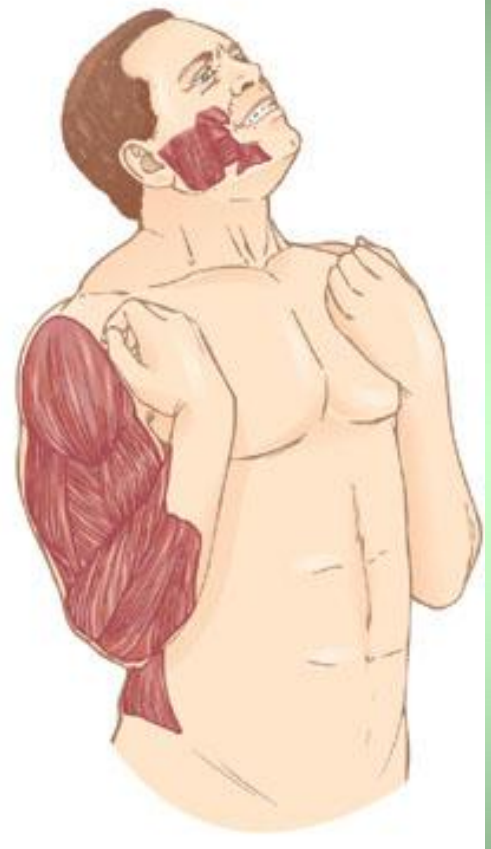
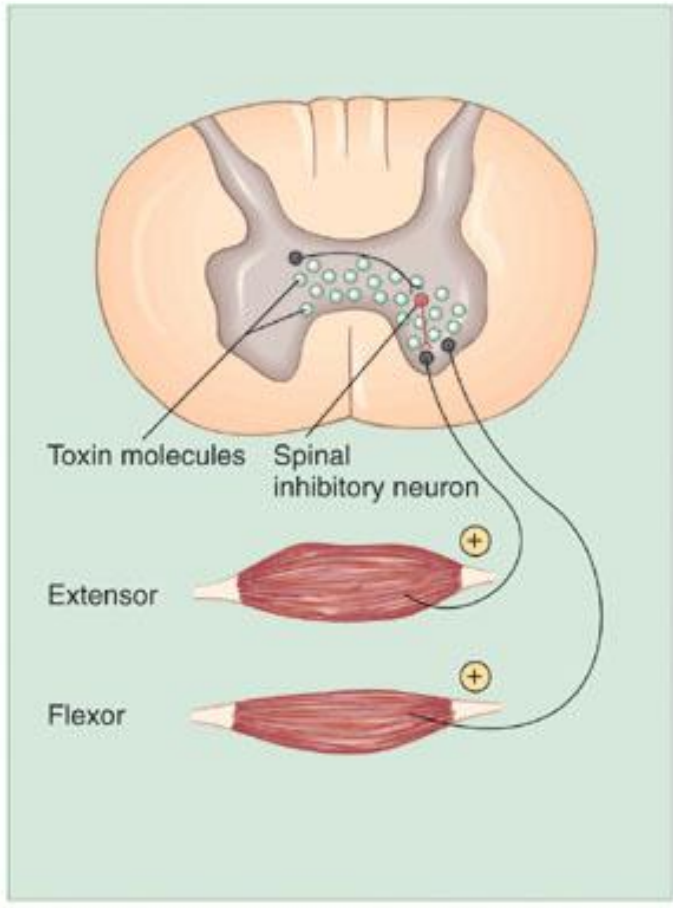
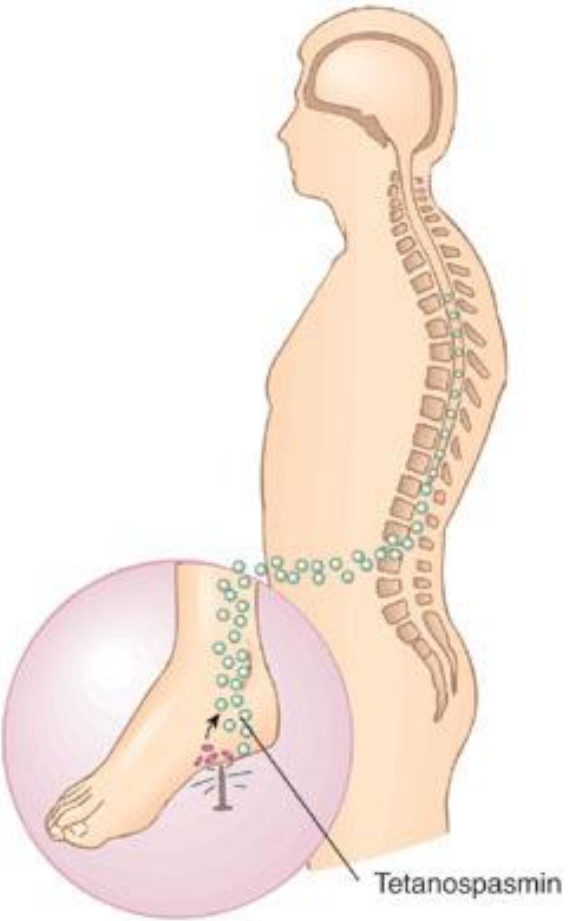
(a)



(b)

Clostridium tetani

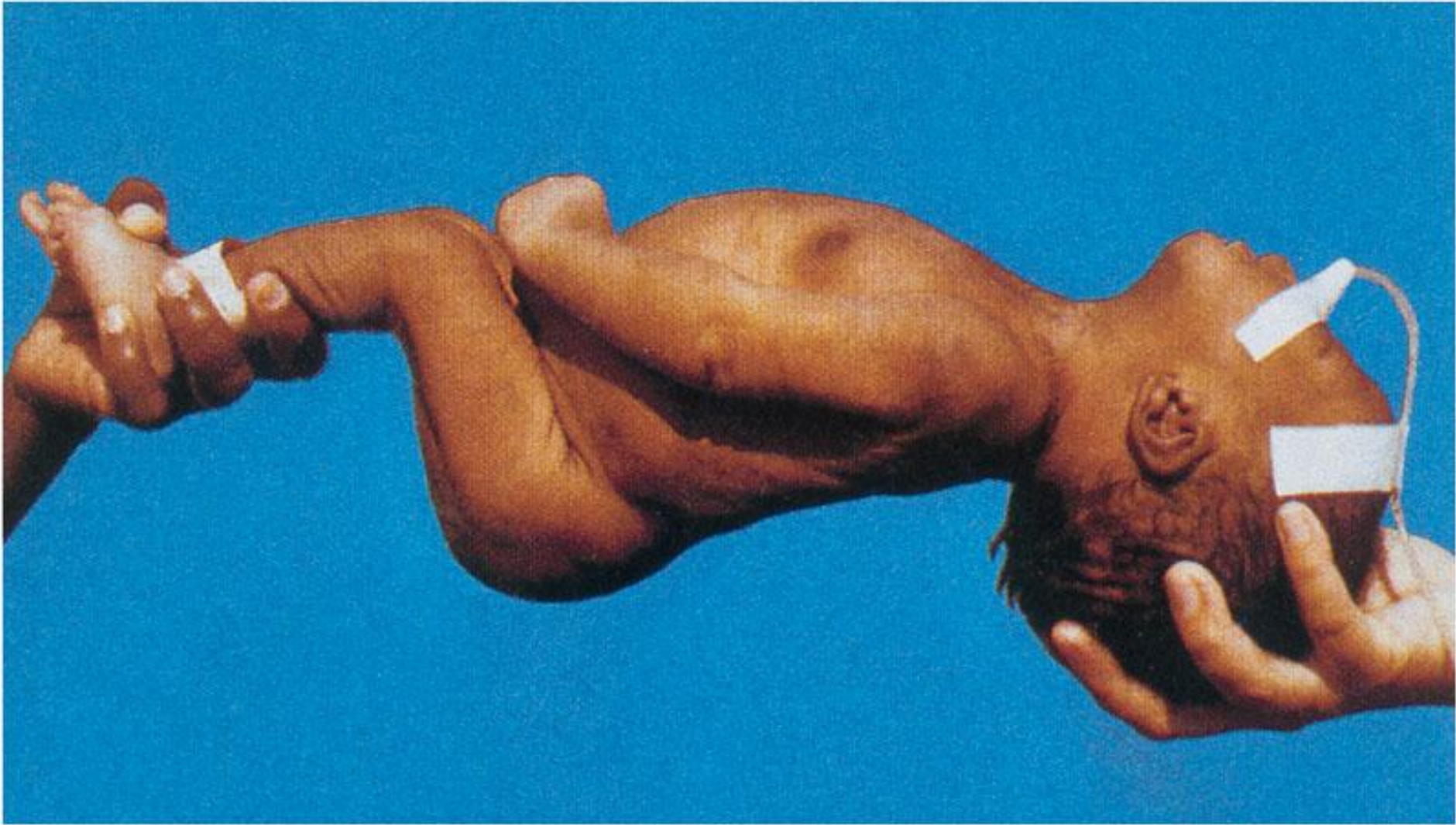
- common resident of soil & GI tracts of animals
- causes tetanus or lockjaw, a neuromuscular disease
- spores usually enter through accidental puncture wounds, burns, umbilical stumps, frostbite, & crushed body parts
- tetanospasmin – neurotoxin causes paralysis
- vaccine booster needed every 10 years



(a)

(b)

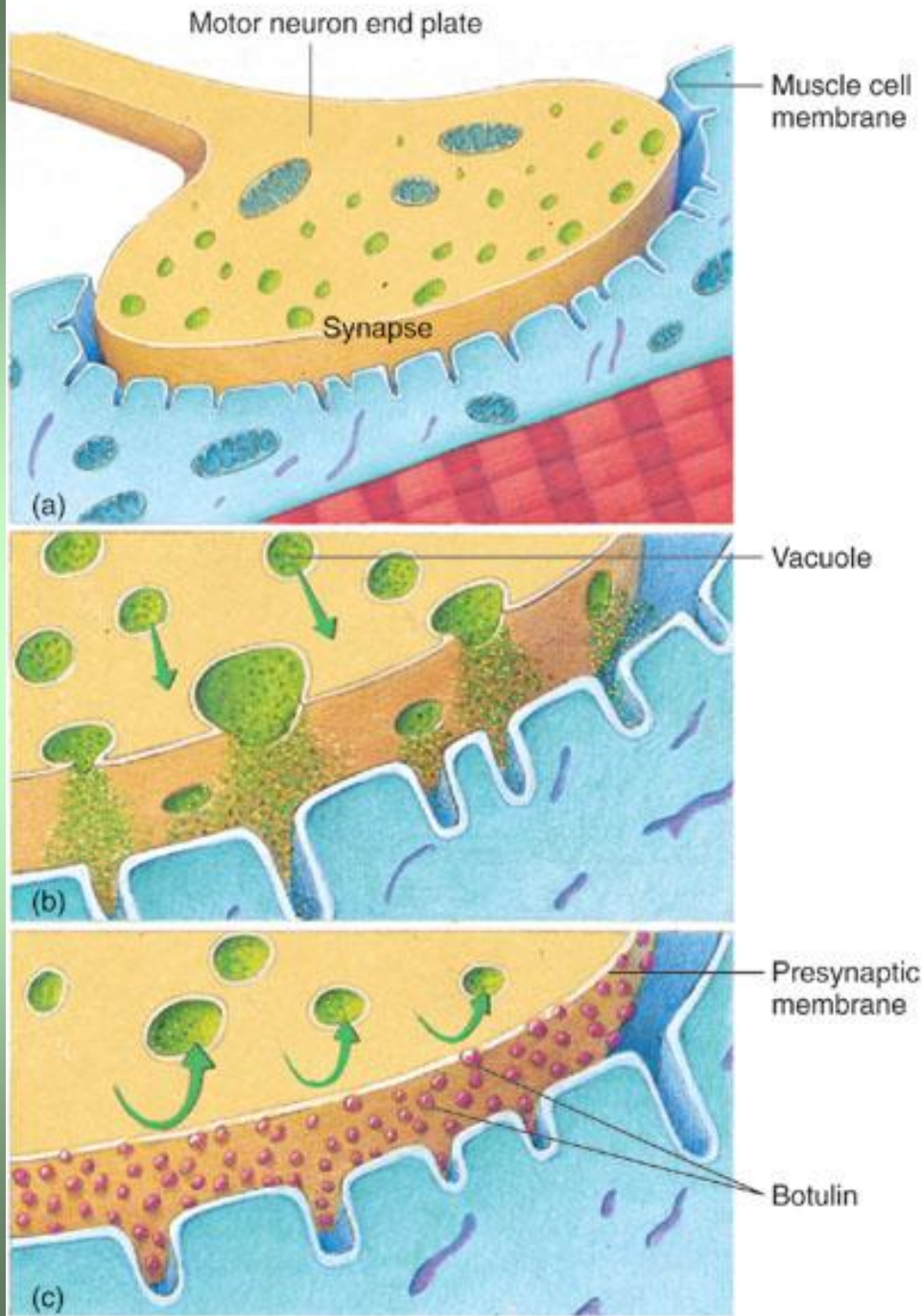
(c)



Clostridium botulinum

Causes 3 diseases

1. **food poisoning** -spores are in soil, may contaminate vegetables; improper canning does not kill spores & they germinate in the can producing botulinum toxin
 - toxin causes paralysis by preventing release of acetylcholine
2. infant botulism – caused by ingested spores that germinate & release toxin
3. wound botulism – spores enter wound & cause food poisoning symptoms







Hi Spore, do you believe in life after sterilization?"

SPORE

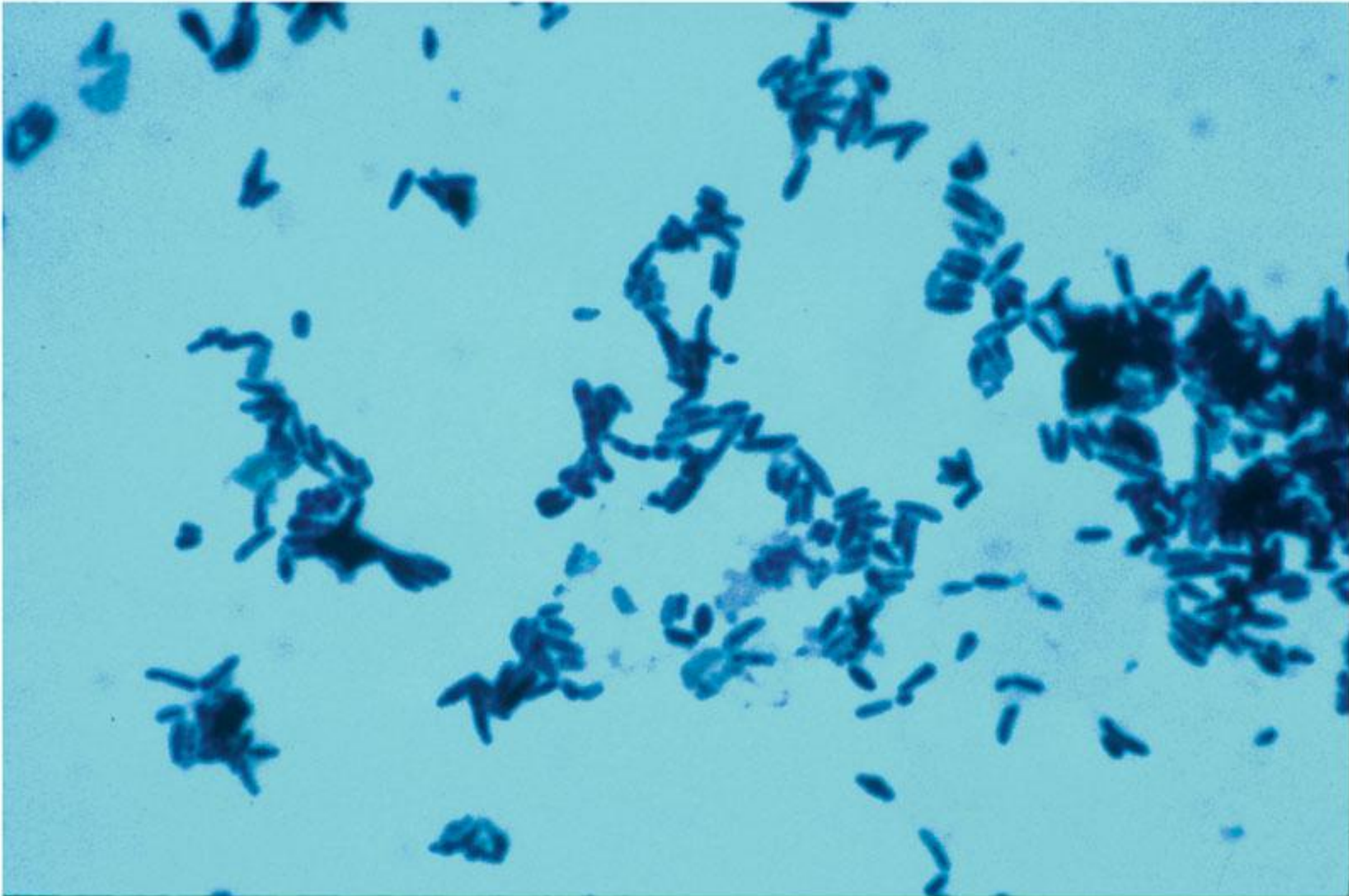
Josy Holdener

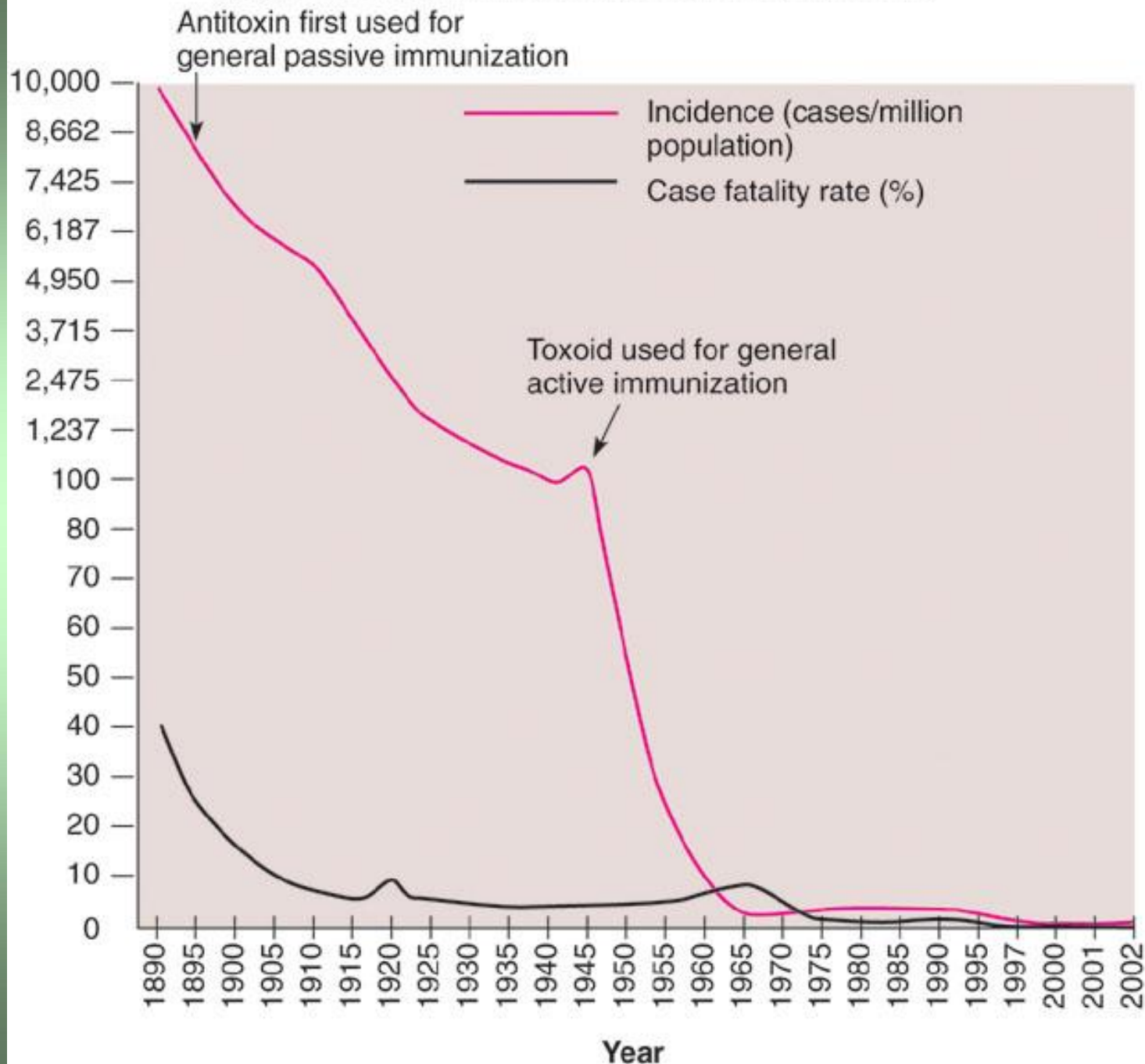
Listeria monocytogenes

- non-spore-forming gram-positive
- ranging from coccobacilli to long filaments
- 1-4 flagella
- no capsules
- resistant to cold, heat, salt, pH extremes & bile
- primary reservoir is soil & water
- can contaminate foods & grow during refrigeration
- Listeriosis in immunocompromised patients, fetuses & neonates affects brain & meninges
 - 20% death rate
- ampicillin & trimethoprim-sulfamethoxazole
- Prevention – pasteurization & cooking

Corynebacterium diphtheriae

- gram-positive irregular bacilli
- produce catalase
- possess mycolic acids & a unique type of peptidoglycan
- 2 stages of disease
 - local infection –upper respiratory tract
 - diphtherotoxin production & toxemia
- pseudomembrane formation can cause asphyxiation







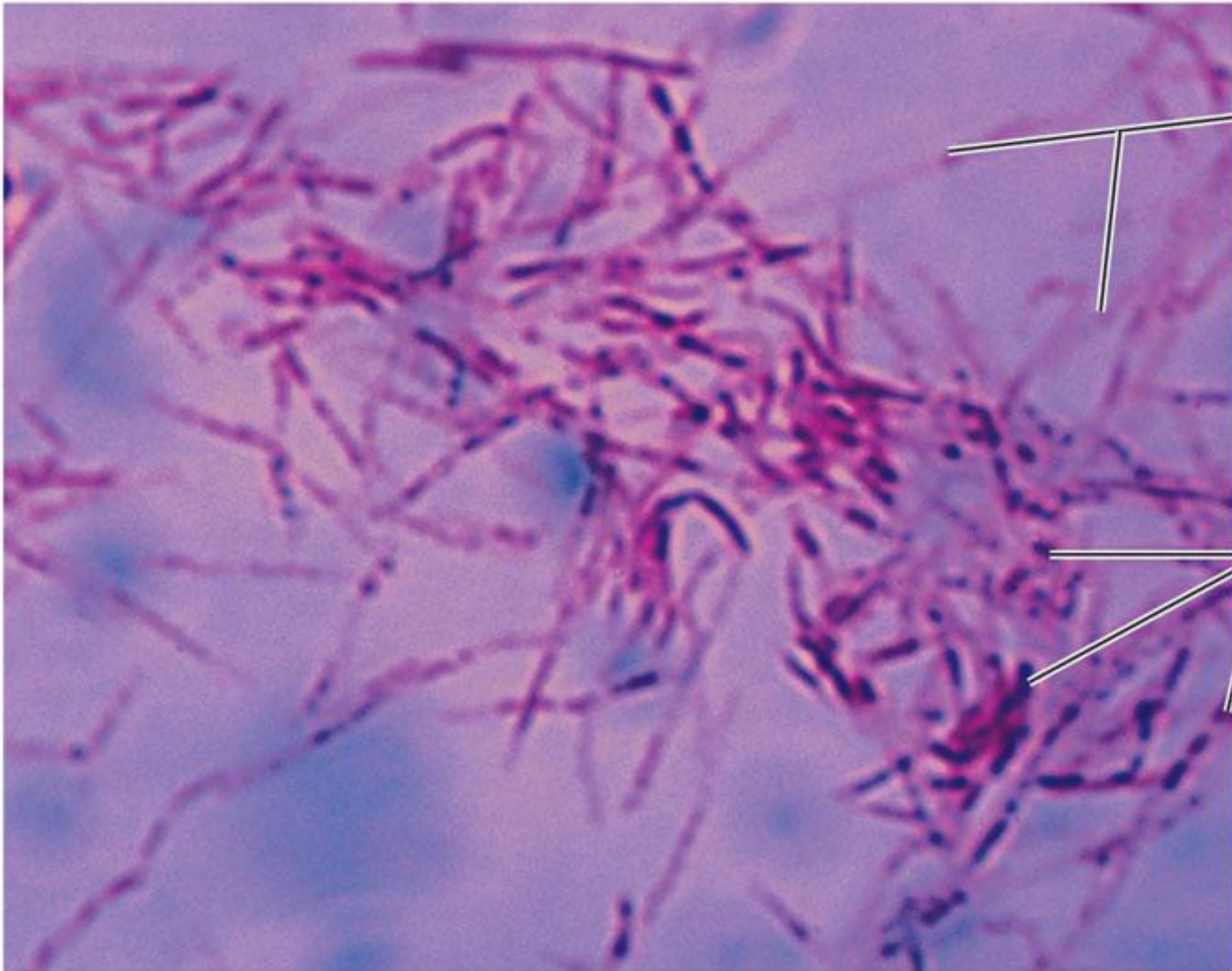
Propionibacterium acnes

- gram-positive rods
- aerotolerant or anaerobic
- nontoxigenic
- common resident of sebaceous glands
- causes acne

Mycobacteria

- gram-positive irregular bacilli
- acid-fast staining
- strict aerobes
- produce catalase
- possess mycolic acids & a unique type of peptidoglycan
- do not form capsules, flagella or spores
- grow slowly

- *Mycobacterium tuberculosis*
- *Mycobacterium leprae*



Filaments

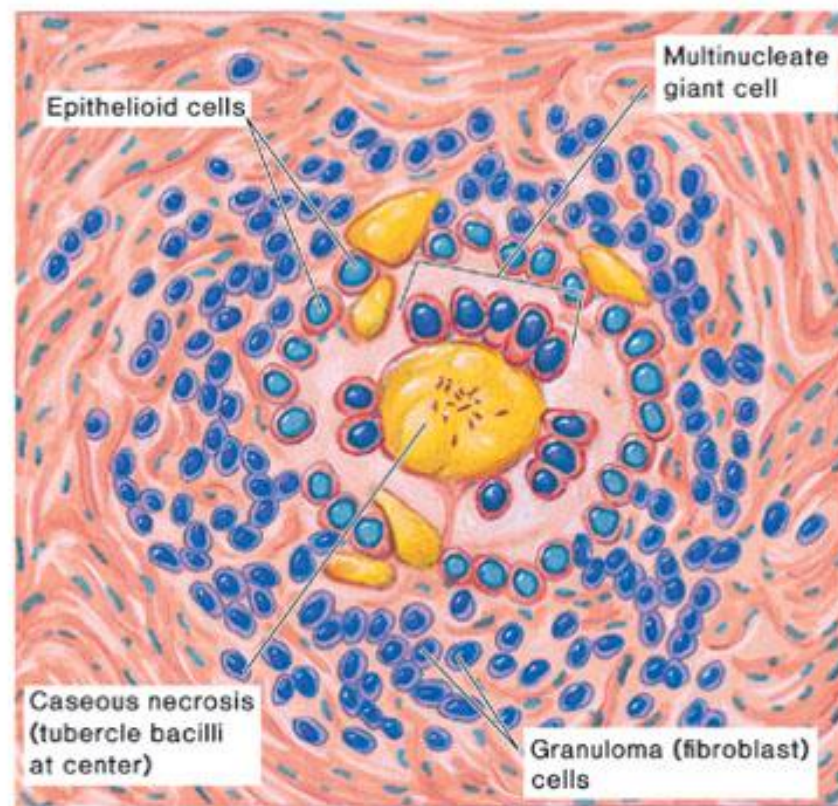
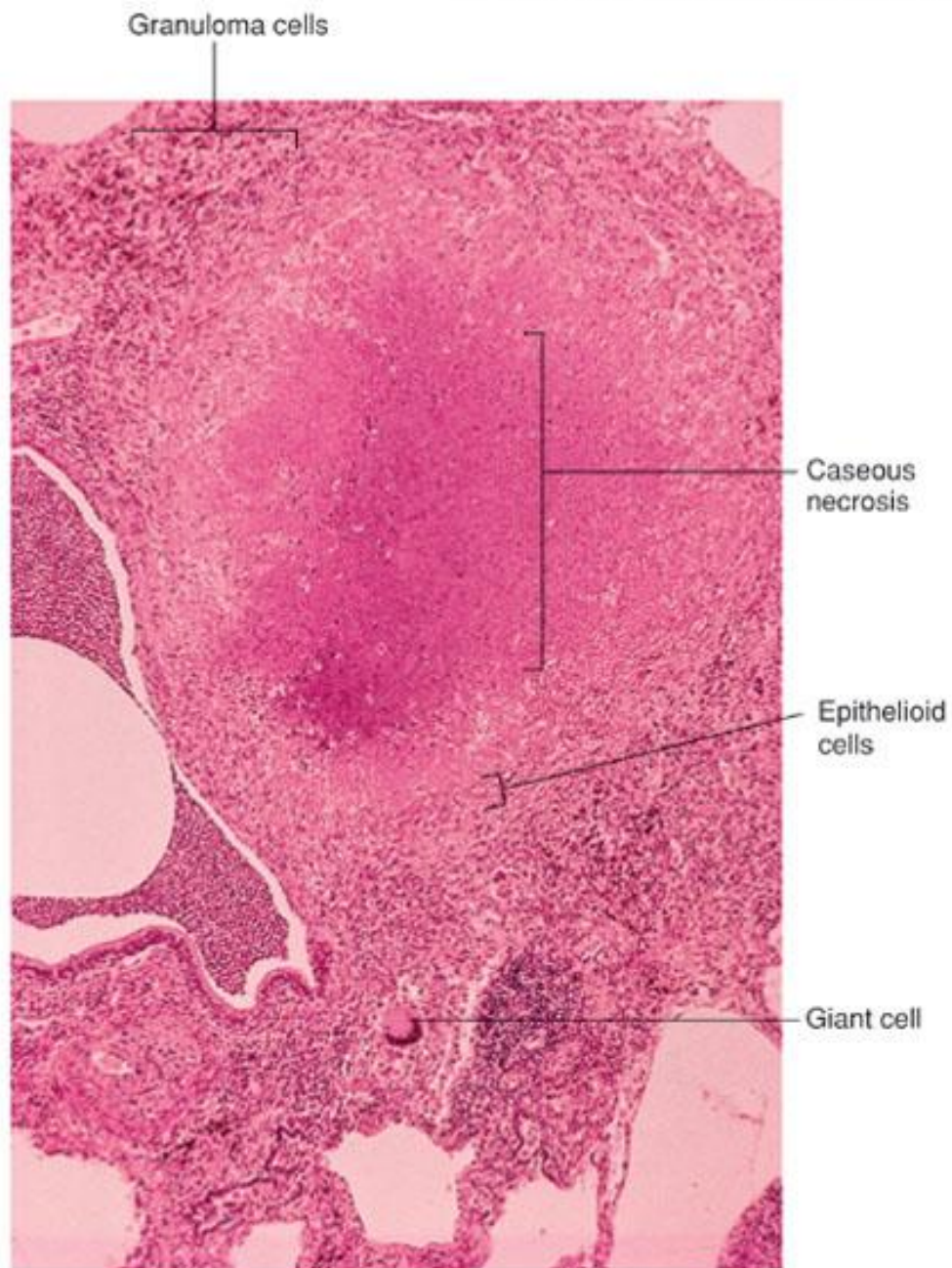
Granules

Mycobacterium tuberculosis

- produces no exotoxins or enzymes that contribute to infectiousness
- contain complex waxes & cord factor that prevent destruction by lysosomes of macrophages
- transmitted by airborne respiratory droplets
- only 5% infected people develop clinical disease

Primary TB

- infectious dose 10 cells
- phagocytosed by alveolar macrophages & multiply intracellularly
- after 3-4 weeks immune system attacks, forming tubercles, granulomas consisting of a central core containing bacilli surrounded by WBCs

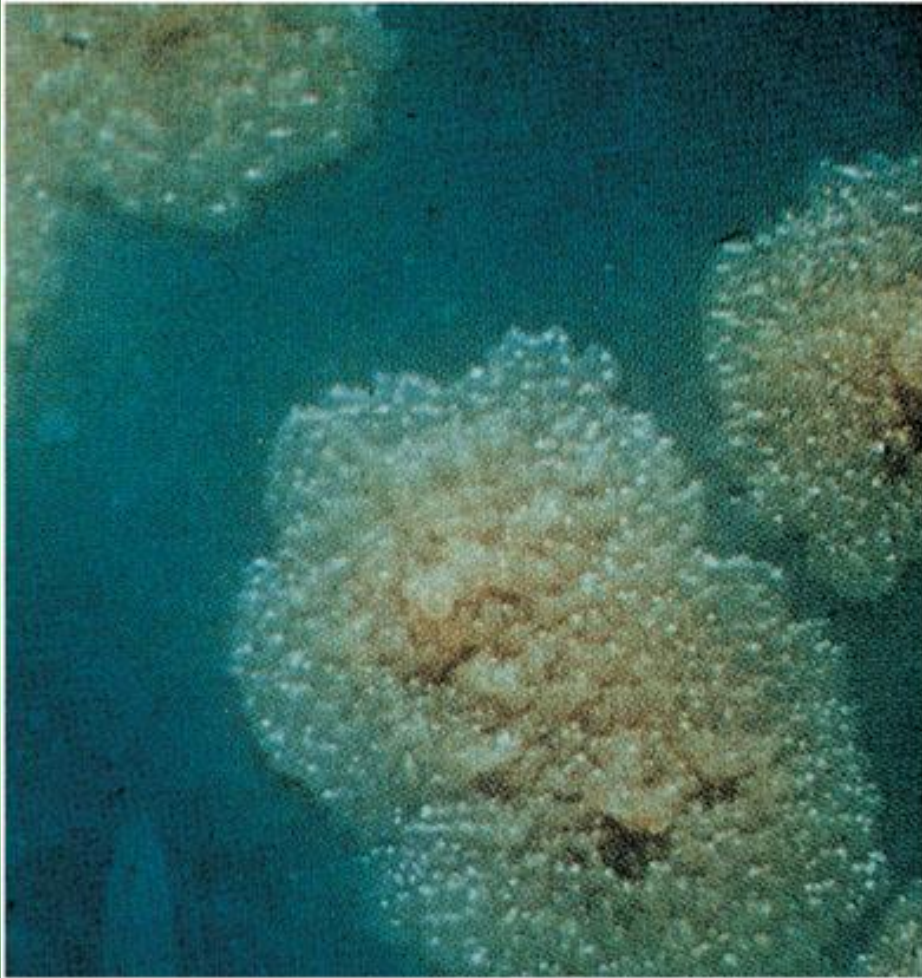


Extrapulmonary TB

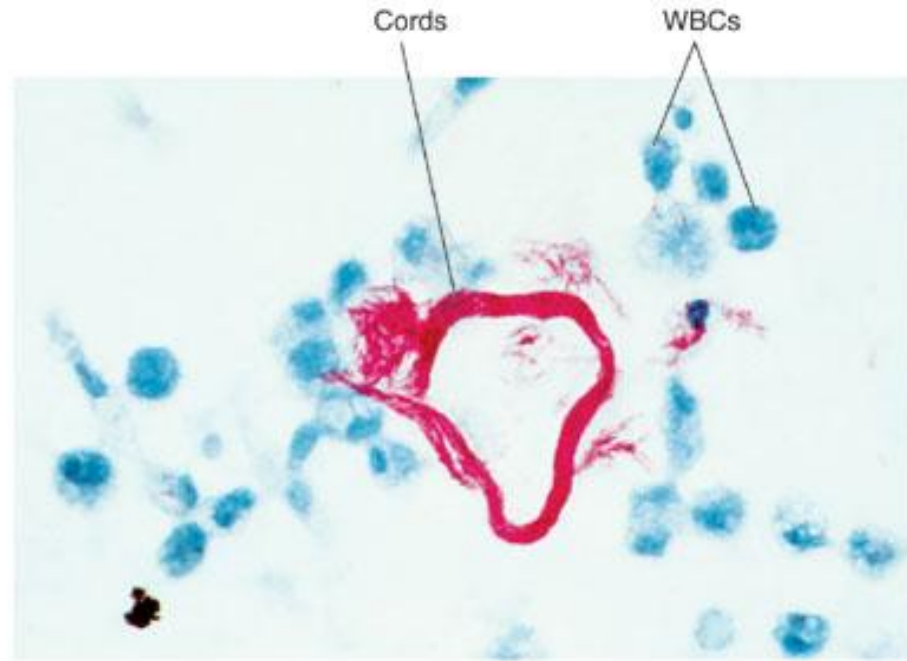
- during secondary TB, bacilli disseminate to regional lymph nodes, kidneys, long bones, genital tract, brain, meninges
- these complications are grave

Diagnosis

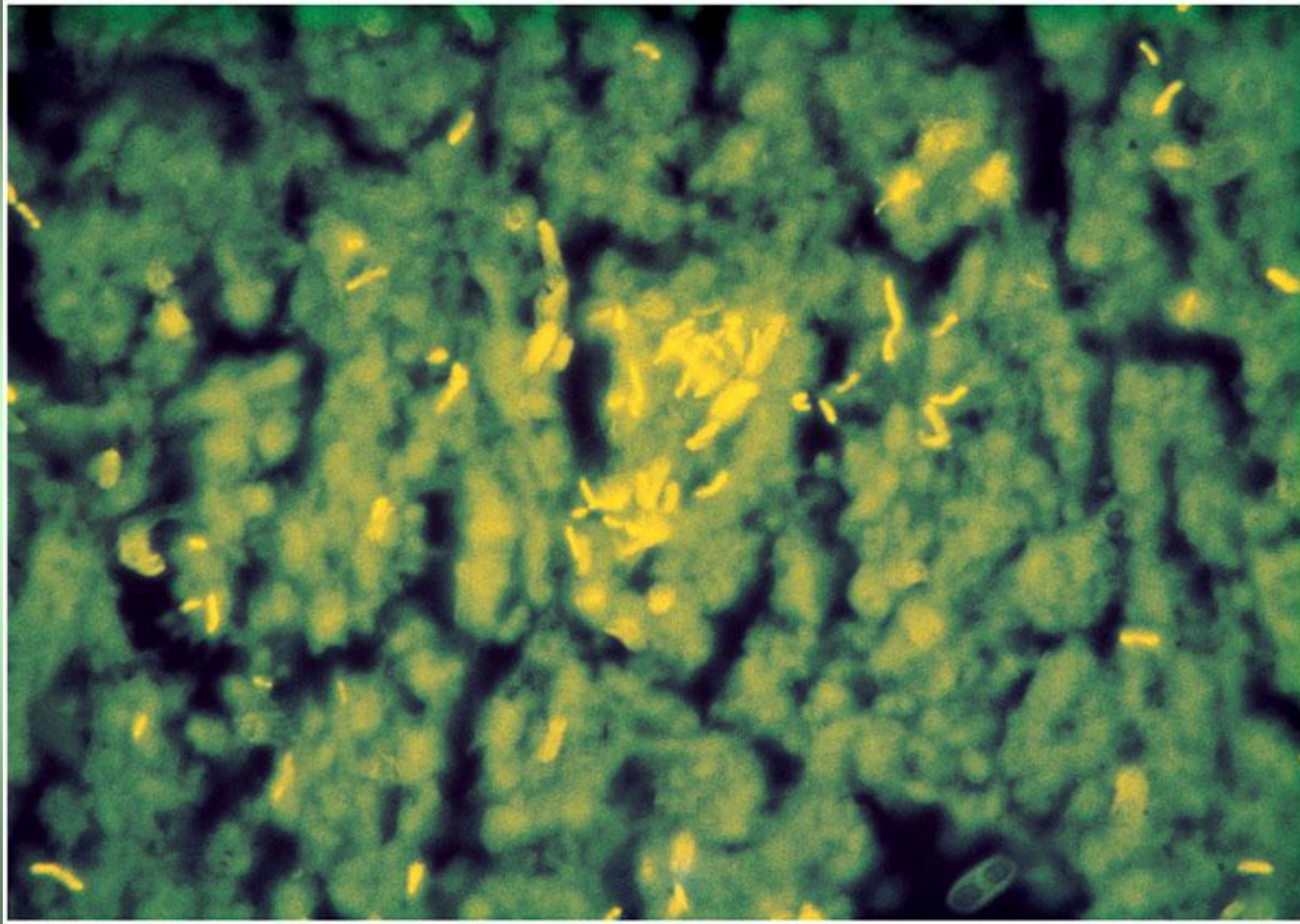
1. *in vivo* or tuberculin testing
2. X rays
3. direct identification of acid-fast bacilli in specimen
4. cultural isolation and biochemical testing



(a)

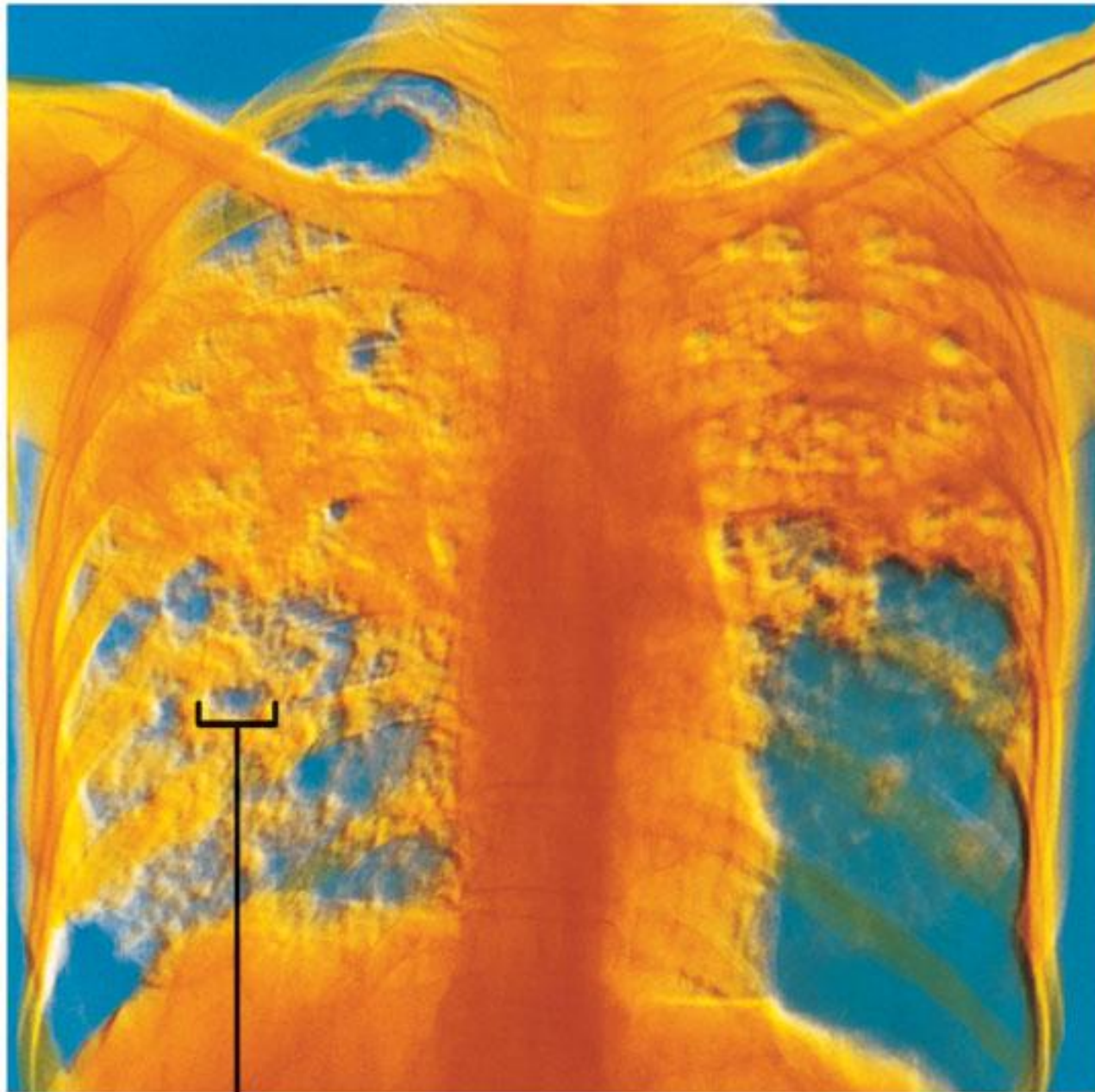


(b)

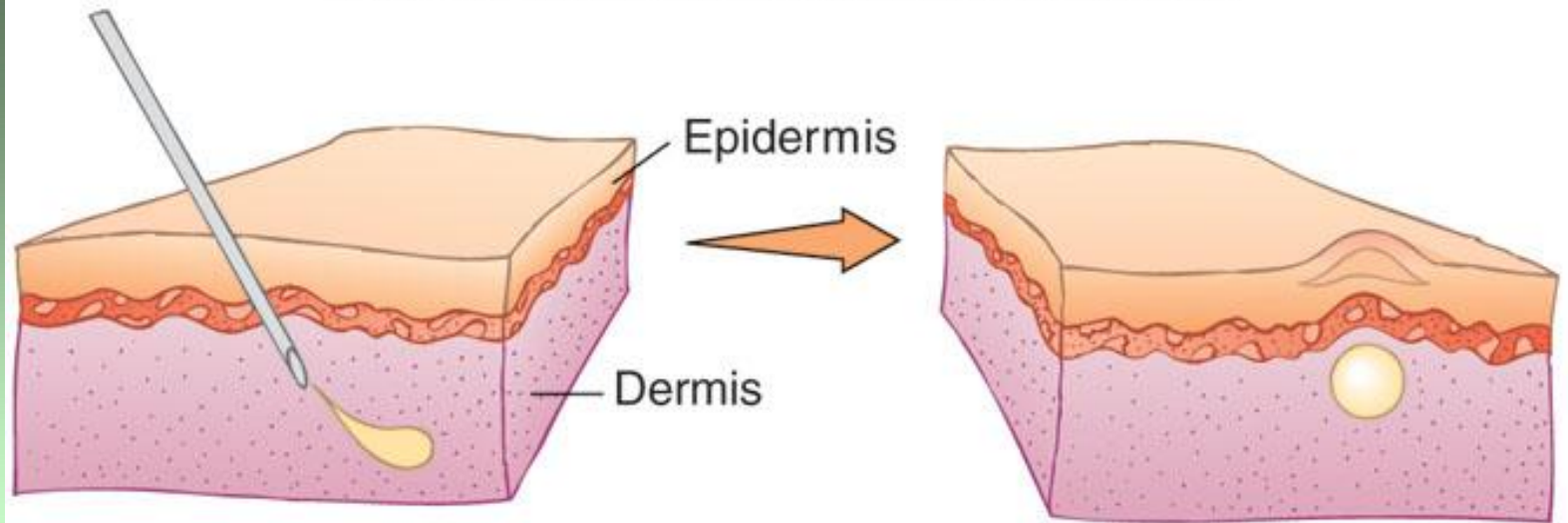


Secondary TB

- reactivation of bacilli
- tubercles expand & drain into the bronchial tubes & upper respiratory tract
- gradually patient experiences more severe symptoms
 - violent coughing, greenish or bloody sputum, fever, anorexia, weight loss, fatigue
- untreated 60% mortality rate



Area of tubercles



Injection of PPD

Small bleb develops

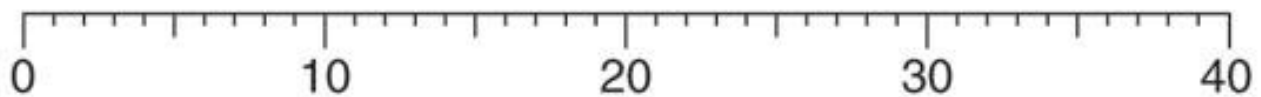
(a)



Negative reaction
(0–5 mm)

Indeterminate reaction
(5–9 mm)

Positive reaction
(>10 mm)

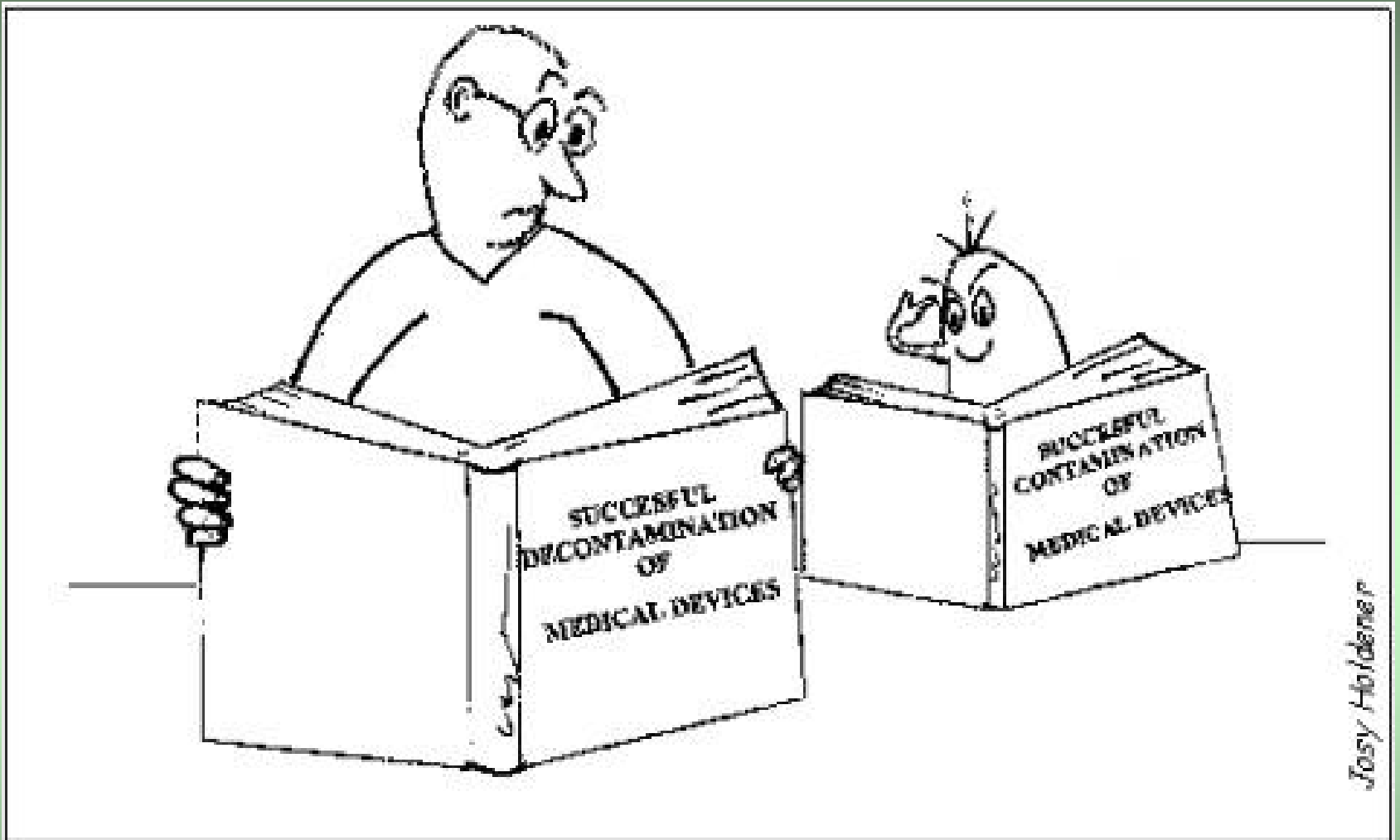


(b)

mm

Treatment of TB

- 6-24 months of at least 2 drugs from a list of 11
- one pill regimen called *Rifater* (isoniazid, rifampin, pyrazinamide)
- vaccine based on attenuated bacilli Calmet-Guerin strain of *M. bovis* used in other countries



.. It is the microbes that will have the last word"...
Louis Pasteur

TABLE 19.2

Differentiation of Important *Mycobacterium* Species

Species	Primary Habitat	Disease in Humans	Treatment	Rate of Growth*	Pigmentation**
<i>M. tuberculosis</i>	Humans	Tuberculosis (TB)	Combined drugs	S	NP
<i>M. bovis</i>	Cattle	Tuberculosis	Same as TB	S	NP
<i>M. ulcerans</i>	Humans	Skin ulcers	Surgery, grafts	S	NP
<i>M. kansasii</i>	Not clear	Opportunistic lung infection	Difficult, similar to TB	S	PP
<i>M. marinum</i>	Water, fish	Swimming pool granuloma	Tetracycline, rifampin	S	PP
<i>M. scrofulaceum</i>	Soil, water	Scrofula	Removal of lymph nodes	S	PS
<i>M. avium- M. intracellulare</i> complex	Birds	Opportunistic AIDS infection; lung infection like TB	Combined drugs	S	NP
<i>M. fortuitum- M. chelonae</i> complex	Soil, water, animals	Wound abscess; postsurgical infection	4–6-drug regimen; surgery	R	NP
<i>M. phlei</i>	Sputum, soil	Not pathogenic	None	R	PS
<i>M. smegmatis</i>	Smegma, soil	Not pathogenic	None	R	Usually NP
<i>M. leprae</i>	Strict parasite of humans	Leprosy	See text	S	Cannot be grown in artificial media

The mycobacteria are grouped into major categories by their growth rate and their pigment production.

*Growth rate is rapid (R), occurring in less than 7 days, or slow (S), occurring in more than 7 days.

**Photochromogens (PP) develop yellow to dark orange pigment in the presence of light; scotochromogens (PS) synthesize pigment in darkness; and nonpigmented forms (NP) have no color.

Mycobacterium leprae

- Hansen's bacillus
- strict parasite – has not been grown on artificial media or tissue culture
- slowest growing of all species
- multiplies within host cells in large packets called globi
- causes leprosy, a chronic disease that begins in the skin & mucous membranes & progresses into nerves

leprosy

- endemic regions throughout the world
- spread through direct inoculation from leprotics
- 2 forms
 - tuberculoid – superficial infection without skin disfigurement which damages nerves and causes loss of pain perception
 - lepromatous – a deeply nodular infection that causes severe disfigurement of the face & extremities
- treatment by long-term combined therapy



(a)



(b)

TABLE 19.3**The Two Major Clinical Forms of Leprosy**

Tuberculoid Leprosy	Lepromatous Leprosy
Few bacilli in lesions	Many bacilli in lesions
Few shallow skin lesions in many areas	Numerous deeper lesions concentrated in cooler areas of body
Loss of pain sensation in lesions	Sensory loss more generalized; occurs late in disease
No skin nodules	Gross skin nodules
Occasional mutilation of extremities	Mutilation of extremities common
Reactive to lepromin*	Not reactive to lepromin
Lymph nodes not infiltrated by bacilli	Lymph nodes massively infiltrated by bacilli
Well-developed cell- mediated (T-cell) response	Poorly developed T-cell response

**Lepromin is an extract of the leprosy bacillus injected intradermally, like tuberculin, to detect delayed allergy to leprosy.*







