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MICROBIOLOGY

WITH DISEASES BY TAXONOMY, THIRD EDITION

Chapter 21

Rickettsias, Chlamydias, Spirochetes, and Vibrios

力克次體、衣原菌、螺旋菌與弧菌

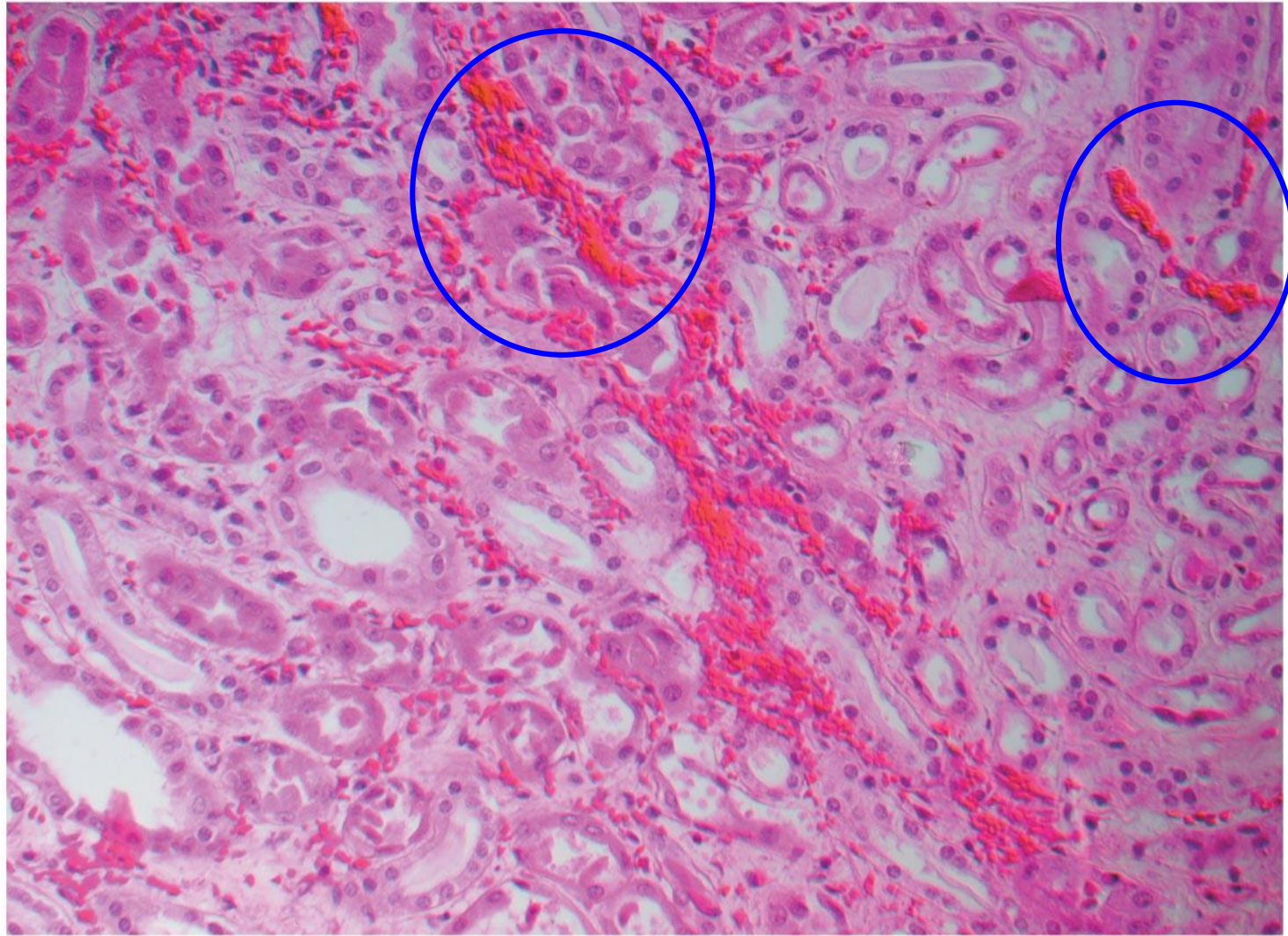
- Understand the characteristics of clinically important bacteria
 - Rickettsias
 - Chlamydias
 - Spirochetes
 - Pathogenic Vibrios

- Extremely small
- Appear **almost wall-less** due to small amount of peptidoglycan present
- **Obligate intracellular parasites**
 - Unusual since have functional genes for protein synthesis, ATP production, and reproduction
- Four genera cause disease in humans
 - *Rickettsia*, *Orientia*, *Ehrlichia*, and *Anaplasma*

- *Rickettsia*
 - Transmitted via arthropod vectors
 - Bacteria live in the cytosol of host cell
 - Three species cause most human infections
 - *R. rickettsii*
 - *R. prowazekii*
 - *R. typhi*

A H & E stain for visualizing *Rickettsia rickettsii*

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Hematoxylin and eosin stain

LM

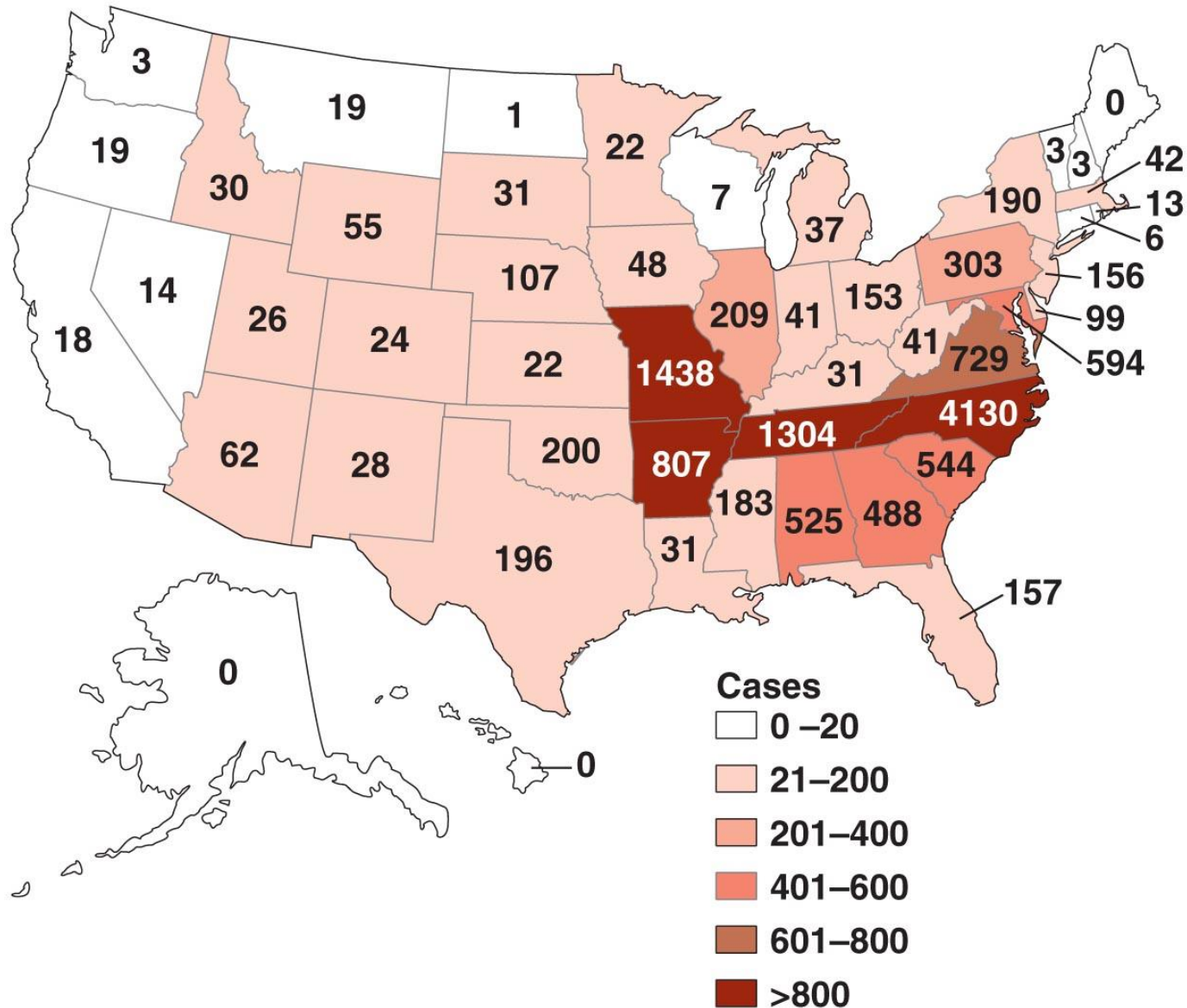
20 μm

- *Rickettsia*
 - *Rickettsia rickettsii*
 - Causes Rocky Mountain spotted fever
 - Most severe and common rickettsial illness
 - Hard ticks transmit among humans and rodents
 - Most infected individuals develop rash on trunk and appendages
 - Approximately 5% of patients die
 - Prevention involves avoiding ticks



Incidence of Rocky Mountain spotted fever in the U.S.

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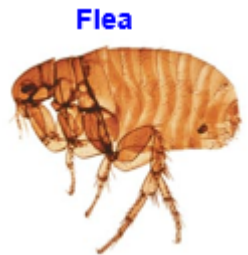
The rash in a case of Rocky Mountain spotted fever



- *Rickettsia*
 - *Rickettsia prowazekii*
 - Causes epidemic typhus 流行性斑疹傷寒
 - Human body louse transmits bacteria to humans
 - Humans are primary host of *R. prowazekii*
 - Occurs in crowded, unsanitary conditions
 - Prevent with good personal hygiene
 - Vaccine available for high-risk populations



- *Rickettsia*
 - *Rickettsia typhi*
 - Causes **murine typhus (endemic typhus)** 地方性斑疹傷寒
 - **Fleas** transmit bacteria among animal hosts and humans
 - Disease is not usually fatal
 - Most often seen in southern United States
 - **Endemic in every continent** except Antarctica
 - Prevent by avoiding the arthropod vectors



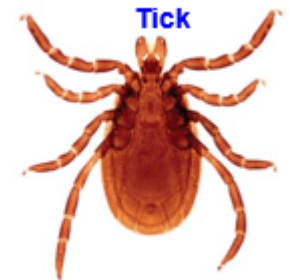
- *Orienta* 東方體屬

- Formerly classified in the genus *Rickettsia*
- **Mites** are the reservoir and vector of *Orienta*
 - Transmit bacterium among rodents and humans
- *O. tsutsugamushi* causes **scrub typhus** 恙蟲病
 - Occurs in U.S. among immigrants from endemic areas
- Prevent by avoiding exposure to mites

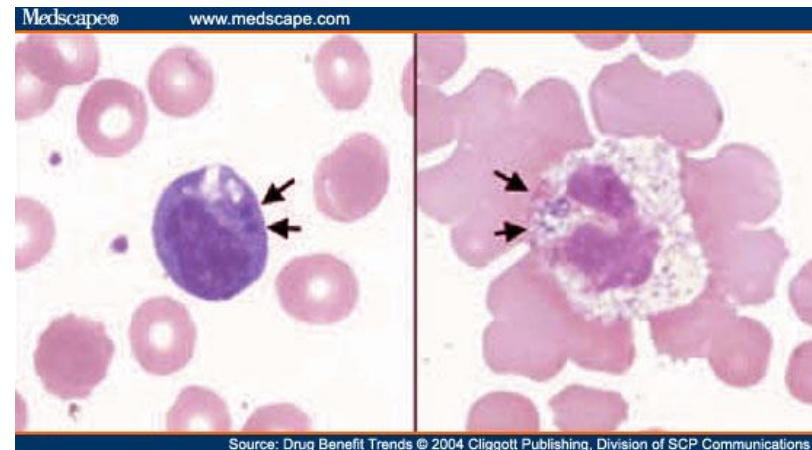
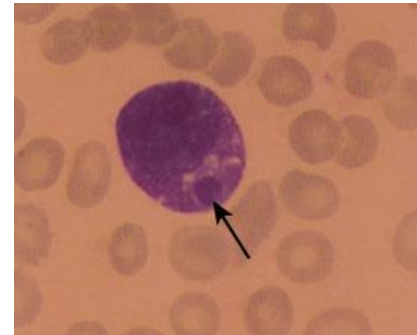
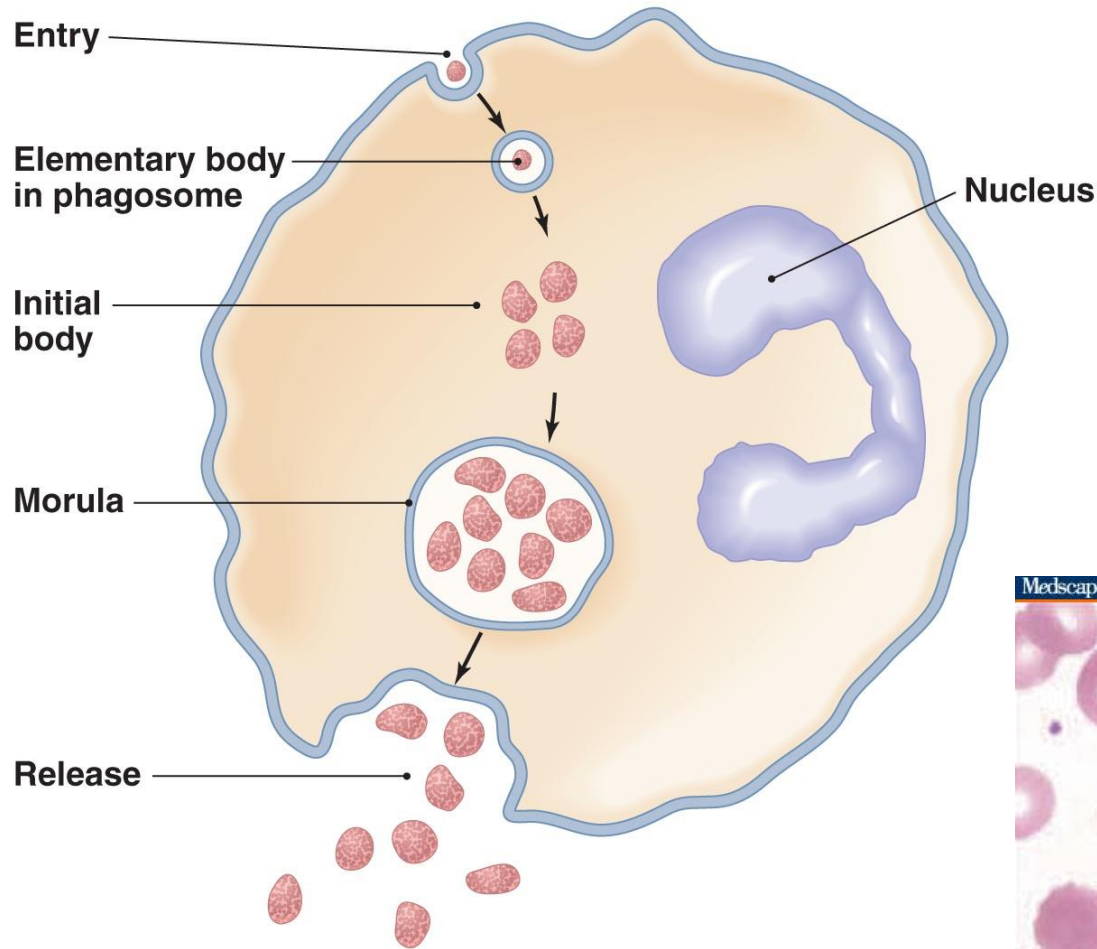


別來。無恙

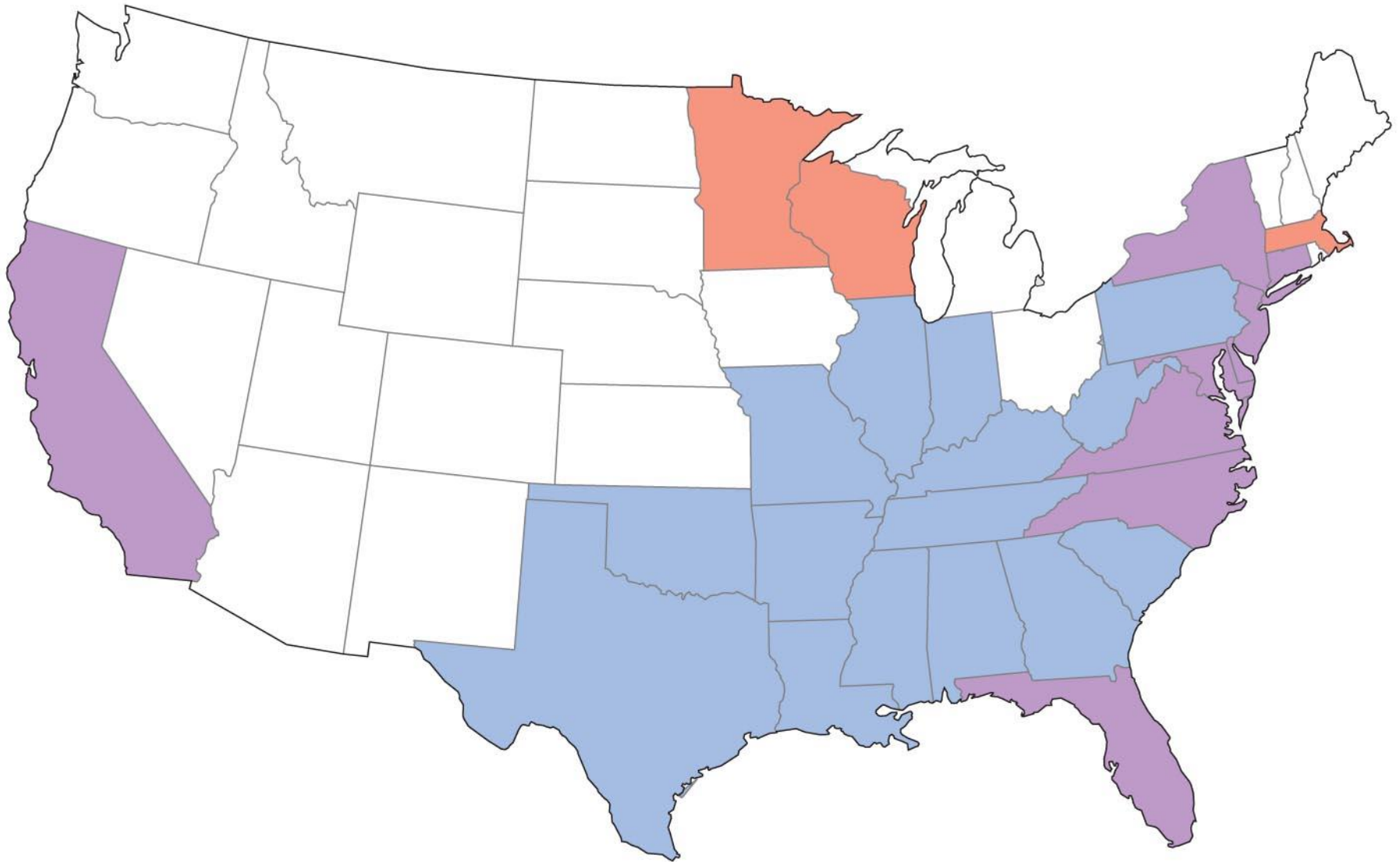
- *Ehrlichia* and *Anaplasma*
 - Cause two emerging diseases in the U.S.
 - *E. chaffeensis*
 - Causes human monocytic ehrlichiosis 單核性埃立克體病
 - *Anaplasma phagocytophilum*
 - Causes anaplasmosis 無漿體病
 - Ticks transmit these bacteria
 - Three developmental stages in leukocytes
 - Elementary body, initial body, morula
 - Prevent by avoiding ticks



Growth and reproduction cycle of *Ehrlichia* and *Anaplasma* ¹³



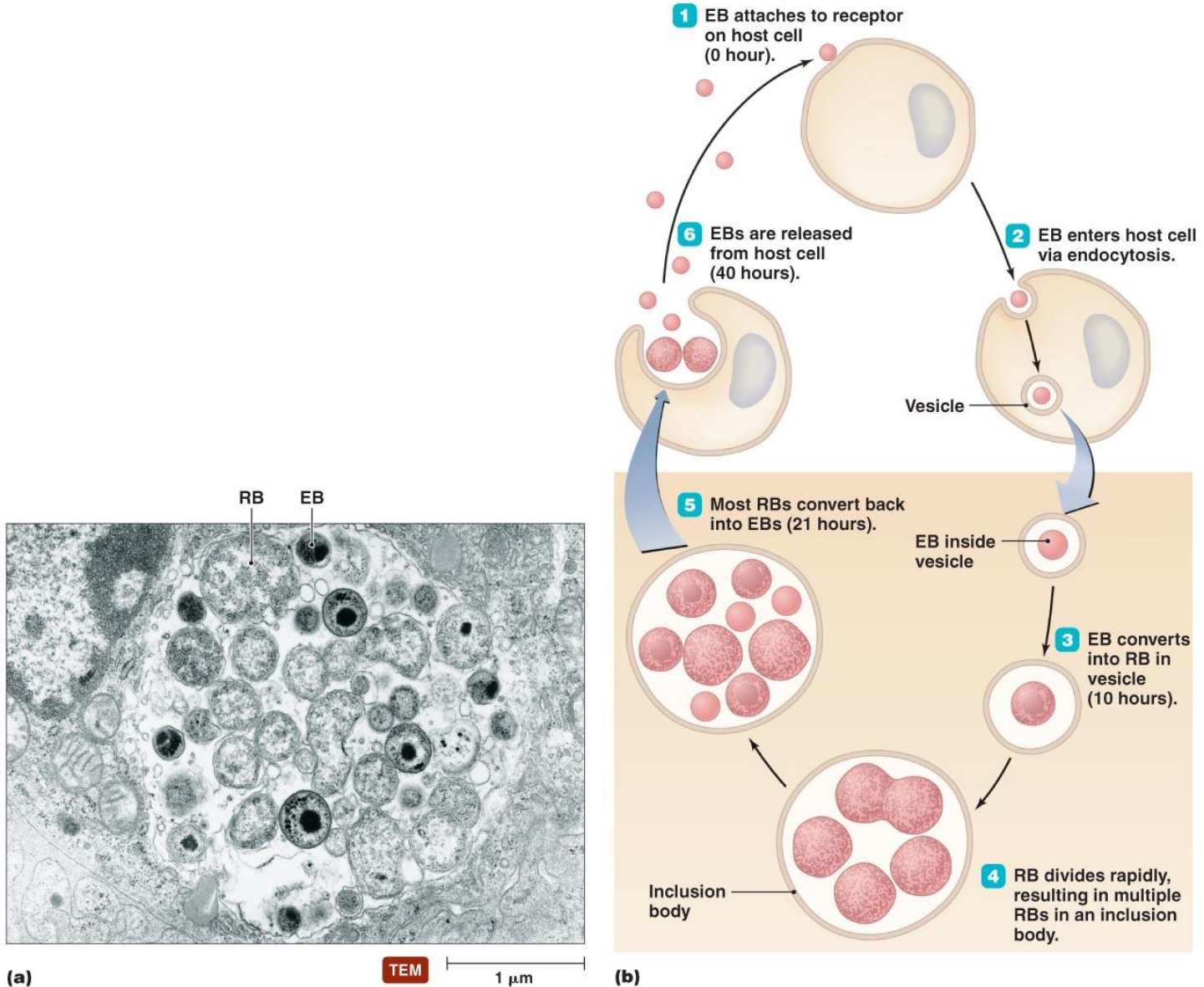
Geographical distribution of *Ehrlichia* and *Anaplasma*



- Do not have cell walls
 - Have **two membranes** without any peptidoglycan between them
- Grow and multiply **only within the vesicles** of host cells
- Have a unique developmental cycle involving two forms
 - **Elementary bodies** and **reticulate bodies**
 - Both forms can occur within the phagosome of a host cell

Developmental forms and life cycle of *Chlamydia*

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- *Chlamydia trachomatis* 砂眼披衣菌
 - Pathogenesis and epidemiology
 - Has a **limited host range**
 - One strain infects **mice**; all others infect **humans**
 - Infects the **conjunctiva** and various **mucous membranes**
 - Enters the body through abrasions and lacerations
 - Most common **reportable sexually transmitted disease** in U.S.
 - Clinical manifestations due to cell destruction and inflammatory response

- *Chlamydia trachomatis*
 - Diseases
 - Sexually transmitted diseases (STD)
 - Lymphogranuloma venereum 性病淋巴肉芽腫
 - Nongonococcal urethritis 非淋菌性尿道炎
 - Proctitis 直腸炎
 - Trachoma
 - Ocular disease
 - Leading cause of nontraumatic blindness in humans
 - Infection typically occurs during childbirth

Advanced case of lymphogranuloma venereum in a man

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An eye afflicted with **trachoma**

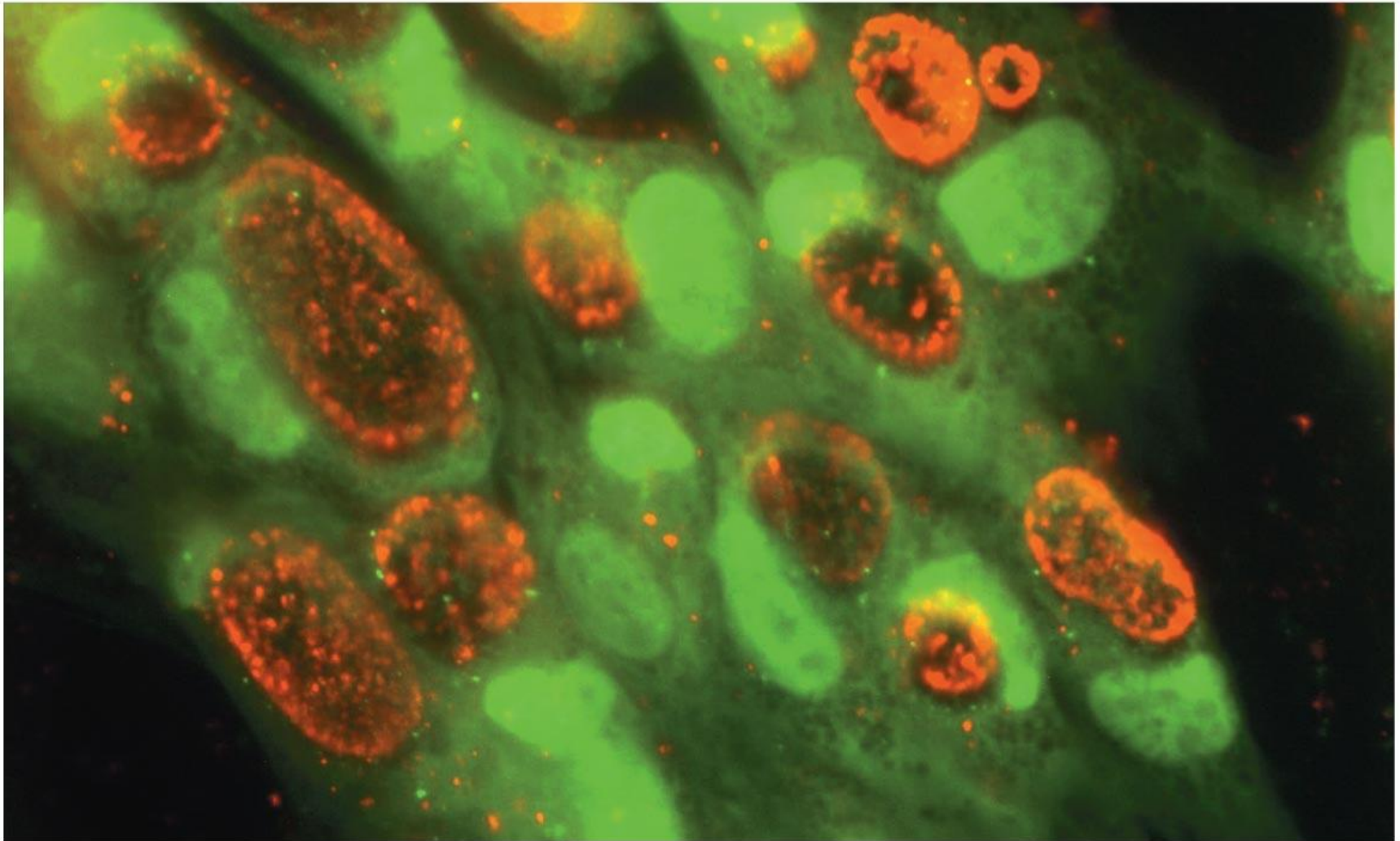
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- Diagnosis, treatment, and prevention
 - Diagnosis
 - Demonstrate bacteria inside cells from the site of infection
 - Treatment
 - **Antibiotics** can be administered for genital and ocular infections
 - **Surgical correction** of deformities from trachoma may prevent blindness
 - Prevention
 - Abstinence to prevent sexually transmitted infections
 - Blindness prevented with prompt use of antibacterial agents

Direct fluorescent antibody test for *C. trachomatis*

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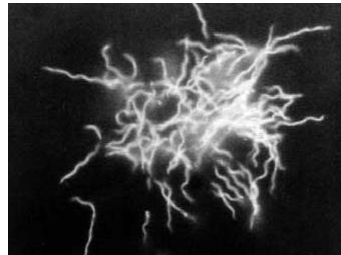
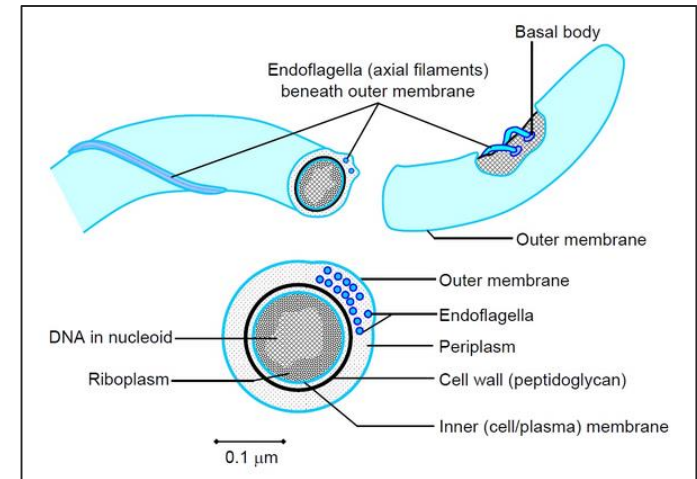
LM

0.6 μm

- *Chlamydophila pneumonia* 肺炎披衣菌
 - Causes bronchitis, pneumonia, and sinusitis
 - Most infections don't require hospitalization
 - Severe cases can resemble primary atypical pneumonia caused by *Mycoplasma pneumoniae*
 - Prevention is difficult because *C. pneumoniae* is ubiquitous

- *Chlamydia psittaci* 鸚鵡披衣菌
 - Causes ornithosis
 - Disease of bird that can be transmitted to humans
 - Usually causes flulike symptoms
 - Rarely nonrespiratory conditions are observed
 - Individuals who handle animals are at greatest risk of infection
 - Transmitted via inhalation of aerosols or contact with infected material or a pet bird
 - Difficult diagnosis since symptoms similar to other respiratory infections

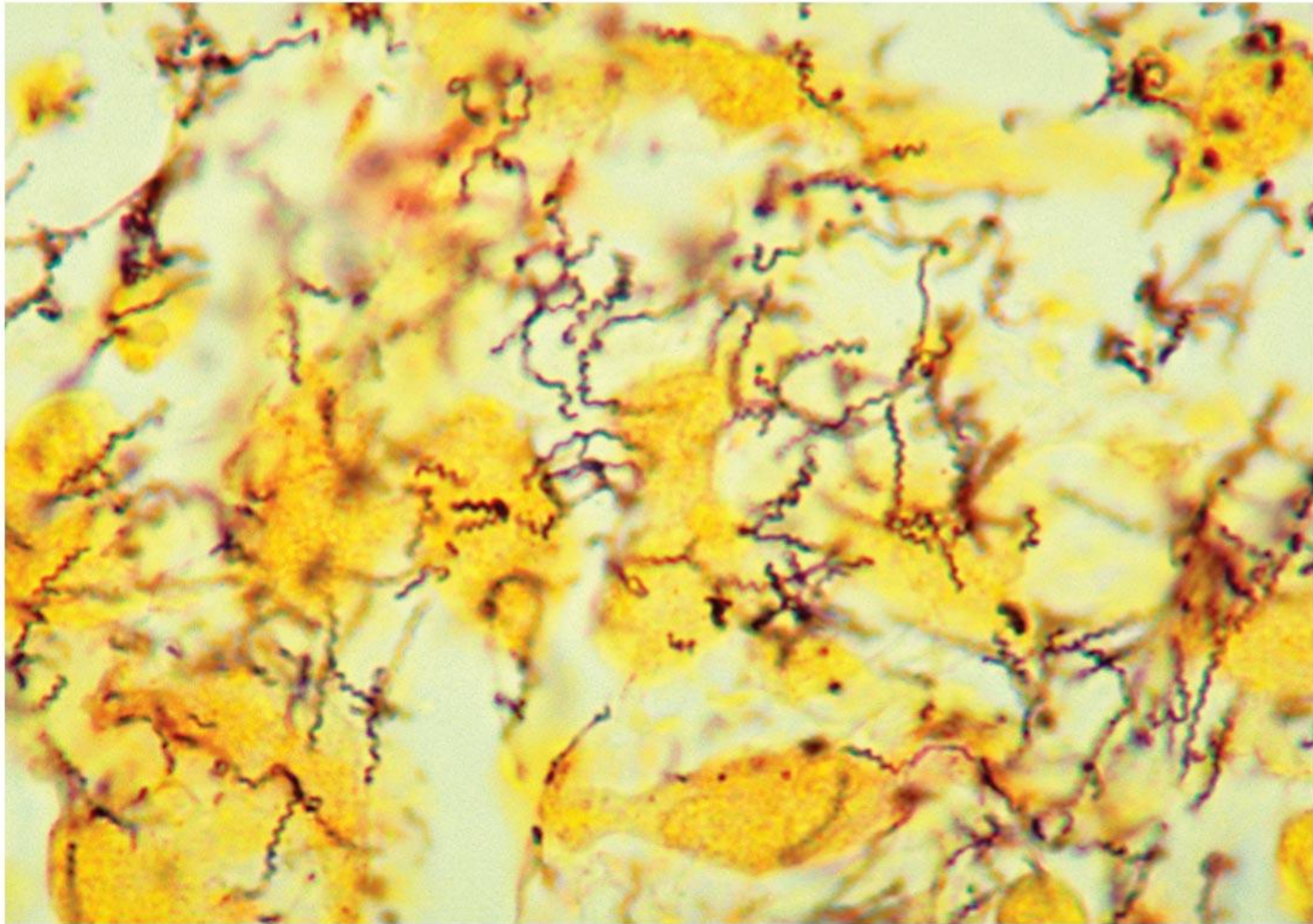
- Thin, tightly coiled, helically shaped bacteria
- Moves in a **corkscrew fashion** through its environment
 - Thought to enable pathogenic spirochetes to burrow through hosts' tissues
- Three genera cause human disease
 - *Treponema*, *Borrelia*, and *Leptospira*



- ***Treponema*** 梅毒螺旋體, 密螺旋體
 - Pathogen of humans only
 - *T. pallidum pallidum* is most widespread
 - Causative agent of syphilis
 - Syphilis occurs worldwide
 - Transmission is almost solely via sexual contact
 - Endemic among sex workers, men who have sex with men, and users of illegal drugs
 - Can also be spread from an infected mother to her fetus
 - Can result in fetal death or mental retardation and malformation

Spirochetes of *Treponema pallidum pallidum*

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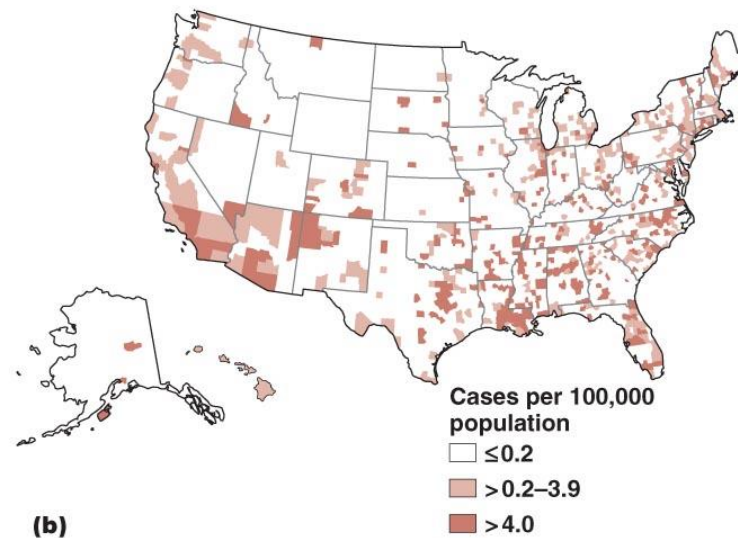
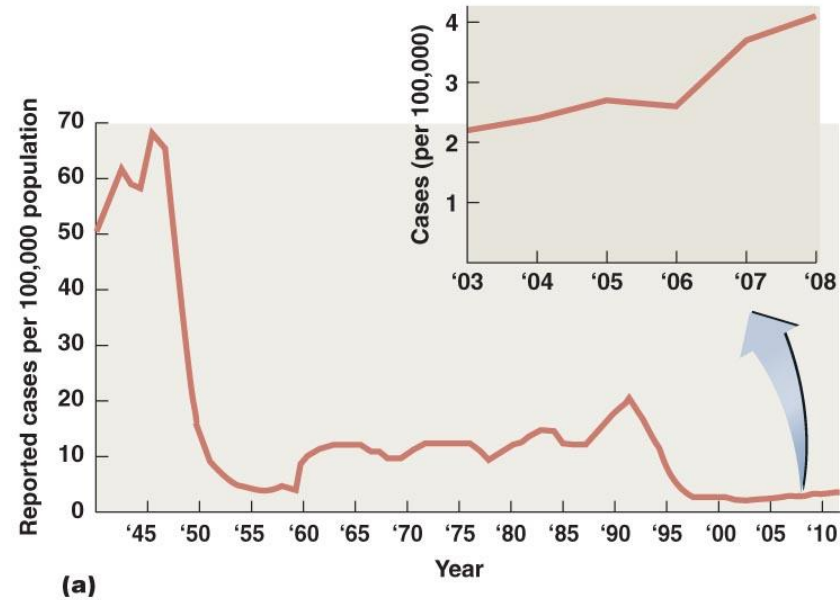


LM

3 μ m

Incidence of adult syphilis in the United States

28



Lesions of syphilis

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(a) Chancre (硬性下疳) on the external genitalia



(b) widespread rash



(c) Gummas (梅毒瘤) on skin, bone, nervous tissues

- (a) Primary syphilis
- (b) Secondary syphilis
- (c) Tertiary syphilis

- *Treponema*

- Diagnosis, treatment, and prevention
 - Diagnosis
 - Antibody tests against bacterial antigens
 - Tertiary syphilis is difficult to diagnose
 - Treatment
 - Penicillin is the drug of choice
 - Ineffective against tertiary syphilis
 - Prevention
 - Abstinence and safe sex



手上的第一期梅毒硬下疳



第二期梅毒的典型表現：手掌上出現皮疹



罹患第三期梅毒（梅毒瘡）的病患。
巴黎人類博物館內半身像。



身上許多部位因第二期梅毒出現紅色丘疹及結核

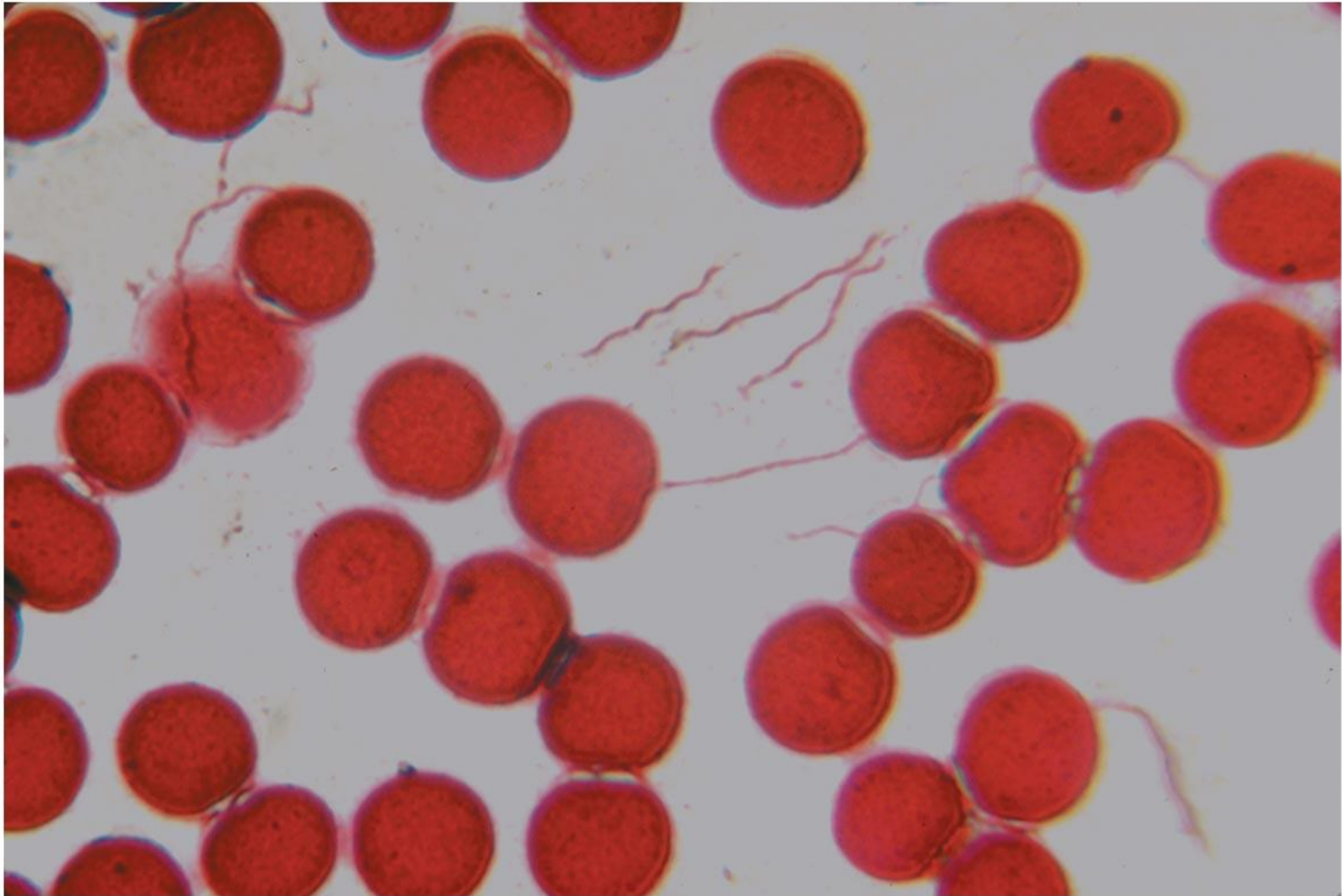
- ***Treponema***

- **Nonvenereal treponemal diseases** 非性病梅毒疾病
- Three non-sexually transmitted diseases
 - Primarily seen in impoverished children in unsanitary conditions
 - **Bejel** 非性病梅毒
 - *T. pallidum endemicum* is the causative agent
 - **Pinta** 品他病
 - *T. carateum* is the causative agent
 - **Yaws** 雅思病
 - *T. pallidum pertenue* is the causative agent



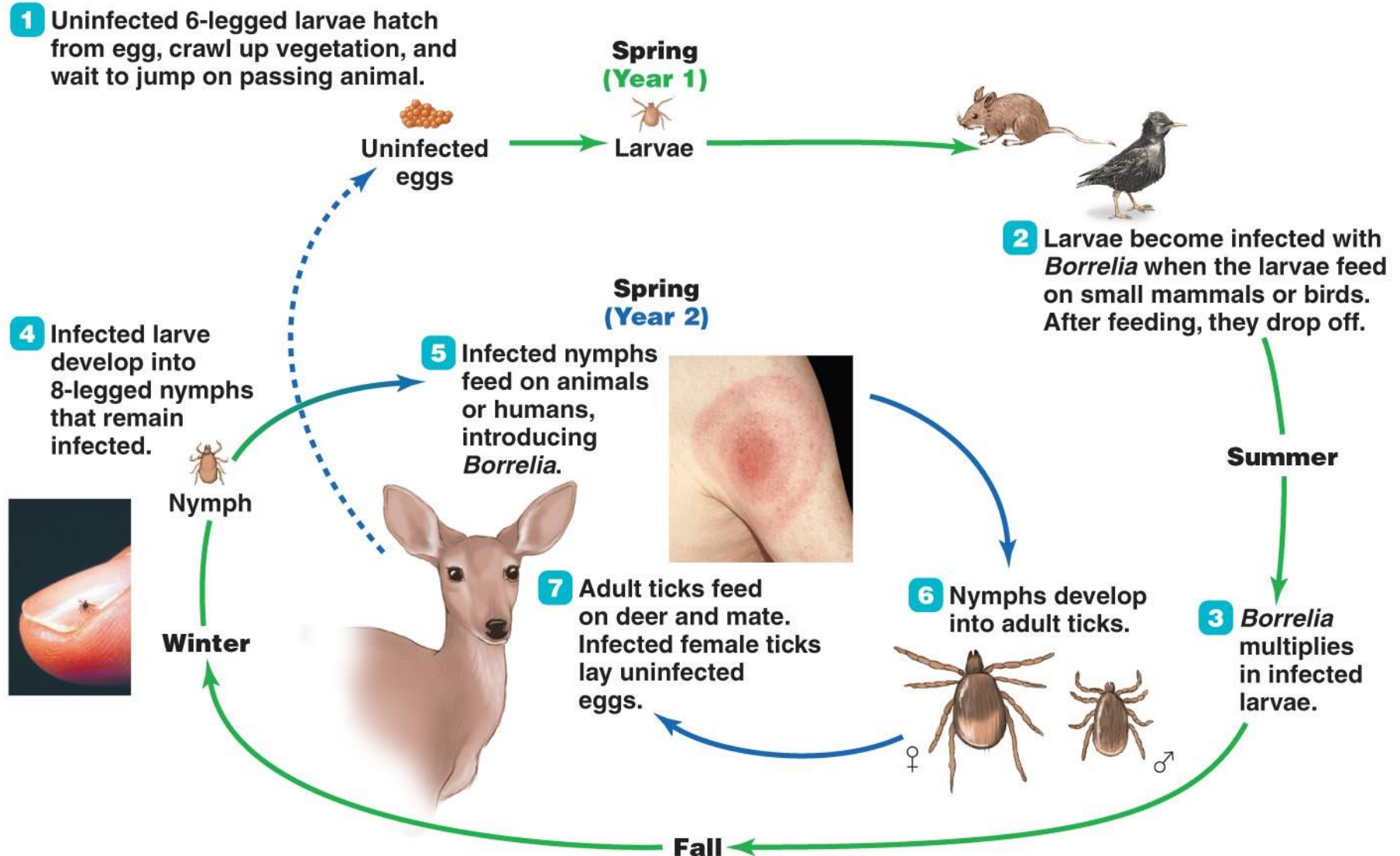
- **Borrelia** 伯瑞氏疏螺旋體
 - Lightly staining, Gram-negative spirochetes
 - Cause two diseases in humans
 - **Lyme disease** 萊姆病
 - **Relapsing fever** 回歸熱

- ***Borrelia***
 - Lyme disease
 - *Borrelia burgdorferi* is the causative agent
 - Bacteria are transmitted to humans via a tick bite
 - Hard ticks of the genus *Ixodes* are the vectors
 - Tick life cycle important in understanding spread of Lyme disease

**LM**7.5 μm

Life cycle of the deer tick *Ixodes*

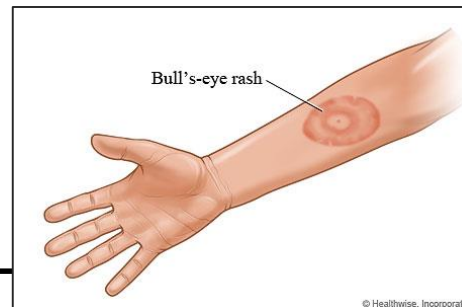
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- ***Borrelia***

- **Lyme disease**

- Shows a broad range of signs and symptoms
 - **Three phases** of disease in untreated patients
 - Expanding red “bull’s-eye” rash occurs at infection site
 - **Neurological** symptoms and **cardiac** dysfunction
 - Severe **arthritis** that can last for years
 - Result of the body’s immune response



- ***Borrelia***

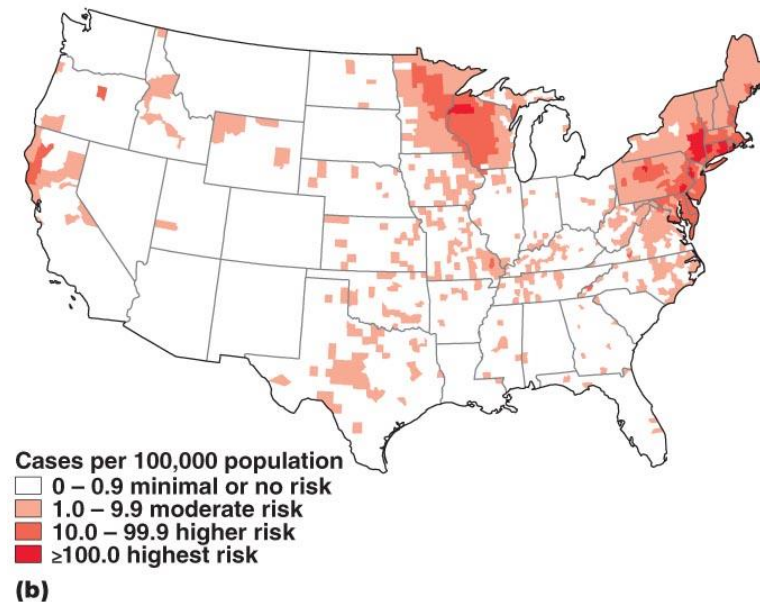
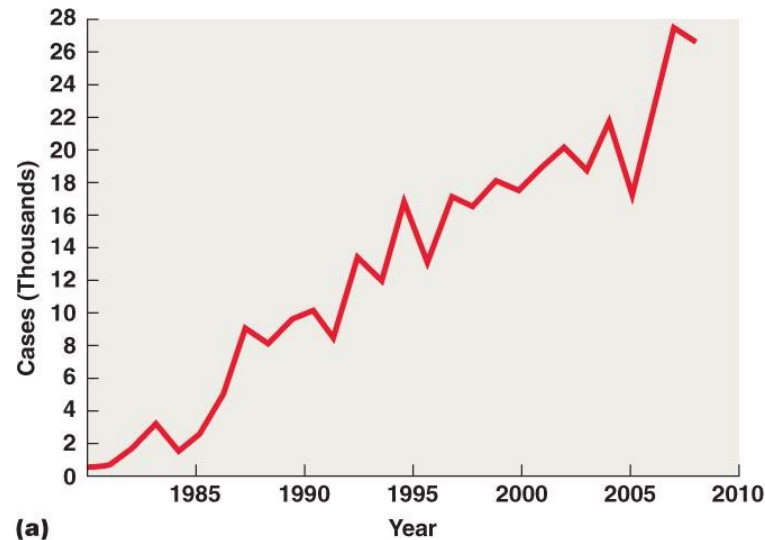
- Lyme disease

- Increase of cases in the United States
 - Humans coming in closer association with *Borrelia*-infected deer ticks
 - Antimicrobial drugs effectively treat first stage of Lyme disease
 - Treatment of later stages difficult because symptoms primarily result from the immune response
 - Prevention is best achieved by avoiding ticks



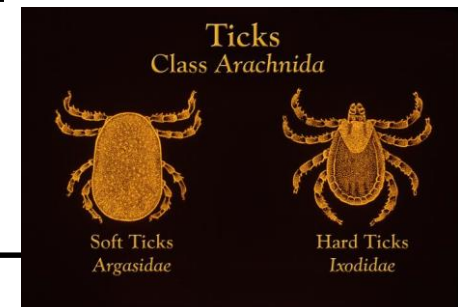
Occurrence of Lyme disease in the United States

39



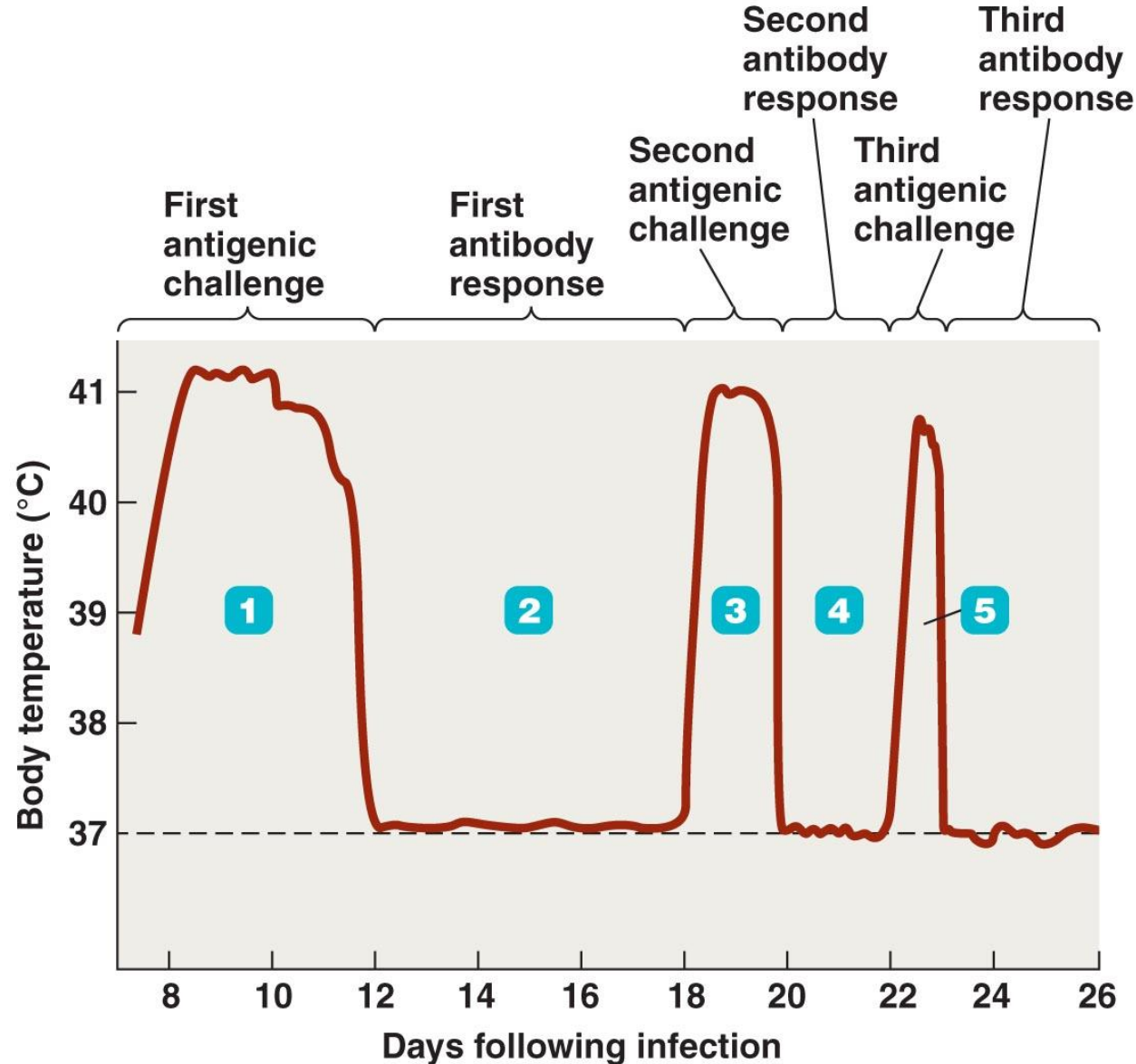
- *Borrelia*

- Relapsing fever
 - **Louse-borne relapsing fever**
 - *Borrelia recurrentis* is the causative agent
 - Transmitted to humans by the human body louse
 - **Endemic relapsing fever**
 - Several *Borrelia* species can cause this disease
 - Transmitted to humans by soft ticks
- Characterized by recurring episodes of septicemia and fever
 - Due to body's repeated efforts to remove the spirochetes



Recurring episodes of fever in relapsing fever

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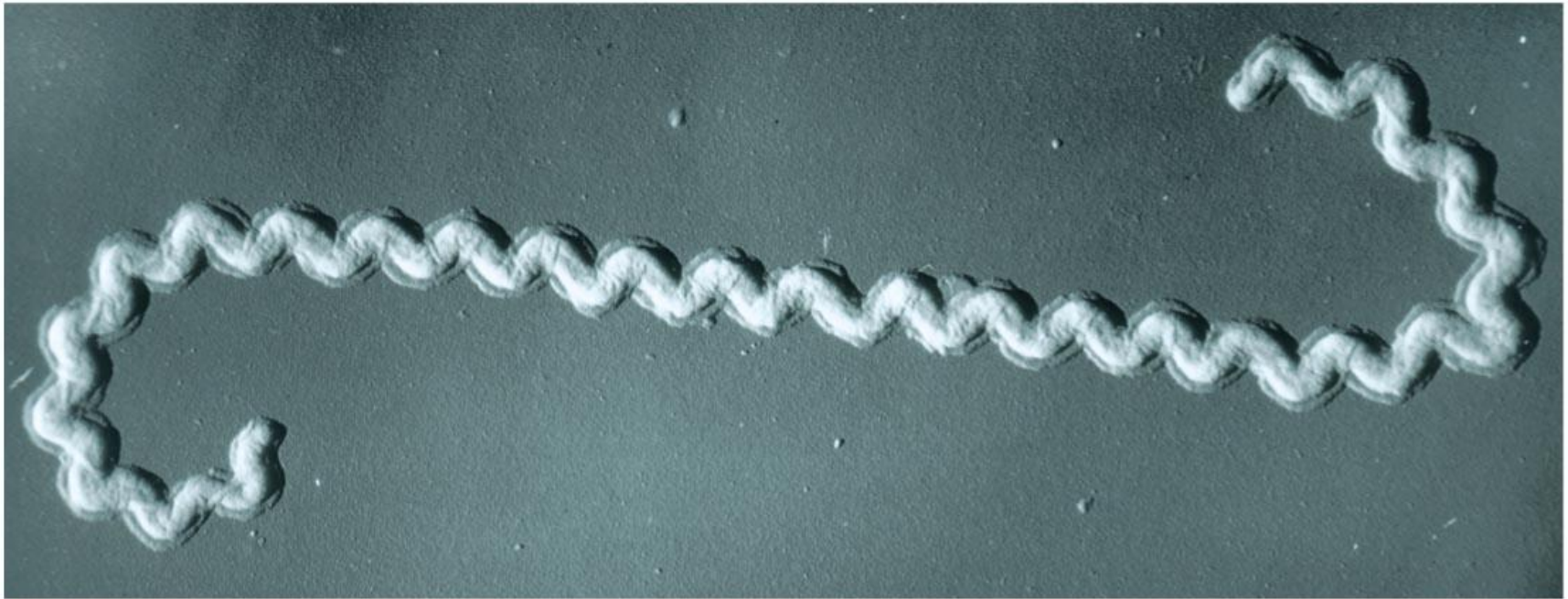


- ***Borrelia***

- Relapsing fever

- Observation of spirochetes is the primary method of diagnosis
- Successful treatment is with antimicrobial drugs
- Preventive measures
 - Avoidance of ticks and lice
 - Good personal hygiene
 - Use of repellent chemicals

- **Leptospira** 鉤端螺旋體
 - Motile, obligately aerobic bacteria
 - Found in numerous wild and domestic animals
 - **Leptospirosis**
 - Caused by *L. interrogans*
 - *Leptospira* enters cuts/abrasions in skin and mucous membranes
 - Travels via the bloodstream throughout the body
 - Bacteremia eventually resolves
 - Eradication impractical due to the various animal reservoirs
 - Vaccine available for livestock and pets



SEM

0.5 μm

- ***Vibrios***

- Share many characteristics with enteric bacteria
- Found in water environments worldwide
- ***Vibrio cholerae***
 - Most common species to infect humans
 - Causes cholera
 - Humans infected by ingesting contaminated food and water
 - “Rice-water stool” is characteristic
 - Most important virulence factor is cholera toxin

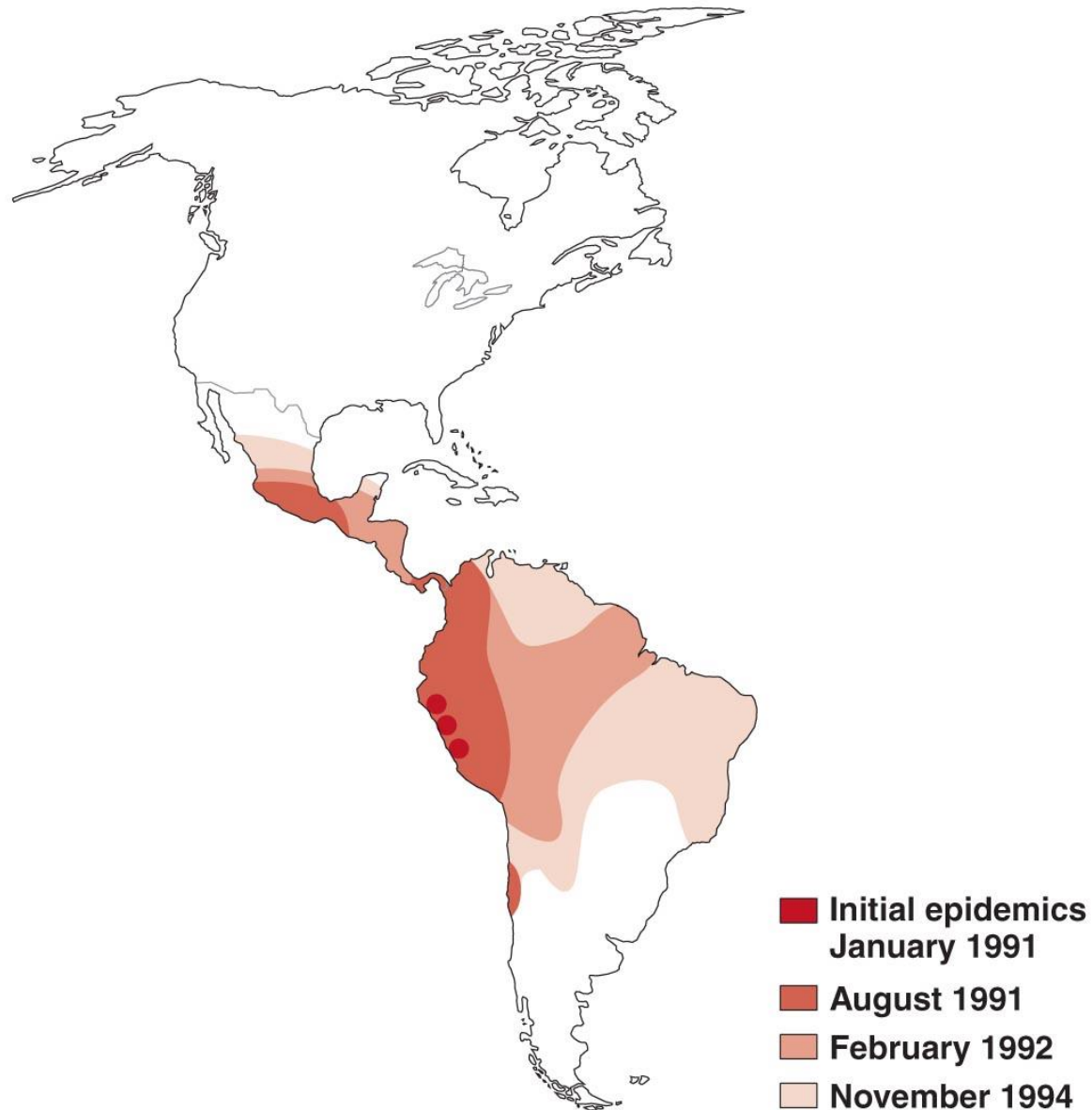


TEM

1 μ m

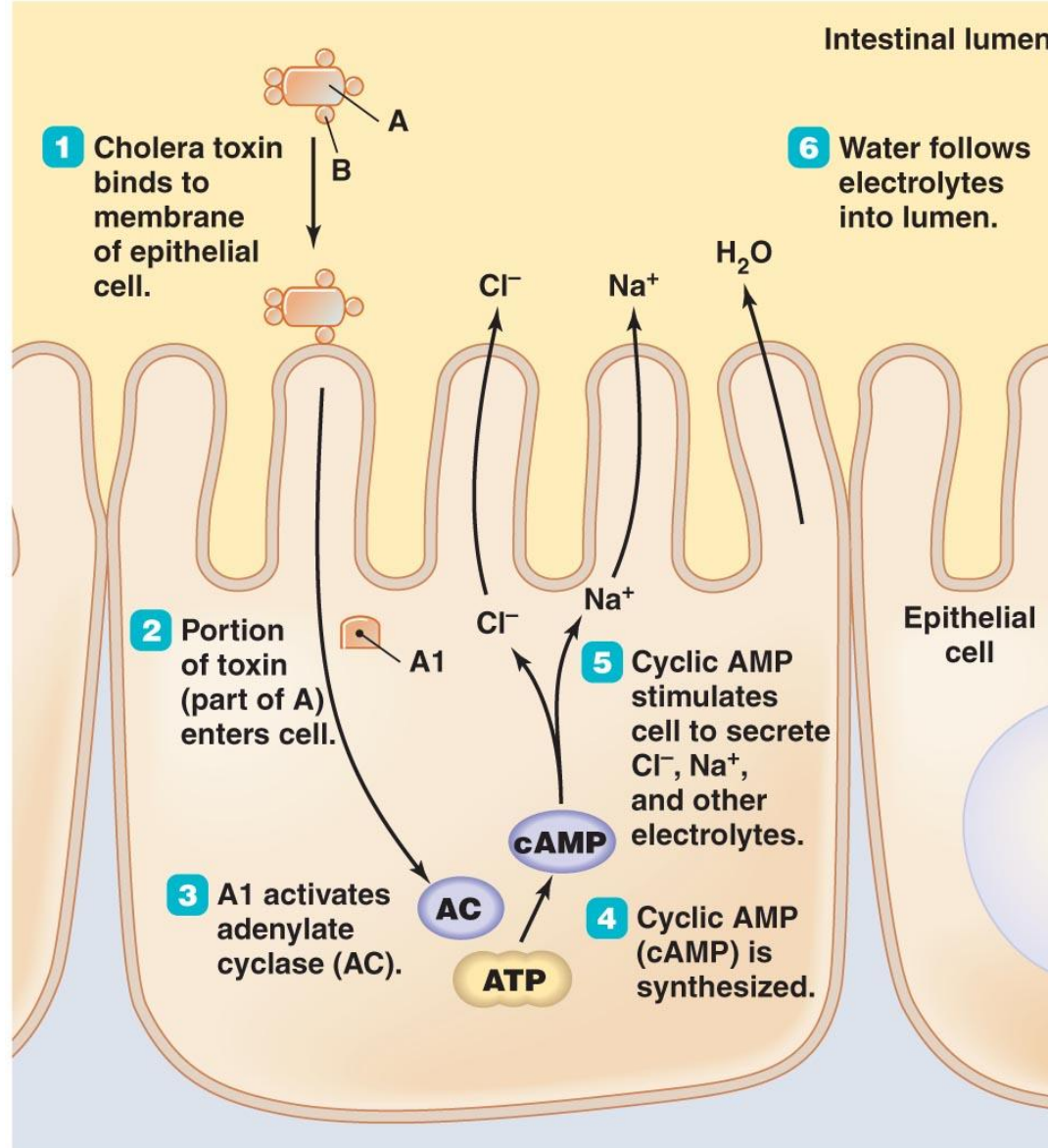
The spread of cholera

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The action of cholera toxin in intestinal epithelial cells

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- **Vibrios**
 - Diagnosis usually based on characteristic diarrhea
 - Treatment
 - Fluid and electrolyte replacement
 - Antimicrobial drugs are lost in the watery stool
 - Adequate sewage and water treatment can limit spread of *V. cholerae*

- **Vibrios**

- Other diseases of Vibrio

- *V. parahaemolyticus* 腸炎弧菌, 副溶血弧菌

- Results from ingestion of shellfish

- Causes cholera-like gastroenteritis

- *V. vulnificus* 海洋弧菌, 創傷弧菌

- Septicemia due to consumption of contaminated shellfish

- Infections can result from washing wounds with contaminated seawater

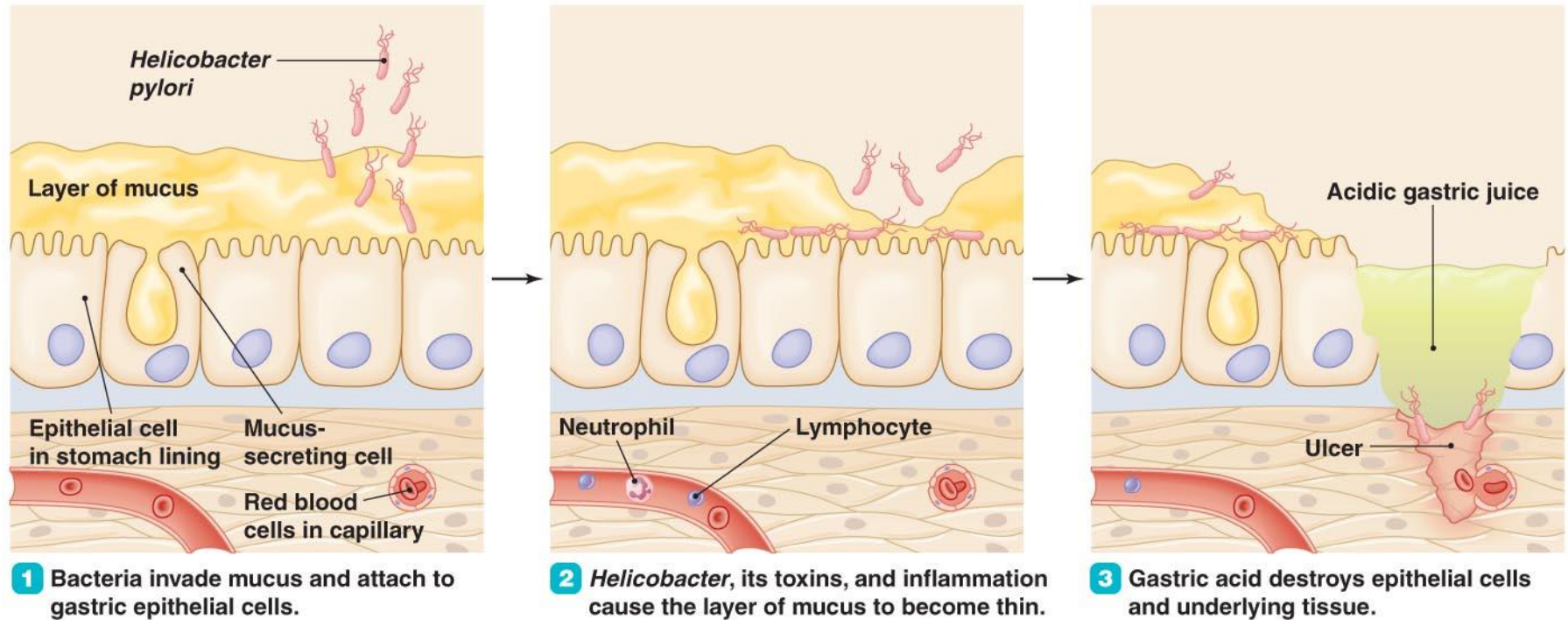
- *Campylobacter jejuni*
 - Likely most common cause of **gastroenteritis** in the United States
 - Many animals serve as reservoirs for the bacteria
 - Humans infected by consuming contaminated food, milk, or water
 - **Poultry** is the most common source of infection
 - Infections produce self-limiting **bloody and frequent diarrhea**
 - Proper food handling and preparation can reduce spread of bacteria

- *Helicobacter pylori*
 - Slightly helical, motile bacterium that colonizes stomach of its hosts
 - Causes gastritis and most peptic ulcers
 - Produces numerous virulence factors that enable it to colonize the stomach



SEM 1 μm

The role of *Helicobacter pylori* in formation of peptic ulcers 54



- *Helicobacter pylori*

- Presence of *H. pylori* can be demonstrated by positive urease test
 - Biochemical tests provide a definitive identification
- Treat with antimicrobial drugs in combination with drugs that inhibit acid production
- Prevention
 - Good hygiene
 - Adequate sewage treatment
 - Proper food handling

End of Chapter

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