BACTERIA

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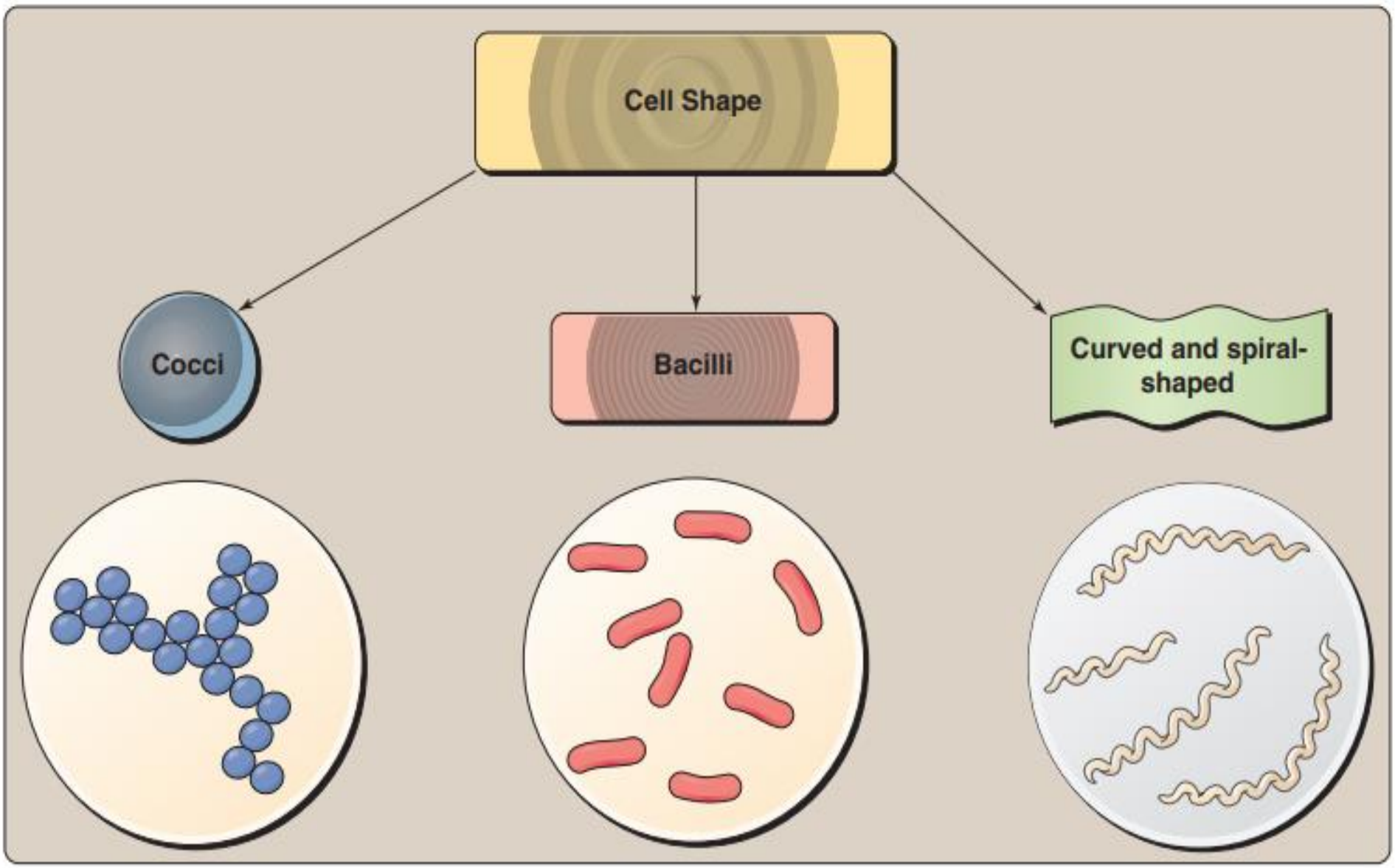
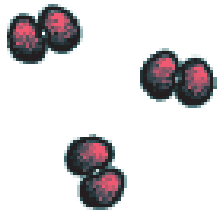
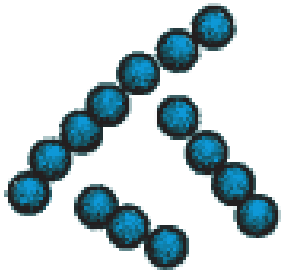
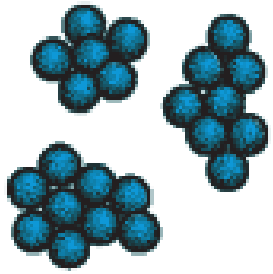
LEARNING OBJECTIVES

- Describe the characteristics used to classify Bacteria
- List specific properties of viruses that distinguish them from bacteria
- List at least three important Bacteria diseases of humans

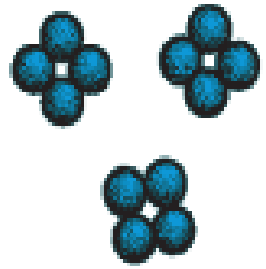
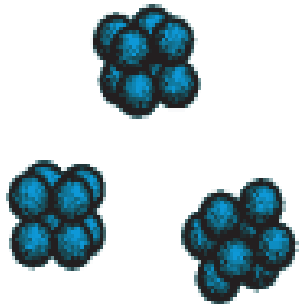
Categories of bacteria based on the shape of their cells.



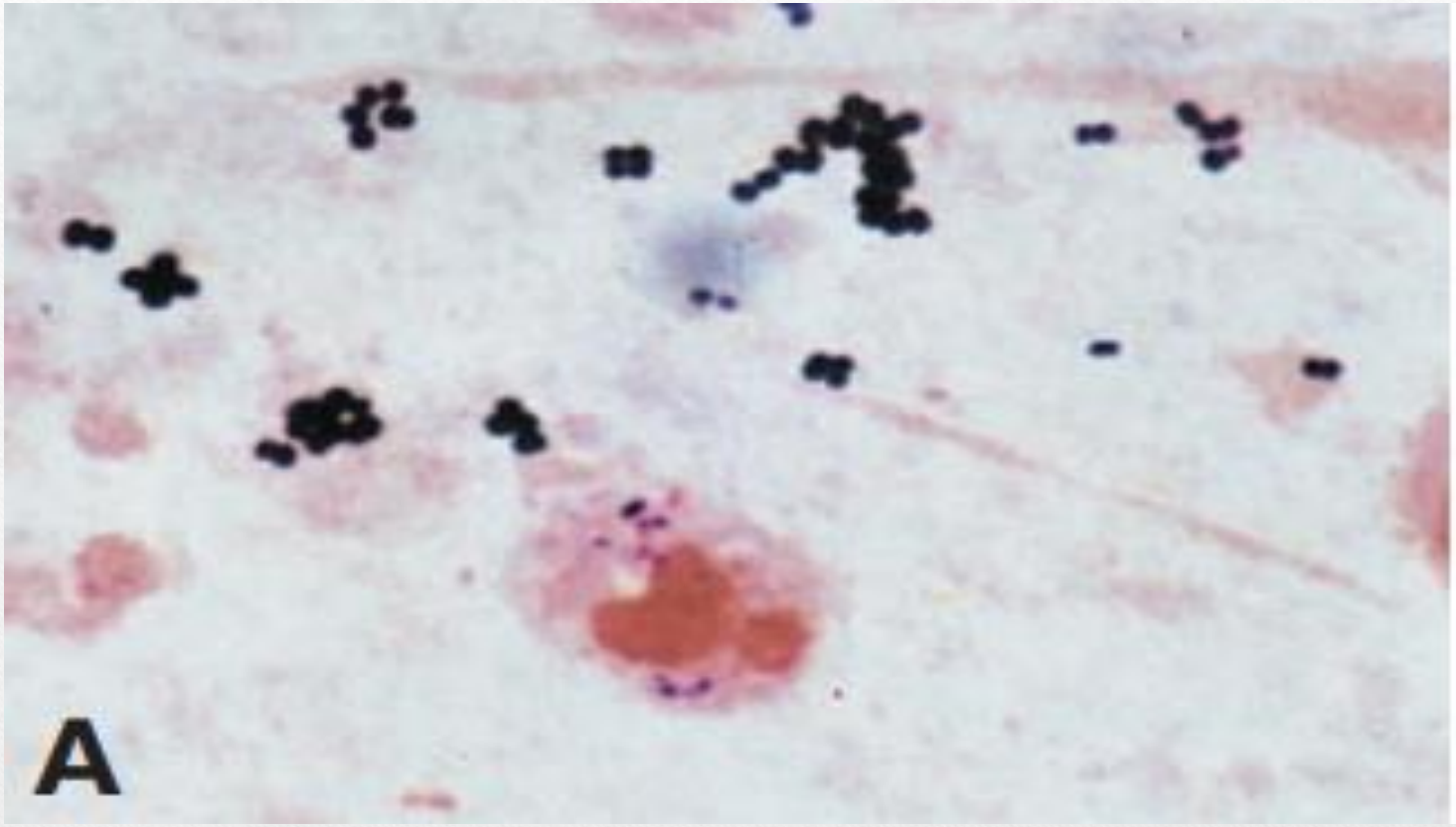
Morphologic arrangements of cocci and examples of bacteria having these arrangements.

Arrangement	Description	Appearance	Example	Disease
Diplococci	Cocci in pairs		*Neisseria gonorrhoeae*	Gonorrhea
Streptococci	Cocci in chains		*Streptococcus pyogenes*	Strep throat
Staphylococci	Cocci in clusters		*Staphylococcus aureus*	Boils

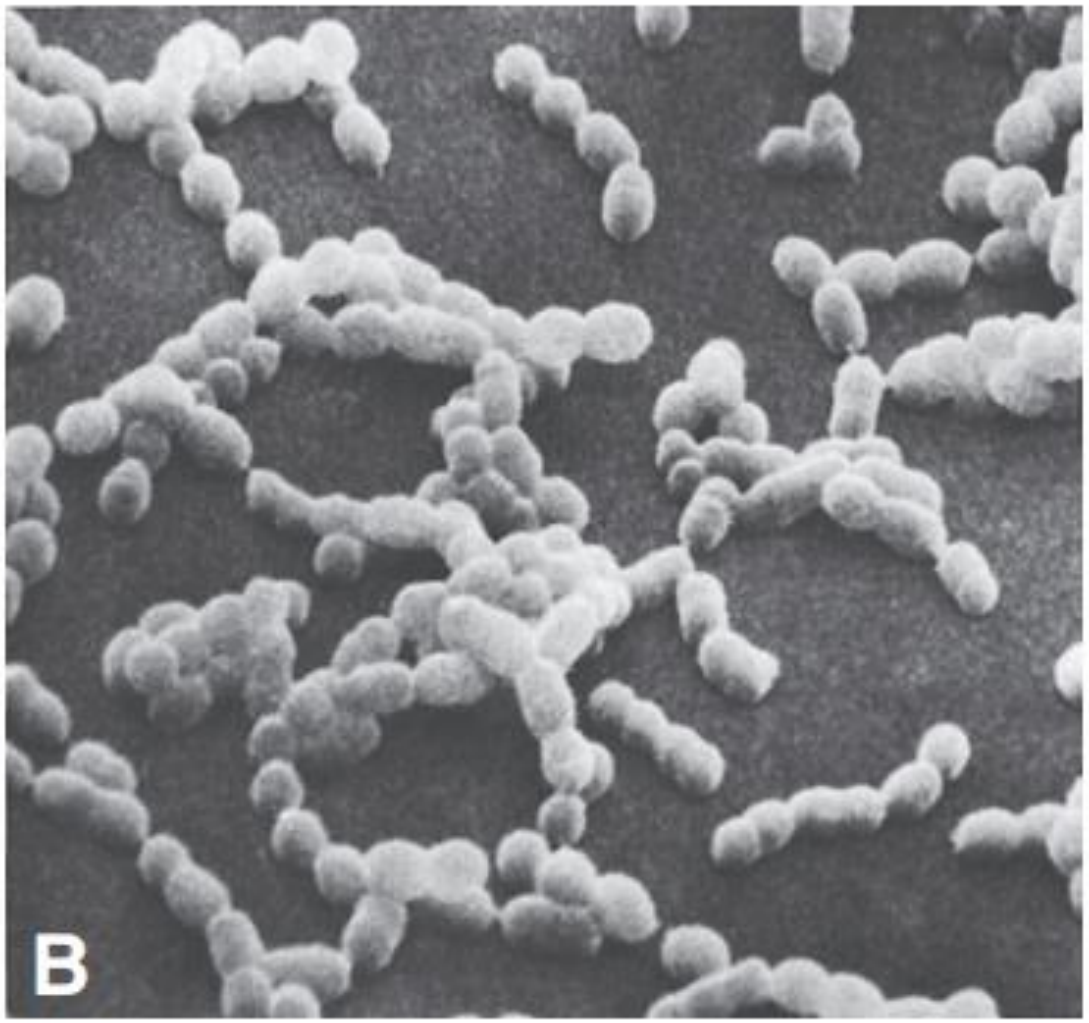
Morphologic arrangements of cocci and examples of bacteria having these arrangements. (continue)

Arrangement	Description	Appearance	Example	Disease
Tetrad	A packet of 4 cocci		*Micrococcus luteus*	Rarely pathogenic
Octad	A packet of 8 cocci		*Sarcina ventriculi*	Rarely pathogenic

Morphologic arrangements of cocci.

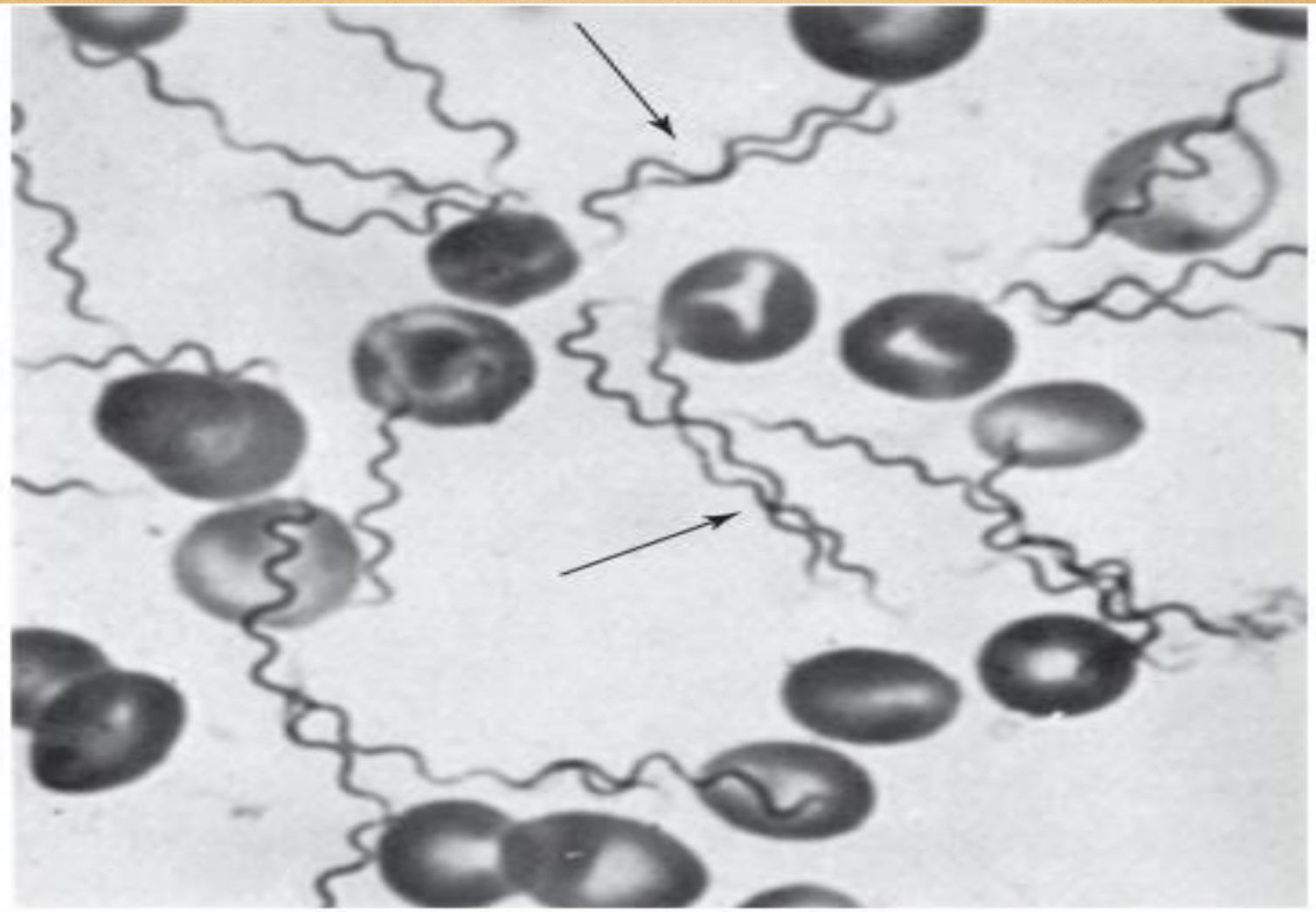


(A) Photomicrograph of Gram-stained *Staphylococcus aureus* cells illustrating Gram-positive (blue) cocci in grapelike clusters. A pink-stained white blood cell can also be seen in the lower portion of the photomicrograph. ([A] From Winn WC Jr, et al. Koneman's Color Atlas and Textbook of Diagnostic Microbiology, 6th ed. Philadelphia: Lippincott Williams & Wilkins, 2006.)



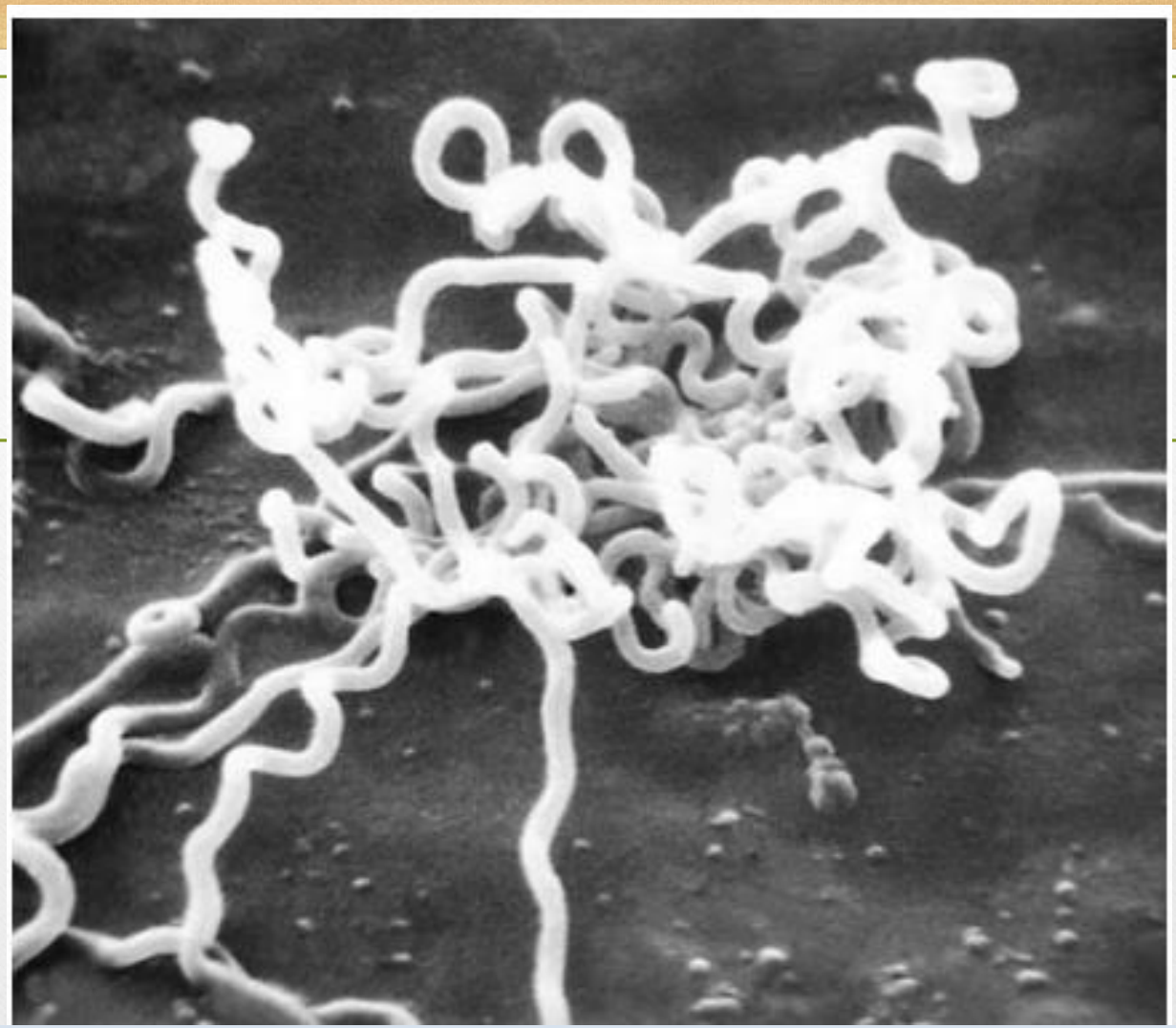
(B) Scanning electron micrograph of *Streptococcus mutans* illustrating cocci in chains.

([B] From Volk WA, et al. Essentials of Medical Microbiology, 5th ed. Philadelphia: Lippincott-Raven, 1996.)



Spiral-shaped *Borrelia hermsii* (arrows), a cause of relapsing fever, in a stained blood smear.

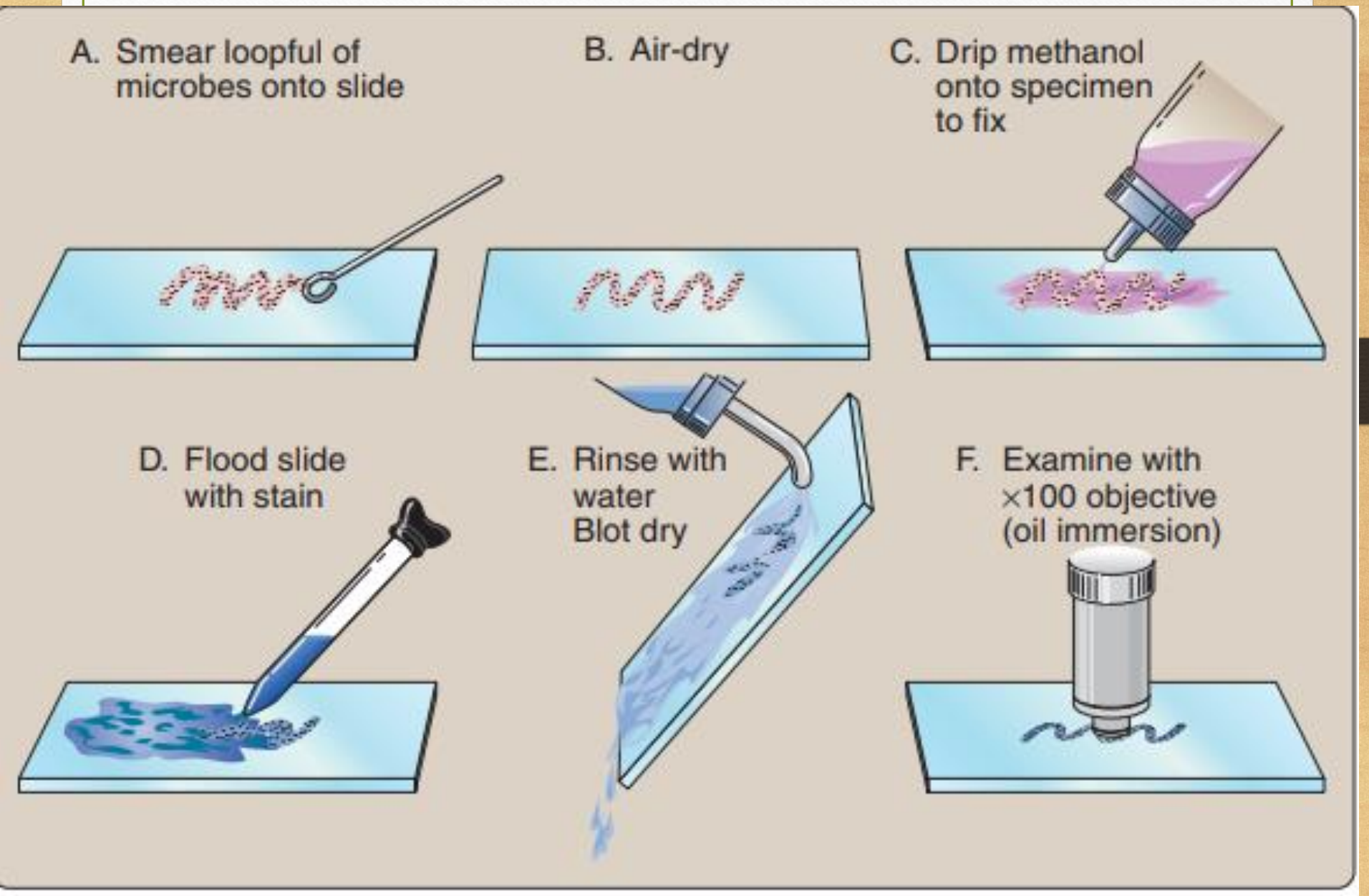
(From Volk WA, et al. Essentials of Medical Microbiology, 5th ed. Philadelphia: Lippincott Raven, 1996.)



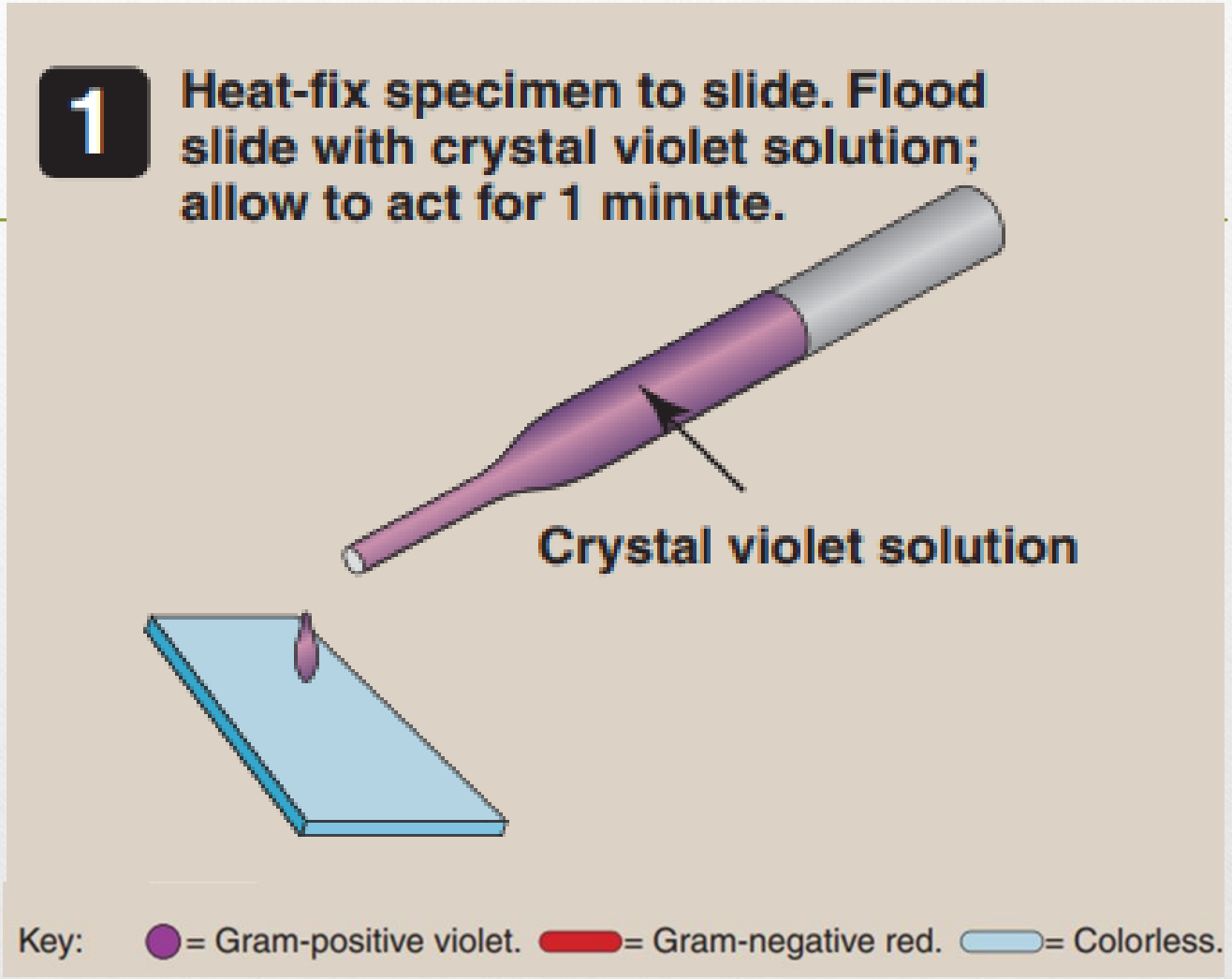
Scanning electron micrograph of *Treponema pallidum*, the bacterium that causes syphilis.

(Courtesy of Dr. David Cox and the Centers for Disease Control and Prevention.)

Simple bacterial staining technique

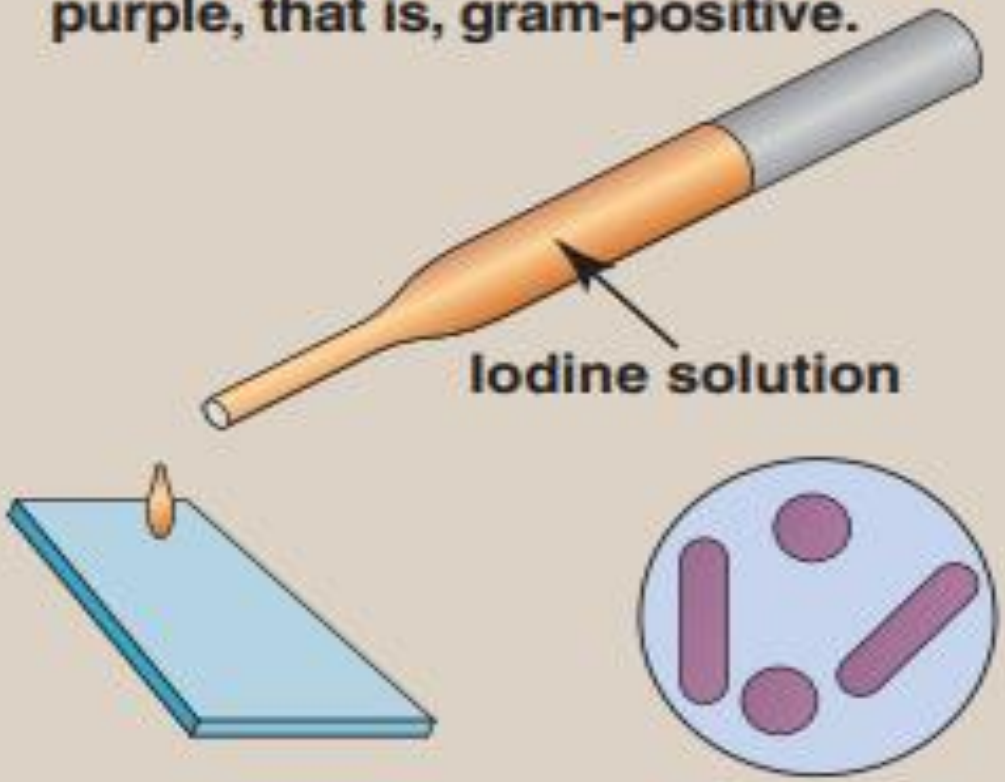


Steps in the Gram staining technique



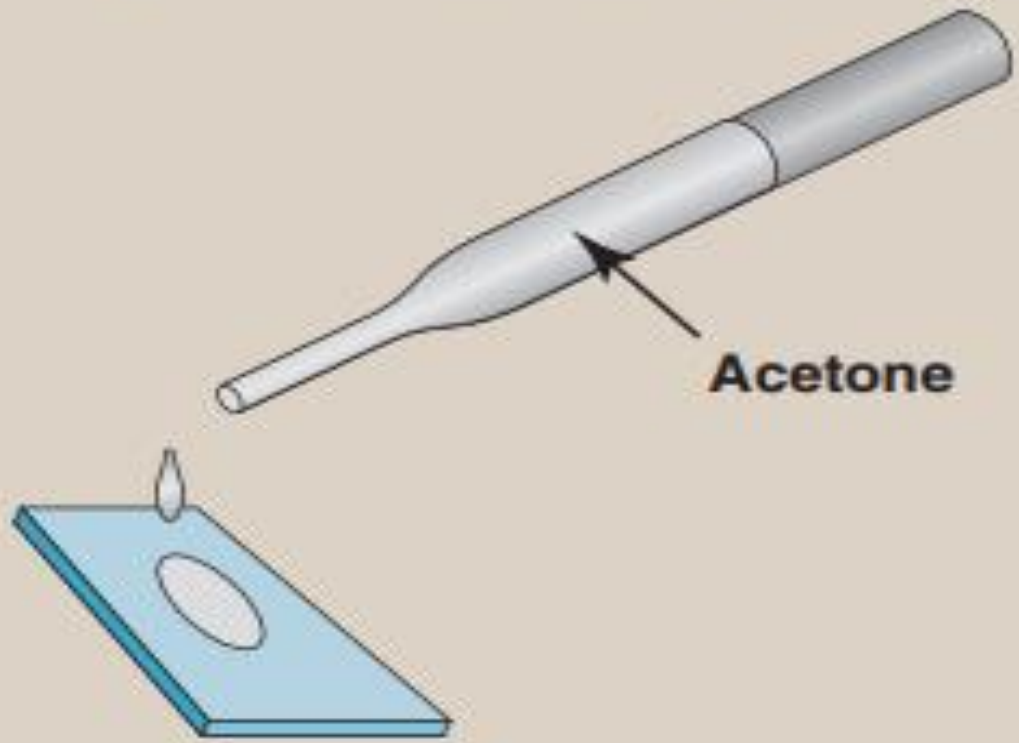
(From Harvey RA et al. Lippincott's Illustrated Reviews: Microbiology, 2nd ed. Philadelphia: Lippincott Williams & Wilkins, 2007.)

2 Rinse the slide, then flood with iodine solution; allow iodine to act for 1 minute. Before acetone decolorization (next step), all organisms appear purple, that is, gram-positive.



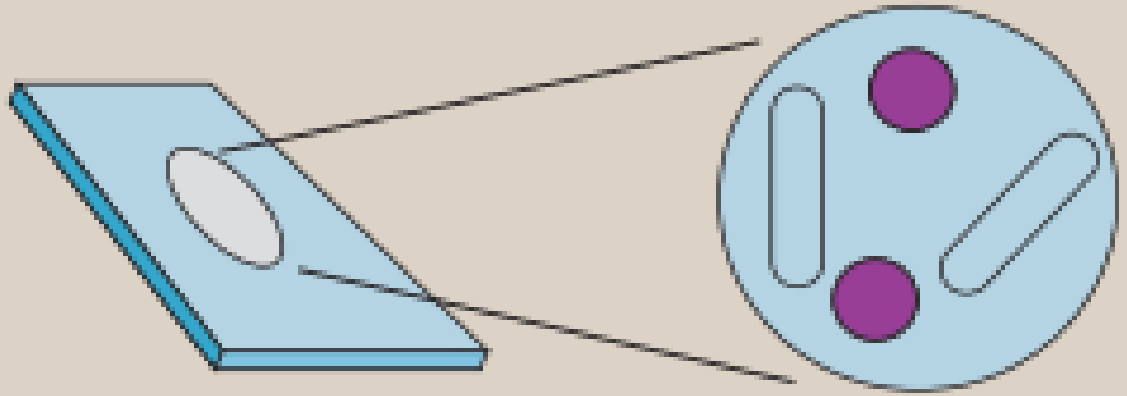
Key: = Gram-positive violet. = Gram-negative red. = Colorless.

3 **Rinse off excess iodine. Decolorize with acetone, approximately 5 seconds (time depends on density of specimen).**

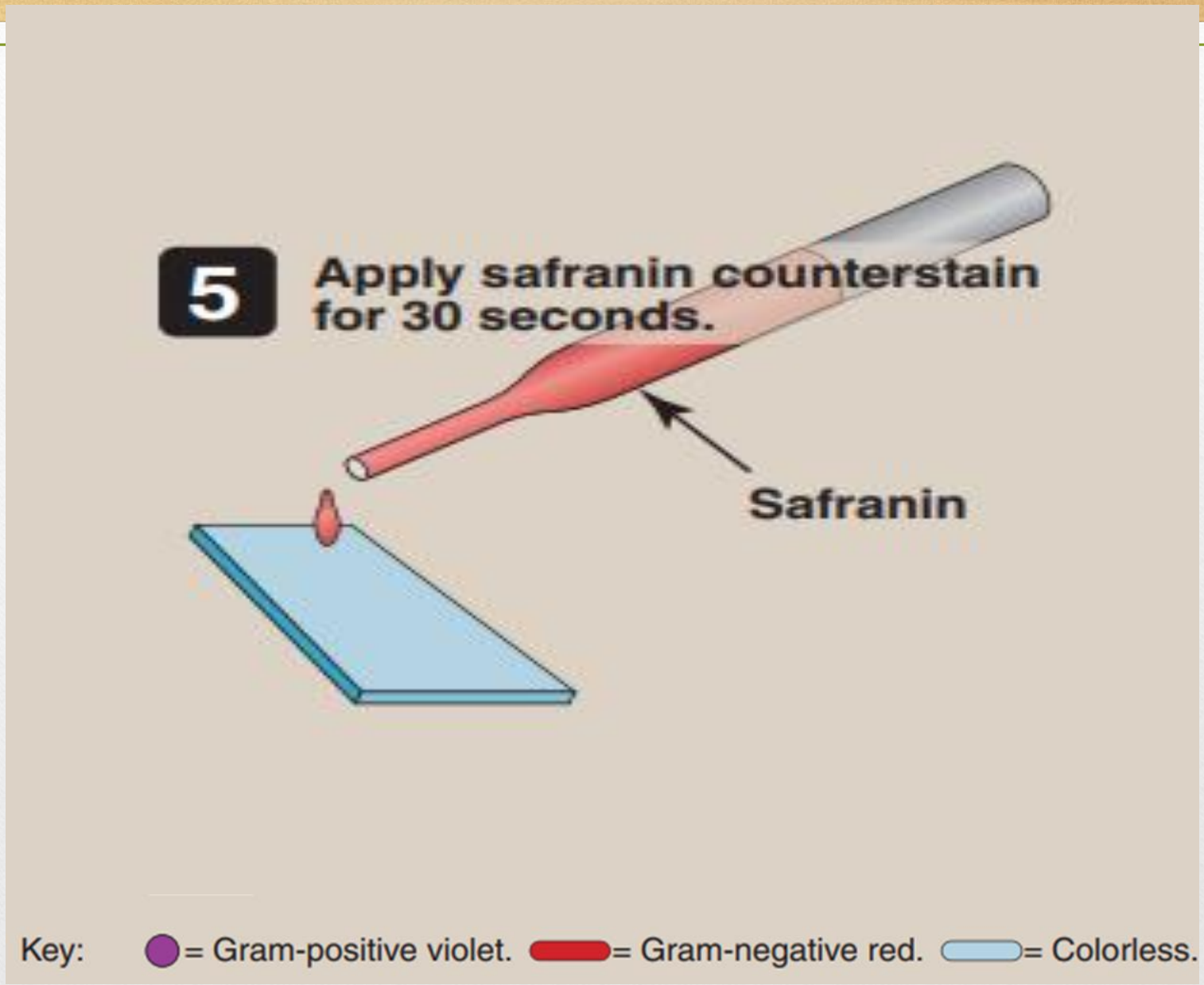


Key: = Gram-positive violet. = Gram-negative red. = Colorless.

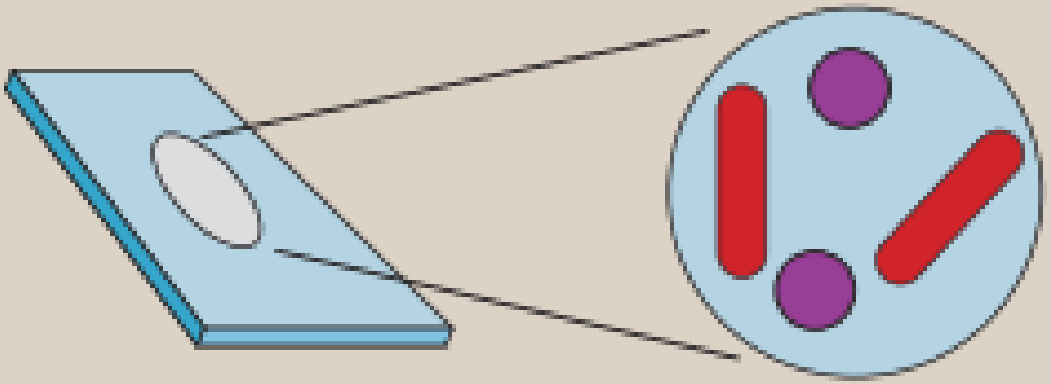
4 **Wash slide immediately in water. After acetone decolorization, those organisms that are gram-negative are no longer visible.**



Key: = Gram-positive violet. = Gram-negative red. = Colorless.


5
Apply safranin counterstain for 30 seconds.
Safranin
Key:
= Gram-positive violet.
= Gram-negative red.
= Colorless.

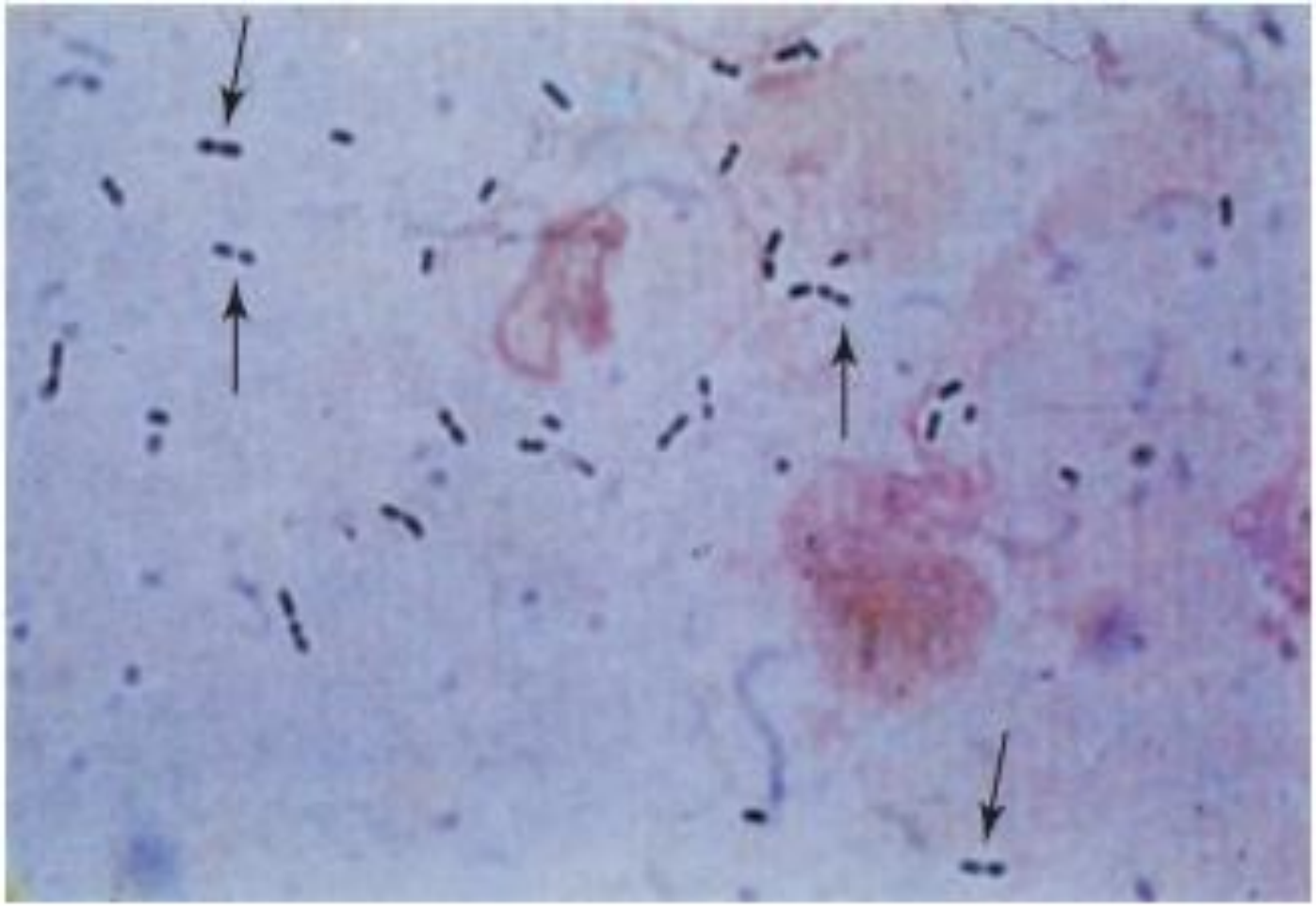
6 **Wash in water, blot, and dry in air. Gram-negative organisms are visualized after application of the counterstain.**



Key: = Gram-positive violet. = Gram-negative red. = Colorless.

Chains of Gram-positive streptococci in a Gram-stained smear from a broth culture.

(From Winn WC Jr, et al. Koneman's Color Atlas and Textbook of Diagnostic Microbiology, 6th ed. Philadelphia: Lippincott Williams & Wilkins, 2006.)

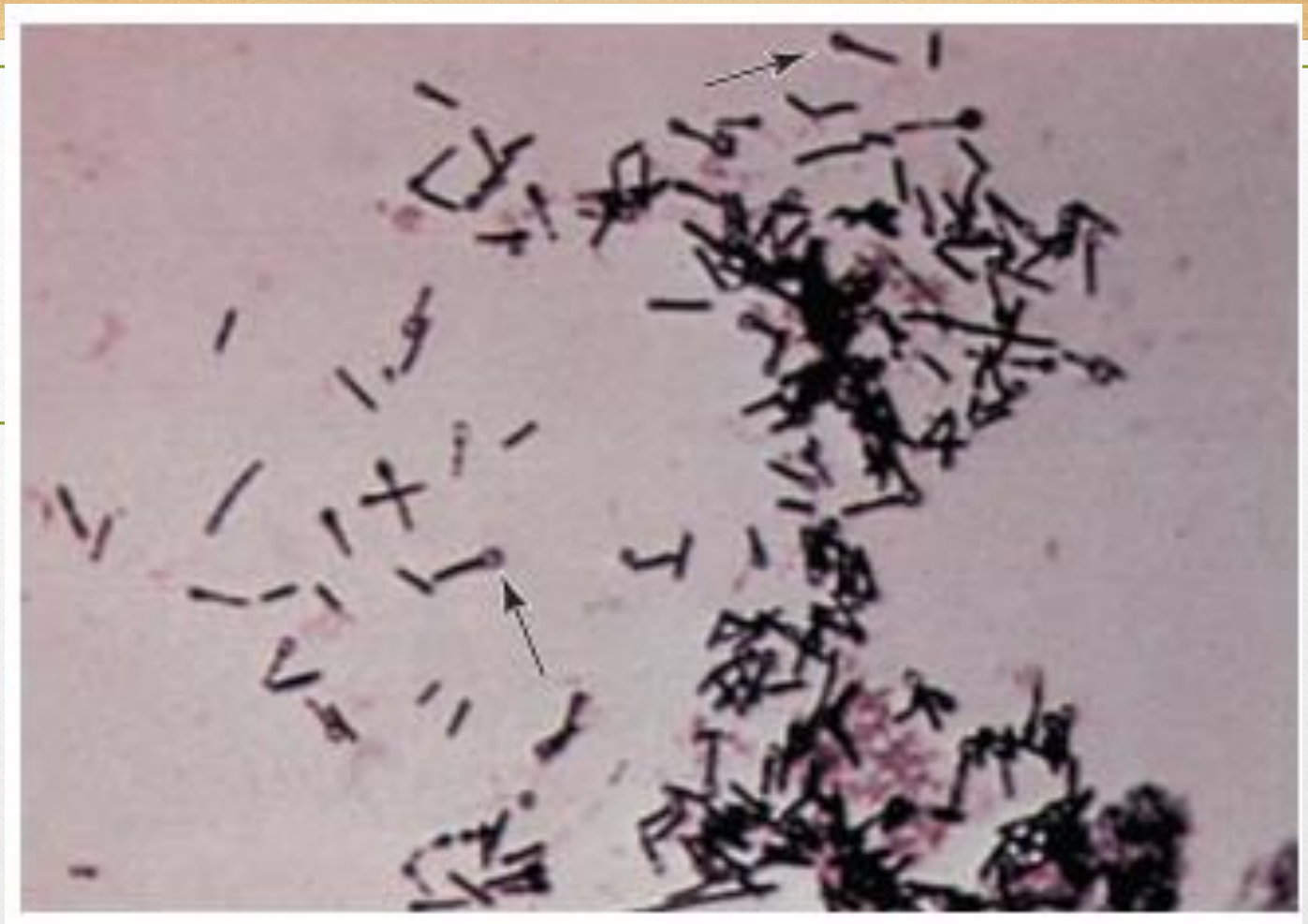


Gram-positive *Streptococcus pneumoniae* in a Gram-stained smear of a blood culture. Note the pairs of cocci, known as diplococci (arrows).

(From Winn WC Jr, et al. Koneman's Color Atlas and Textbook of Diagnostic Microbiology, 6th ed. Philadelphia: Lippincott Williams & Wilkins, 2006.)

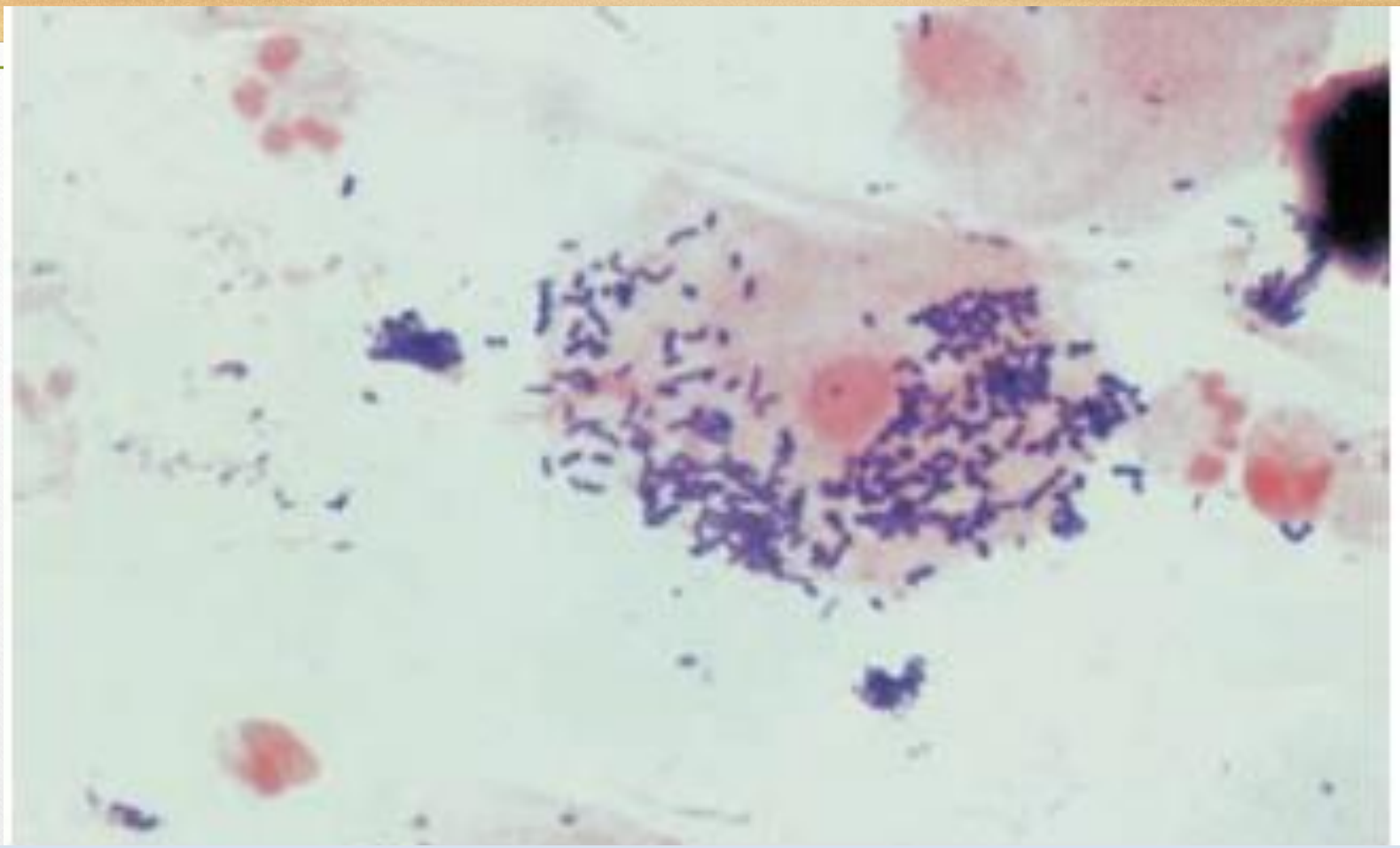
Gram-positive bacilli (*Clostridium perfringens*) in a Gram-stained smear prepared from a broth culture. Individual bacilli and chains of bacilli (streptobacilli) can be seen.

(From Winn WC Jr, et al. Koneman's Color Atlas and Textbook of Diagnostic Microbiology, 6th ed. Philadelphia: Lippincott Williams & Wilkins, 2006.)



Gram-positive bacilli (*Clostridium tetani*) in a Gram-stained smear from a broth culture. Terminal spores can be seen on some of the cells (arrows).

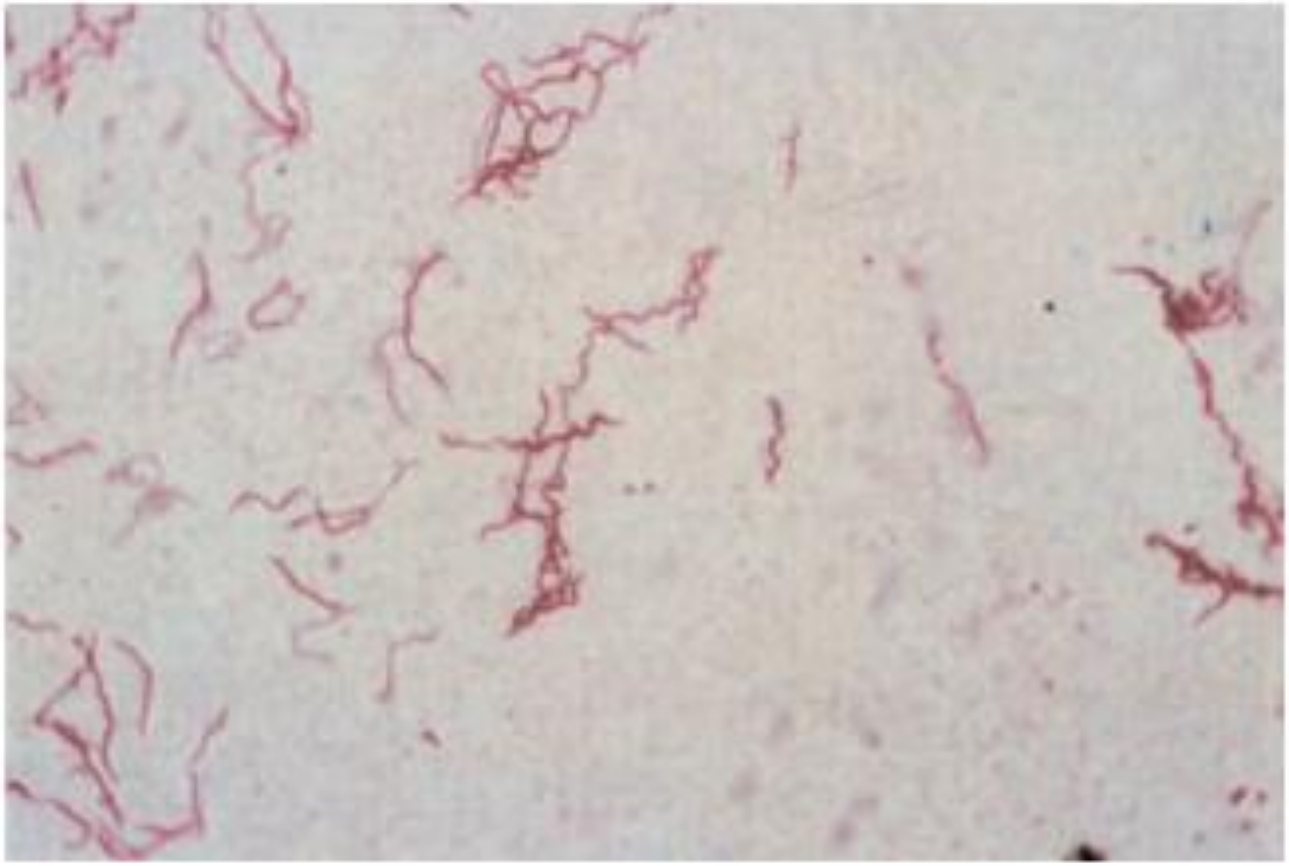
(From Winn WC Jr, et al. Koneman's Color Atlas and Textbook of Diagnostic Microbiology, 6th ed. Philadelphia:Lippincott Williams & Wilkins, 2006.)



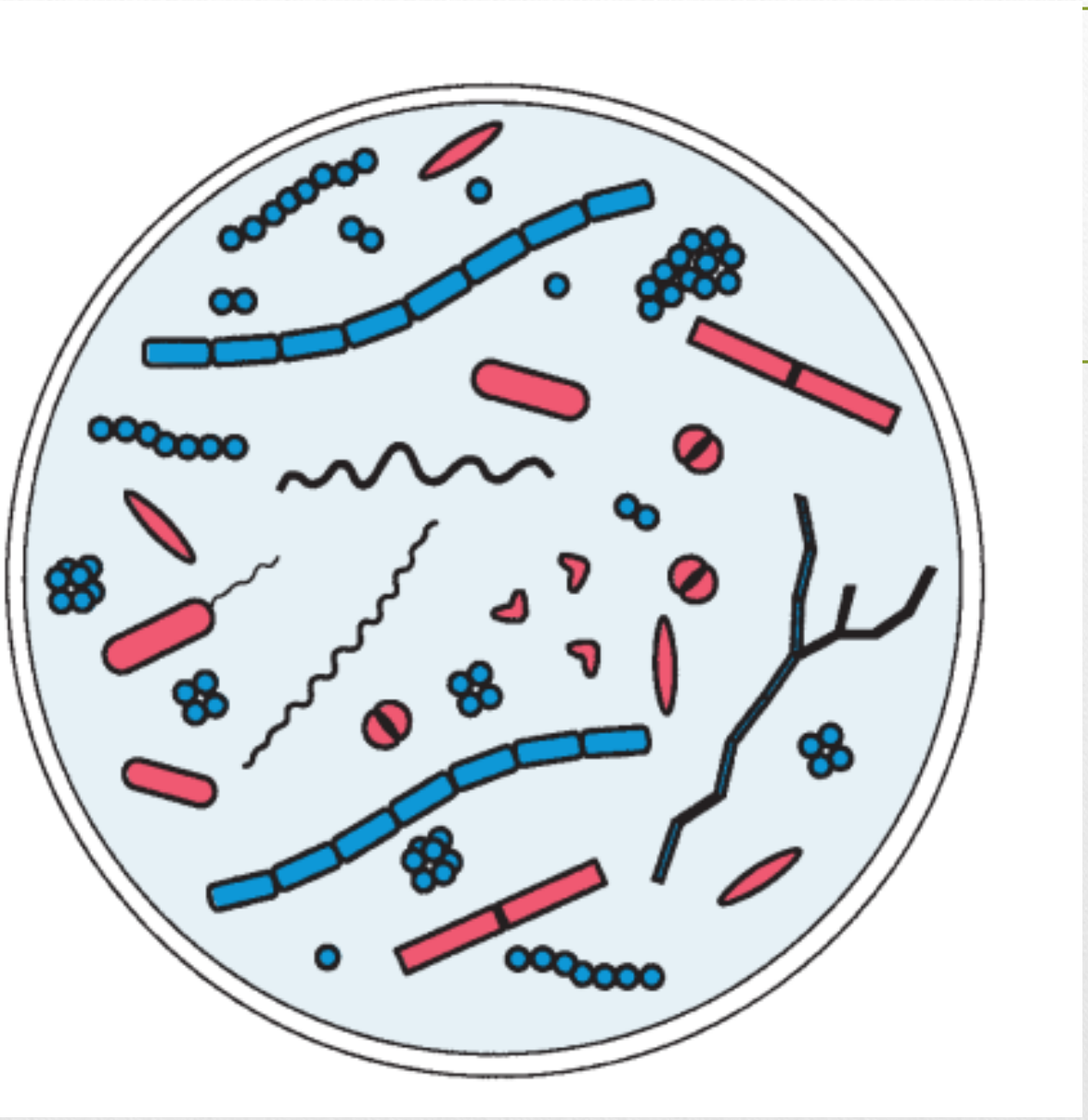
Many Gram-positive bacteria can be seen on the surface of a pink-stained epithelial cell in this Gram-stained sputum specimen. Several smaller pink-staining polymorphonuclear leukocytes can also be seen. (From Winn WC Jr, et al. Koneman's Color Atlas and Textbook of Diagnostic Microbiology, 6th ed. Philadelphia: Lippincott Williams & Wilkins, 2006.)

Gram-negative bacilli in a Gram stained smear prepared from a bacterial colony. Individual bacilli and a few short chains of bacilli can be seen.

(From Koneman E, et al. Color Atlas and Textbook of Diagnostic Microbiology, 5th ed. Philadelphia: Lippincott Williams & Wilkins, 1997.)



Loosely coiled Gram-negative spiro-chetes. *Borrelia burgdorferi* is the etiologic agent (cause) of Lyme disease. (From Winn WC Jr, et al. Koneman's Color Atlas and Textbook of Diagnostic Microbiology, 6th ed. Philadelphia: Lippincott Williams & Wilkins, 2006.)

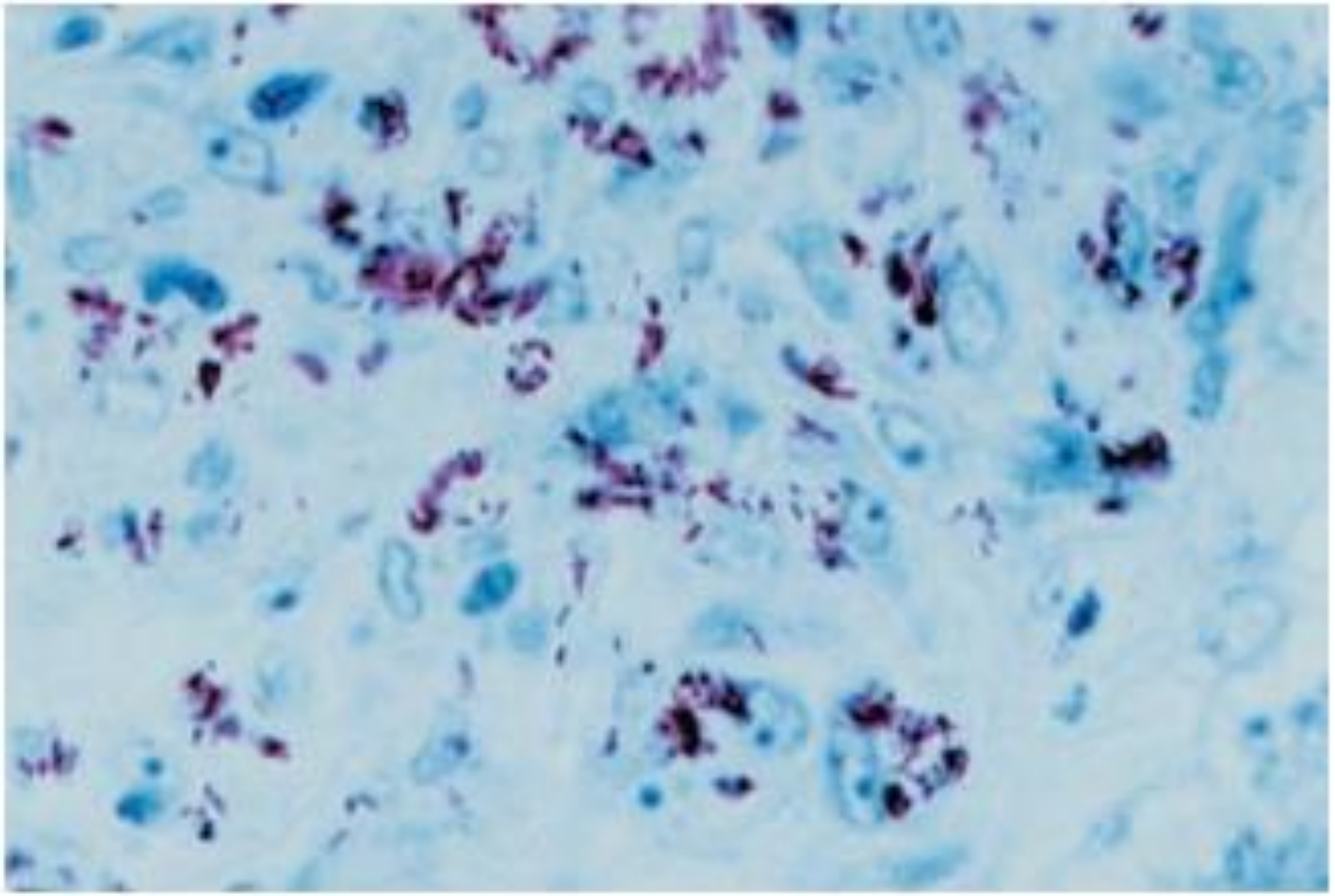


Characteristics of Some Important Pathogenic Bacteria

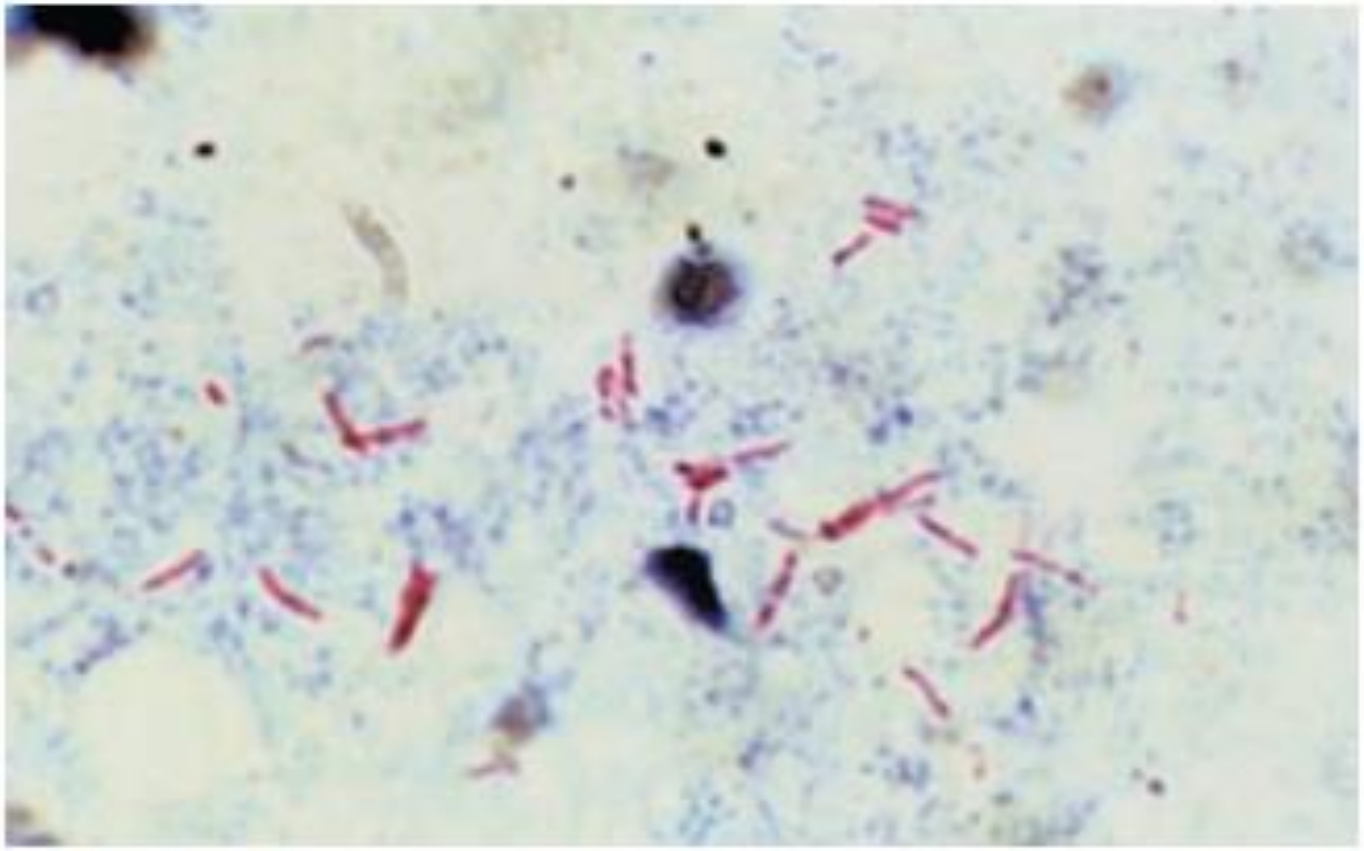
STAINING REACTION	MORPHOLOGY	BACTERIUM	DISEASE(S)
Gram-positive	Cocci in clusters	*Staphylococcus aureus*	Wound infections, boils, pneumonia, septicemia, food poisoning
	Cocci in chains	*Streptococcus pyogenes*	Strep throat, scarlet fever, necrotizing fasciitis, septicemia
	Diplococci	*Streptococcus pneumoniae*	Pneumonia, meningitis, ear and sinus infections
	Bacillus	*Corynebacterium diphtheriae*	Diphtheria
	Spore-forming bacillus	*Bacillus anthracis*	Anthrax
		Clostridium botulinum	Botulism
		Clostridium perfringens	Wound infections, gas gangrene, food poisoning
		Clostridium tetani	tetanus

Characteristics of Some Important Pathogenic Bacteria

Gram-negative	Diplococci	*Neisseria gonorrhoeae*	gonorrhea
		Neisseria meningitidis	Meningitis, respiratory infections
	Bacillus	*Bordetella pertussis*	Whooping cough (pertussis)
		Brucella abortus	Brucellosis
		Chlamydia trachomatis	Genital infections, trachoma
		Escherichia coli	Urinary tract infections, septicemia
		Francisella tularensis	Tularemia
		Haemophilus ducreyi	Chancroid
		Haemophilus influenzae	Meningitis; respiratory, ear and sinus infections
		Klebsiella pneumoniae	Urinary tract and respiratory infections
		Proteus vulgaris	Urinary tract infections
		Pseudomonas aeruginosa	Respiratory, urinary, and wound infections
		Rickettsia rickettsii	Rocky Mountain spotted fever
		Salmonella typhi	Typhoid fever
		Salmonella spp.	Gastroenteritis
		Shigella spp.	Gastroenteritis
		Yersinia pestis	Plague
	Curved bacillus	*Vibrio cholerae*	Cholera
	Spirochete	*Treponema pallidum*	Syphillis
Acid-fast, Gram-variable	Branching bacilli	*Mycobacterium leprae*	Leprosy (Hansen disease)
		Mycobacterium tuberculosis	Tuberculosis



Many red acid-fast mycobacteria can be seen in this acid-fast stained liver biopsy specimen. (From Winn WC Jr, et al. Koneman's Color Atlas and Textbook of Diagnostic Microbiology, 6th ed. Philadelphia: Lippincott Williams & Wilkins, 2006.)

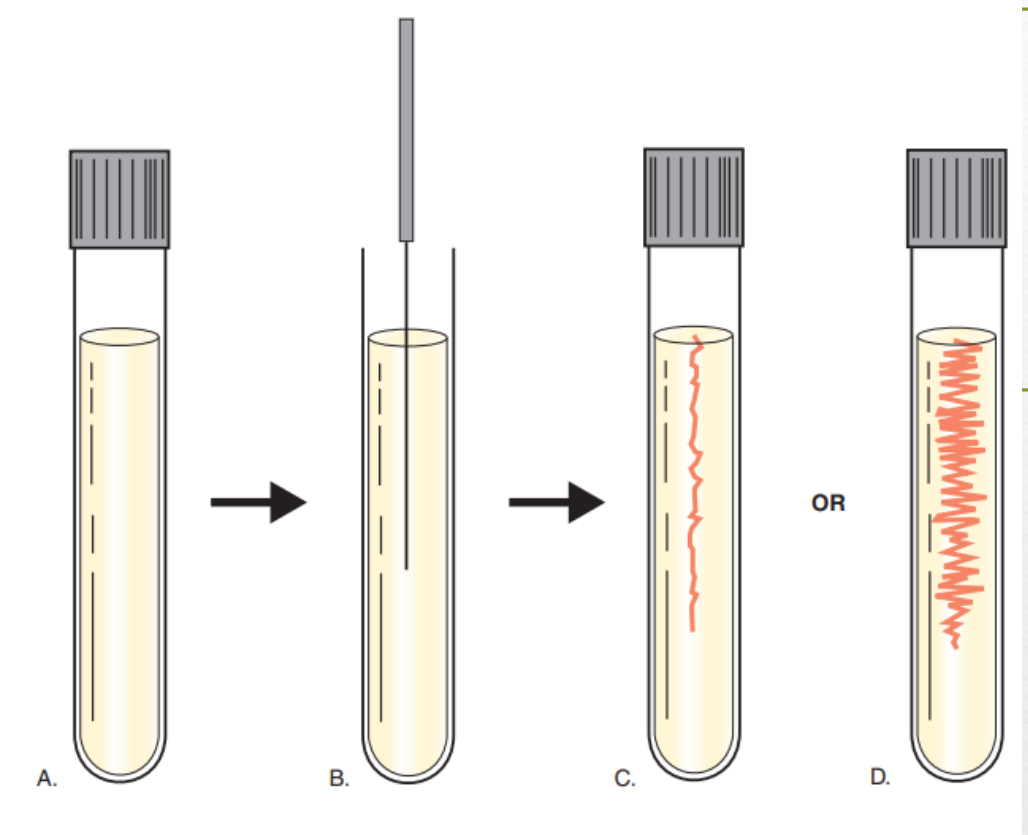


Many red acid-fast bacilli (*Mycobacterium tuberculosis*) can be seen in this acid-fast stained concentrate from a digested sputum specimen. **(From Koneman, E, et al. Color Atlas and Textbook of Diagnostic Microbiology, 5th ed. Philadelphia: Lippincott Williams & Wilkins, 1997.)**

Types of Bacterial Staining Procedures

CATEGORY	EXAMPLE(S)	PURPOSE
Simple staining procedure	Staining with methylene blue	Merely to stain the cells so that their size, shape, and morphologic arrangement can be determined
Structural staining procedures	Capsule stains	To determine whether the organism is encapsulated
	Flagella stains	To determine whether the organism possesses flagella and, if so, their number and location on the cell
	Endospore stains	To determine whether the organism is a spore-former and, if so, to determine whether the spores are terminal or subterminal spores
Differential staining procedures	Gram stain	To differentiate between Gram-positive and Gram-negative bacteria
	Acid-fast stain	To differentiate between acid-fast and non–acid-fast bacteria

Motility



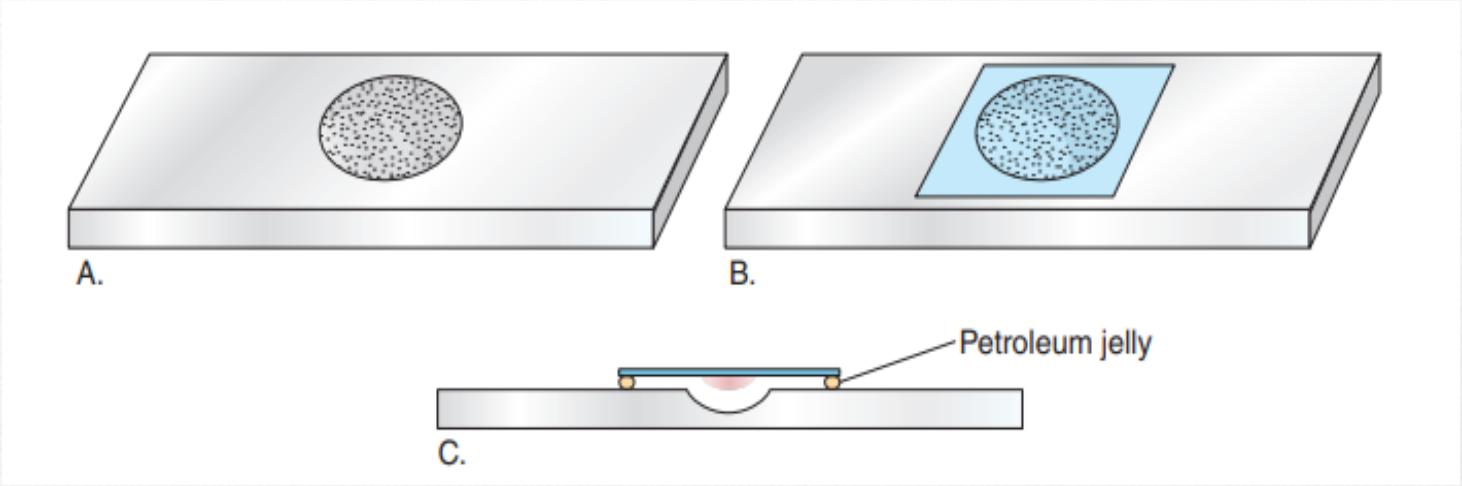
Semisolid agar method for determining motility.

(A) Uninoculated tube of semisolid agar.

(B) Same tube being inoculated by stabbing the inoculating wire into the medium.

(C) Pattern of growth of a nonmotile organism, after incubation.

(D) Pattern of growth of a motile organism, after incubation.



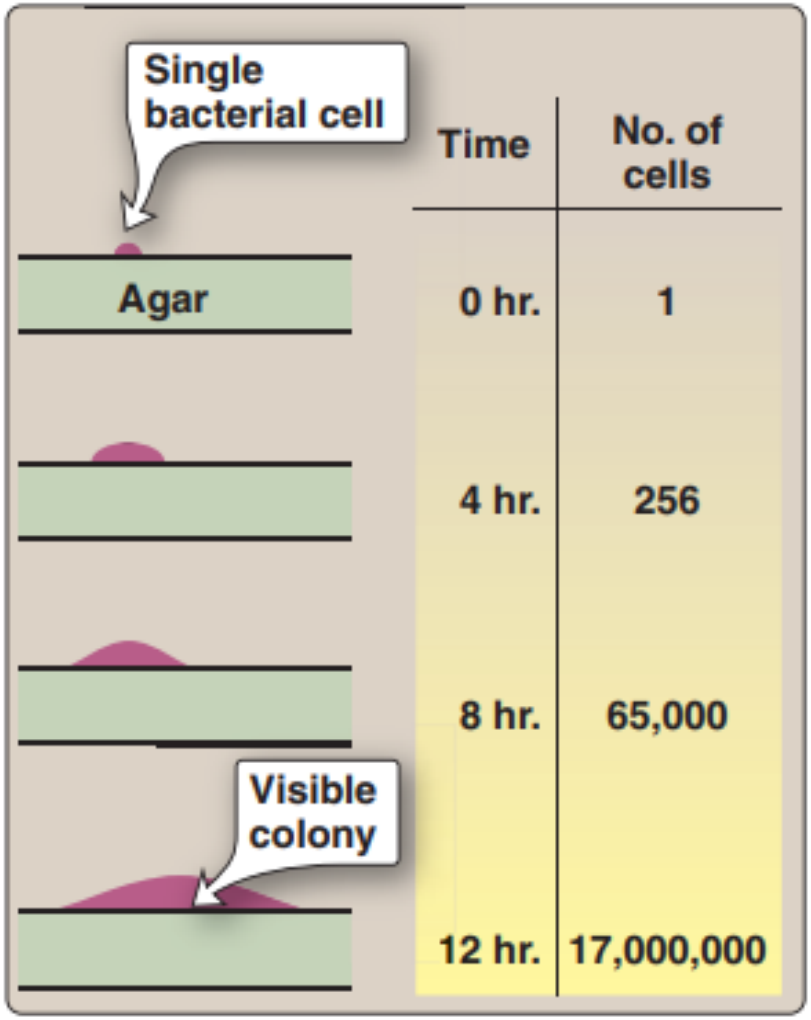
Hanging-drop preparation for study of living bacteria.

(A) Depression slide.

(B) Depression slide with coverglass over the depression area.

(C) Side view of hanging-drop preparation showing the drop of liquid culture medium hanging from the center of the coverglass above the depression.

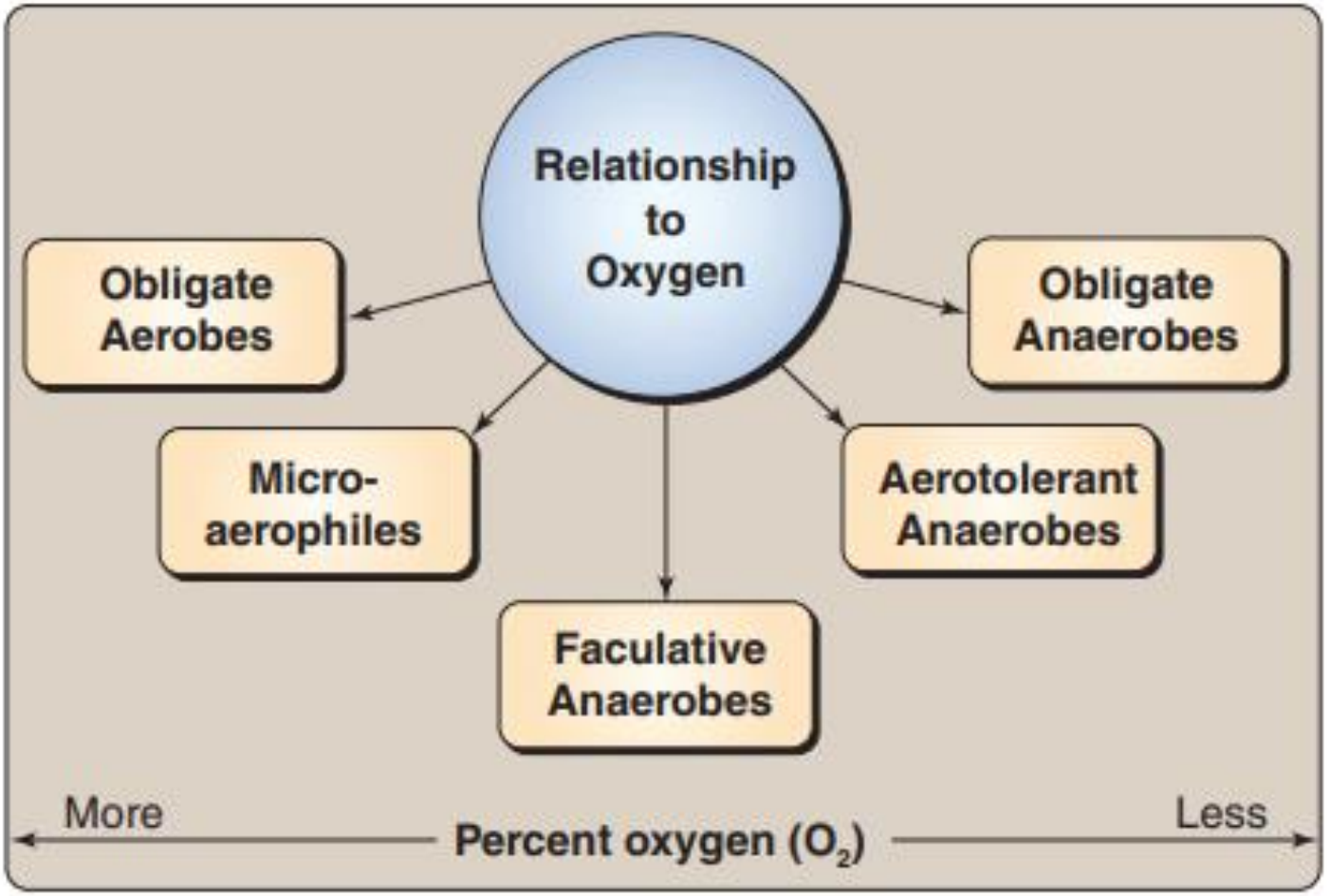
Colony Morphology



Formation of a bacterial colony on solid growth medium. In this illustration, the generation time is assumed to be 30 minutes.

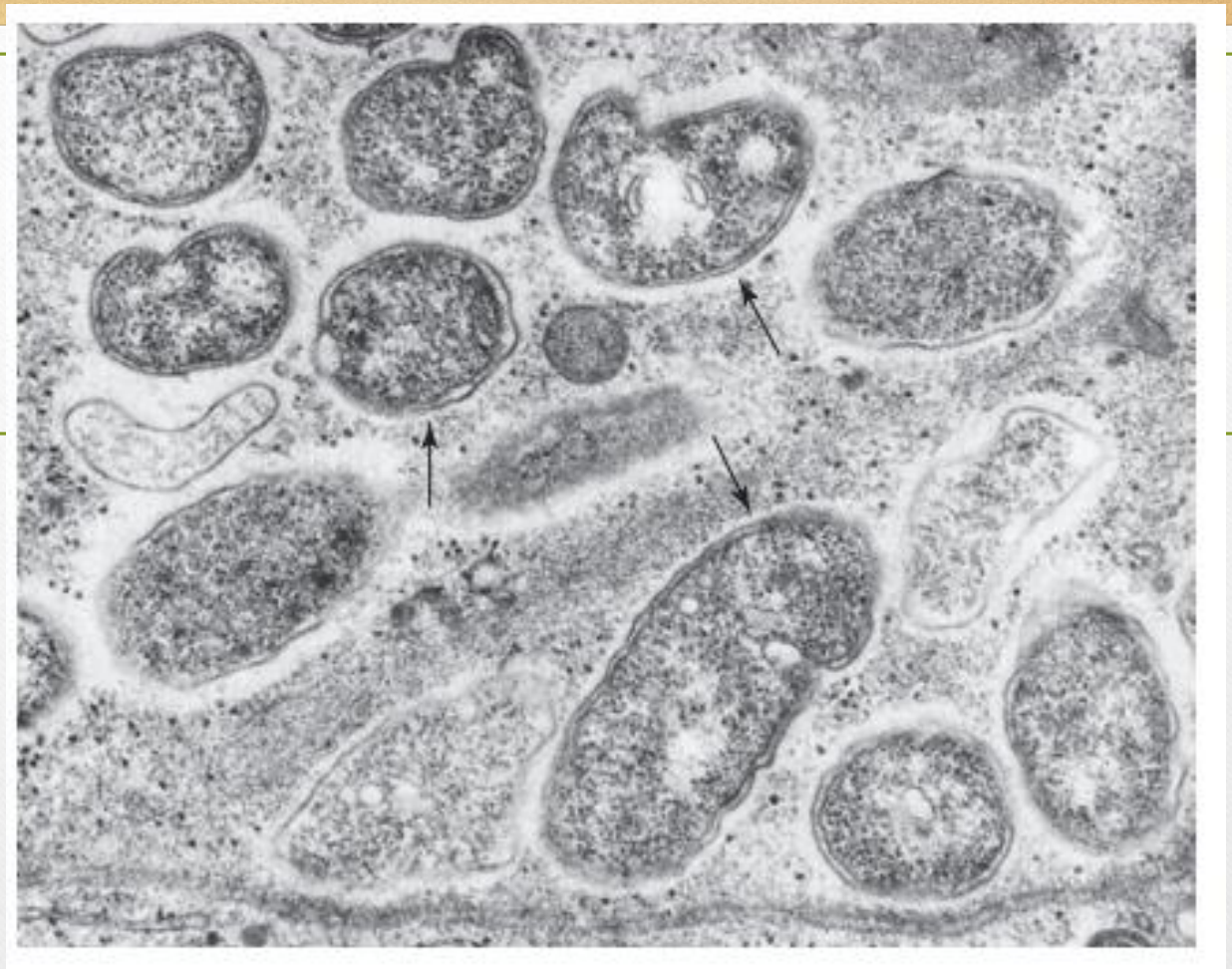
(From Harvey RA,et al. Lippincott's Illustrated Reviews: Microbiology, 2nd ed. Philadelphia: Lippincott Williams & Wilkins, 2007.)

Categories of bacteria based on their relationship to oxygen



Rickettsias, Chlamydias, and Closely Related Bacteria

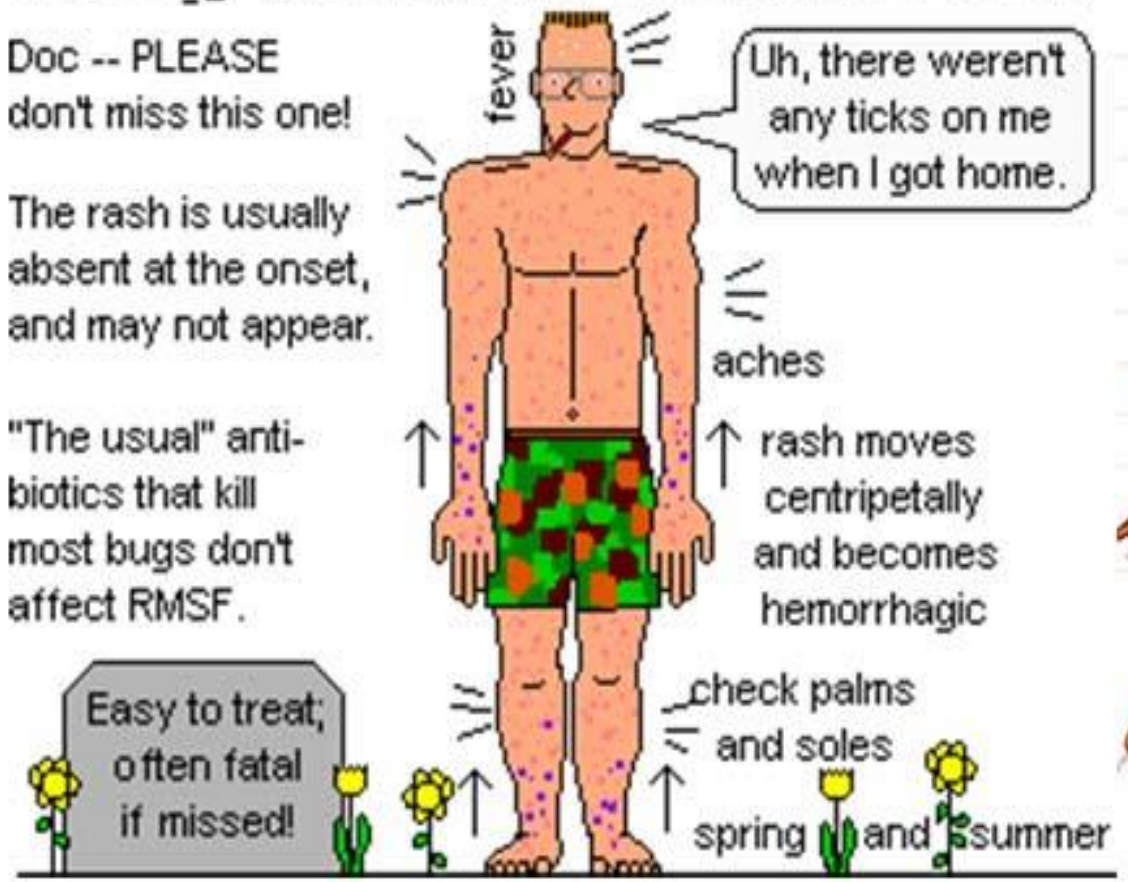
https://journals.plos.org/plosntds/article



Rickettsia prowazekii **(arrows), the cause of epidemic louseborne typhus, in experimentally infected tick tissue.**

(From Volk WA, et al. Essentials of Medical Microbiology, 5th ed. Philadelphia: Lippincott-Raven, 1996.)

Rocky Mountain Spotted Fever

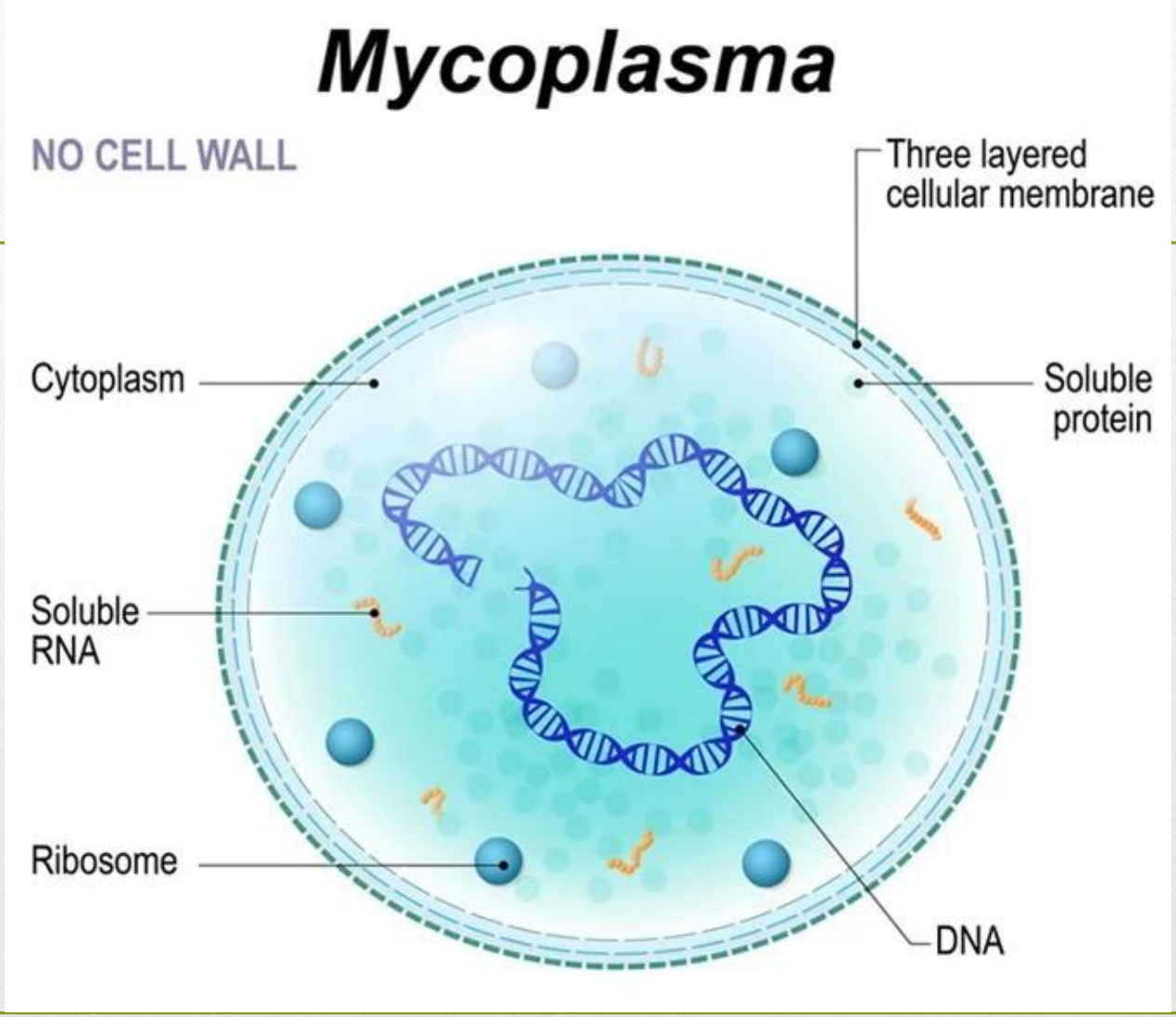


https://microbenotes.com/pathogenesis

Human Diseases Caused by Unique Bacteria

GENUS	SPECIES	HUMAN DISEASE(S)
Rickettsia	*R. akari*	Rickettsialpox (a miteborne disease)
	R. prowazekii	Epidemic typhus (a louseborne disease)
	R. rickettsii	Rocky Mountain spotted fever (a tickborne disease)
	R. typhi	Endemic or murine typhus (a fleaborne disease)
Ehrlichia spp.	*E. chaffeensis*	Human monocytic ehrlichiosis
Anaplasma spp.	*Anaplasma phagocytophilum*	Human granulocytic ehrlichiosis
Chlamydia (and *Chlamydia*–like bacteria)	*Chlamydophila pneumoniae*	Pneumonia
	Chlamydophila psittaci	Psittacosis (a respiratory disease; a zoonosis; sometimes called "parrot fever")
	Chlamydia trachomatis	Different serotypes cause different diseases, including trachoma (an eye disease) inclusion conjunctivitis (an eye disease), nongonococcal urethritis (NGU; a sexually transmitted disease), lymphogranuloma venereum (LGV; a sexually transmitted disease)
Mycoplasma	*M. pneumoniae*	Atypical pneumonia
	M. genitalium	Nongonococcal urethritis (NGU)
Orientia	*O. tsutsugamushi*	Scrub typhus (a miteborne disease)
Ureaplasma	*U. urealyticum*	Nongonococcal urethritis (NGU)

Mycoplasmas



https://www.news-medical.net/health/

Scanning electron micrograph of *Mycoplasma pneumoniae*.

(From Strohl WA, et al. Lippincott's Illustrated Reviews: Microbiology. Philadelphia: Lippincott Williams & Wilkins, 2001.)


Engbreaking