

# Introduction to Microbiology

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Ph.D.



Lecture  
14

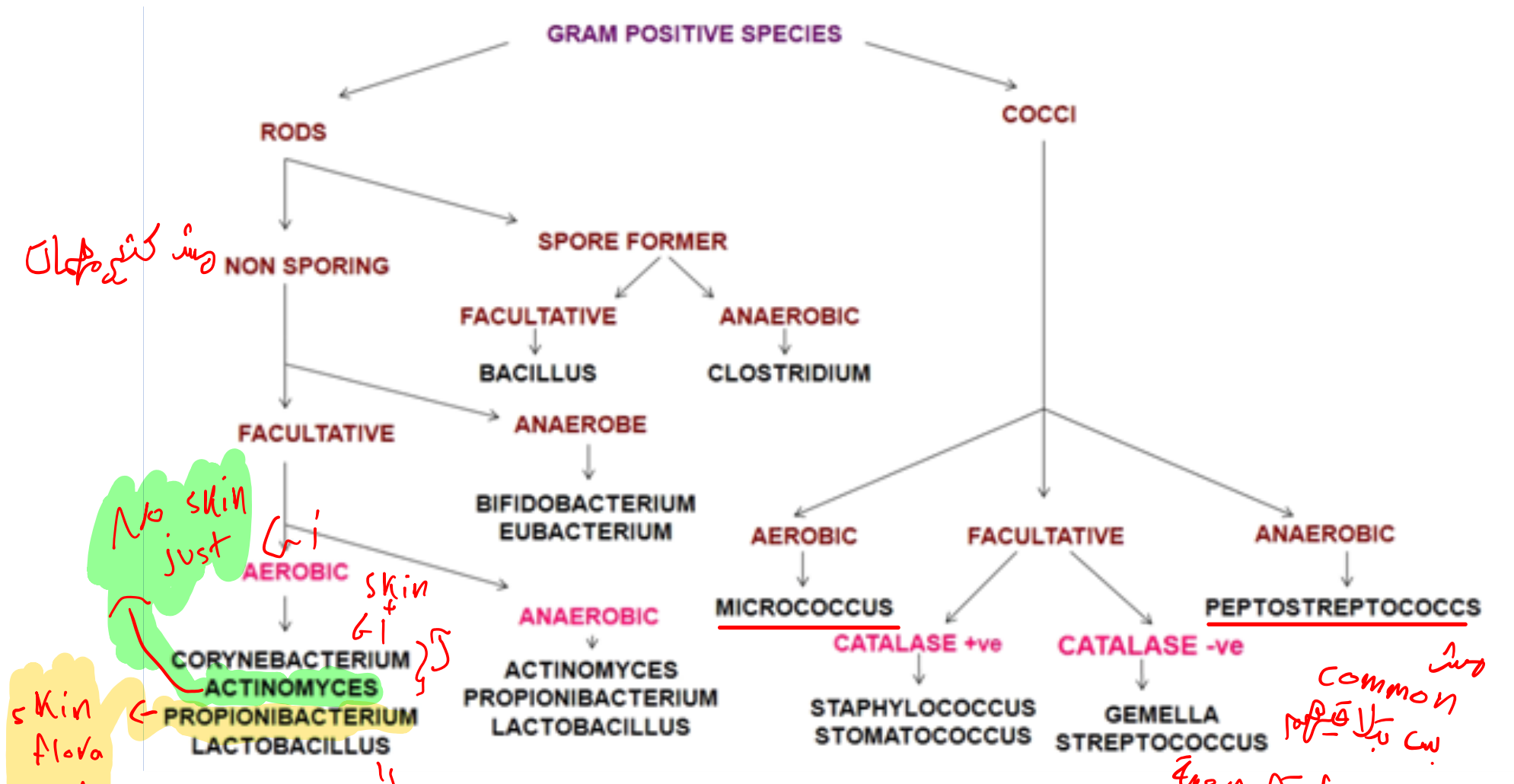
# Overview

**Pathogens that will be discussed this lecture are**

- **Non-Spore-Forming Gram-Positive rods (aerobic and anaerobic),**
- **anerobic gram positive cocci,**
- **anaerobic gram-negative rods**



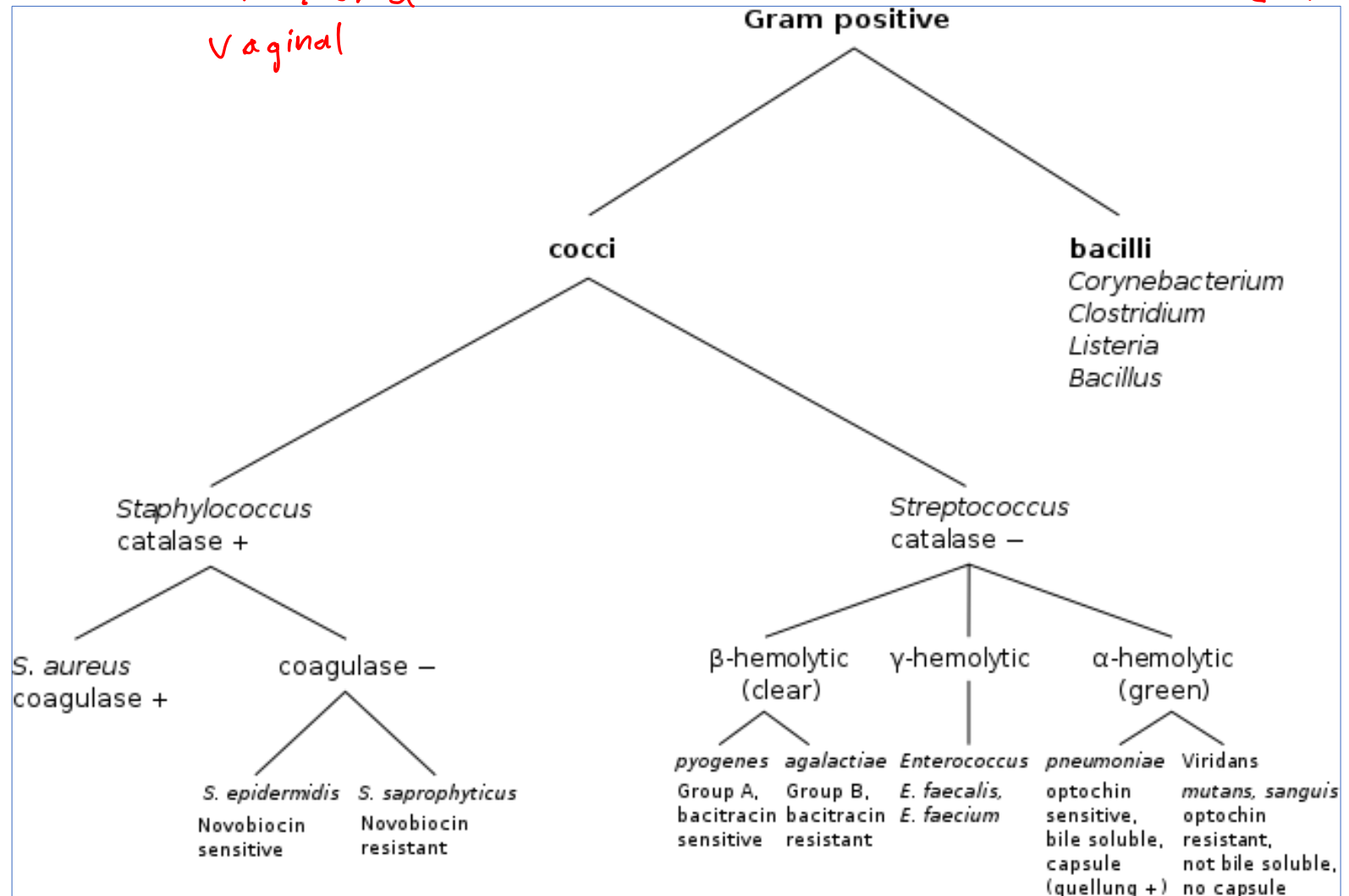
# Overview



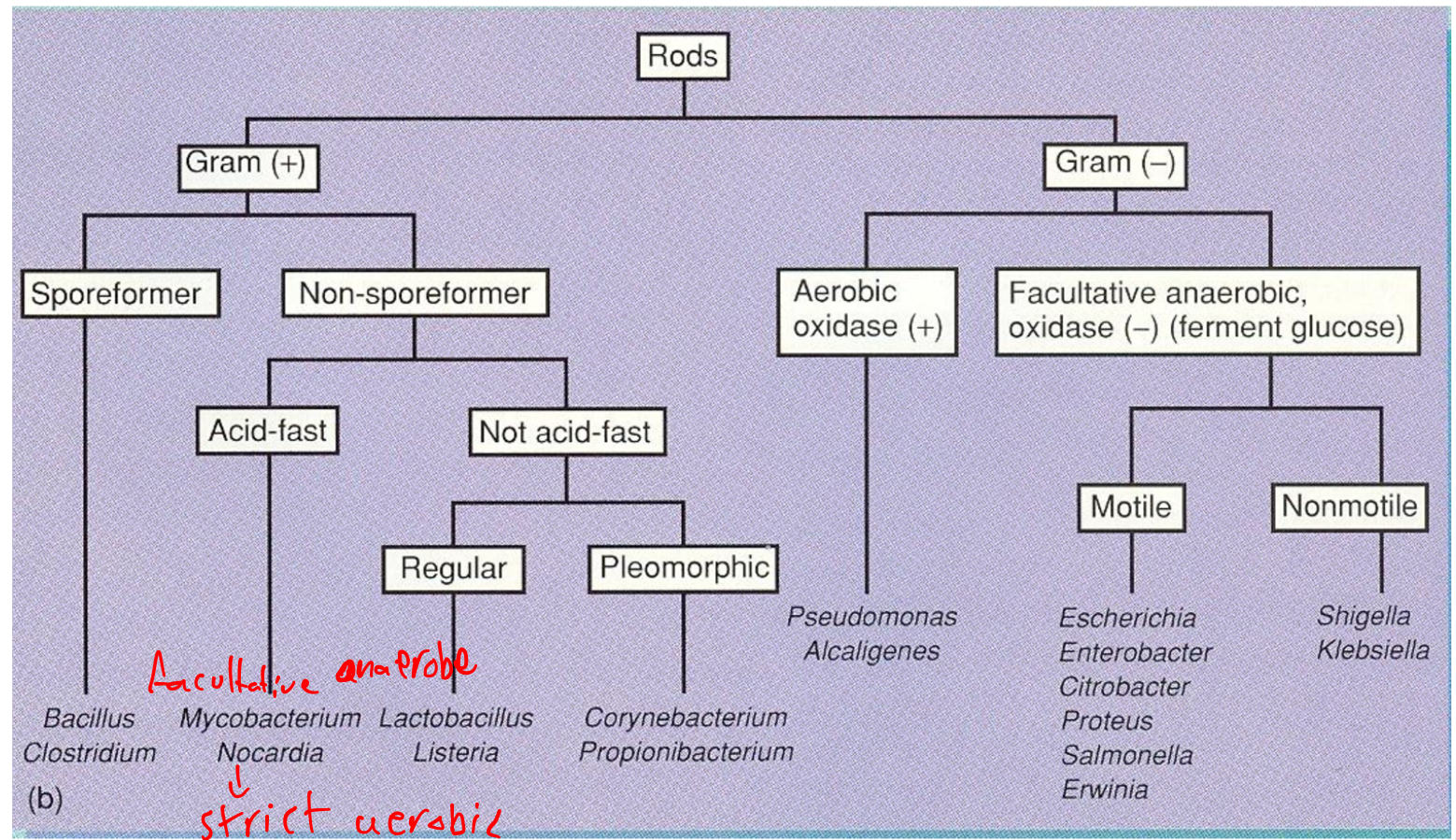
# Overview

GI flora  
vaginal

باللي صايفه



# Overview



## **NON-SPORE-FORMING** gram-positive rods

- **Anaerobic Gram-Positive Rods** : The non-spore-forming gram-positive rods are a diverse collection of facultatively anaerobic or strictly anaerobic bacteria that colonize the skin and mucosal surfaces.
- ***Actinomyces*, *Mobiluncus*, *Lactobacillus*, and *Propionibacterium*** are well-recognized opportunistic pathogens, whereas other genera such as *Bifidobacterium* and *Eubacterium* can be isolated in clinical specimens but rarely cause human disease.





## Actinomyces

ببذ كرك بال Mycosis  
هيك كاتوا يفكروهم Aungi

لجوه التحقيرة  
Prokar

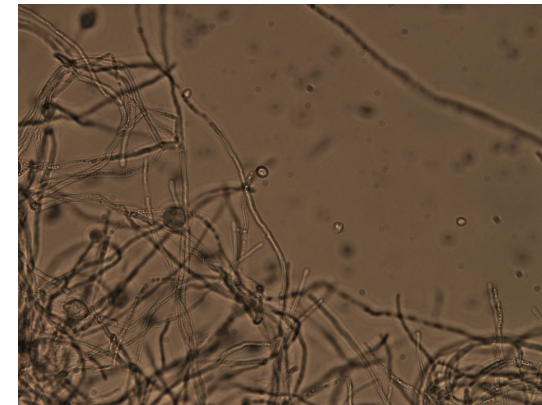
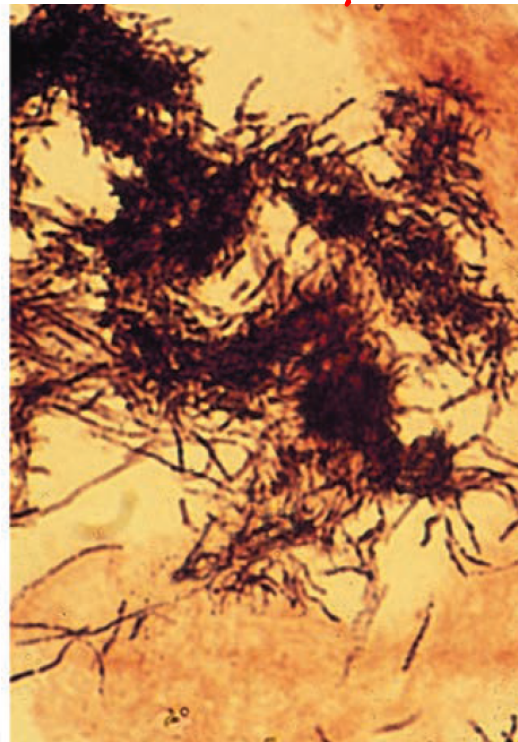
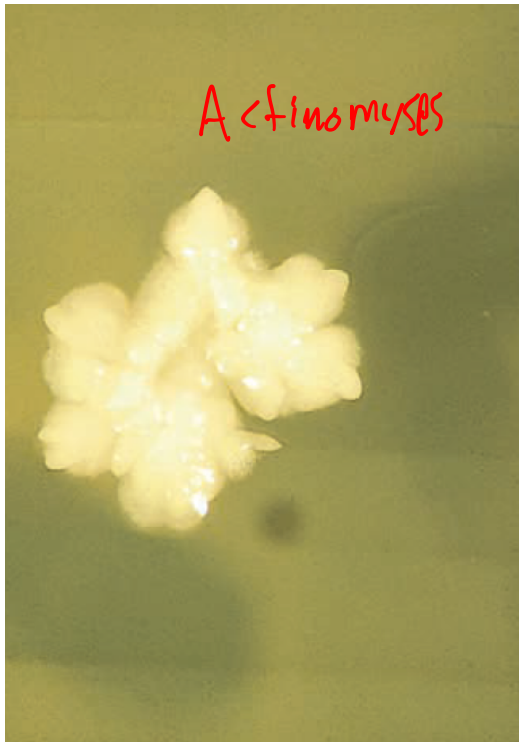
- Actinomyces organisms are facultatively anaerobic or strictly anaerobic gram-positive rods

هه من الملوحة Normal

الحا فرة الملوحة سرعيات Acute

- they grow slowly in culture, and they tend to produce chronic, slowly developing infections.
- Actinomyces organisms colonize the upper respiratory, GI, and female genital tracts but are not normally present on the skin surface.
- Infections caused by actinomycetes are endogenous, with no evidence of person-to-person spread or disease originating from an exogenous source. (specimens can be contaminated with Actinomyces that are part of the normal bacterial population on mucosal surfaces).

# Actinomyces



fungi

They typically develop **delicate filamentous forms or hyphae** (resembling fungi) in clinical specimens or when isolated in culture, *Actinomyces* are **fastidious** and grow slowly under anaerobic conditions; it can take 2 weeks or more for the organisms to be isolated

Fungal colonies and hyphae

مرض التهابي مزمن

# Actinomyces

- Classic disease caused by *Actinomyces* is termed **actinomycosis**. Characterized by the development of **chronic granulomatous lesions** that become **suppurative and form abscesses connected by sinus tracts**.

بكتيريا و T cells  
لبنة الرقبة والوجه

- Most actinomycetes infections are **cervicofacial** (following invasive dental procedure or oral trauma).

Lesions

- The finding of tissue swelling with fibrosis and scarring, as well as **draining sinus tracts** along the angle of the jaw and neck, should alert the physician to the possibility of actinomycosis

- The major sites of actinomycoses are **cervicofacial, abdominopelvic, and thoracic**

كاملية المعدة

- Abdominal and pelvic infections are associated with abdominal surgery, tuboovarian abscess, ruptured appendicitis, and **intrauterine contraceptive devices (IUCD)**

Abdominal + pelvic

- Treatment for actinomycosis involves the combination of drainage of a **localized abscess** or **surgical debridement** of the involved tissues, and **prolonged administration of antibiotics**.

1

والتي تشكل الحطام

بلاستيك بال I و UT

2



قبل ان Sinus ممكن يتكون

Abscess

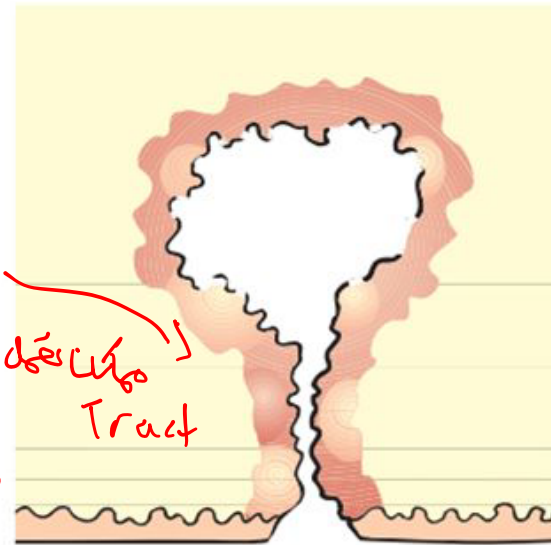
مع الوقت بتروح تفتح  
الى الepithelial sinus  
وتتكون

ممكن يتكون  
Mouth بار

وتتبدأ بالTrauma

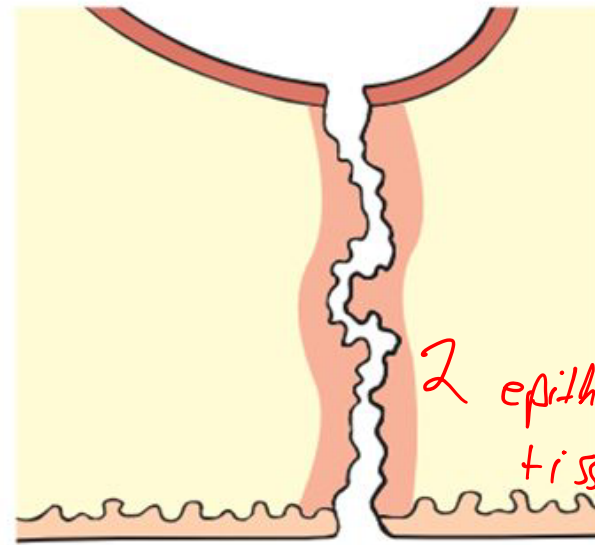
ممكن من  
عملية  
أسنان

Sinus



A sinus is a connection between a cavity lined with granulation tissue and an epithelial surface.

Fistula



A fistula is a connection between two epithelial-lined surfaces.

A **fistula** is an abnormal pathway between two anatomic spaces or a pathway that leads from an internal cavity or organ to the surface of the body. A **sinus** tract is an abnormal channel that originates or ends in one opening.



**FIGURE 31-4** Patient suffering from cervicofacial actinomycosis. Note the draining sinus tract (*arrow*).



**FIGURE 31-6** Molar tooth appearance of *Actinomyces israelii* after incubation for 1 week. This colonial morphology serves as a reminder that the bacteria are normally found in the mouth.

لازم نکون برا حلقه نرنا

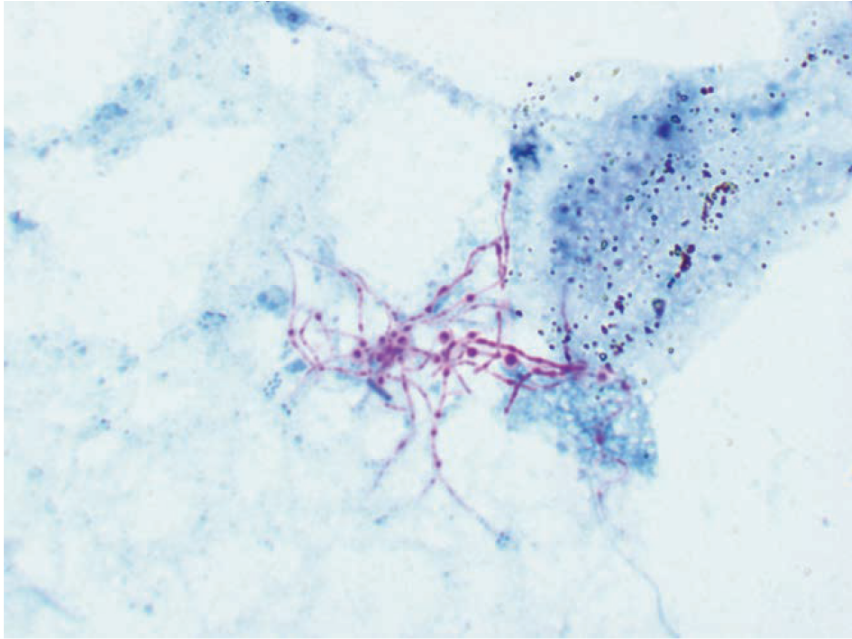
Acid fast: mycobacterium tuberculosis

Chronic  
+ slow growing

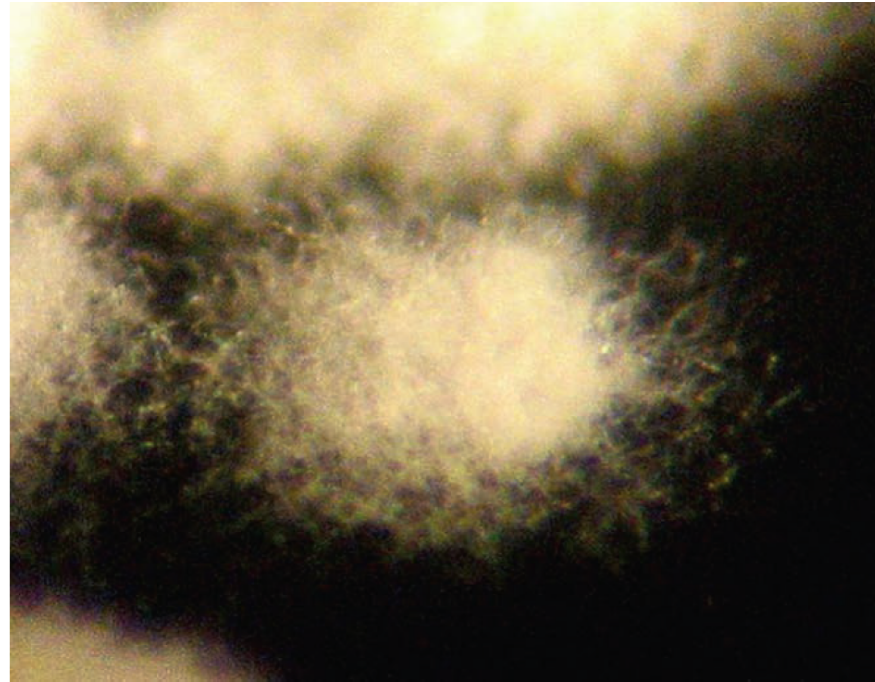
**Nocardia (added here for similarity to actinomyces)**

- Nocardiae are **strict aerobic rods** that form branched filaments in tissues and culture.   
 وبتكثير بمتعدي   
 المتأخرة
- Nocardia* is described as "**weakly acid-fast**"; that is, a **weak decolorizing solution** of hydrochloric acid must be used to demonstrate the acid-fast property of nocardiae.   
 لا تمشحها لثقة بروج اللون   
 This distinguish it from the similar **Actinomyces**.   
 Slow
- Growth is slow, requiring 3 to 5 days of incubation before colonies may be observed on the culture plates.   
 Not Normal   
 Slowly growing
- Nocardia* infections are **exogenous** (i.e., caused by organisms not normally part of the normal human flora). The ubiquitous presence of the organism in soil rich with organic matter and the increasing numbers of immunocompromised individuals living in communities have led to dramatic increases in disease caused by this organism.





**FIGURE 22-10** Acid-fast stain of *Nocardia* species in expectorated sputum. In contrast with the mycobacteria, members of the genus *Nocardia* do not uniformly retain the stain (“partially acid-fast”).



**FIGURE 22-12** Aerial hyphae of *Nocardia*.

تجسین زی-آر  
Filamentous Aungi لانی کینا

The combination of both **presence of aerial hyphae and acid-fastness is unique** to the genus *Nocardia* and can be used as a rapid test for identification of the genus

## Nocardia

infection  
مستعمرات  
وبعير لضعيف المناعة

Cord factor

\* ممكن يوصل للدماغ

- It would appear that the primary factor associated with virulence is the ability of pathogenic strains to **avoid phagocytic killing**. Through :

Secretion of **catalase** and **superoxide dismutase** that counter **hydrogen peroxide and superoxide released by phagocytic cells**, preventing fusion of the phagosome-lysosome (mediated by **cord factor**) and preventing acidification of the phagosome.

بتلا قتلها

كندها

- 1
- **Bronchopulmonary disease** develops after the initial colonization of the upper respiratory tract by inhalation and then aspiration of oral secretions into the lower airways, occurs **almost always in immunocompromised patients**.

- 2
- **Primary cutaneous nocardiosis** develops after traumatic introduction of organisms into subcutaneous tissues, can present in the form of **Mycetoma** is characterized by a triad of painless subcutaneous mass, multiple sinuses and discharge containing grains.

Tumor, fistula, grain

لنسيبه او Mycomyces ولكن بختلاف الصفة  
وال flora

- As many as one third of all patients with *Nocardia* infections have dissemination to the brain, most commonly involving the formation of **single or multiple brain abscesses**.

## Nocardia

كاسه عند Abscess وعندهم sinus داظله للepithelial



2 sinus  
مع بعض

بطلومني  
حبوب

النفخ

**Mycetoma** is a chronic suppurative disease of the skin and subcutaneous tissue, characterized by a symptomatic triad: tumor, fistulas and grains. It can be caused by fungi (eumycetoma) and bacteria (actinomycetoma), with similar clinical features. Painless

الحقيقية

Given its **slow progression**, **painless nature**, massive lack of health education and scarcity of medical and health facilities in endemic areas, many patients present late with advanced infection where amputation may be the only available treatment.

# Lactobacillus

نظرا لمساهمة  
ببلاستها بار probiotics يعني محبوبة

التي قبل نموها  
growing

- Lactobacillus species are facultatively anaerobic or strictly anaerobic rods that ferment to yield lactic acid.   
myco probiono  
sugars  
corney

- They are found as part of the normal flora of the mouth, stomach, intestines, and genitourinary tract. In around 70% of women, a Lactobacillus species is dominant in the female genital tract. + GI

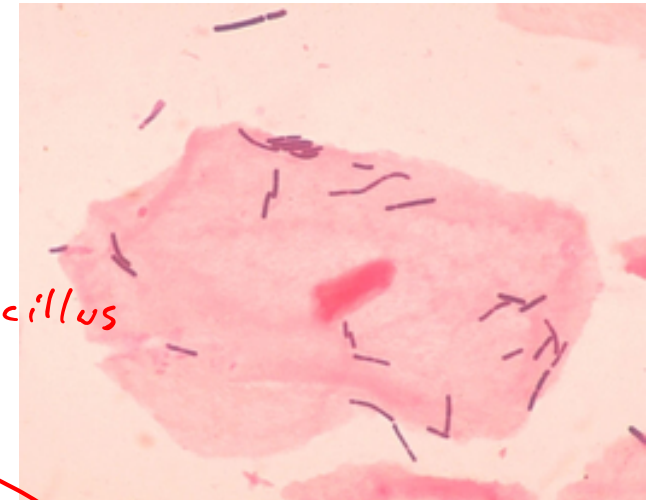
- Rarely cause infections.

- Commonly found in probiotics.

Fermentation = Lacto bacillus

- Some Lactobacillus species are used as starter cultures in industry for controlled fermentation in the production of yogurt, cheese, sauerkraut, pickles, beer, cider.

- Invasion into blood occurs in one of the following three settings: (1) transient bacteremia from a genitourinary source (e.g., after childbirth or a gynecologic procedure), (2) endocarditis and (3) opportunistic septicemia in an immunocompromised patient.



ببلاستها بار probiotics

يمكن تنزله في الدم

يمكن اعتبارها

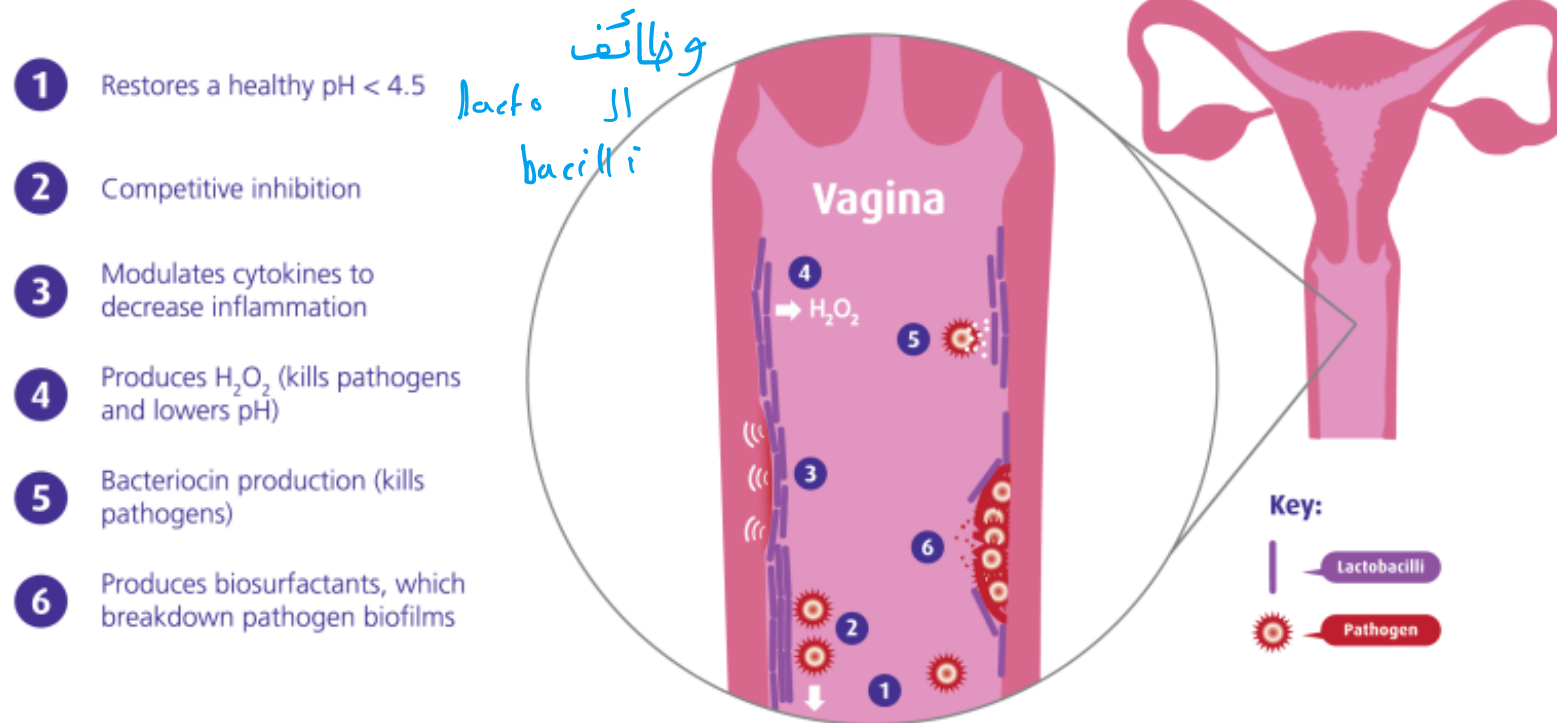
التي قبل نموها

Prebiotics

- 1) endocarditis
- 2) opportunistic
- 3) Bactremi



## Mechanisms of action of *L. reuteri* RC-14® & *L. rhamnosus* GR-1®



Taken from a website promoting probiotic therapy, proceed with caution!

## Propionibacterium

common في الجلد

Non spore forming  
لأنه

Acne Vulgaris

- Propionibacteria are small gram-positive rods often arranged in short chains or clumps, commonly found on the skin (in contrast with the *Actinomyces*), conjunctiva, and external ear, and in the oropharynx and female genital tract.

في  
الجلد

- The most commonly isolated species is **Propionibacterium acnes**. *P. acnes* is responsible for two types of infections: (1) **acne vulgaris** in teenagers and young adults and (2) **opportunistic infections** in patients with prosthetic devices or intravascular lines.

أهم

نوع

- P. acnes* apparently only triggers the disease (acne vulgaris) when it meets favorable dermatophysiological terrain; *P. acnes* colonization of the skin is therefore **necessary but not sufficient for the establishment of the pathology**.



لازم تكون عوامل البشرة/بكتيريا (كما نحتاجها) Patho  
يعني مرض  
د ايا بتجلبدك

# Propionibacterium

بالمرأفة بزيه افراز وطبيعة \*

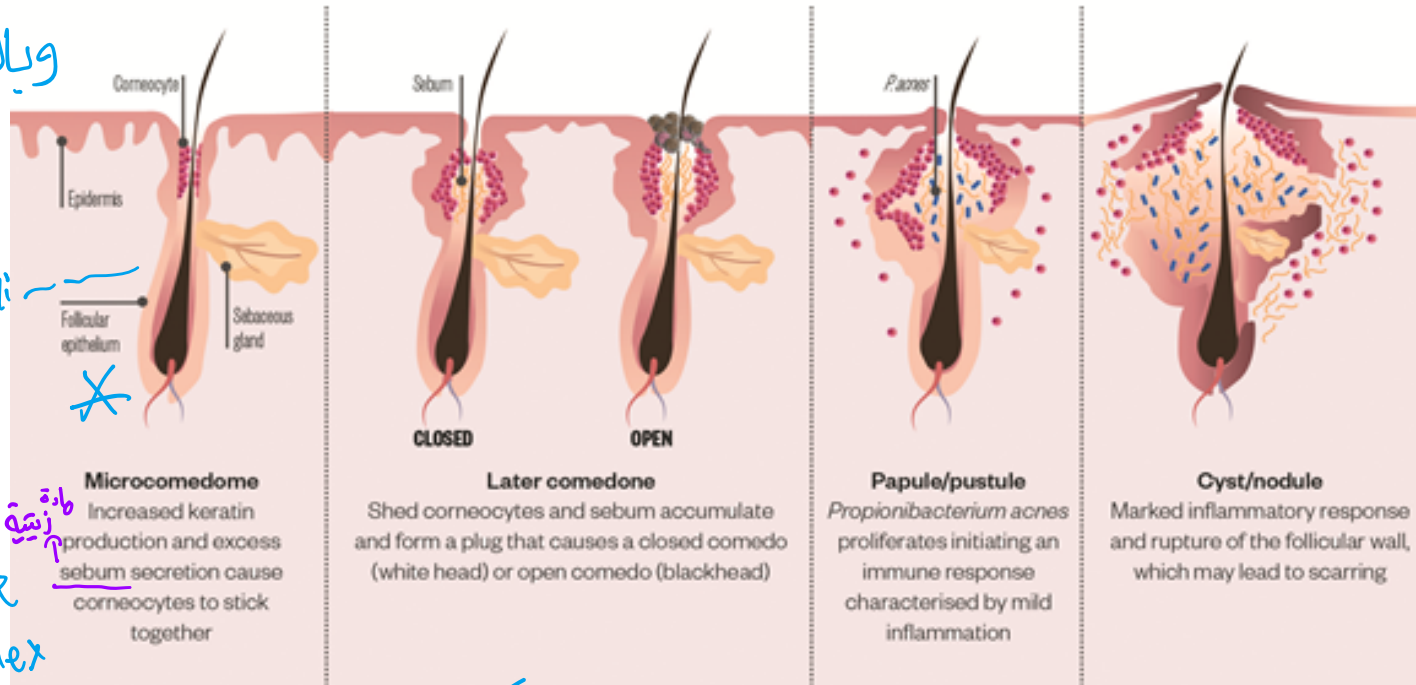
وبالتالي بغير المكان

انصب لل

Propioni

وبلاقي

Immune complex



ال quorum sensing. بتميز البكتيريا genes جدار

لازم توقفهم قبل ما يهبطون وتفرز sebum

م

## Other non-spore-forming anaerobic gram-positive rods

مخيرة  
[+]

*Mobiluncus curtisii*

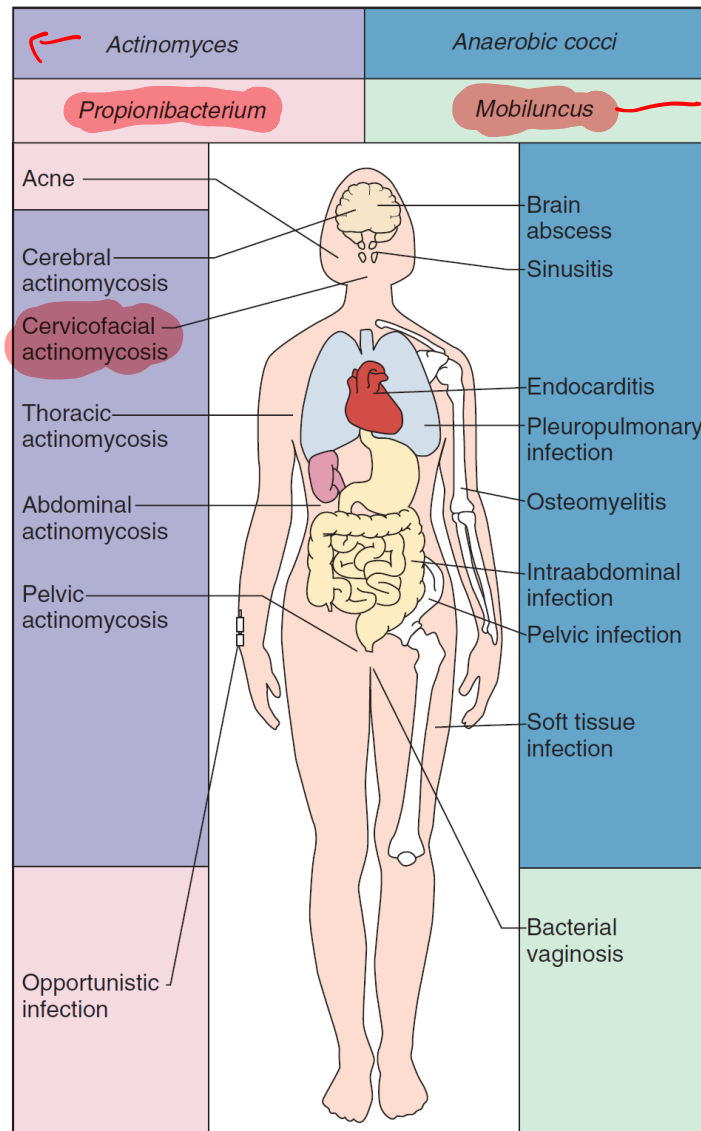
- ***Mobiluncus***: Members of the genus *Mobiluncus* are obligate anaerobic, gram-variable or gram-negative, curved rods with tapered ends. **But classified as gram positive** . because they (1) have a gram-positive cell wall, (2) lack endotoxin, and (3) are susceptible to vancomycin, clindamycin, erythromycin, and ampicillin but **resistant to colistin**. *M. curtisii* is rarely found in the vaginas of healthy women but is abundant in women with **bacterial vaginosis**. → مست *pathogen* واحدة
- ***Bifidobacterium* and *Eubacterium*** : commonly found in the oropharynx, large intestine, and vagina. Usually represent clinically insignificant contaminants

خير مخيرة ، بيدر ولا بتفتر ولا بتنفع

كندنا Wall وفتش Endo toxin

ولكنها تبستحل ال Colistin

sinuses  
 و يمكن الـ G و الـ UT



قراءة ذاتية  
 ولكن

## Overview



اللي كفا تحكى عنك  $P. aeruginosa$



## Non-spore forming Aerobic Gram-Positive Rods

- Heterogeneous group of bacteria. هذه مجموعة متنوعة من البكتيريا
- Some are well-recognized **human pathogens** (e.g., *Listeria monocytogenes*, *Corynebacterium diphtheriae*); Gram positive  
↓  
aerobic  
↓  
1  
2
- Others are **primarily animal pathogens** that can cause human disease (e.g., *Erysipelothrix rhusiopathiae*); Rose للحيوانات
- And some are opportunistic pathogens that typically infect hospitalized or immunocompromised patients (e.g., *Corynebacterium jeikeium*)

جايكيمر يا مضاف

Actinomyces اللي فوق  
يا بطل  
Intra ليس هيا اللي آخذناها و ف د ف mycobacterium



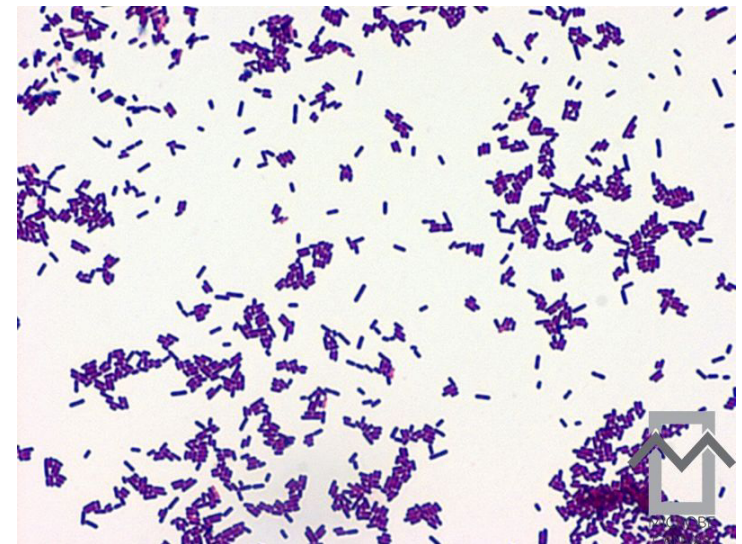
## Listeria monocytogenes

intracellular mainly

تتطلب الأكسجين والكبار

- *L. monocytogenes* is a short (0.4 to 0.5 × 0.5 to 2 μm), nonbranching, gram-positive, **facultatively anaerobic rod**. The **short rods** appear singly, in pairs, or in short chains and can be mistaken for *Streptococcus pneumoniae*.
- The organisms are **motile** at room temperature but less so at 37° C, and they exhibit a characteristic end-over-end tumbling motion when a drop of broth is examined microscopically. exhibits **weak β-hemolysis** when grown on sheep blood agar plates.
- These differential characteristics (i.e., **Gram-stain morphology, motility, β-hemolysis**) are useful for the preliminary identification of *Listeria*.
- Although the bacteria are widely distributed in nature, human disease is uncommon and is restricted primarily to several well-defined populations: **neonates, the elderly, pregnant women, and patients with defective cellular immunity**

intracellular



# Listeria monocytogenes



## Clinical Case 21-1 *Listeria* Meningitis in Immunocompromised Man

The following patient described by Bowie and associates (*Ann Pharmacother* 38:58–61, 2004) illustrates the clinical presentation of *Listeria* meningitis. A 73-year-old man with refractory rheumatoid arthritis was brought by his family to the local hospital because he had a decreased level of consciousness and a 3-day history of headache, nausea, and vomiting. His current medications were infliximab, methotrexate, and prednisone for his rheumatoid arthritis. On physical examination, the patient had a stiff neck and was febrile, had a pulse of 92 beats/min, and had a blood pressure of 179/72 mm Hg. Because meningitis was suspected, blood and cerebrospinal fluid (CSF) were collected for culture. The Gram stain of the CSF was negative, but *Listeria* grew from both blood and CSF cultures. The patient was treated with vancomycin, the infliximab was discontinued, and he made an uneventful recovery despite using less-than-optimal antimicrobial therapy. Infliximab has been associated with a dose-dependent monocytopenia. Because monocytes are key effectors for clearance of *Listeria*, this immunocompromised patient was specifically at risk for infection with this organism. Failure to detect *Listeria* in CSF by Gram stain is typical of this disease because the bacteria fail to multiply to detectable levels.

# Listeria monocytogenes

Staph + strep  
 هنا بنعتبرهم intracellular بشكل عام ولكنهم بقدر اوانتخل

الباقى كلهم  
 Extra cellular

- L. monocytogenes* is a **facultative intracellular pathogen**.

Following ingestion of contaminated food, *L. monocytogene* adhere to host cells via the interaction of proteins on the surface of the bacteria (**internalin A**) with glycoprotein receptors on the host cell surface (e.g., **epithelial cadherin**)

بالهترتديلا  
 والجنبنة

أنتقله بتعلقه (Virulence من الخلايا)

- After **penetration into the cells**, the acid pH of the phagolysosome that surrounds the bacteria activates a bacterial pore-forming cytolysin (**listeriolysin O**) and two different **phospholipase C** enzymes, leading to **release of the bacteria into the cell cytosol**.

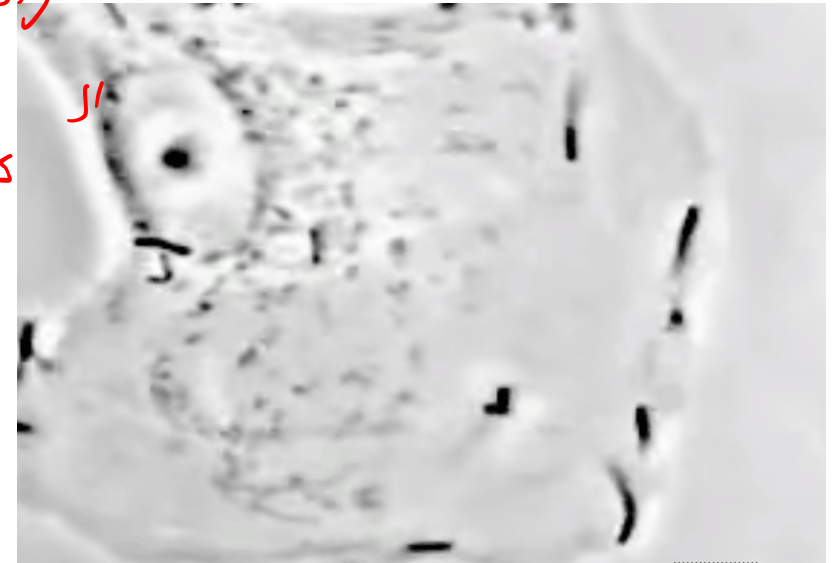
1  
 cool cuts

2

- This movement is mediated by a bacterial protein, **ActA** that coordinates **assembly of actin**.

هناك بتبتر

- These bacteria can replicate in **macrophages** and move within cells, thus **avoiding antibody-mediated clearance**. Patients with defects in **cellular immunity**, but not in humoral immunity, are particularly susceptible to severe infections



Internalin  
 with  
 cadherin

## Listeria monocytogenes

- The primary source of infection with this organism **is consumption of contaminated food**; causing **Foodborne Listeriosis**.
- Human-to-human transmission can occur primarily from **mother to child in utero or at birth**.  
و يمكن من الولادة  
الـ *menengitis* كان بسبب الـ *galactae*
- **Neonatal Disease** (1) early-onset disease, acquired **transplacentally** in utero, and (2) late-onset disease, acquired at or soon after birth. Early-onset disease can result in abortion, stillbirth, or premature birth. Late-onset disease occurs 2 to 3 weeks after birth in the form of meningitis or meningoencephalitis with **septicaemia**.
- Most infections in pregnant women occur during the **third trimester** when **cellular immunity is most impaired**.  
يكون لهفمت المناعة
- Disease in **Healthy Adults** is self limited and **asymptomatic** or in the form of a mild influenza-like illness.

## **Corynebacterium diphtheriae**

Catalase positive

- *C. diphtheriae* is an irregularly staining, pleomorphic rod (0.3 to 0.8 × 1.0 to 8.0 μm).  
Normal
- Corynebacteria are **aerobic or facultatively anaerobic**, nonmotile, and catalase positive.
- Corynebacteria are **ubiquitous** in plants and animals, and they **normally colonize** the skin, upper respiratory tract, gastrointestinal tract, and urogenital tract in humans.  
بلا صفا هي وال clostridium Normal ↓ flora
- The most famous of these is *C. diphtheriae*, the etiologic agent of **diphtheria**.
- **Humans** are the **only known reservoir** for this organism. **Respiratory droplets or skin contact** transmits it from person to person.  
+ سنا ليعو  
لها لذلك سنا

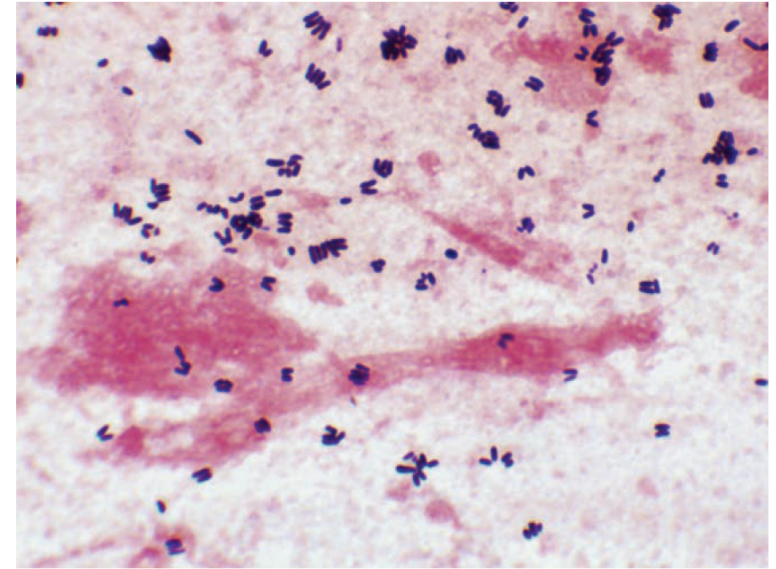


FIGURE 21-4 Gram stain of *Corynebacterium* species in sputum specimen.



# Corynebacterium diphtheriae

القرص



## Clinical Case 21-3 Respiratory Diphtheria

Lurie and associates (*JAMA* 291:937–938, 2004) reported the last patient with respiratory diphtheria seen in the United States. An unvaccinated 63-year-old man developed a sore throat while on a week-long trip in rural Haiti. Two days after he returned home to Pennsylvania, he visited a local hospital with complaints of a sore throat and difficulties in swallowing. He was treated with oral antibiotics but returned 2 days later with chills, sweating, difficulty swallowing and breathing, nausea, and vomiting. He had diminished breath sounds in the left lung, and radiographs confirmed pulmonary infiltrates as well as enlargement of the epiglottis. Laryngoscopy revealed yellow exudates on the tonsils, posterior pharynx, and soft palate. He was admitted to the intensive care unit and treated with azithromycin, ceftriaxone, nafcillin, and steroids, but over the next 4 days he became hypotensive with a low-grade fever. Cultures were negative for *Corynebacterium diphtheriae*. By the eighth day of illness, a chest radiograph showed infiltrates in the right and left lung bases, and a white exudate consistent with *C. diphtheriae* pseudomembrane was observed over the supraglottic structures. Cultures at this time remained negative for *C. diphtheriae*, but polymerase chain reaction testing for the exotoxin gene was positive. Despite aggressive therapy the patient continued to deteriorate, and on the seventeenth day of hospitalization he developed cardiac complications and died. This patient illustrates (1) the risk factor of an unimmunized patient traveling to an endemic area, (2) the classic presentation of severe respiratory diphtheria, (3) delays associated with diagnosis of an uncommon disease, and (4) the difficulties most laboratories would now have isolating the organism in culture.

## **Corynebacterium diphtheriae** هناك ثلاثة أنواع بالمنازل تسمى المتلوية

- The clinical presentation of diphtheria is determined by the (1) site of infection, (2) immune status of the patient, and (3) virulence of the organism. Exposure to *C. diphtheriae* may result in **asymptomatic colonization in fully immune people**. يتمكن من أن يكون حاداً ويتنشر السم تبعاً
- Diphtheria toxin is produced at the site of the infection and then disseminates through the blood to produce the systemic signs of diphtheria.
- 1  
• Respiratory Diphtheria, The symptoms of diphtheria involving the **respiratory tract** develop after a 2- to 4-day incubation period.
- 2  
• Evidence of myocarditis can be detected in the majority of patients .
- 3  
• Cutaneous Diphtheria A papule develops first and then evolves into a **chronic, nonhealing ulcer**



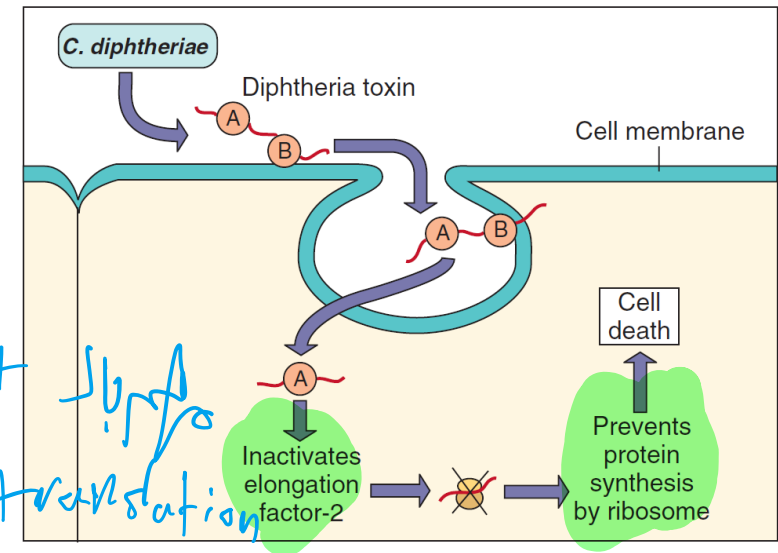
# Corynebacterium diphtheriae

- **Diphtheria toxin** is the major virulence factor of *C. diphtheriae*. An example of the classic **A-B exotoxin**.
- A **catalytic region** on the **A subunit**.  
And a **receptor-binding region** and a **translocation region** on the **B subunit**.
- The toxin binds to **heparin-binding epidermal growth factor precursor (HB-EGF)** present on many epithelial membranes. And is endocytosed by the cell. **A subunit** is translocated to the **cytosol**.
- A subunit ADP-ribosylates host eEF-2. **eEF-2 is required for protein synthesis**; when it is inactivated by the toxin, the host cannot make protein and thus dies

A catalytic  
B receptor-binding  
translocation

Vaccine ↓  
toxoid

A Inhibition of protein synthesis



# Corynebacterium diphtheriae

كثير بسبب deadly

## Respiratory Diphtheria

The onset is sudden, with malaise, sore throat, **exudative pharyngitis**, and a low-grade fever. The exudate evolves into a thick **pseudomembrane** composed of bacteria, lymphocytes, plasma cells, fibrin, and dead cells that can cover the tonsils, uvula, and palate and can extend up into the **nasopharynx** or down into the **larynx** (Pyogenesis)

**Diphtheria** has become **uncommon** in the United States because of an **active immunization program**, as shown by the fact that more than 200,000 cases were reported in 1921 but **no cases have been reported since 2003.**

تجمع  
Pus

Group A  
والPyogenesis

↓

كانوا  
يعملوا

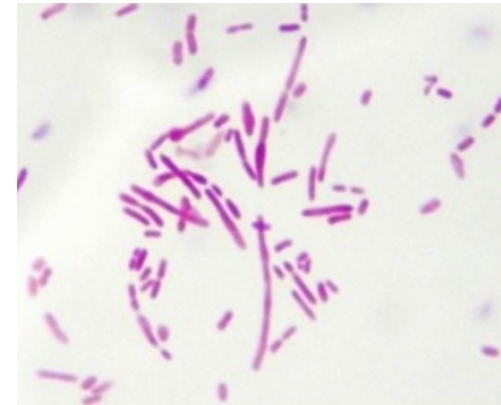
مستأكل بالضم ويدفع علاج سريع  
Vaccine



**FIGURE 21-5** Pharynx of a 39-year-old woman with bacteriologically confirmed diphtheria. The photograph was taken 4 days after the onset of fever, malaise, and sore throat. Hemorrhage caused by removal of the membrane by swabbing appears as a dark area on the left. (From Mandell G, Bennett J, Dolin R: *Principles and practice of infectious diseases*, ed 8, Philadelphia, 2015, Elsevier.)

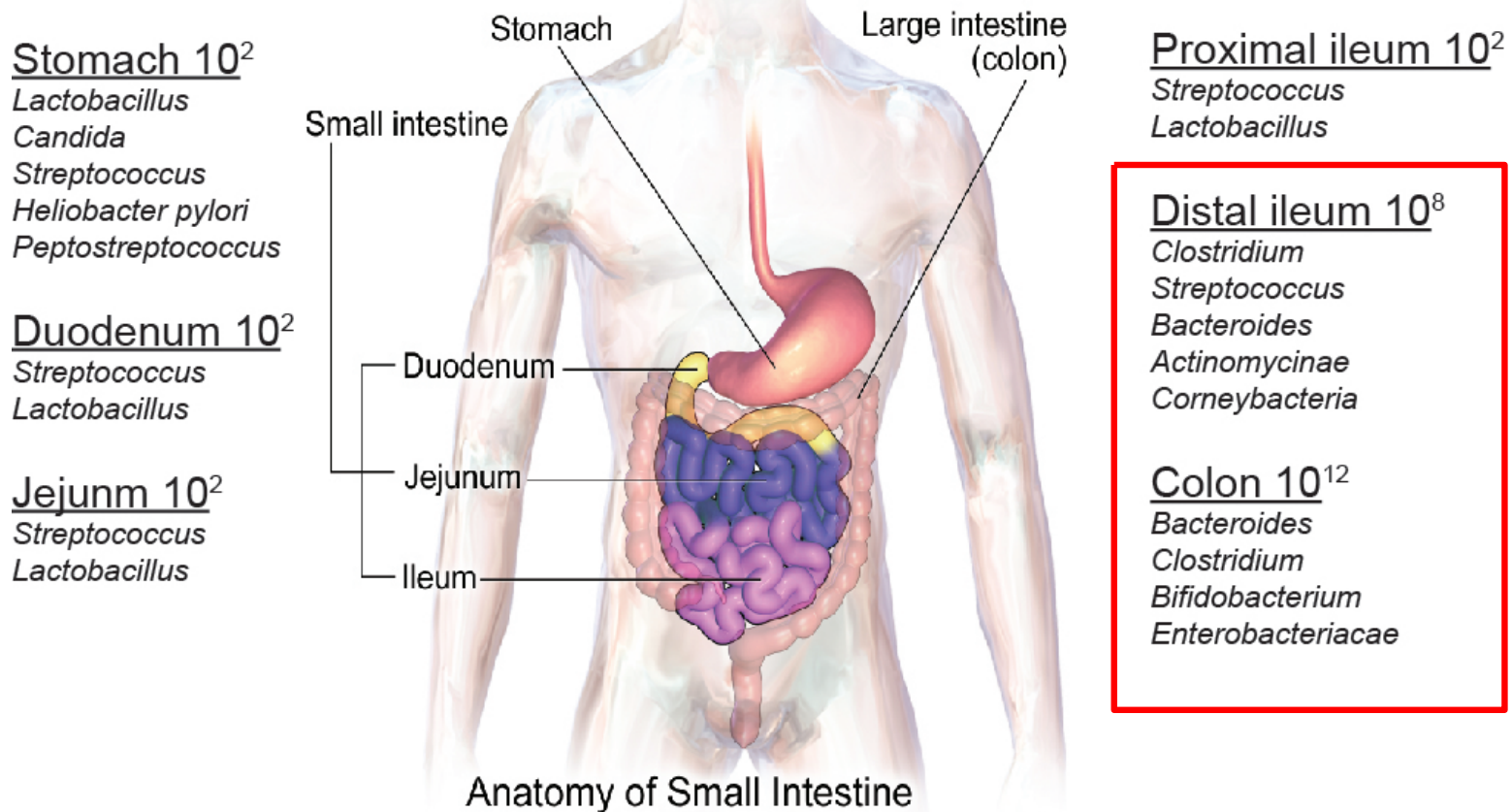
## كثير فعال Anaerobic Gram-Negative Rods

- These anaerobes are the **predominant bacteria on most mucosal surfaces, outnumbering aerobic bacteria 10- to 1000-fold**. Despite the abundance and diversity of these bacteria, most infections are caused by relatively few species
- ***Bacteroides*, *Fusobacterium*, *Parabacteroides*, *Porphyromonas*, and *Prevotella***
- Characteristically, *Bacteroides* growth is **stimulated by bile**. Other anaerobic gram-negative rods are fastidious. *Bacteroides* species are **pleomorphic in size and shape** and resemble a mixed population of organisms in a casually examined Gram stain.
- *Bacteroides* have a typical gram-negative cell wall structure, which can be surrounded by a **polysaccharide capsule**
- *Bacteroides* LPS has **little endotoxin activity**, probably due to **structural differences to pathogen LPS**.



**FIGURE 31-13** Growth of *Bacteroides fragilis* on *Bacteroides* bile-esculin agar. Most aerobic and anaerobic bacteria are inhibited by bile and gentamicin in this medium, whereas the *B. fragilis* group of organisms is stimulated by bile, resistant to gentamicin, and able to hydrolyze esculin, producing a black precipitate.

# Anaerobic Gram-Negative Rods



## Anaerobic Gram-Negative Rods

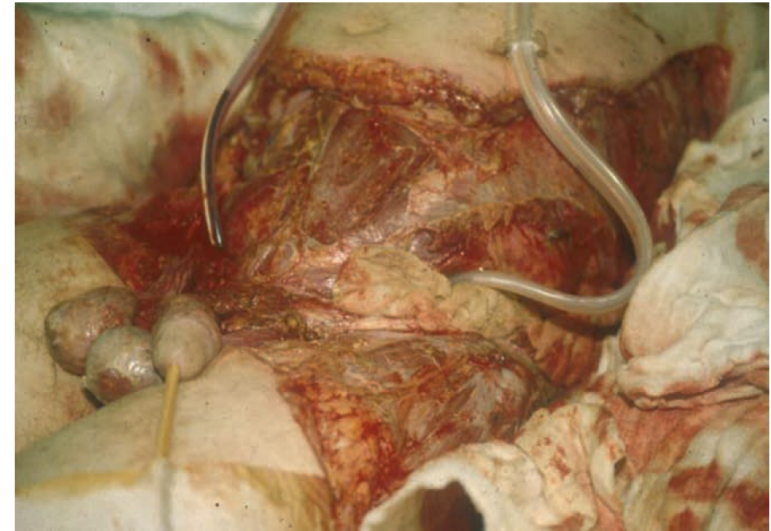
- To cause disease, *Bacteroides fragilis* in the resident flora are able to **spread by trauma or disease from the normally colonized mucosal surfaces to sterile tissues or fluids**
- Infections are **usually polymicrobial**.
- **Respiratory Tract Infections**, Nearly half of the **chronic infections of the sinuses and ears**, and virtually all periodontal infections, involve **mixtures of gram-negative anaerobes**, with *Prevotella*, *Porphyromonas*, *Fusobacterium*, and **non-fragilis Bacteroides** the most commonly isolated.
- Strains of enterotoxigenic *B. fragilis* that cause diarrheal disease produce a **heat-labile zinc metalloprotease toxin (B. fragilis toxin)**. This toxin causes morphologic changes of the intestinal epithelium via F-actin rearrangement, with the resultant stimulation of chloride secretion and fluid loss. *B. fragilis* can produce a **self-limited watery diarrhea**.
- **Bacteremia**, Anaerobes were at one time responsible for more than 20% of all clinically significant cases of bacteremia; however, these organisms now cause 3% to 10% of such infections.



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**FIGURE 31-11** Liver abscesses caused by *Bacteroides fragilis*.



**FIGURE 31-12** Synergistic polymicrobial infection involving *Bacteroides fragilis* and other anaerobes. The infection started at the scrotum and rapidly spread up the trunk and down the thighs, with extensive myonecrosis.

- **Intraabdominal Infections,** Anaerobes are recovered in **virtually all** of these infections, with ***B. fragilis*** the most common organism.
- **Skin and Soft-Tissue Infections,** *B. fragilis* is the organism most commonly associated with significant disease.

## Anaerobic Gram-Positive Cocci

- **Anaerobic Gram-Positive Cocci**: The anaerobic gram-positive cocci normally colonize the oral cavity, gastrointestinal (GI) tract, genitourinary tract, and skin. They produce infections when they spread from these sites to normally sterile sites.
- Although anaerobic cocci can be isolated from infections at all body sites, a predisposition for certain sites has been observed.
- ***Peptostreptococcus*** species have been recovered more often **from subcutaneous and soft tissue abscesses and diabetes-related foot ulcers** than from intra-abdominal infections. *Peptostreptococcus* infections occur more often in **chronic infections**. Many infections caused by *peptostreptococcus* bacteria are **synergistic**.

## **Further reading:**

- Murray - Medical Microbiology 8th Edition  
Section 4: Bacteriology  
Chapter 21:  
Chapter 31: