Introduction to Microbiology

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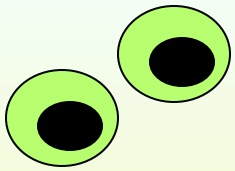
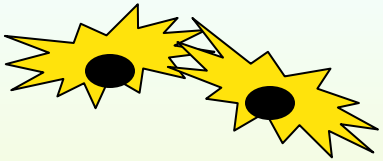
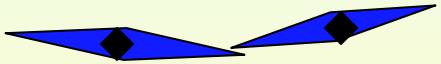
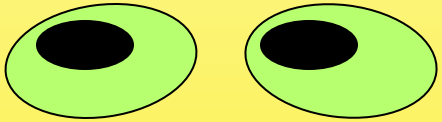
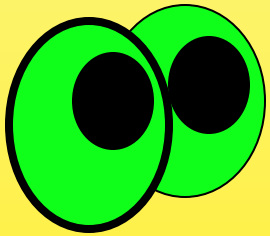
Outline

- Introduction
- Classification of bacteria
- Normal flora
- Pathogenic bacteria
- Virulence factors


We are Not Alone


They are in the air we breath . . .

In our food . . .

On our skin . . .

-on everything we touch.

• What are bacteria?

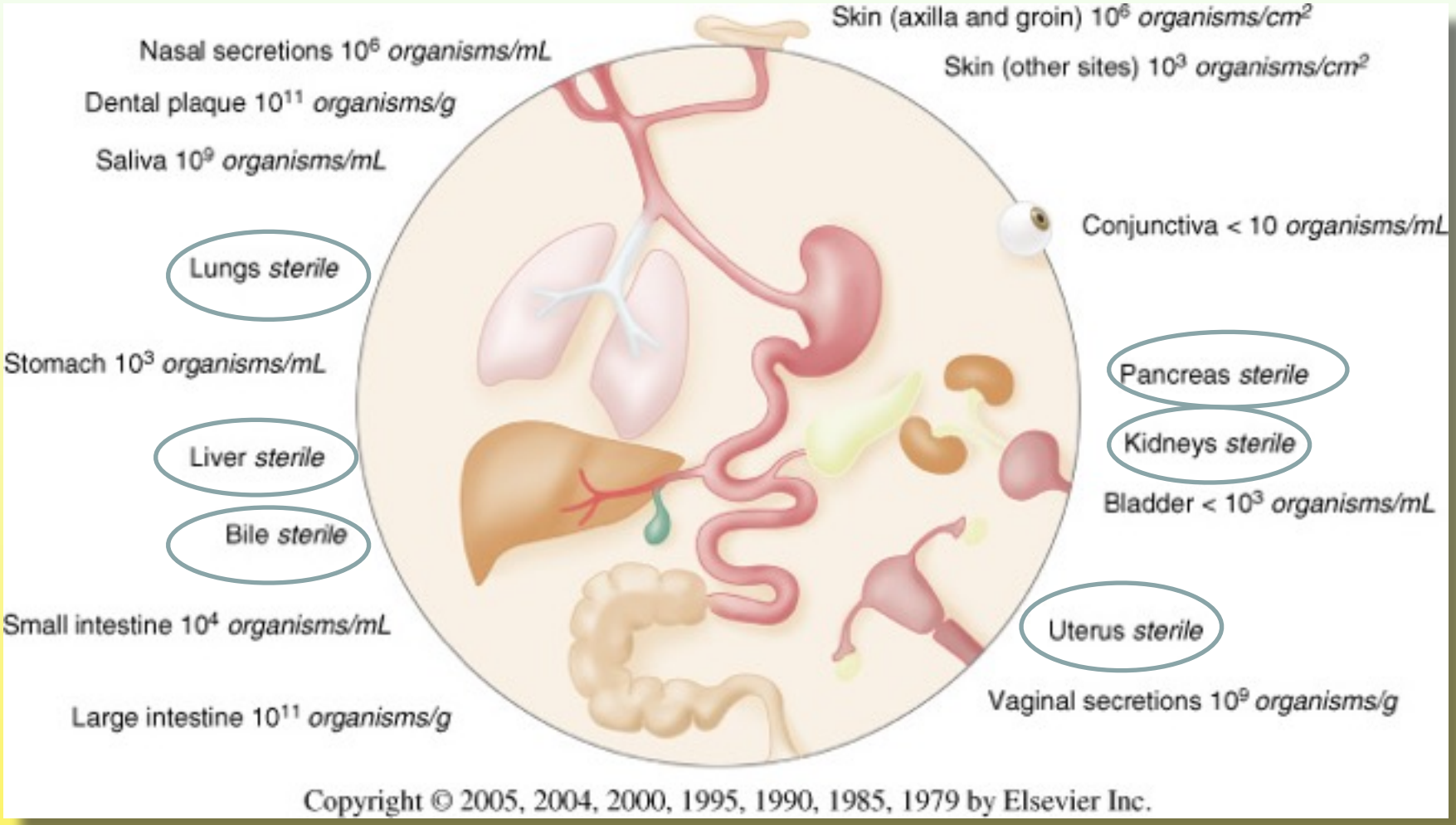
- Bacteria are single-celled, prokaryote microorganisms
- Typically a few micrometers in length
- Have a wide range of shapes, ranging from spheres to rods and spirals.

Introduction…(cont.)

- Bacteria are found in every habitat on Earth
  - Growing in soil
  - Acidic hot springs
  - Radioactive waste
  - Water
  - Deep in the Earth crust
  - In organic matter
  - Bodies of plants and animals.

Introduction...(cont.)

- There are typically 40 million bacterial cells in a gram of soil and
- a million bacterial cells in a millilitre of fresh water
- Making 10% of the body mass.



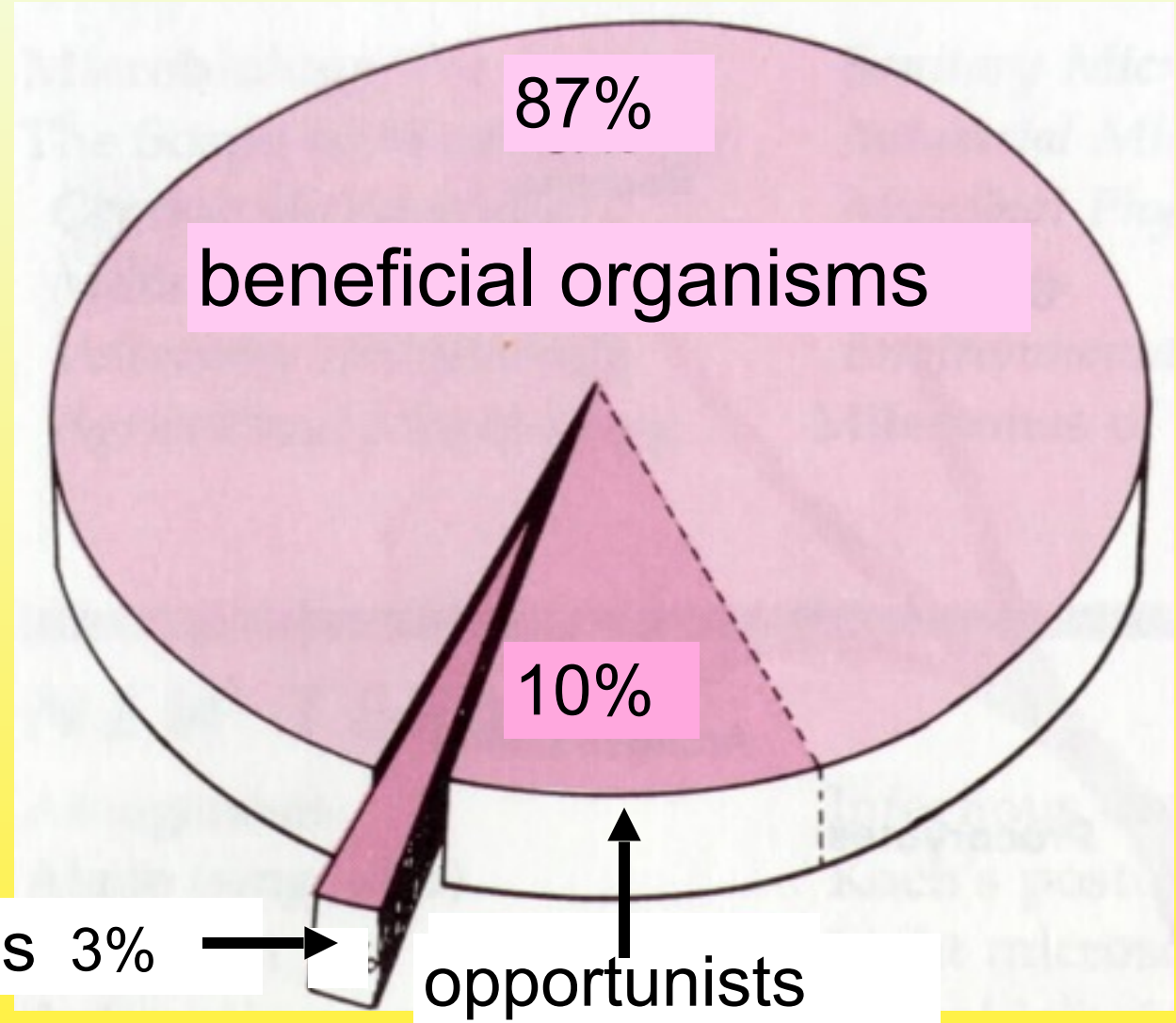
Mandell et al. Principles and Practice of Infectious Diseases. Sixth Edition

Humans vs Microbes

Variable	Microbes	Humans	Factor
No. on earth	5×10^{31}	6×10^{9}	$\sim 10^{22}$
Mass, metric tons	5×10^{16}	3×10^{8}	$\sim 10^{8}$
Generation time	30 min	30 years	$\sim 5 \times 10^{5}$
Time on earth, years	3.5×10^{9}	4×10^{6}	$\sim 10^{3}$

CID 2008:46 (15 January) • Spellberg et al

Most microbes are considered beneficial or harmless.

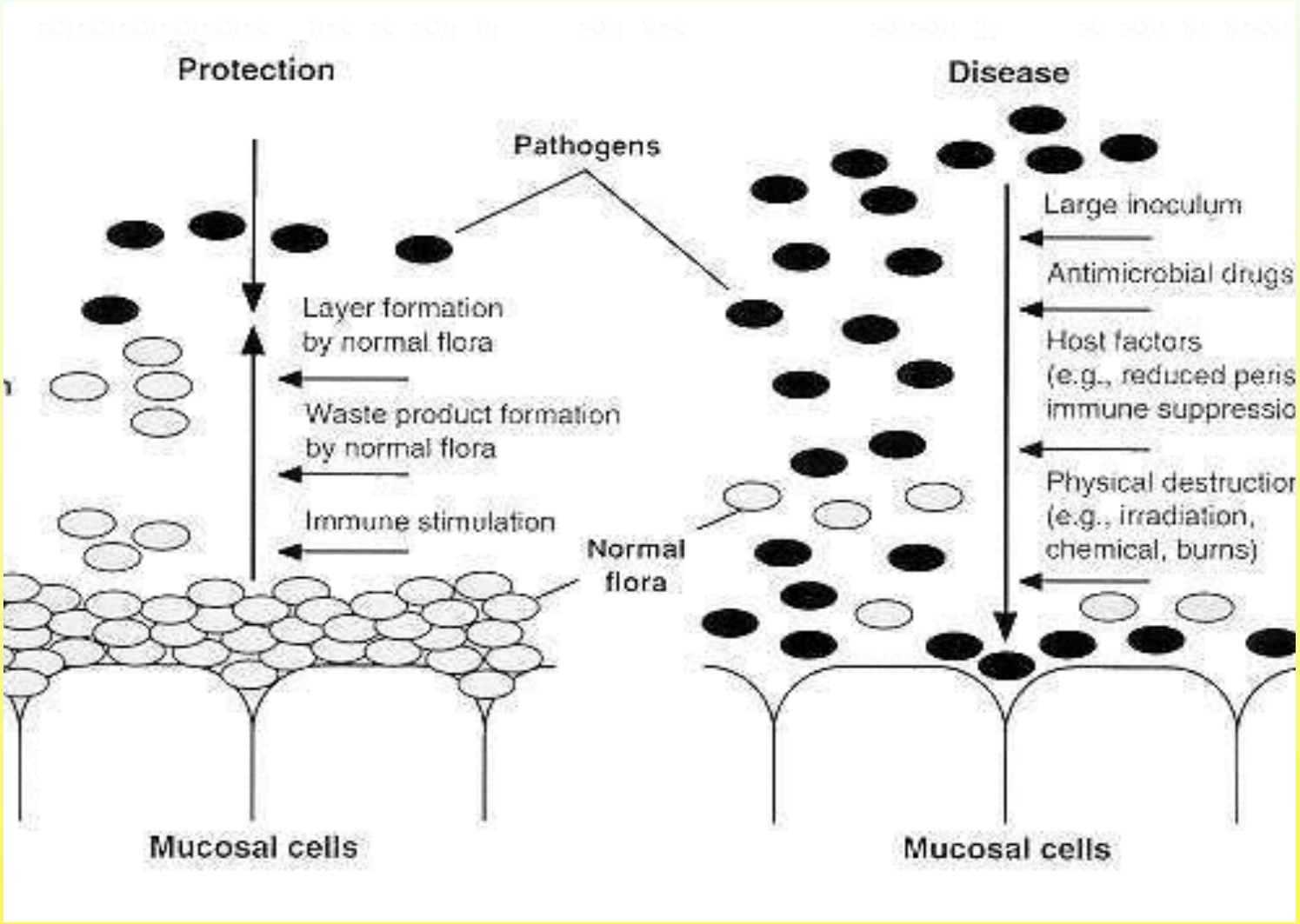


Microorganisms that are harmless or beneficial are called *nonpathogens*.

Introduction…(cont.)

- Are there any benefits from having bacteria in/on human bodies?
  - Vitamin K production
  - Normal flora competes with the pathogenic bacteria
  - Lactic acid bacteria improve the nutritional value of food, control intestinal infections, improve digestion of lactose, control some types of cancer, and control serum cholesterol levels
  - Bacteria are used in therapeutics e.g. BCG vaccine

SE Gilliland - FEMS Microbiology Letters, 1990



Mechanisms by which the normal flora competes with invading pathogens.
Baron S. Medical microbiology

Introduction…(cont.)

- Bacteria are colorless and usually invisible to light microscopy

Classification of Bacteria

- According to gram stain:
  - Gram positive:
    - Cocci
    - Bacilli
  - Gram negative :
    - Cocci
    - Bacilli

Gram +ve Cocci:

- Staphylococci
- Streptococci
- Enterococci

Gram –ve Cocci

- Neisseria spp
- Moraxella spp

Gram +ve Rods:

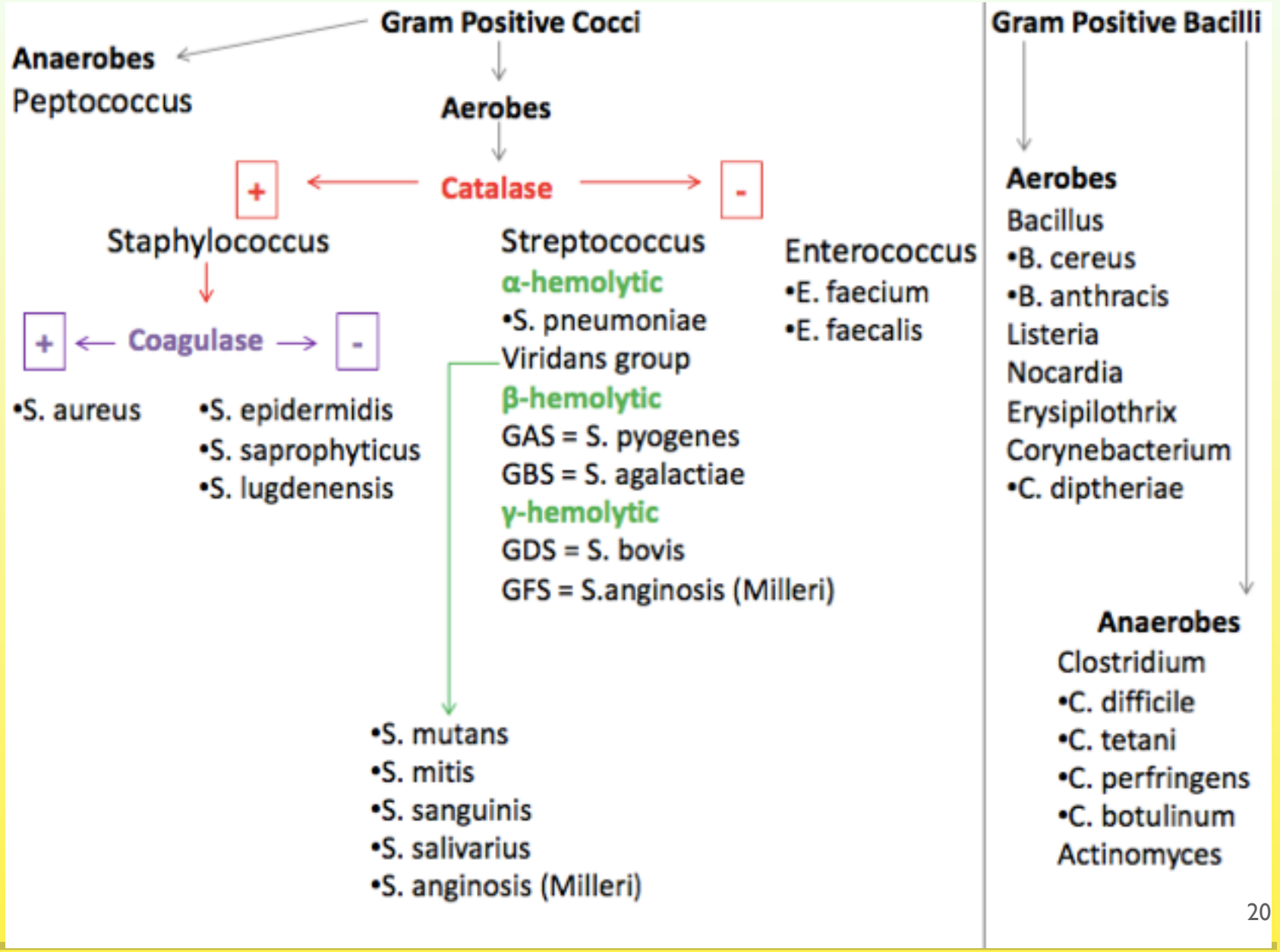
- Corynebacterium spp
- Bacillus spp
- Clostridium spp
- Listeria spp

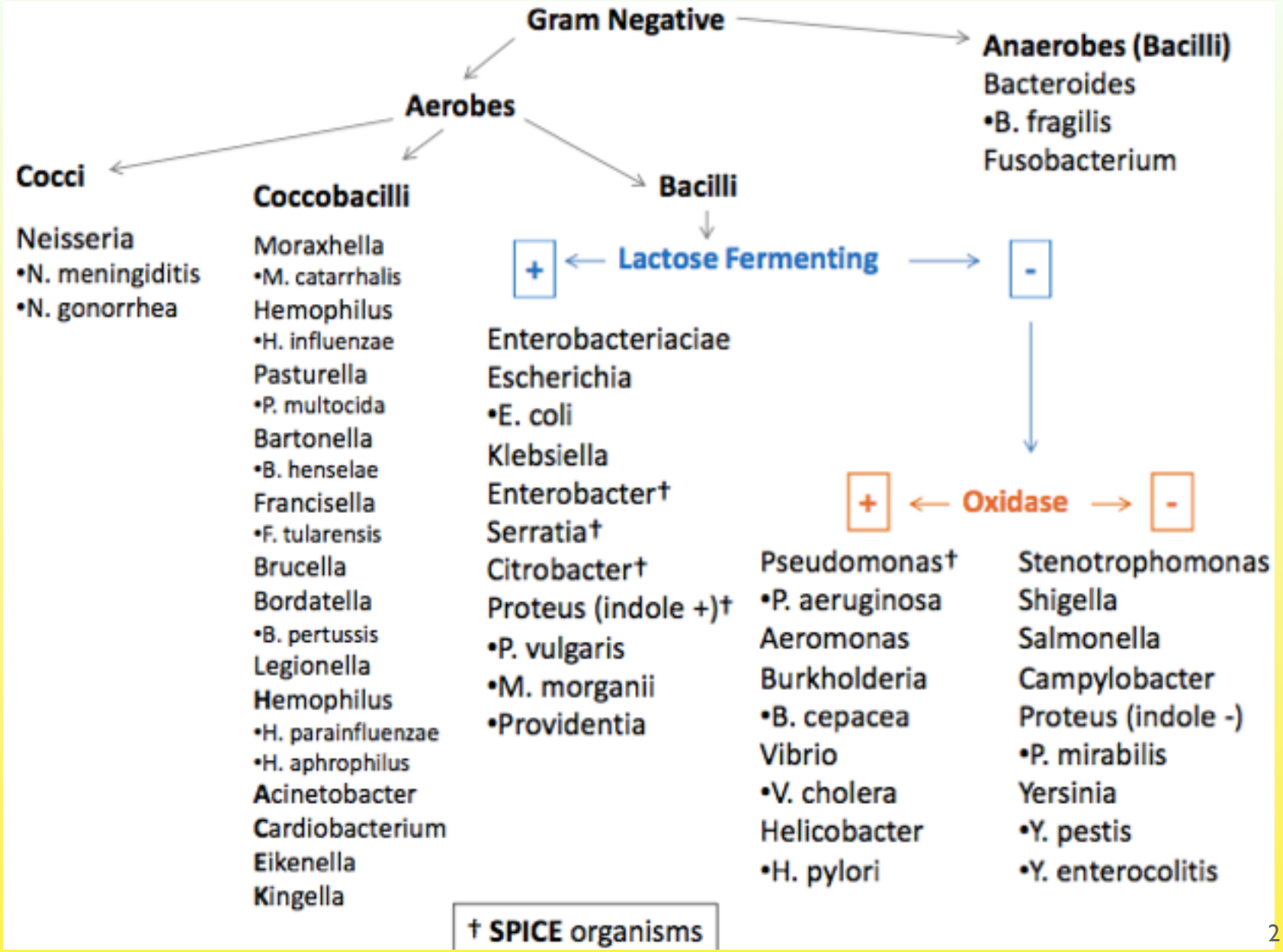
Gram –ve Rods:

- E. coli
- Klebsiella spp
- Acinetobacter spp
- Pseudomonas spp
- Salmonella spp

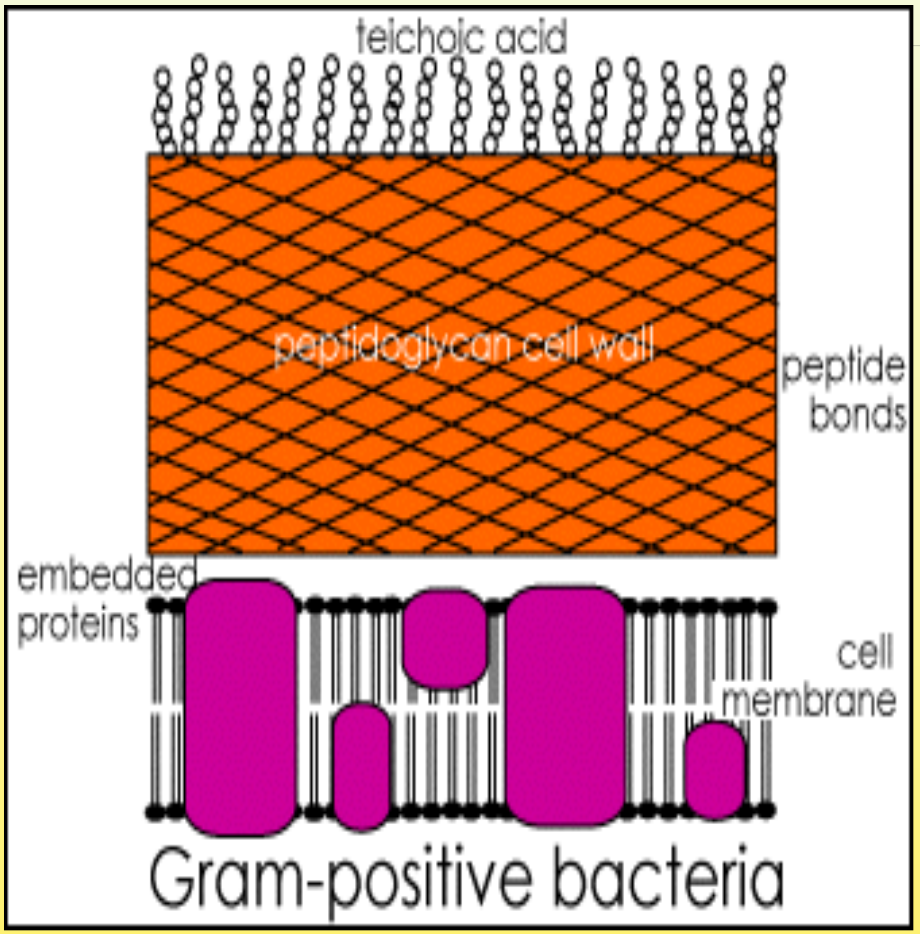
Other classification for bacteria

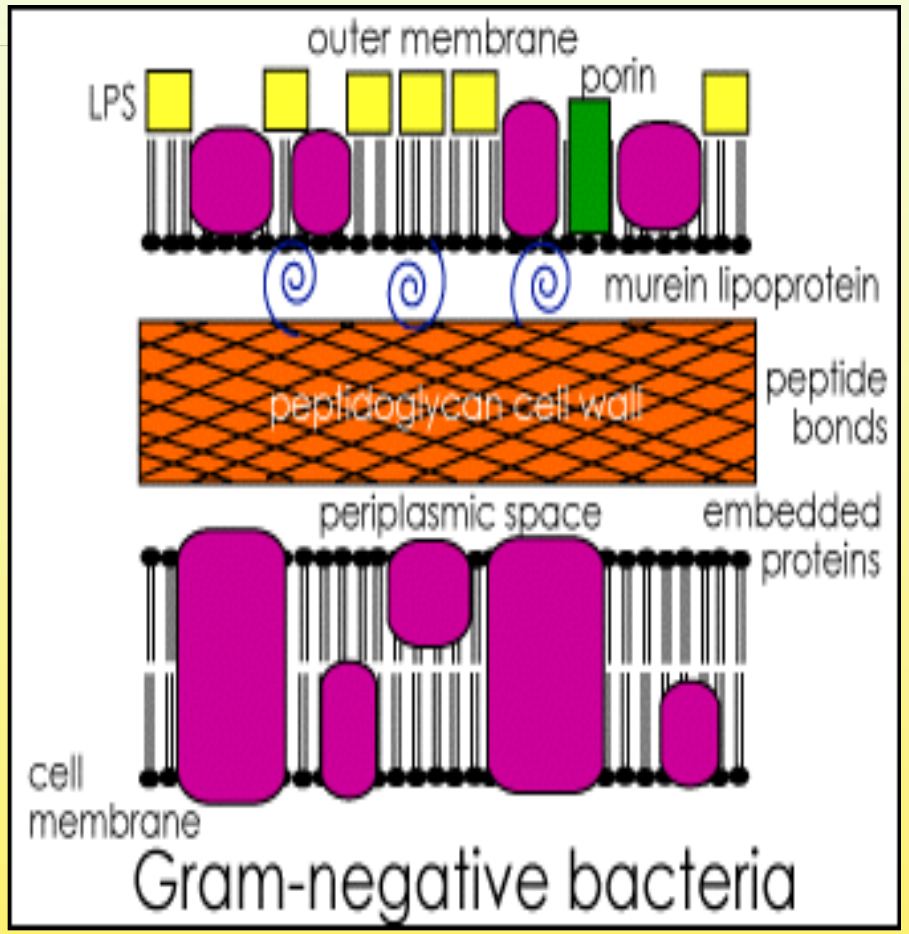
Obligate Aerobes	• *Pseudomonas aeruginosa*
Facultative anaerobes	• *E. coli*
microaerophilic	• *Compylobacter jejuni*
Obligate anaerobes	• *Bacteroides fragilis*


Gram Positive Cocci
Anaerobes
Peptococcus
Aerobes
+
Catalase
-
Staphylococcus
Streptococcus
α-hemolytic
•S. pneumoniae
Viridans group
β-hemolytic
GAS = S. pyogenes
GBS = S. agalactiae
γ-hemolytic
GDS = S. bovis
GFS = S.anginosis (Milleri)
Enterococcus
•E. faecium
•E. faecalis
+
Coagulase
-
•S. aureus
•S. epidermidis
•S. saprophyticus
•S. lugdenensis
•S. mutans
•S. mitis
•S. sanguinis
•S. salivarius
•S. anginosis (Milleri)
Gram Positive Bacilli
Aerobes
Bacillus
•B. cereus
•B. anthracis
Listeria
Nocardia
Erysipilothrix
Corynebacterium
•C. diptheriae
Anaerobes
Clostridium
•C. difficile
•C. tetani
•C. perfringens
•C. botulinum
Actinomyces


Gram Negative
Anaerobes (Bacilli)
Bacteroides
•B. fragilis
Fusobacterium
Aerobes
Cocci
Neisseria
•N. meningiditis
•N. gonorrhea
Coccobacilli
Moraxhella
•M. catarrhalis
Hemophilus
•H. influenzae
Pasturella
•P. multocida
Bartonella
•B. henselae
Francisella
•F. tularensis
Brucella
Bordatella
•B. pertussis
Legionella
Hemophilus
•H. parainfluenzae
•H. aphrophilus
Acinetobacter
Cardiobacterium
Eikenella
Kingella
Bacilli
+
Lactose Fermenting
-
Enterobacteriaciae
Escherichia
•E. coli
Klebsiella
Enterobacter†
Serratia†
Citrobacter†
Proteus (indole +)†
•P. vulgaris
•M. morganii
•Providentia
+
Oxidase
-
Pseudomonas†
•P. aeruginosa
Aeromonas
Burkholderia
•B. cepacea
Vibrio
•V. cholera
Helicobacter
•H. pylori
Stenotrophomonas
Shigella
Salmonella
Campylobacter
Proteus (indole -)
•P. mirabilis
Yersinia
•Y. pestis
•Y. enterocolitis
† SPICE organisms

BACTERIA STRUCTURAL DIFFERENCES





Pathogenic Bacteria

- They are those bacteria that cause disease
- All organs of the body are subject to bacterial infection

Disease Mechanisms Involved in Bacterial Infections

Disease	Example
Pyogenic Infections	Pneumococcal pneumonia, Staphylococcal disease
Granulomatous Infections	Pulmonary Tuberculosis, Brucellosis, Syphilis
Intoxication	Gas gangrene (Clostridium perfingens) Diphtheria (Corynebacterium diphtheriae)
Immunologic mediation	Guillain-Barre syndrome following Campylobacter jejuni infection
Neoplasia	Adenocarcinoma of the stomach as a consequence of Helicobacter pylori persistence

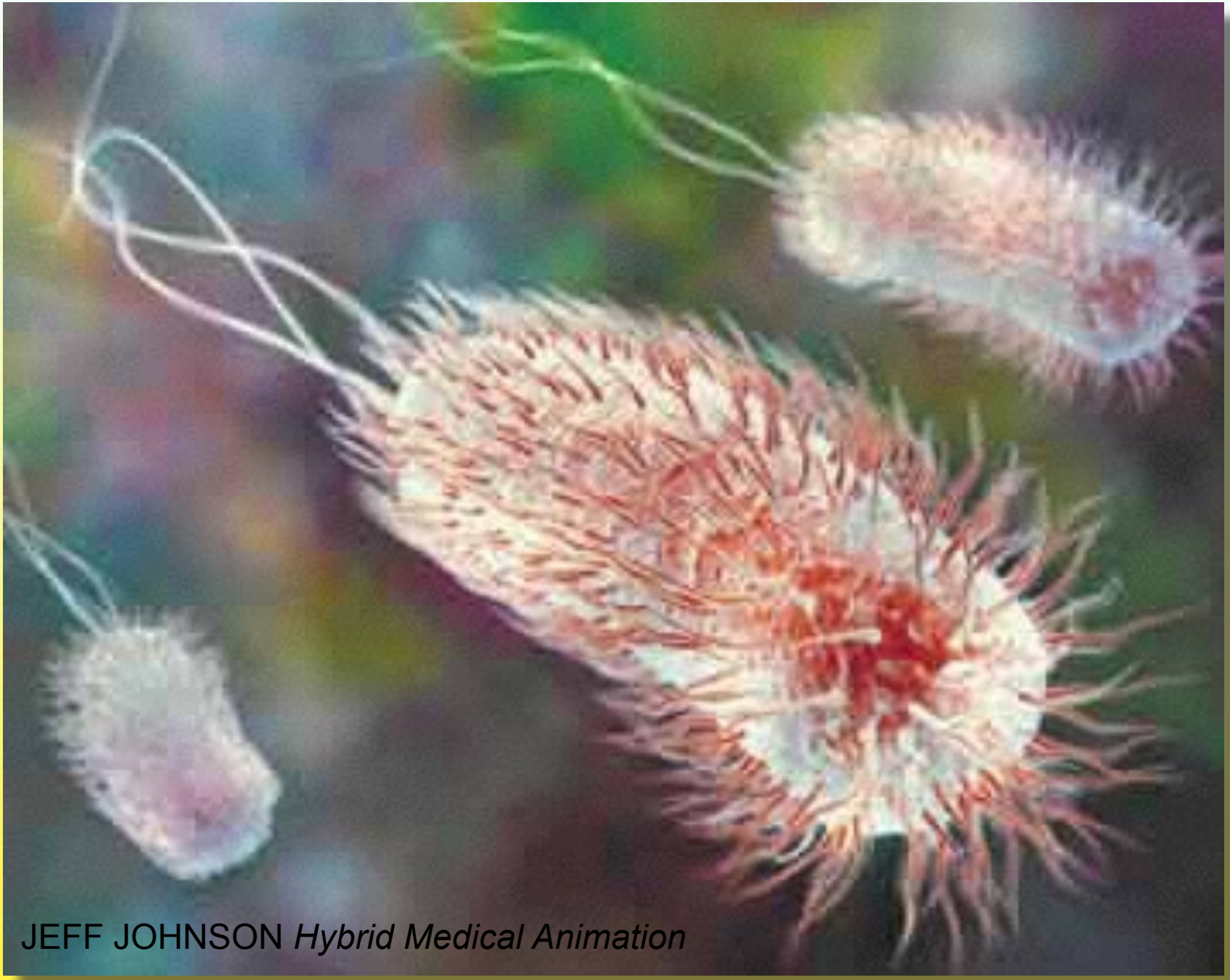
Adapted from Mandell et al. PPID Page 2320 6th Edition

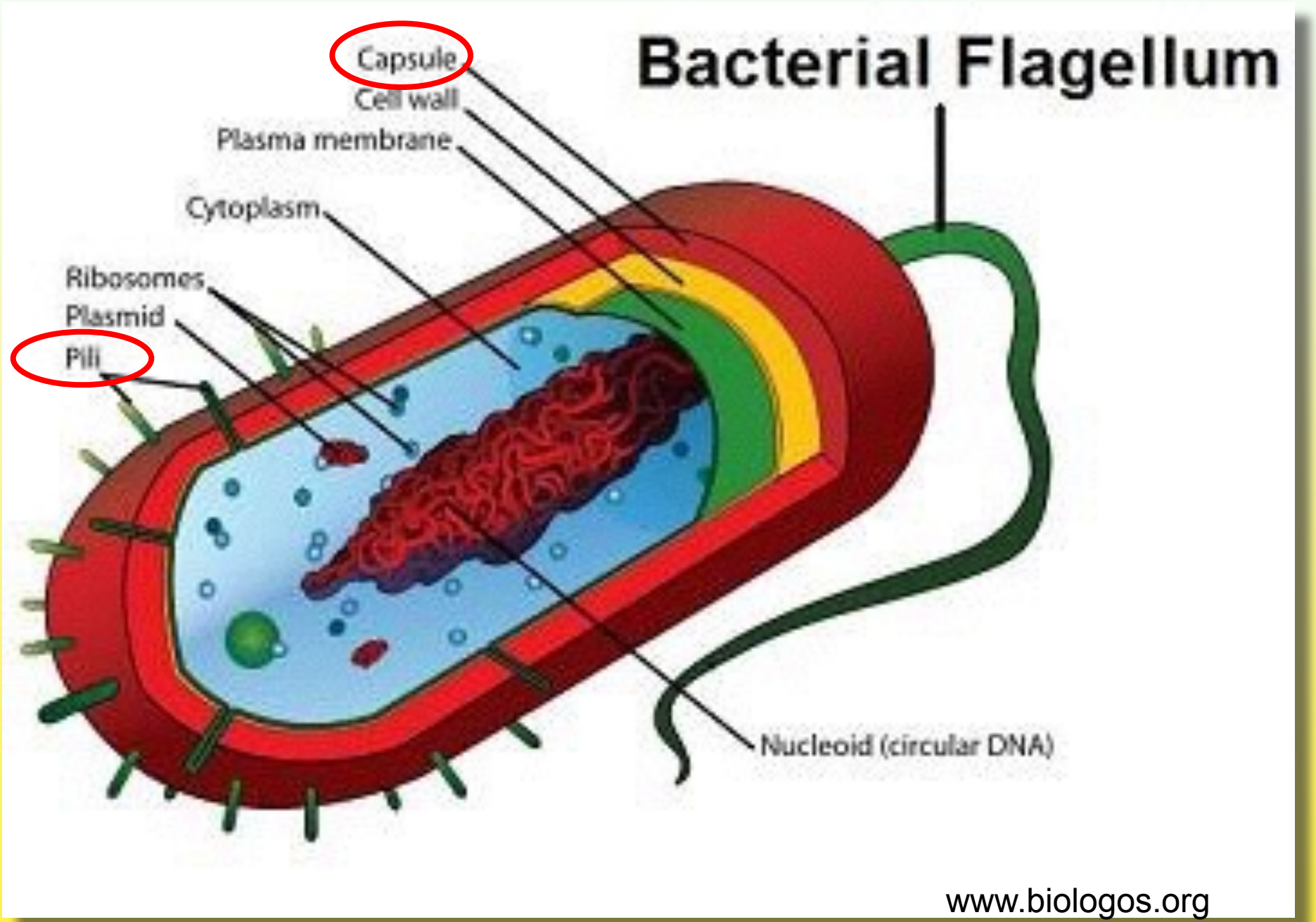
Virulence Factors of Pathogenic Bacteria

- Virulence of an organism is the degree of organism pathogenicity and hostility

Common Virulence Factors of Pathogenic Bacteria

Flagella	Vibrio cholera
Pili	E. coli
Capsules	Streptococcus
Endospores	Bacillus, clostridium
Exotoxins	Vibrio cholera


JEFF JOHNSON *Hybrid Medical Animation*



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Virulence factor	Bacteria	Action
Flagella	*Vibrio cholera* *E. coli*	
(Pili (adhesins	*Neisseria gonorrhea* *E.coli ,Campylobacter jejuni* *Bortadella pertussis*	Allow it to bind to cervical cells and cause disease Bind to intestinal epithelium causing diarrhea Binds to respiratory cells causing whooping cough
Capsules	*Streptococcus pnuemoniae*	Macrophages unable to phagocytize them causing pneumonia
Endospores	*Bacillus* *Clostridium*	Metobolically dormant bacteria resistant to heat (boiling), cold,drying and chemical agents
Exotoxins	*Anthrax* *V. Cholera, E. coli, C.jejuni, S.dysenteriae* *S. aureus, B. cereus*	Bacteria bind to intestinal cells continuously releasing their toxin causing diarrhea Bacteria release toxin in food causing diarrhea
Endotoxins	Gram –ve bacteria	Septic shock

Bacterial Resistance

- Common resistant pathogens;
  - MRSA
  - VRE
  - ESBL producing E. coli and Klebsiella spp (and other enteric bacteria)
  - MDR Acinetobacter
  - MDR Pseudomonas aeruginosa
  - Carbapenenmase producing bacteria (e.g. NDM, KPC)

What Does A Positive Culture Represent?

- Infection
- Colonization
- Contamination

What Does A Positive Culture Represent?… (Cont.)

- Infection: an appropriately collected culture with a clinical presentation compatible with an infectious process.

- Example:
  - Sputum culture growing Streptococcus pneumoniae in a patient with signs and symptoms of pneumonia

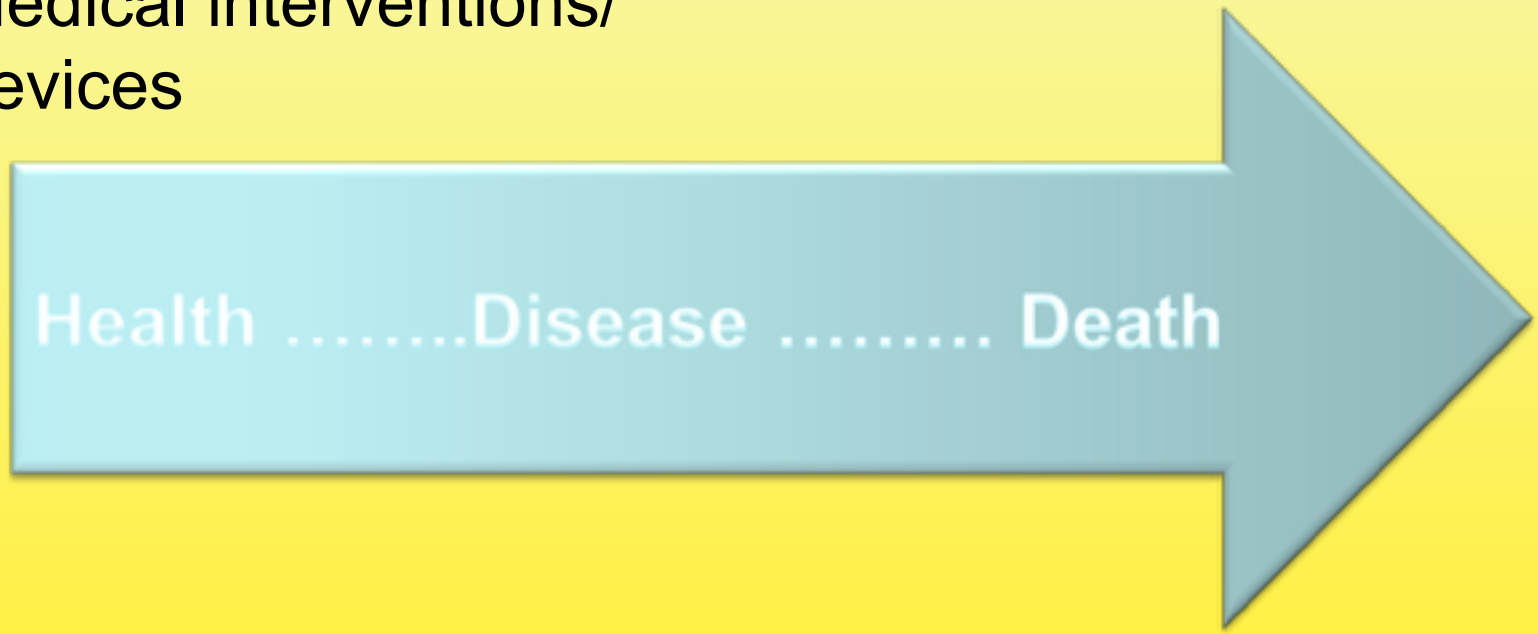
Possible outcomes of infections

Host factors

- General health
- Physical barriers (skin, stomach acidity)
- Sufficient immune response
- Medical interventions/ devices

Microbial factors

- Level of virulence
- Number of organisms
- Body site targeted



What Does A Positive Culture Represent?...(Cont.)

- Colonization: an appropriately collected culture but the patient does not have an infectious process.

- Example:
  - Nasal culture growing *Staphylococcus aureus* in asymptomatic patient.

Significance of Colonization

- Colonization might turn into infection
- Infection control issues of colonization
- Colonization testing in special situations

What Does A Positive Culture Represent?... (Cont.)

- Contamination: an inappropriately collected culture and the patient does not have an infectious process.
- Example:-
  - Blood culture collected (without following the aseptic technique) growing *Staphylococcus epidermidis* in asymptomatic patient.

How to utilize the microbiology laboratory services?

- Collect proper specimens
- Use proper containers
- Communicate with the laboratory in cases where unusual pathogens are suspected
- Provide all the relevant clinical data
- Interpret culture results in light of the clinical presentation

Take Home Message

- Microbiology services are essential for any infection control and guide you to Antibiotic choice

Questions?

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