
بسم الله الرحمن الرحيم

Classification of Bacteria

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Aims & Objectives

At the end of the lecture, students of 3rd Year MBBS should be able to

1. Describe classification of bacteria based on oxygen requirement as aerobes and anaerobes with examples. #83
2. Describe classification of bacteria based on staining characteristics, nature of cell wall, ability to grow in the presence of oxygen and ability to form spores. #84

Taxonomy

It is the science of classification of organisms,

and their organization into groups or types.

Greek; law of arrangement)

Classification of bacteria

- It is the orderly arrangement of bacteria into groups by criteria of interest in a hierarchical (tree like) structure according to the similarities or differences in their characters (both physical /or genetic).
- Current classification of bacteria is based primarily on their morphological and biochemical characteristics.

First system of

bacterial classification

David Hendrick Burgey

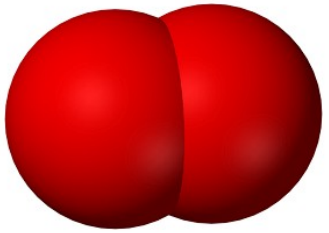
in 1923

Classification

Based on morphology and biochemical characteristics.

- Criteria is
  - **Oxygen requirement**
  - Nature of cell wall,
  - Free living
  - staining reaction
  - Shape
  - Spore formation
  - Biochemical reactions.

Molecular oxygen (O_2)



- Molecular oxygen is essential for life as it is used for respiration by many organisms.
- Molecular oxygen is very reactive, and when it snatches up electrons, it can form hydrogen peroxide (H_2O_2), superoxide radicals (02i), and hydroxyl radical (OH -).
- All of these are toxic unless broken down.

Enzymes to break down oxygen products

- There are 3 enzymes that (some bacteria possess to) break down these oxygen toxic products:

  1) **Catalase** breaks down hydrogen peroxide:

  $$2H_2O_2 \rightarrow H_2O + O_2$$

  2) **Peroxidase** breaks down hydrogen peroxide, that is produced as a byproduct of using oxygen for respiration.

  3) **Superoxide dismutase** breaks down the superoxide radical:

  $$2O_2^- + 2H^+ = H_2O_2 + O_2$$

Classification of bacteria on O_2 demand

Oxygen is a major factor in bacterial classification.

1. Obligate aerobes: These bacteria utilize glycolysis, the Krebs cycle, and the electron transport chain with oxygen as the final electron acceptor.

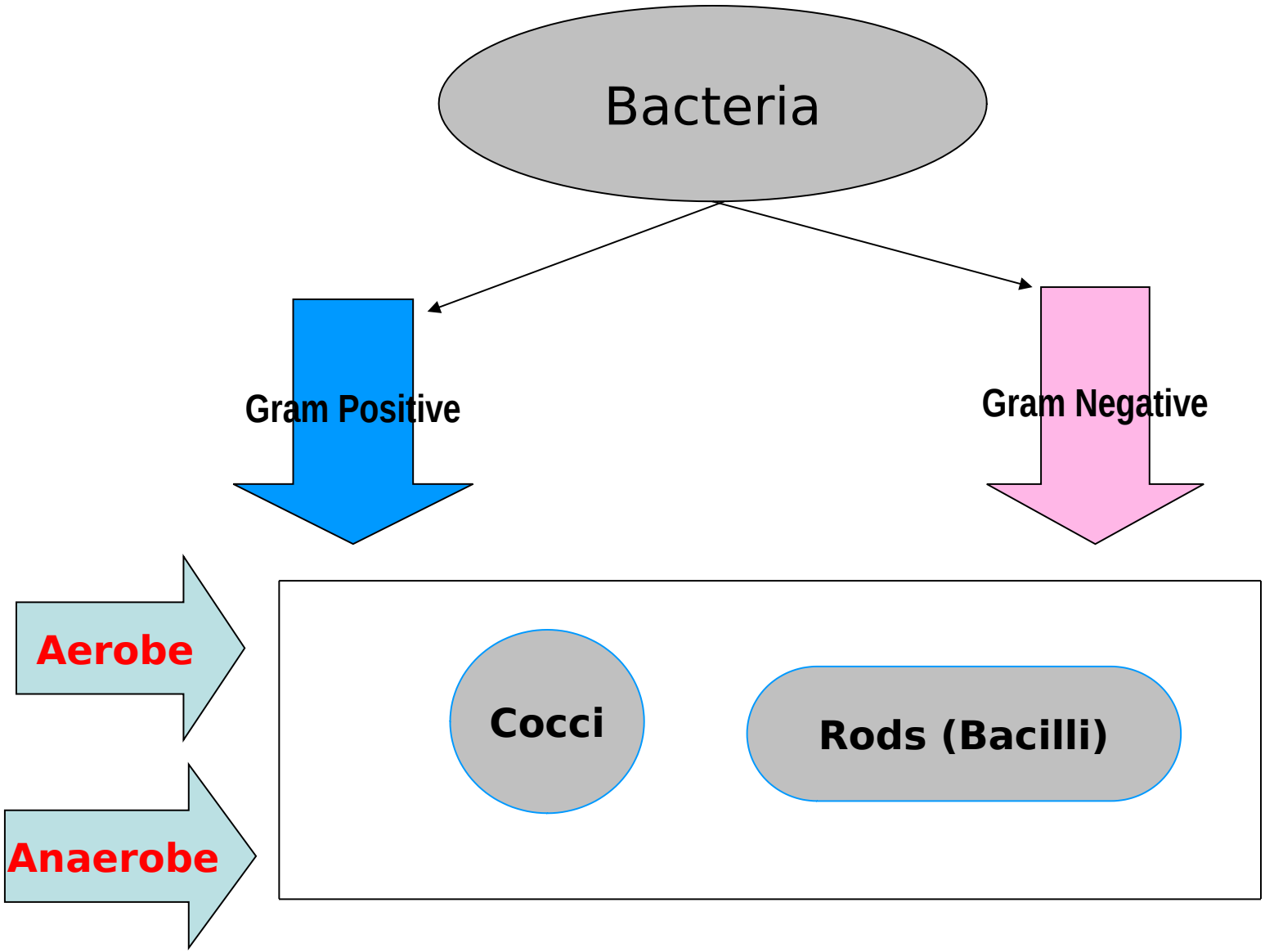
These bacteria have all three enzymes.

2.Facultative anaerobes: They use oxygen as an electron acceptor in their electron transfer chain and have catalase and superoxide dismutase. The only difference is that they **can** grow in the absence of oxygen by using fermentation for energy. Thus they have the *faculty to be anaerobic* but prefer aerobic conditions.

3. **Microaerophilic bacteria (also called aerotolerant anaerobes):** They use fermentation and have no electron transport system. They can tolerate low amounts of oxygen because they have superoxide dismutase (but they have no catalase).

4. **Obligate anaerobes:** These hate oxygen and have no enzymes to defend against it.

Classification on staining characteristic and O2 requirements



	OBLIGATE AEROBES	**FACULTATIVE** ANAEROBES	**MICROAERO PHILIC**	**OBLIGATE** ANAEROBES
Gram positive	• *Bacillus cereus*	• *Staphylococcus* • *Bacillus anthracis* • *Corynebacterium* • *Listeria* • *Actinomyces*	• *Streptococcus*	• *Clostridium*
Gram Negative	• *Neisseria* • *Pseudomonas* • *Bordetella* • *Legionella* • *Brucella*	*Most other Gram negative rods*	• *Spirochetes (Treponema)* • *Compylobacter*	• *Bacteroides*
Acid Fast	• *Mycobacterium* • *Nocardia*			
No cell wall		• *Mycoplasma*		

Medically Important Bacteria

Rigid Thick Cell-wall	All gram + and negative bacteria
Flexible thin wall	Spirochetes (*Treponema, Leptospira, Borrelia*)
Wall less	*Mycoplasma pneumoniae*

Bacterial Spores

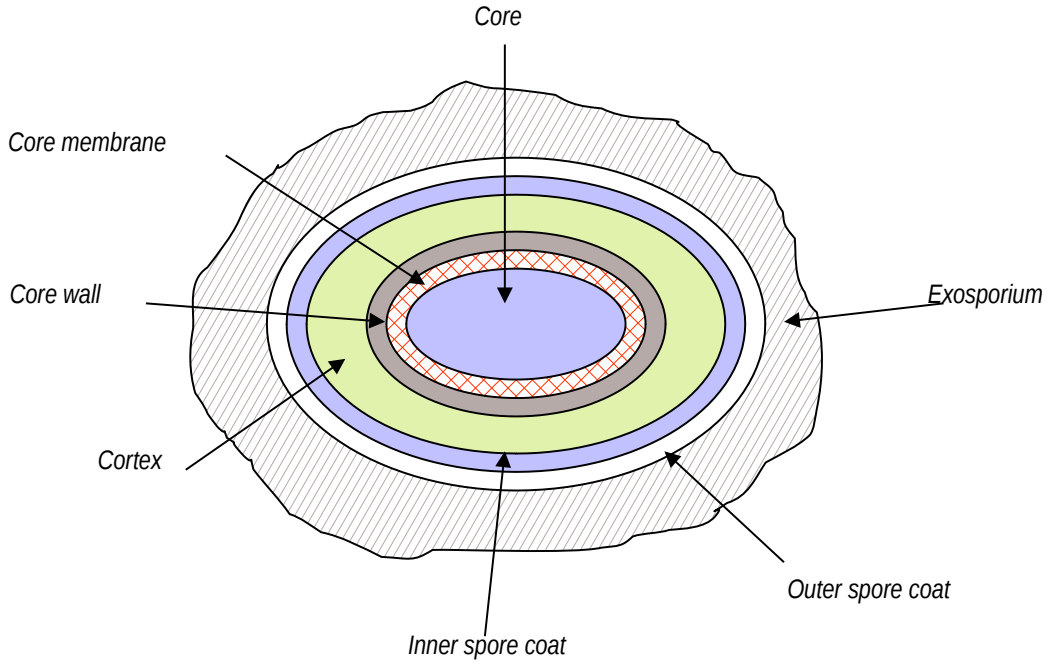
- **Spore is a thick, resistant, multilayered coating secreted by certain G+ bacteria, to be able to survive in hostile environments**

- *Dormant*
- *Almost Inert metabolically*
- *No division*

Spores are resistance to

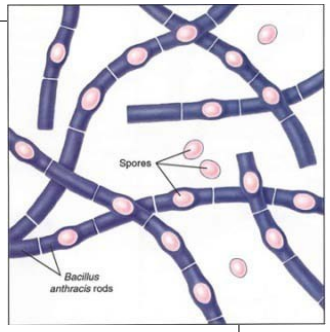
- *Heat*
- *Descication*
- *UV light*
- *Certain chemicals*

Killed by autoclaving



- *Bacillus anthracis*
- *B. cereus*
- *Claustridium tetani*
- *C. perfringens*
- *C. botulinum*

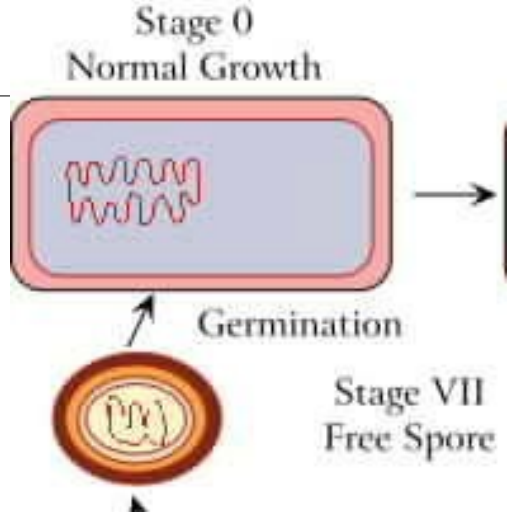
Medical significance of sporulation



- Spores remain
  - viable for many years
  - not killed by boiling, but can be killed by
    - **Sterilization** (autoclave) at >120°C under elevated pressure OR
    - ***Tydallization* / fractional sterilization** (by primary boiling to activate germination & after a short period of vegetative growth, a second boiling.

Spore germination

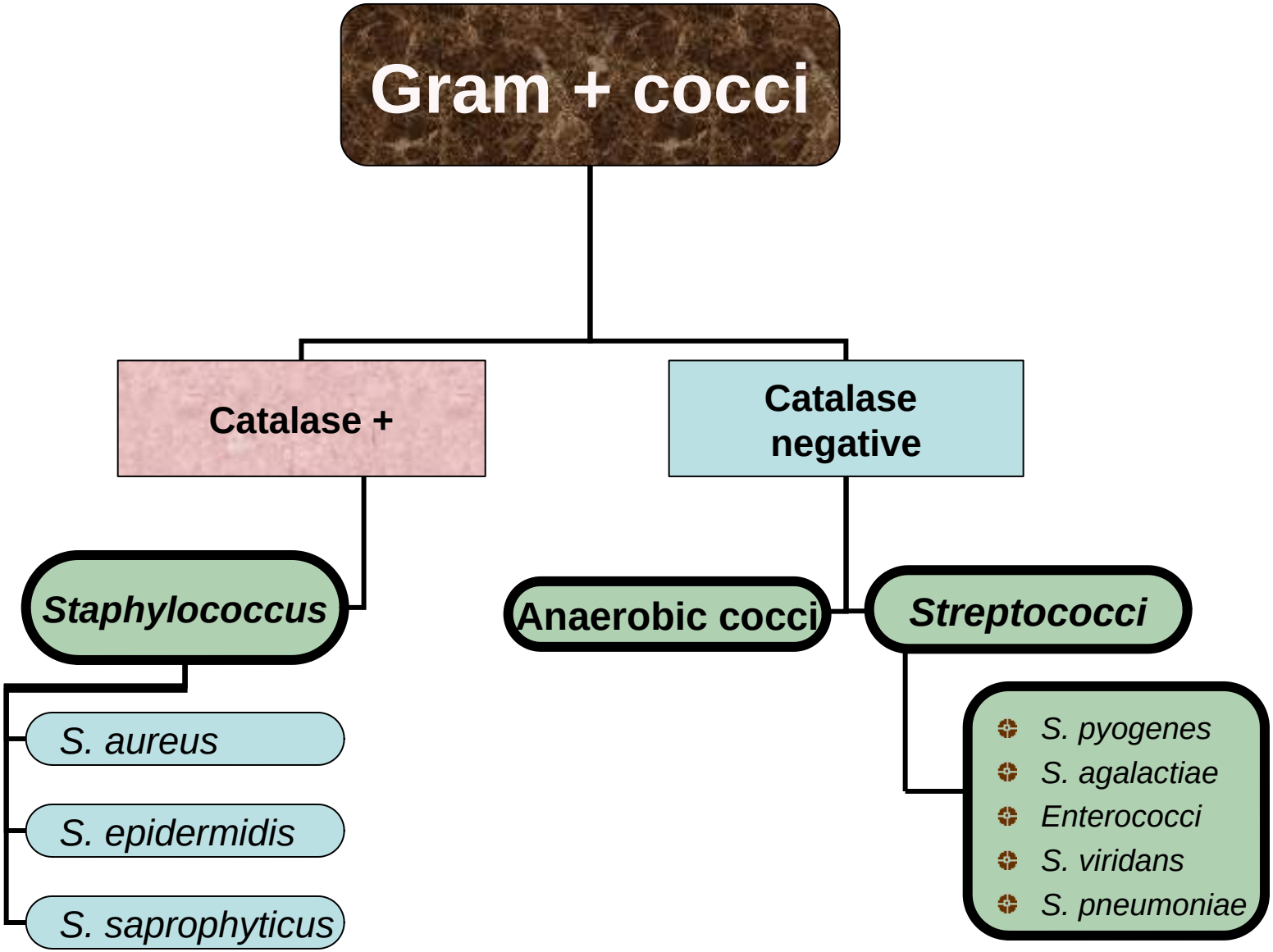
- *Spore coat is weakened by heat / extreme of pH*
- *Or If the environment is nutritious, germination starts*
- *And the cell returns to the vegetative state*

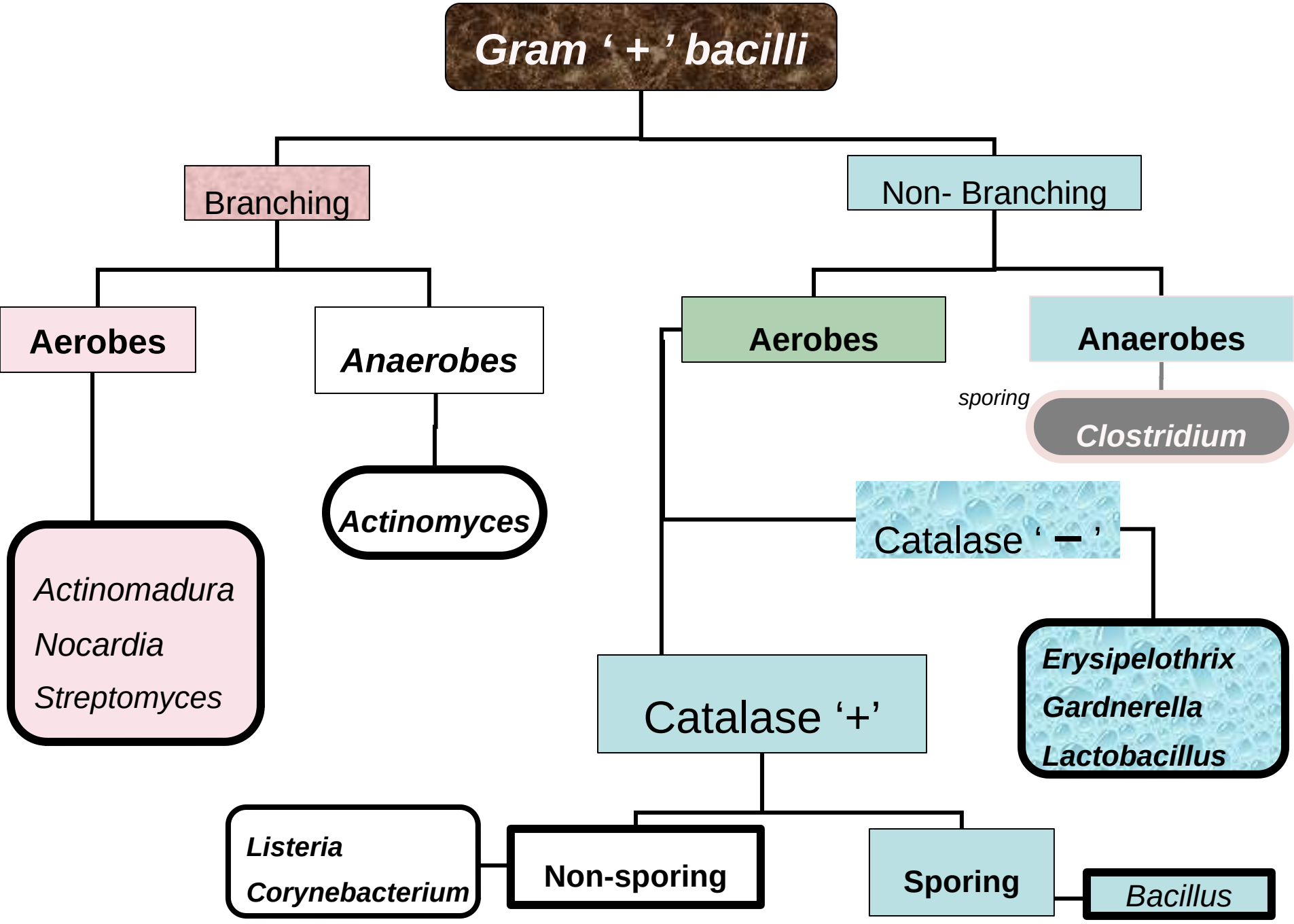


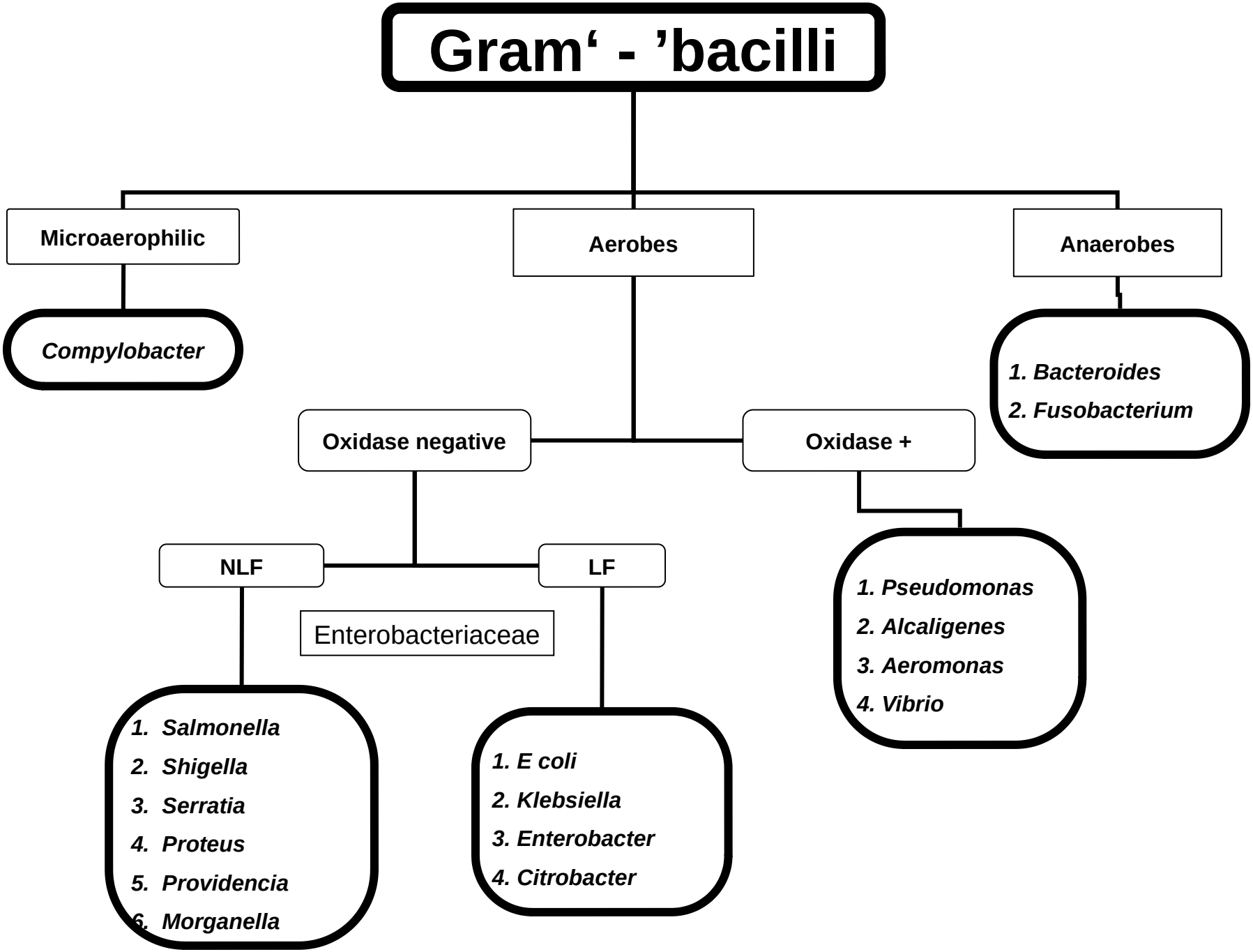
- A. Free living:
  - G +ve
    - A) Cocci (*Staphylococcus, Streptococcus*)
    - B) Sporing
      - » Aerobes: (*Bacillus*)
      - » Anaerobes: (*Clostridium*)
    - C) Non sporing
      - » Fillamentous: (*Actinomyces, Nocardia*)
      - » Non-filamentous: (*Corynebacterium, Listeria*)
  - G -ve
  - AFB (*Mycobacterium*)

- Non free living (Obligate intracellular) {*Rickettsiae, Chlamydia*}

- G -ve
  - Cocci ---------- *Neisseria*
  - Rods
    - Facultative
      - **Straight**
        - » Respiratory organisms (*Haemophilus, Leigionella, Bordetella)*
        - » Zoonotic (*Brucella, Pasteurella, Francisella, Yersinia)*
        - » Enteric & Related (*E.coli, Enterobacter, Serratia, Klebsiella, Salmonella, Shigella, Proteus)*
      - **Curved** ---------- (*Compylobacter, Helicobacter, Vibrios*)
    - Aerobes (*Pseudomonas*)
    - Anaerobes (*Bacteroides*)


Gram + cocci
Catalase +
Catalase negative
Staphylococcus
Anaerobic cocci
Streptococci
S. aureus
S. epidermidis
S. saprophyticus
S. pyogenes
S. agalactiae
Enterococci
S. viridans
S. pneumoniae


Gram ‘ + ’ bacilli
Branching
Non- Branching
Aerobes
Anaerobes
Aerobes
Anaerobes
sporing
Clostridium
Actinomyces
Catalase ‘ – ’
Actinomadura
Nocardia
Streptomyces
Catalase ‘+’
Erysipelothrix
Gardnerella
Lactobacillus
Listeria
Corynebacterium
Non-sporing
Sporing
Bacillus


Gram‘ - ’bacilli
Microaerophilic
Aerobes
Anaerobes
Compylobacter
1. Bacteroides
2. Fusobacterium
Oxidase negative
Oxidase +
NLF
LF
Enterobacteriaceae
1. Pseudomonas
2. Alcaligenes
3. Aeromonas
4. Vibrio
1. Salmonella
2. Shigella
3. Serratia
4. Proteus
5. Providencia
6. Morganella
1. E coli
2. Klebsiella
3. Enterobacter
4. Citrobacter


Thank you