



Lecture 3

Bacterial Growth & physiology



Bacterial Growth

Definitions

B. Reproduction

culture media

A) Definition

B) Classification

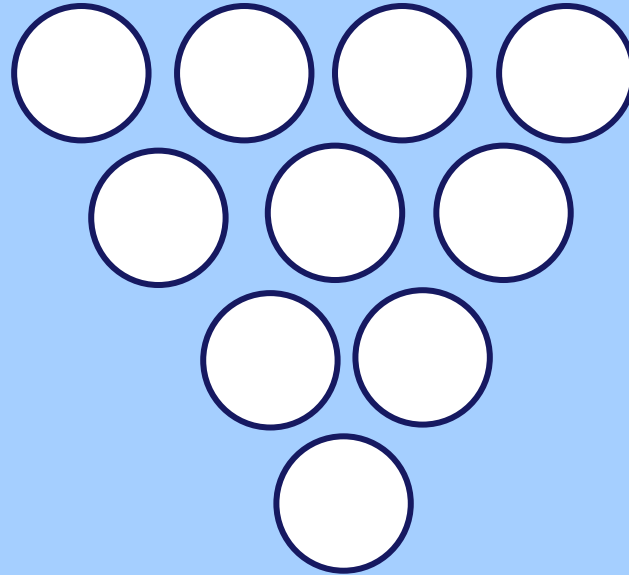
C) Types

Bacterial growth curve



Bacterial Growth: Definition

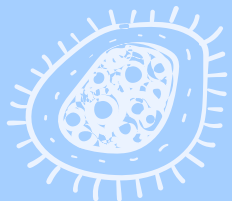
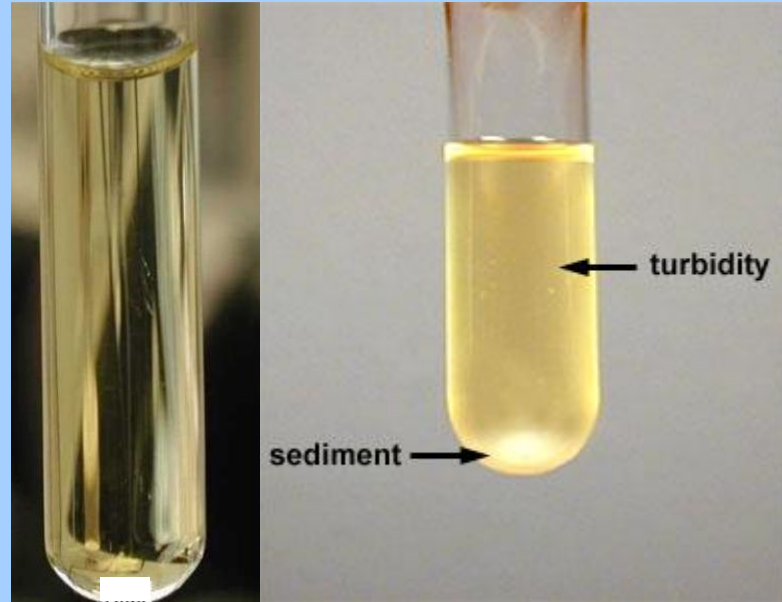
**Size
& Number of
organism**



1) Bacterial Growth

Indicated by

a) Turbidity of
the fluid media

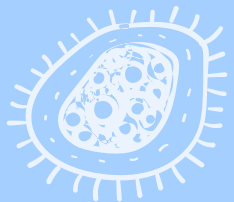


1) Bacterial Growth

Indicated by

b) Colonies on solid media

(Macroscopic product)



2) Colony (Macroscopic product)

Single bacterium

On solid media

After 20-30 division

Binary fission

Colony



So the appearance of colony will be after
20-30 division of single bacterium



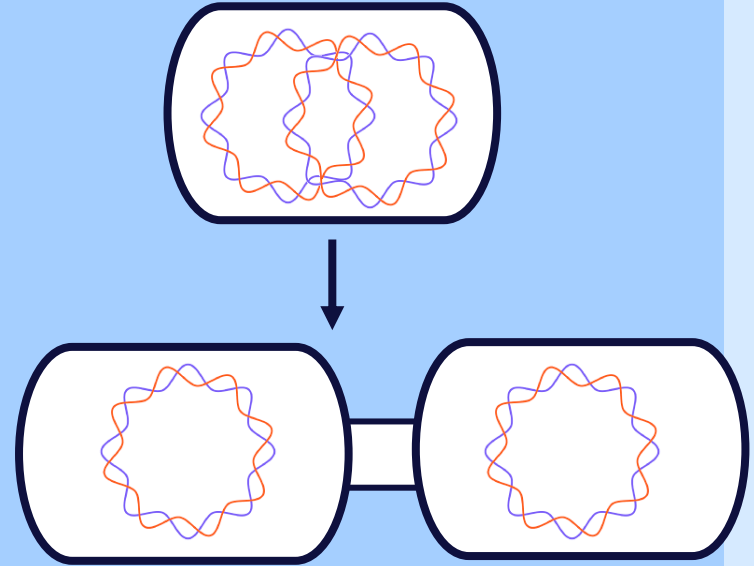
2) Colony

After 20-30 division

Binary fission

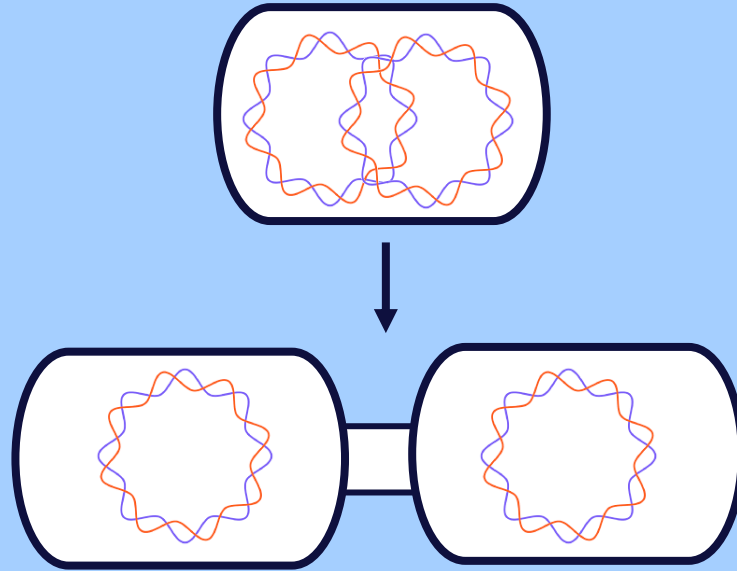
1 Million

(2^{20})



3) Generation time (doubling time)

13min (*V.cholerae*)

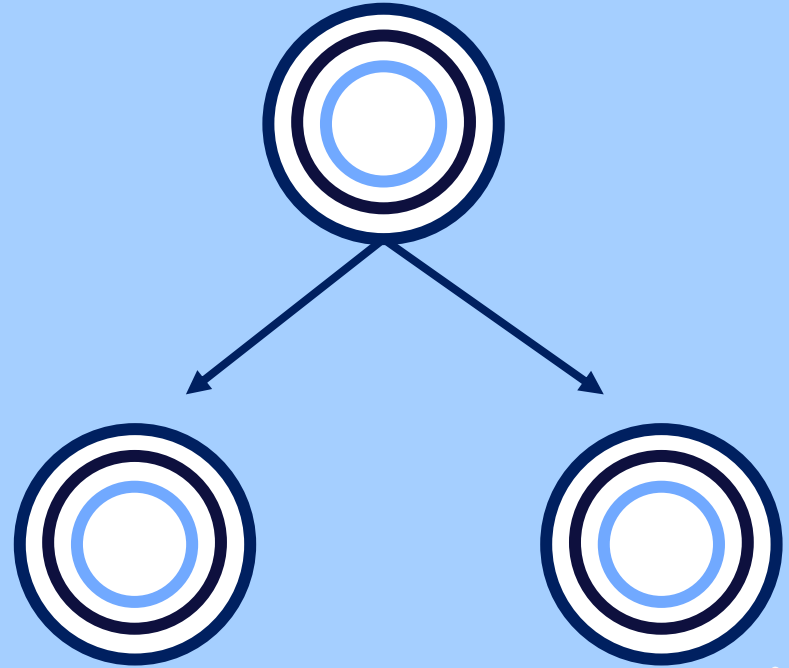


24 hrs (*M.tuberculosis*)



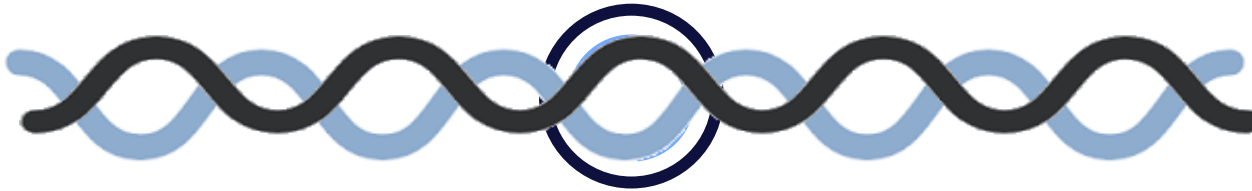
Bacterial Reproduction

Binary fission



Bacterial Reproduction

1 Elongation

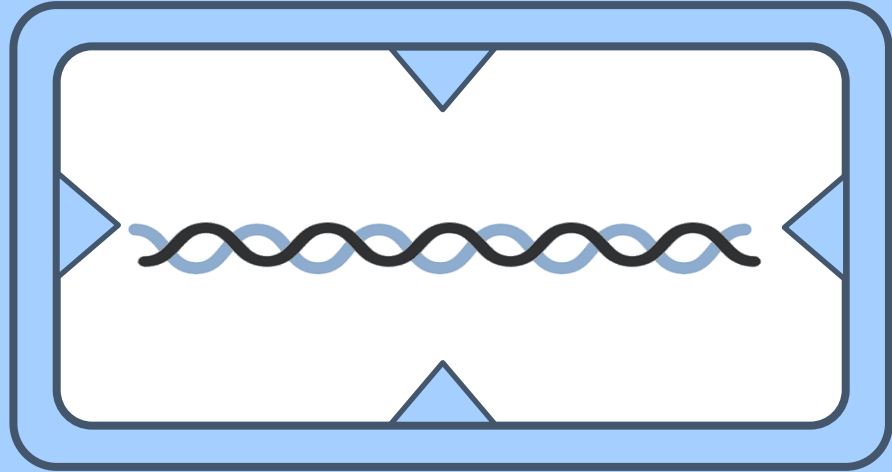


Bacterial Reproduction

2

**Separation of
2 strands**

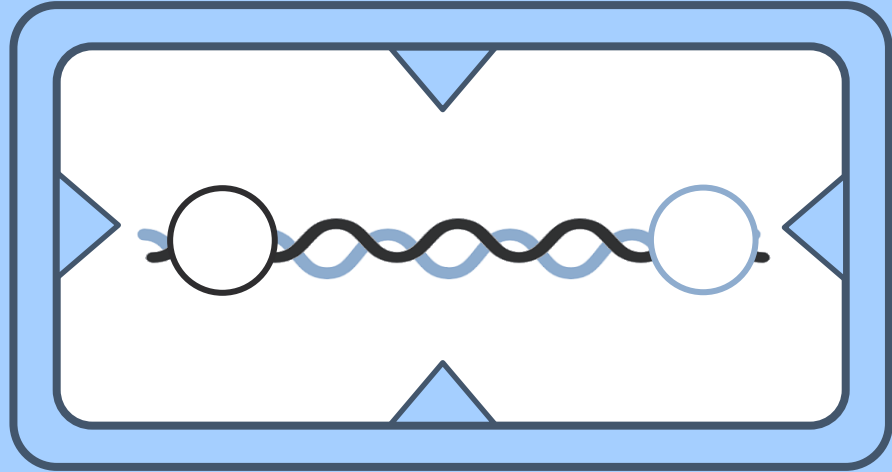
**(ssDNA attached to
mesosome)**



Bacterial Reproduction

2

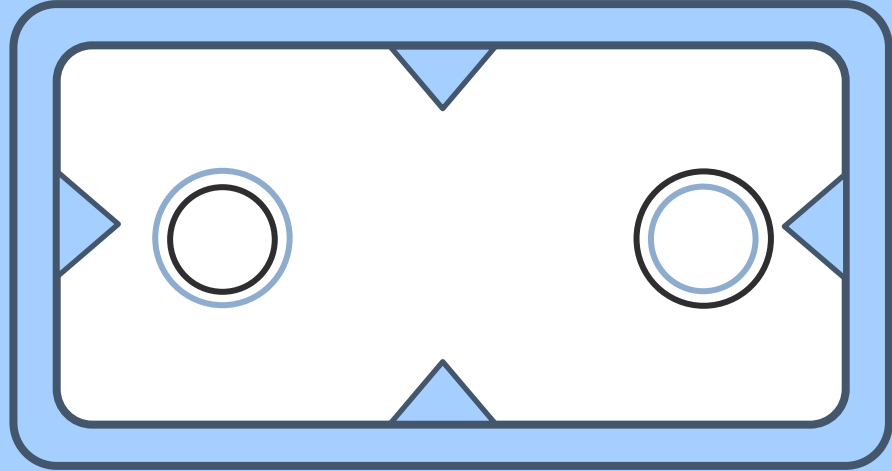
Separation of
2 strands



Bacterial Reproduction

3

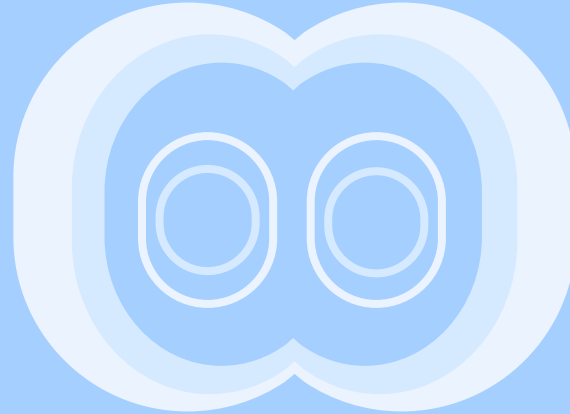
**Separate ssDNA &
become dsDNA**



Bacterial Reproduction

4

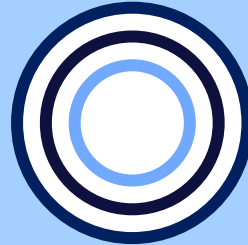
**Formation of
division septum**



Bacterial Reproduction

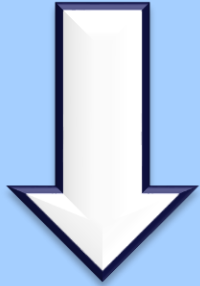
5

Cell separation



Bacterial culture media

**Bacteria grow
(In vitro)**



**Need nutrients for
growth**



Artificial



Purpose

1

Study Properties



Purpose

2

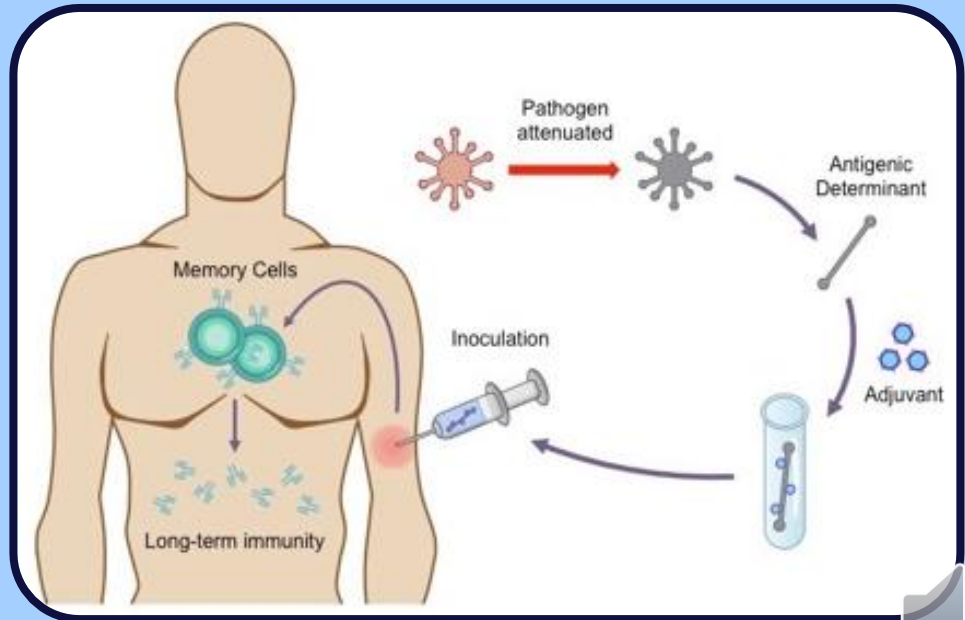
**Isolation &
diagnosis
(Causative agent)**



Purpose

3

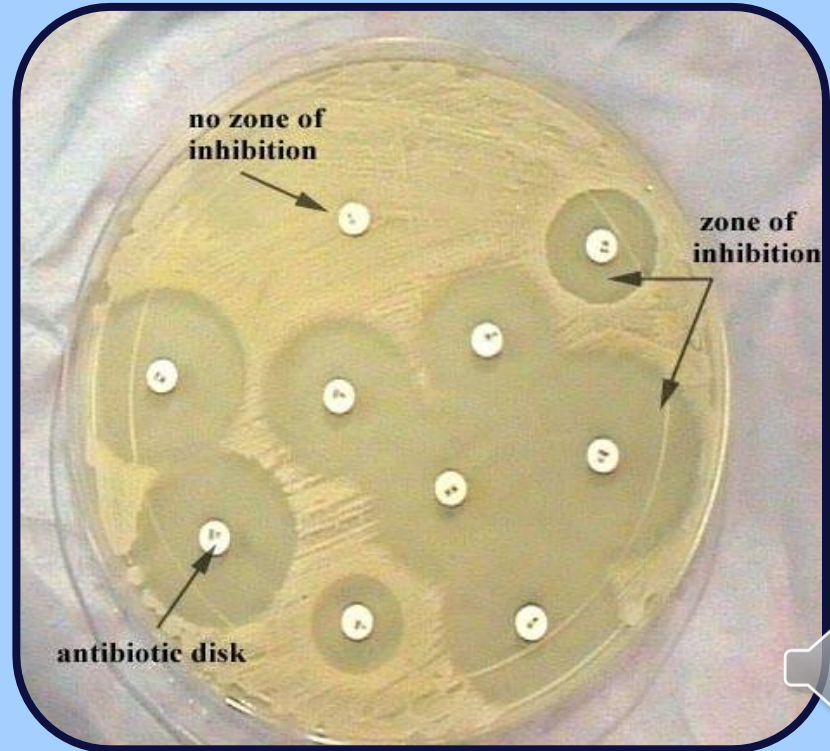
**Prepare vaccine &
Other product**



Purpose

4

**For Selection
proper antibiotics**



Classification of media

Liquid



Solid



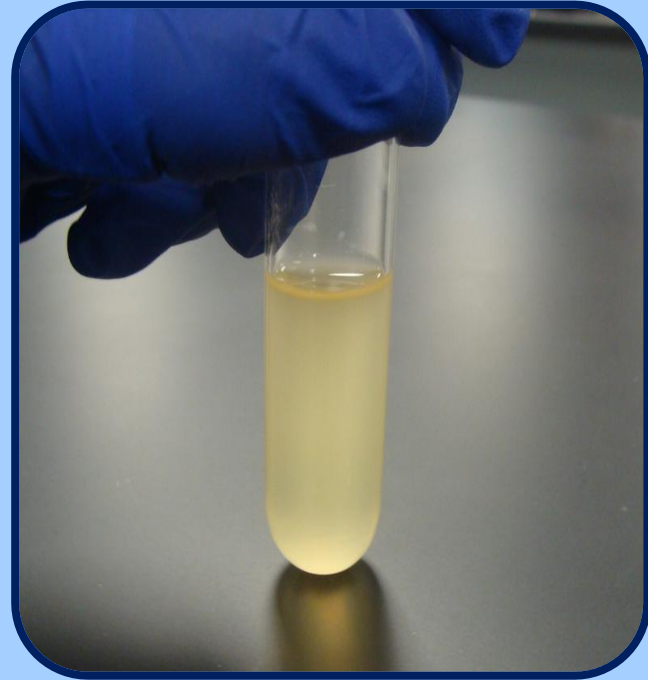
Types of media

- 1) Simple media
- 2) Enriched media
- 3) Selective media
- 4) Differential media



Simple media

**Basic requirement for
growth of most bacteria**



Simple media

A) Peptone water

Peptone + 0.5% NaCl

Enhancement

Sugar media



Simple media

B) Nutrient broth

Meat extract

Enhancement



Simple media

C) Nutrient agar plate

Nutrient broth + 2%

agar agar

(Seaweed)



Staph. aureus



Enriched media

Fastidious bacteria
Need blood, serum for
growth



Enriched media

A) Blood agar

Nutrient agar heated at 45°C
(semisolid)
+ sheep blood

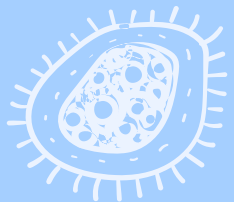


Enriched media

A) Blood agar

Streptococci

Strept. pyogenes



Hemolysis on blood agar:

A. Complete (beta) hemolysis:

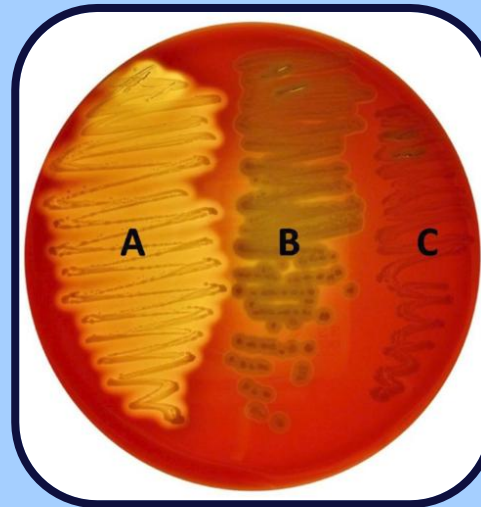
- *Staphylococcus aureus*
- *Streptococcus pyogenes*

C. No (gamma) hemolysis:

- *Enterococci*.

B. Partial (alpha) hemolysis:

- *Streptococcus viridans*
- *pneumococci*.

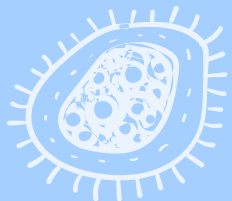


Enriched media

B) Chocolate agar

Nutrient agar heated
at 100°C, add blood

Hb  Haematin
(Chocolate)

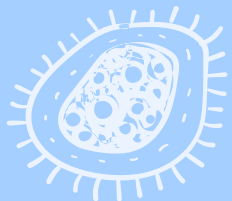


Enriched media

B) Chocolate agar

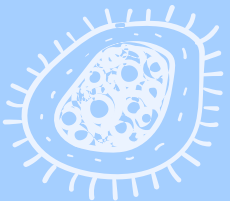
Haemophilus

Neisseria



Selective media

**Allow a certain organism to grow
(Selective) &
inhibits the growth of others**

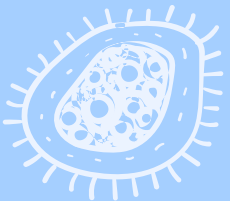


Selective media

Lowenstein Jensen medium

Malachite green

Mycobacterium tuberculosis

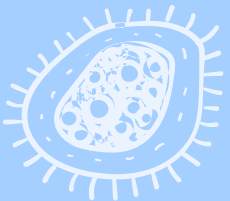


Selective media

Blood tellurite agar

Potassium tellurite

C.diphtheriae



Differential media

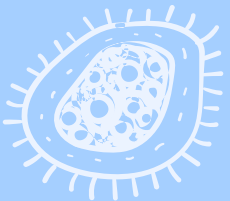
Selective

+

Indicator

**Allow a certain organism
to grow**

**Indicator to differentiate
(change in visibly)**



Purpose

MacConkey's agar

Bile (Enterobacteria)

Lactose= test sugar

Peptone

Neutral red =pH indicator



Pink

Pale

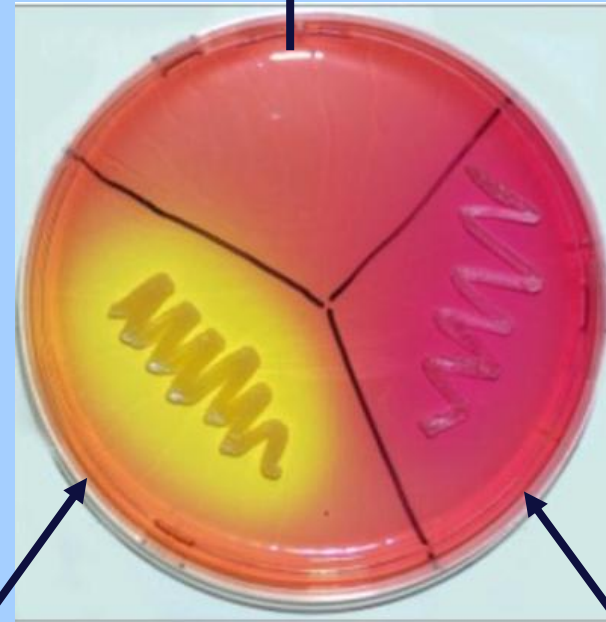


Differential media

Mannitol salt agar

(high salt 7.5% NaCl)

Phenol red = pH indicator



**Staphylococcus
aureus**

**Staphylococcus
epidermidis**

Differential media

Thiosulfate-Citrate-Bile-Sucrose Agar. (TCBS)

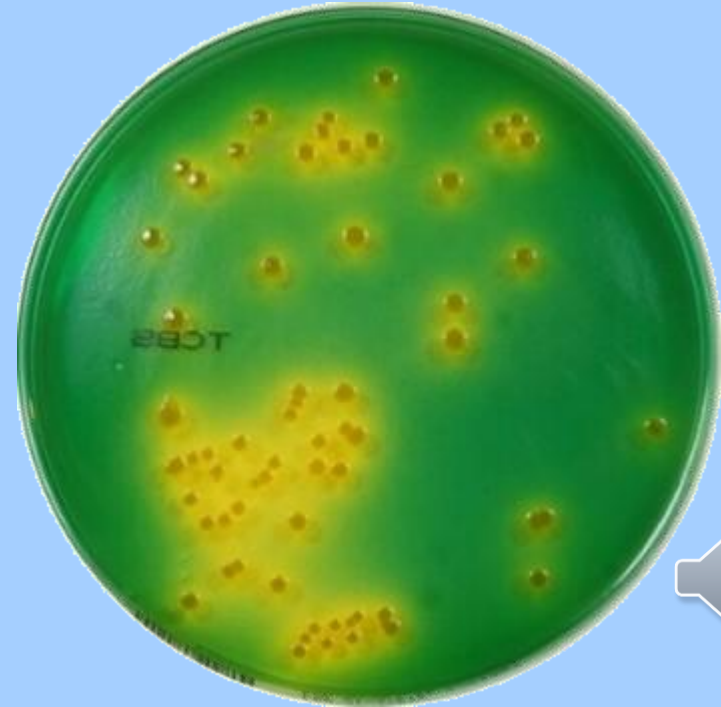
Thiosulphate

Bile

Citrate

Sucrose as test sugar

Bromothymol blue



Bacterial growth curve

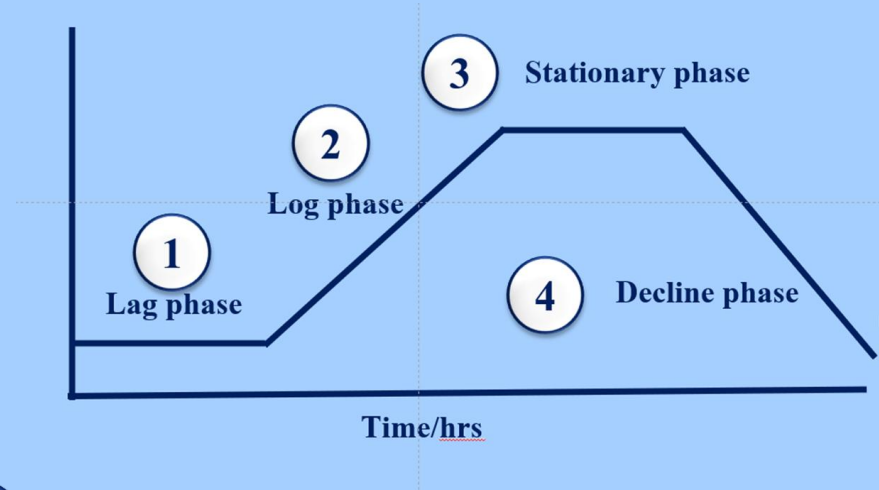
- 1) Lag phase
- 2) Log phase
- 3) Stationary phase
- 4) Decline phase



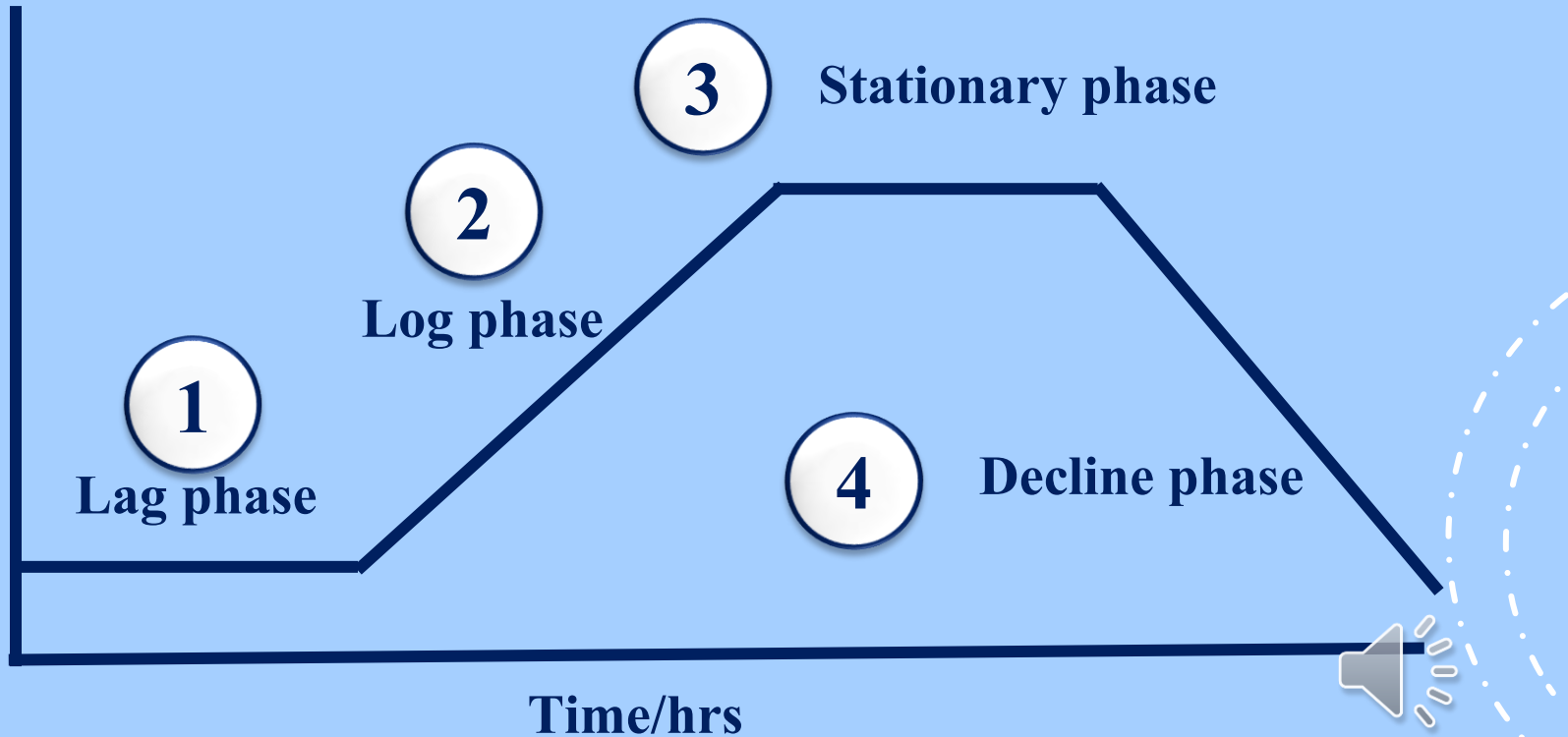
Bacterial growth curve

If a small number
of bacteria are inoculated
into a liquid nutrient
medium

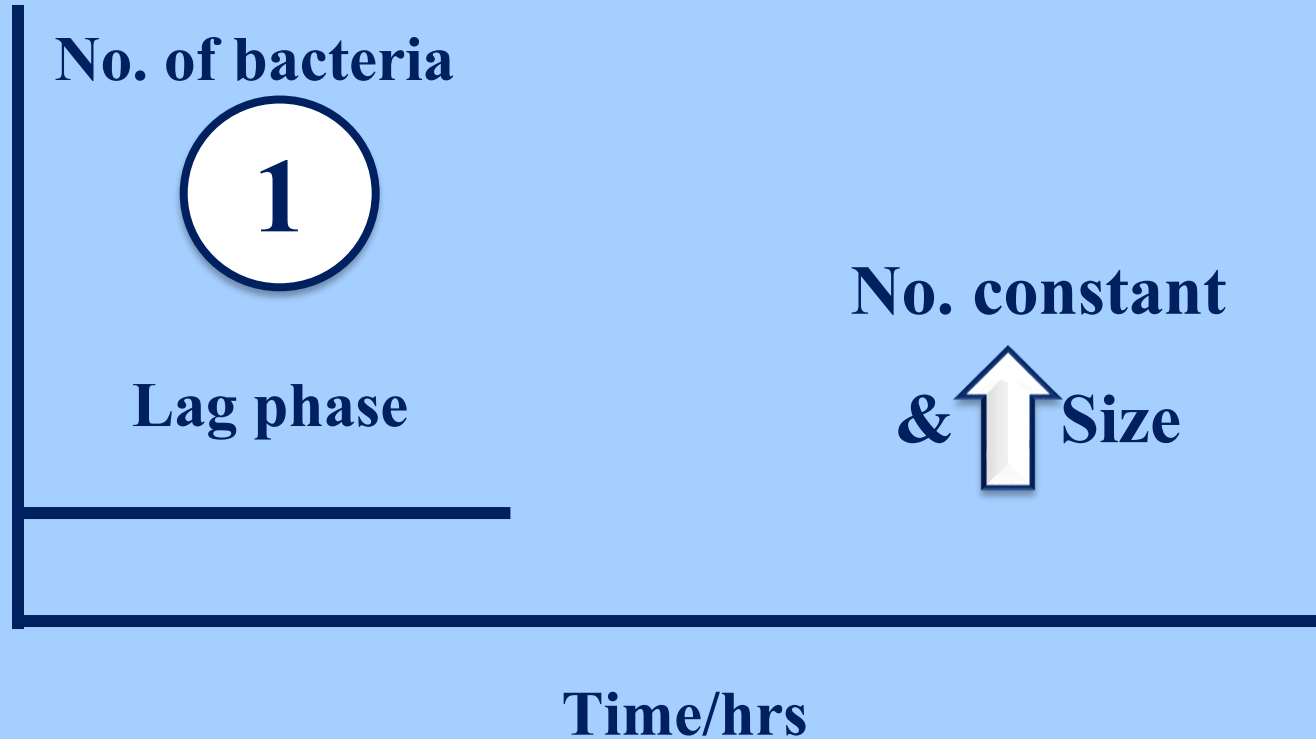
72h



Bacterial growth curve



Lag phase



Log phase

No. of bacteria

2

Start division

Log phase

Number

Protein

Enzymes

Size

Time/hrs



Stationary phase

No. of bacteria

3

Stationary phase

Constant number

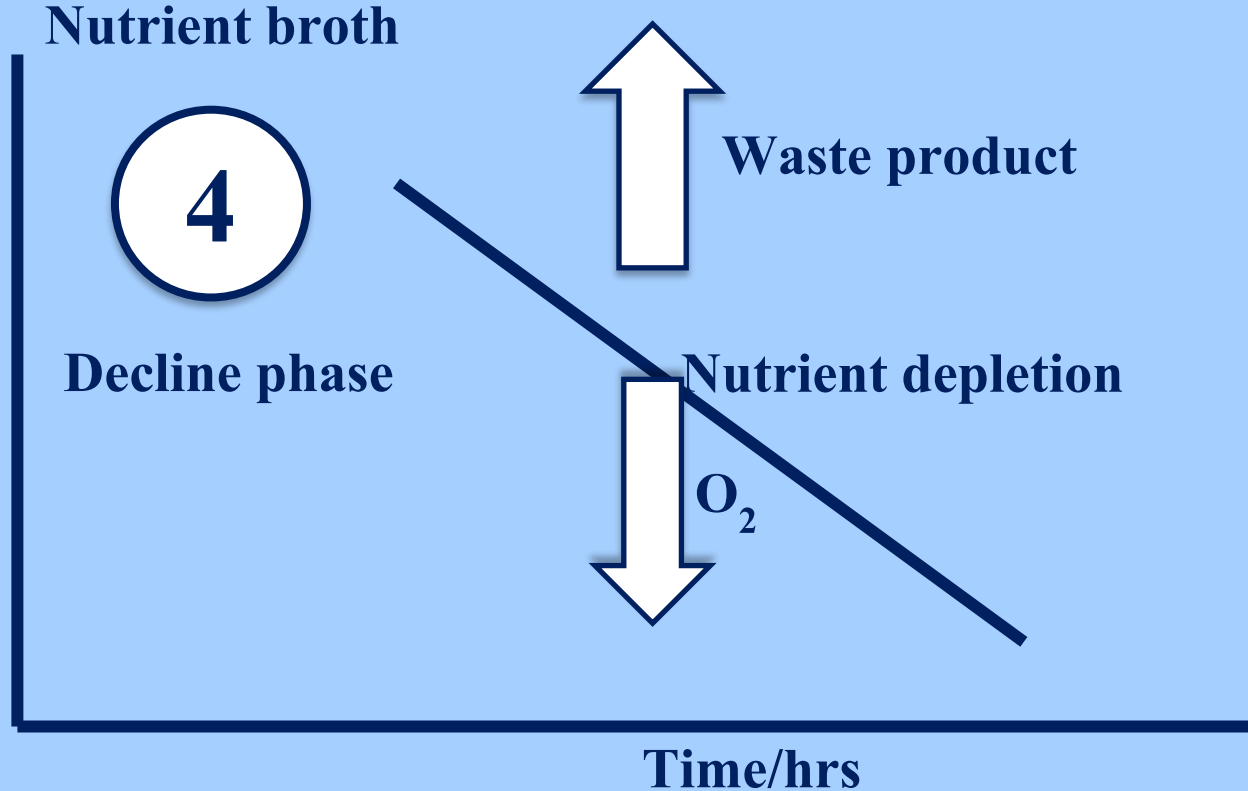
No. of division = No. of
death

(Waste product)

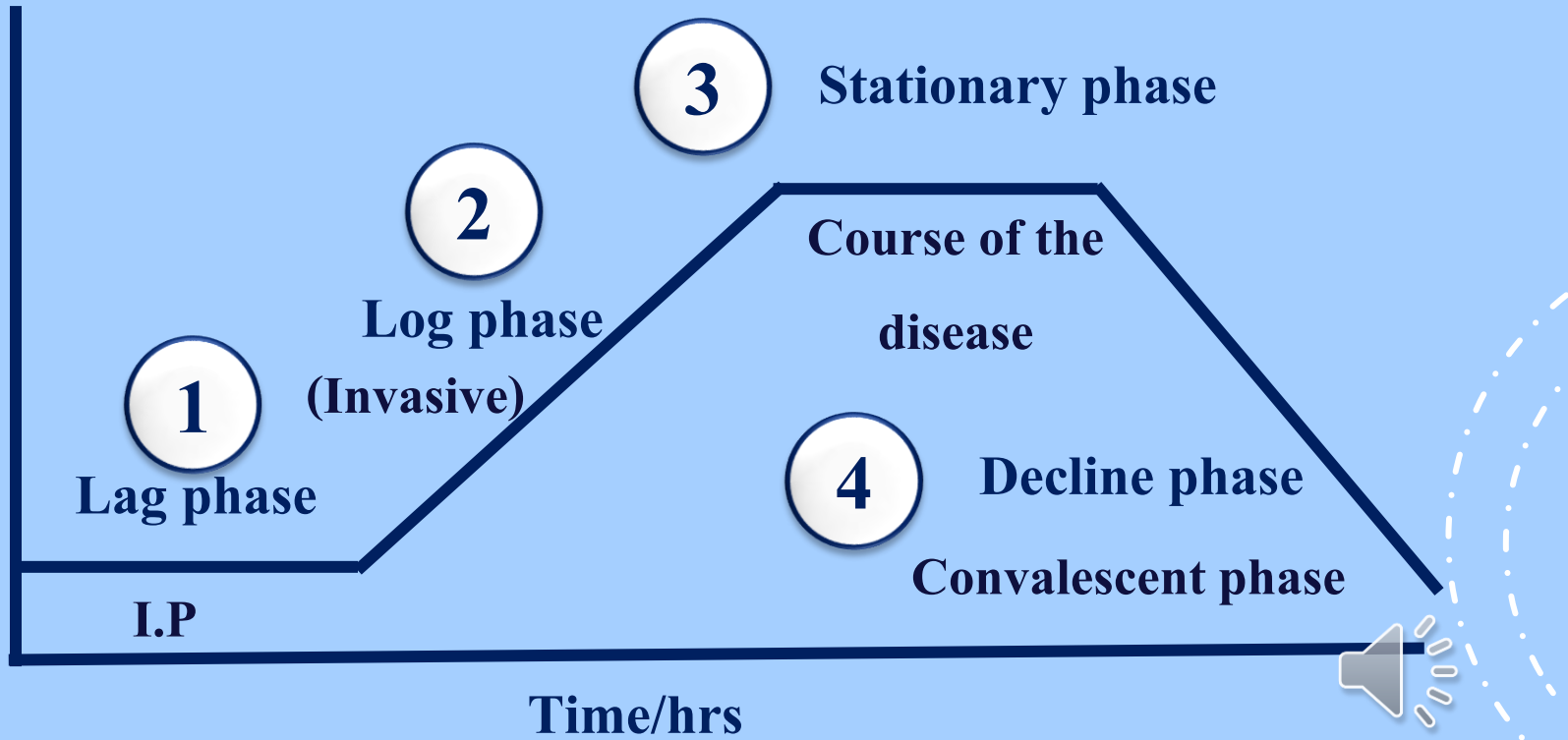
Time/hrs



Decline phase



Bacterial growth curve



Bacterial growth requirements

Growth Requirements

A) Nutrition

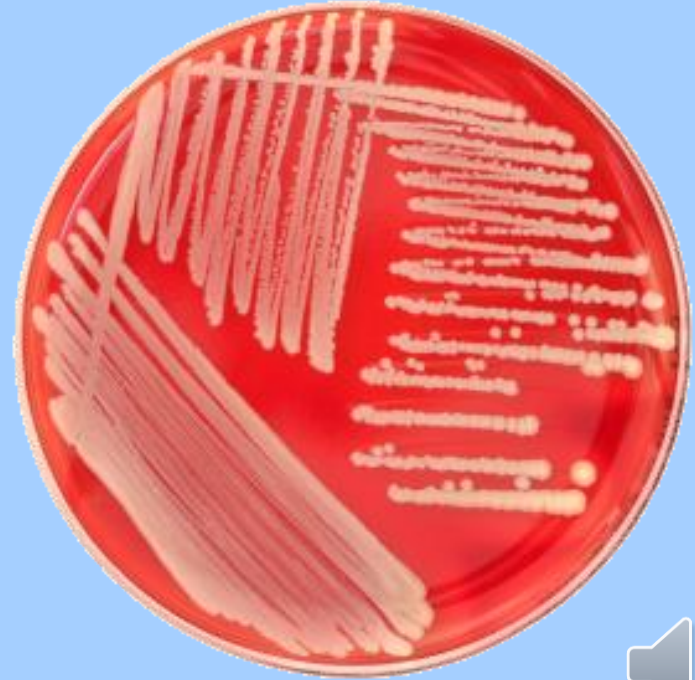
B) Gaseous

C) Temp. & pH



A) Nutrition

**Maintenance of bacterial
growth**



A) Nutrition

1- Autotrophic

auto = self

Trophic=nutrition

2- Heterotrophic

hetero = different

Trophic = nutrition



Autotrophic

CO_2

Ammonium

Utilize simple
inorganic
substance



Carbon



Nitrogen



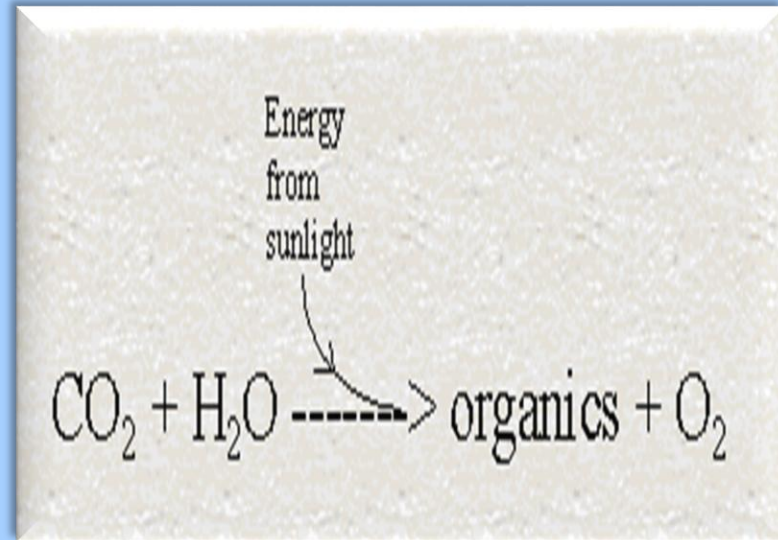
Complex organic materials

(Saprophytic)



Autotrophic

**No medical
importance**



Heterotrophic

Parasitic



Living host

Medical important



**These bacteria require complex
preformed organic substances e.g.
sugars, proteins etc.**

Growth Requirements

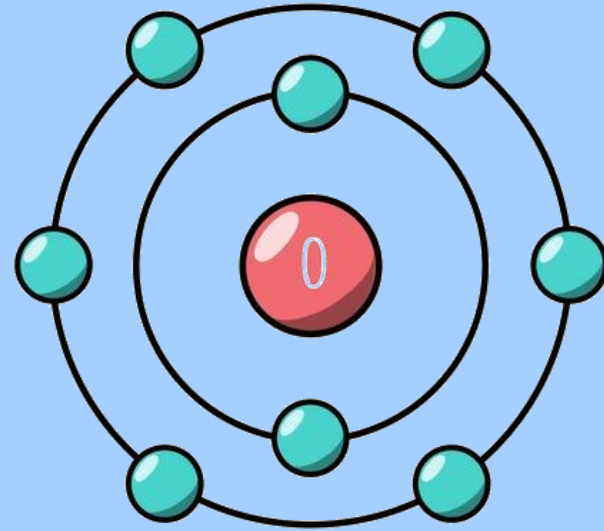
Gaseous requirements

O₂ requirement, bacteria are classified into 5 groups



O₂ requirement

- 1) **Obligate aerobes**
- 2) **Obligate anaerobes**
- 3) **Facultative anaerobes**
- 4) **Micro-aerophilic**
- 5) **Aero-tolerant**



OXYGEN



Respiration

Glucose catabolism

Energy production

Aerobic respiration

(O₂)

Anaerobic respiration

(No O₂)

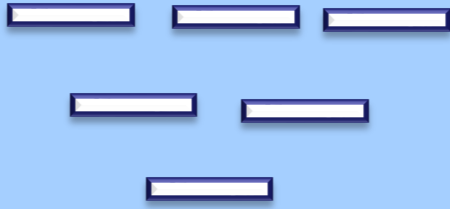


energy



1- Obligate aerobes (Aerobic respiration)

Presence of O₂



Growth

Absence of O₂

No growth

e.g. Pseudomonas aeruginosa



1- Obligate aerobes (Aerobic respiration)

Aerobic respiration



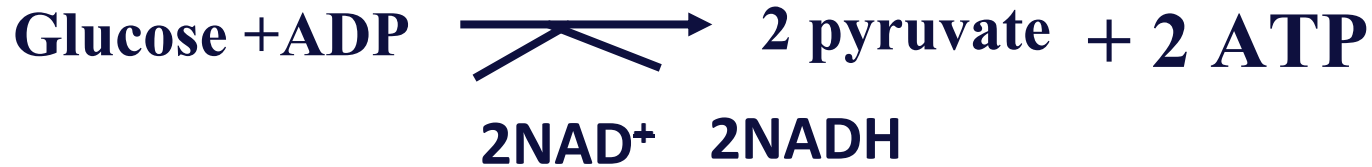
For production Energy (ATP)



Glucose catabolism (glycolysis)



1- Obligate aerobes (Aerobic respiration)



Oxidative phosphorylation



38 ATP

1- Obligate aerobes

Highly toxic molecules

Superoxide (O_2^-)



Superoxide dismutase

(H_2O_2)



Catalase

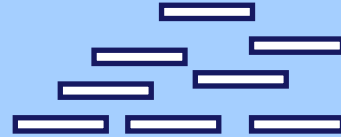


2- Obligate anaerobes

Presence of O₂

No growth

Absence of O₂



Bacteroides fragilis



2- Obligate anaerobes(Anaerobic respiration)



O_2



Other pathway

4 ATP

Lack Superoxide dismutase & Catalase



2- Obligate anaerobes(Anaerobic respiration)

The organism used inorganic molecules

Nitrate

Sulfate

Co₂

Carry H⁺

13 ATP + 4 ATP

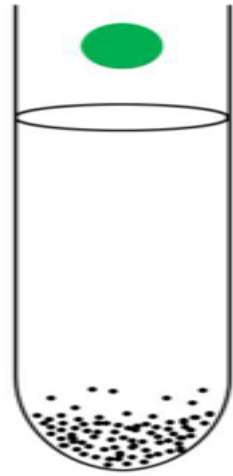
17 ATP

Lack

Superoxide dismutase

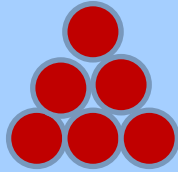
Catalase

Obligate
Anaerobe



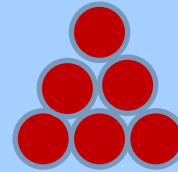
3- Facultative anaerobes

Presence of O_2



Growth

Absence of O_2



Growth

Rate of growth

Most bacteria



3- Facultative anaerobes

Anaerobes

Fermentation

Glucose

glycolysis

2 Pyruvate +

2ATP

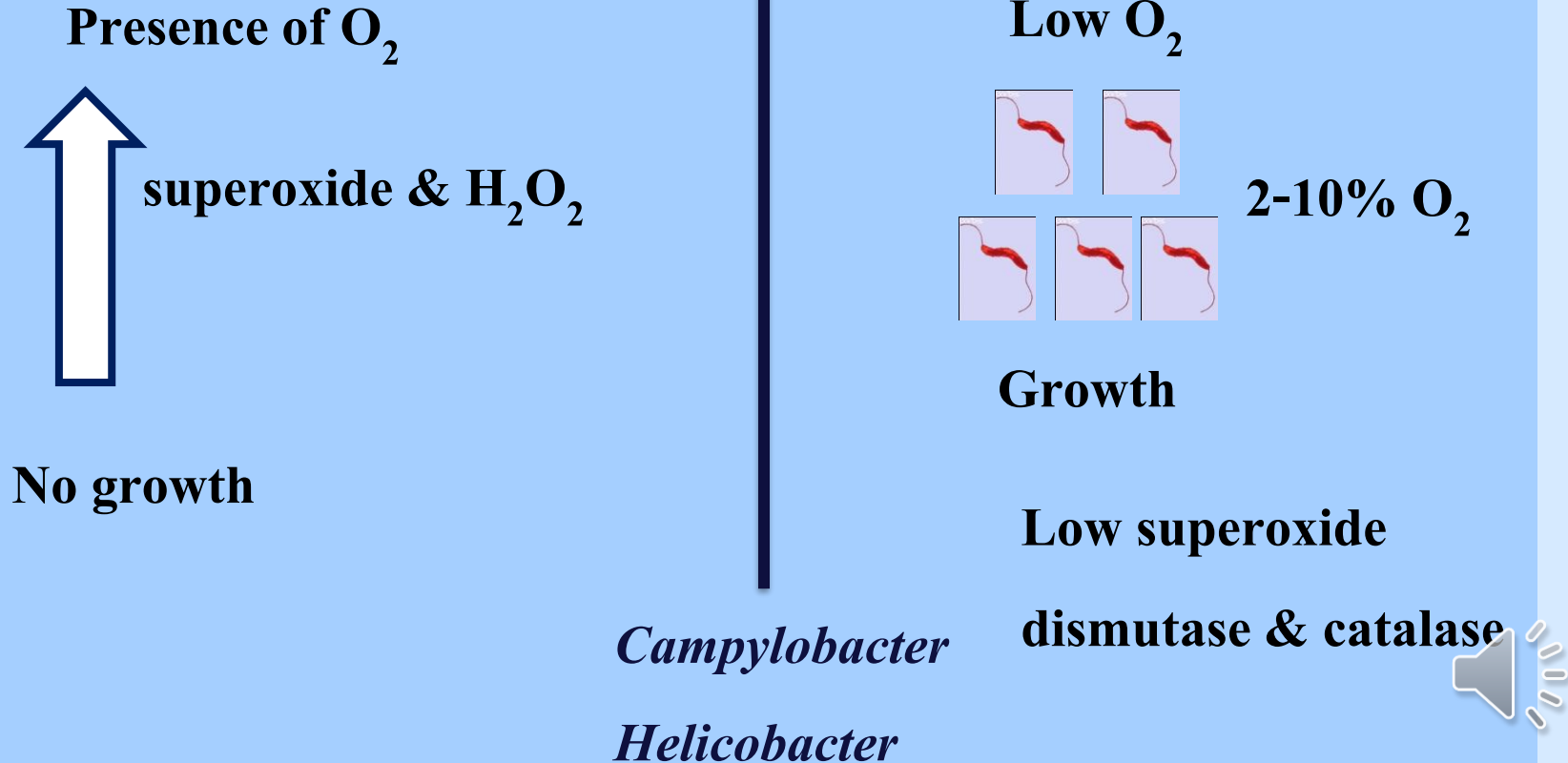
**No Kreb's cycle & other
pathway**

(Absence of carriers)

Acid & Alcohol

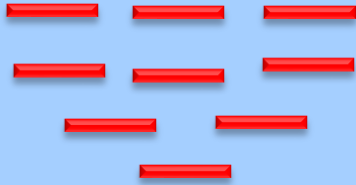


4- Micro-aerophilic

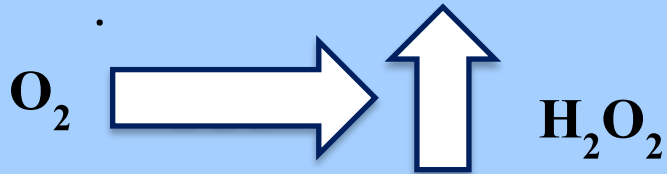


5- Aero-tolerant anaerobes

Low O₂

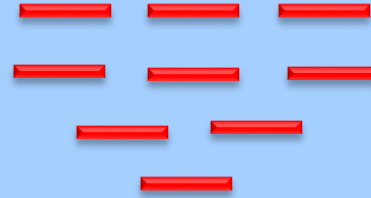


Superoxide dismutase



Tolerate

Absence of O₂



Growth

Cl.perfringens



Growth Requirement: CO₂ requirements

CO₂ (0.03%)

Present in air
is sufficient

CO₂ (5-10%)

(Capnophilic)

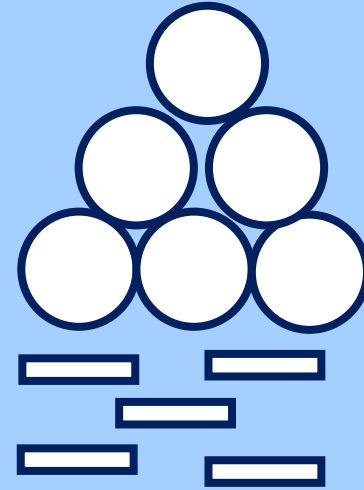
Neisseria

Brucella



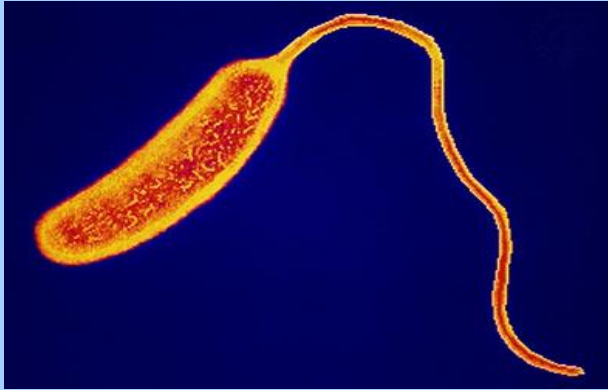
Growth Requirement: Hydrogen ion (pH)

pH (7.2 – 7.4)
(Most bacteria)



Hydrogen ion (pH)

Alkaline (pH 9)



Vibrio cholerae

Acidic (pH 4)



Lactobacilli



Growth Requirement: Temperature

Mesophilic

(20-45)

(Most bacteria)

Psychrophilic

(0-15)

Thermophilic

(55-65)

