Lecture 3

Bacterial Growth& physiology

Bacterial Growth

Definitions

B. Reproduction

culture media

A) Definition

B) Classification

C) Types

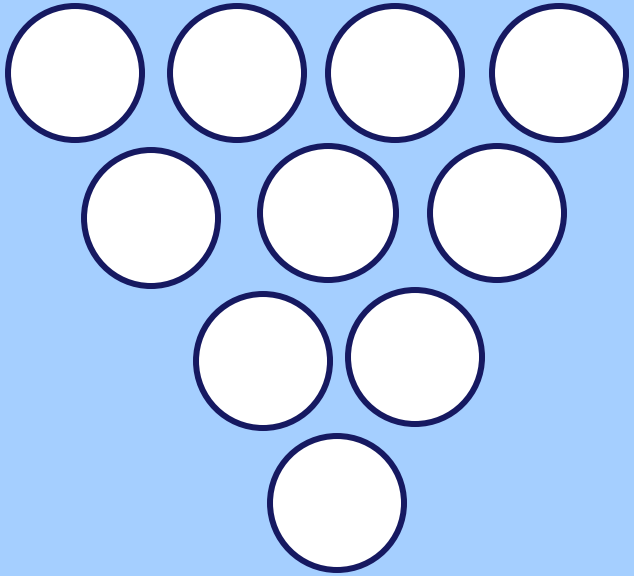
Bacterial growth curve

Bacterial Growth: Definition

Size

&Number of

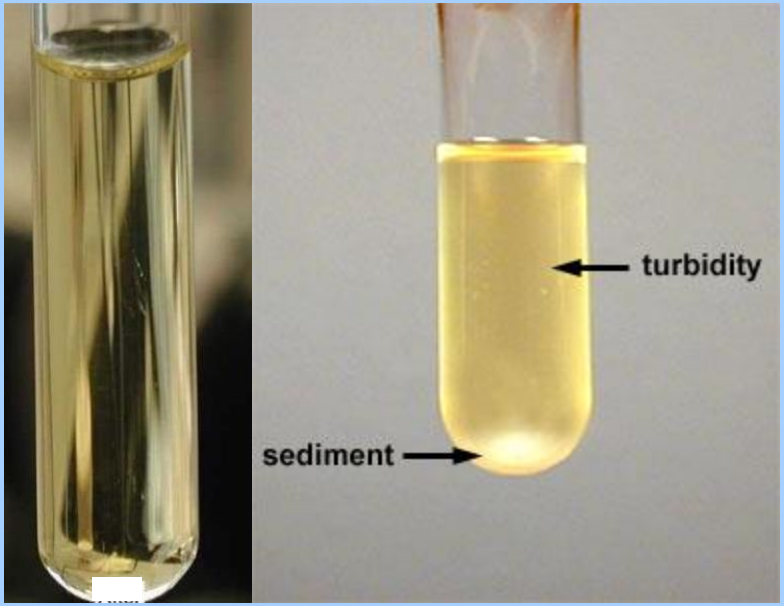
organism



1) Bacterial Growth

Indicated by

a) Turbidity of the fluid media

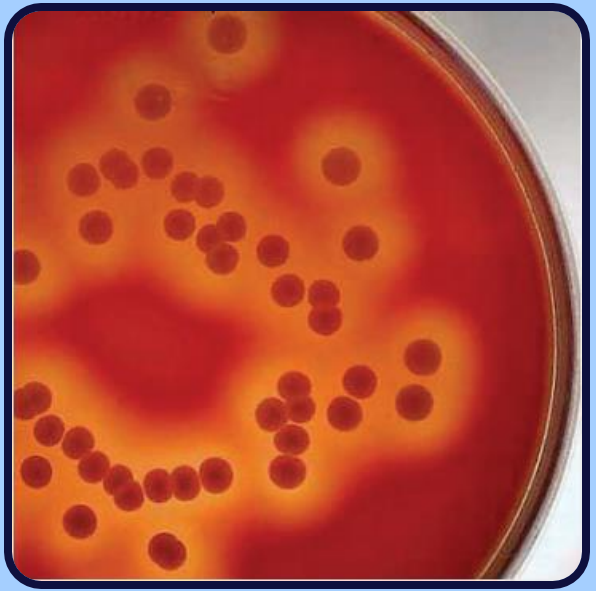


1) Bacterial Growth

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

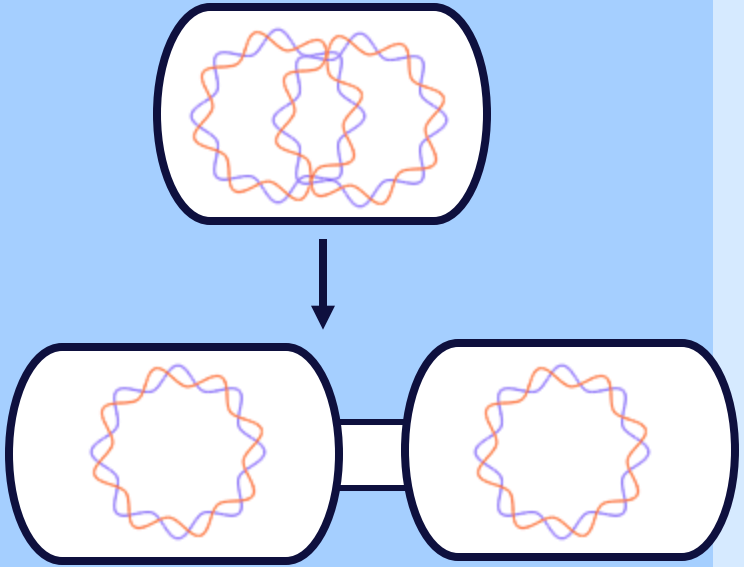
2) Colony

After 20-30 division

Binary fission

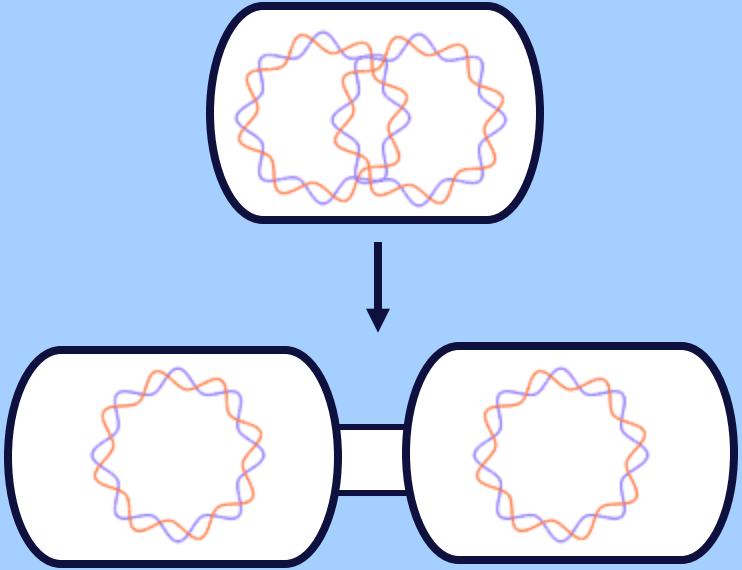
1 Million

(2^{20})



3) Generation time (doubling time)

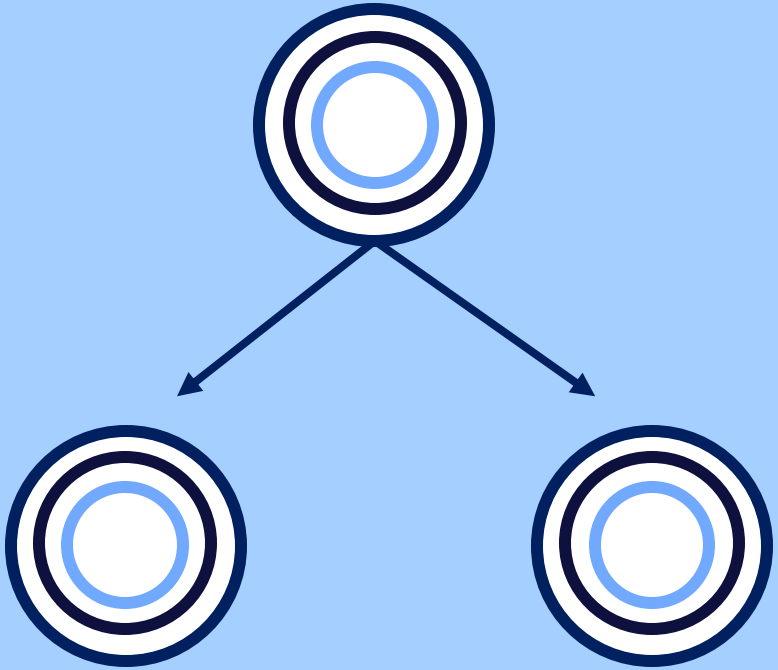
13min (*V.cholerae*)



24 hrs (*M.tuberculosis*)

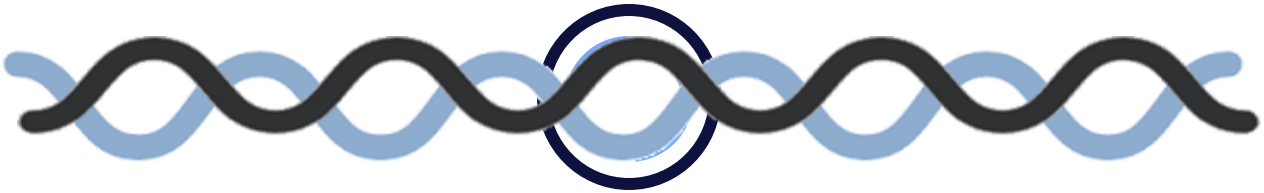
Bacterial Reproduction

Binary fission



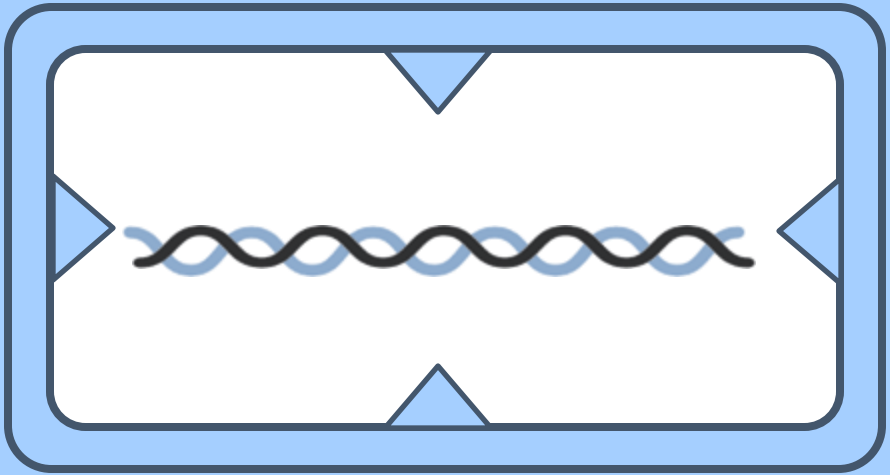
Bacterial Reproduction

1 Elongation



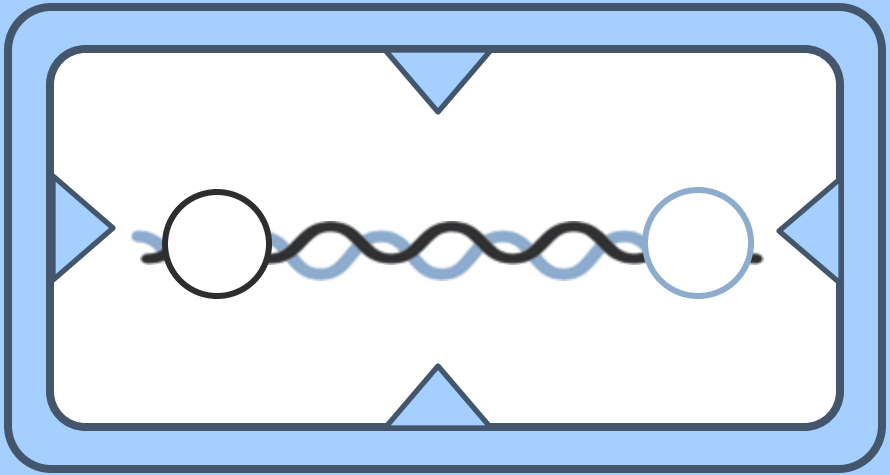
Bacterial Reproduction

2 Separation of 2 strands (ssDNA attached to mesosome)



Bacterial Reproduction

2 **Separation of 2 strands**

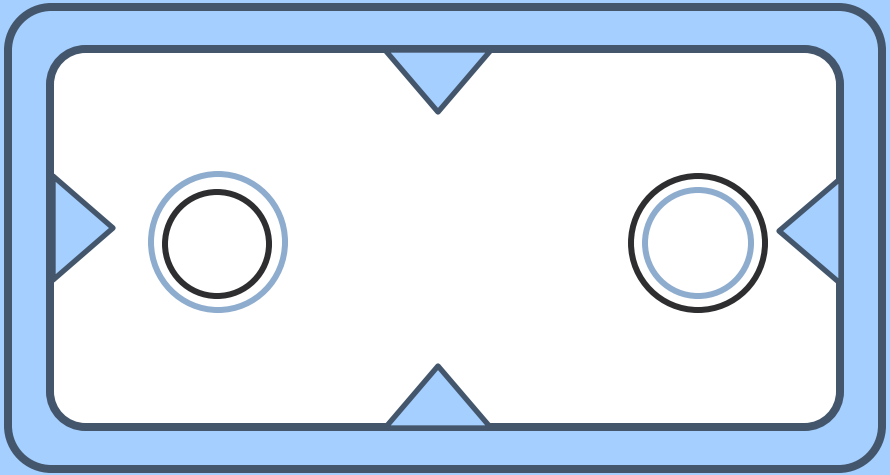


Bacterial Reproduction

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

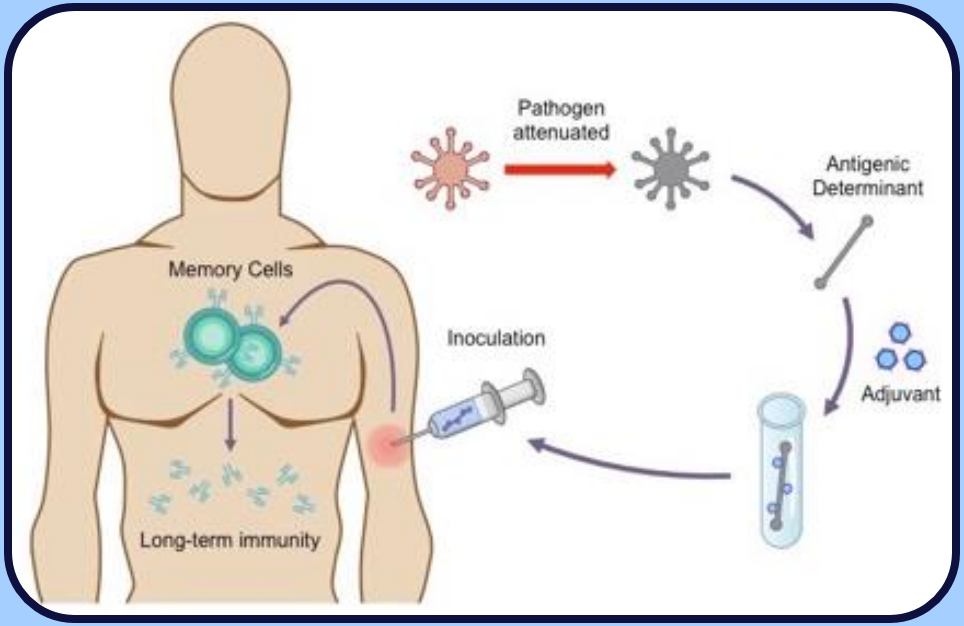
Isolation & diagnosis (Causative agent)

Purpose

3

Prepare vaccine &

Other product

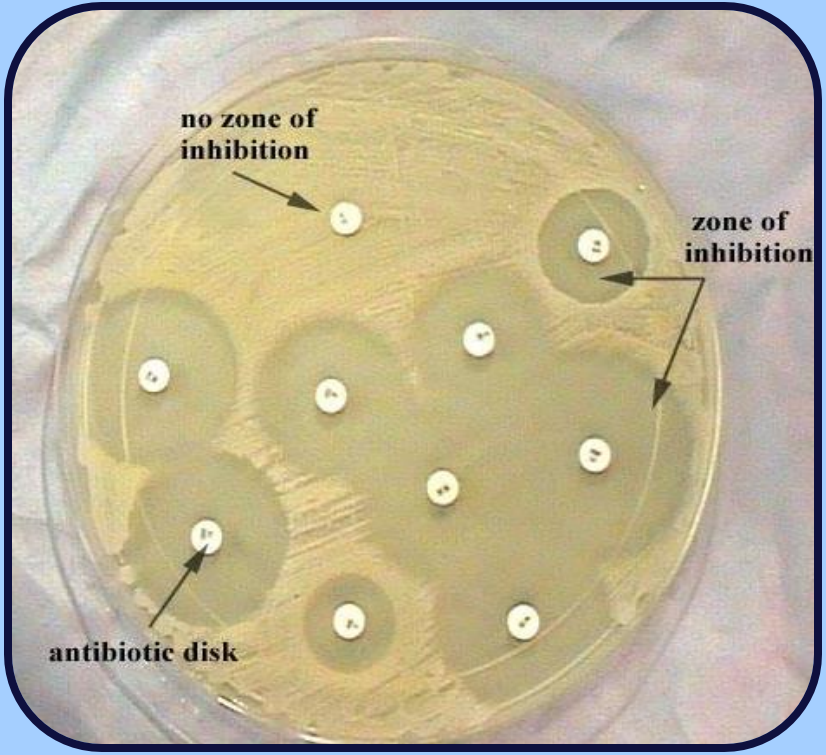


Purpose

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

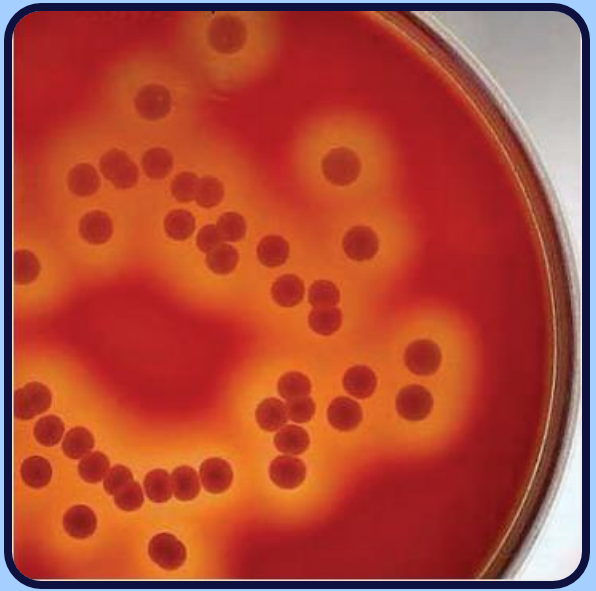
Nutrient agar heated at 45°C

(semisolid)

+ sheep blood

Enriched media

A) Blood agar



Streptococci

Strept. pyogenes

Hemolysis on blood agar:

A. *Complete (beta) hemolysis:*

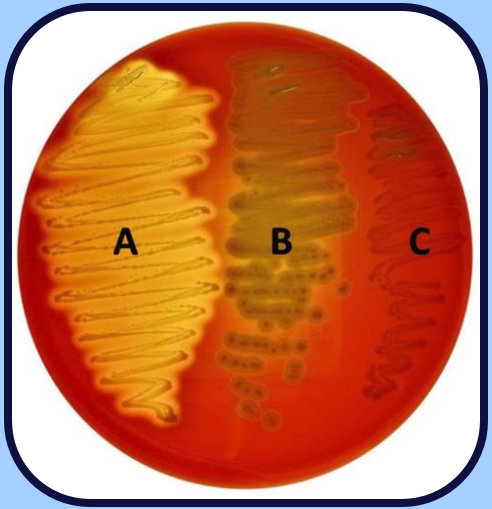
- ***Staphylococcus aureus***
- ***Streptococcus pyogenes***

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 —Heat→ Haematin

(Chocolate)

Enriched media

B) Chocolate agar

Haemophilus

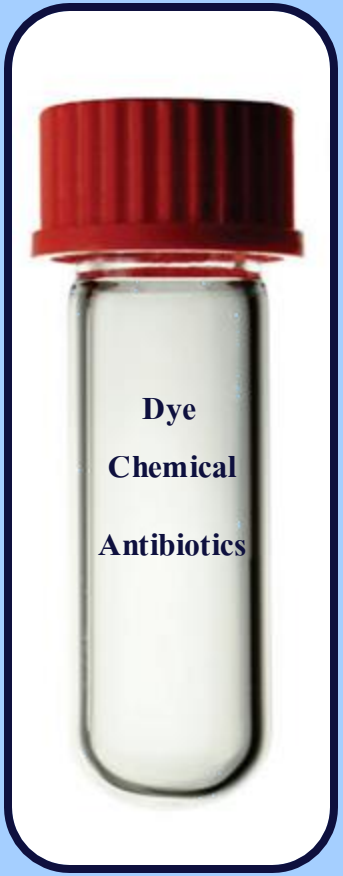
Neisseria

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

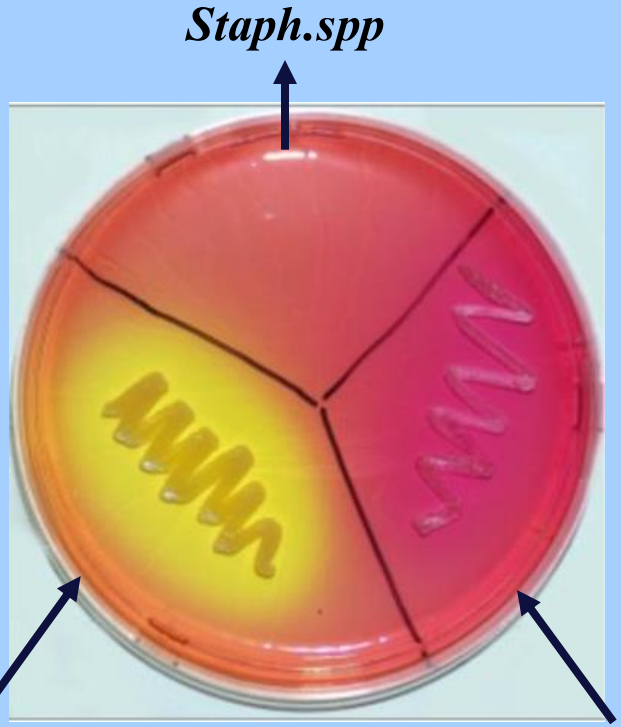
Pink **Pale**

Differential media

Mannitol salt agar

(high salt 7.5% NaCl)

Phenol red =pH indicator



Differential media

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

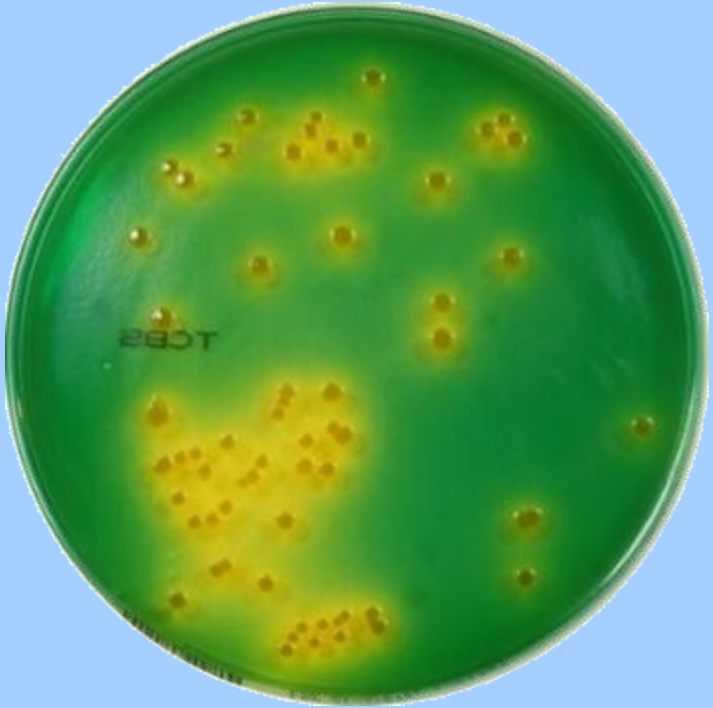
Thiosulphate

Bile

Citrate

Sucrose as test sugar

Bromothymol blue

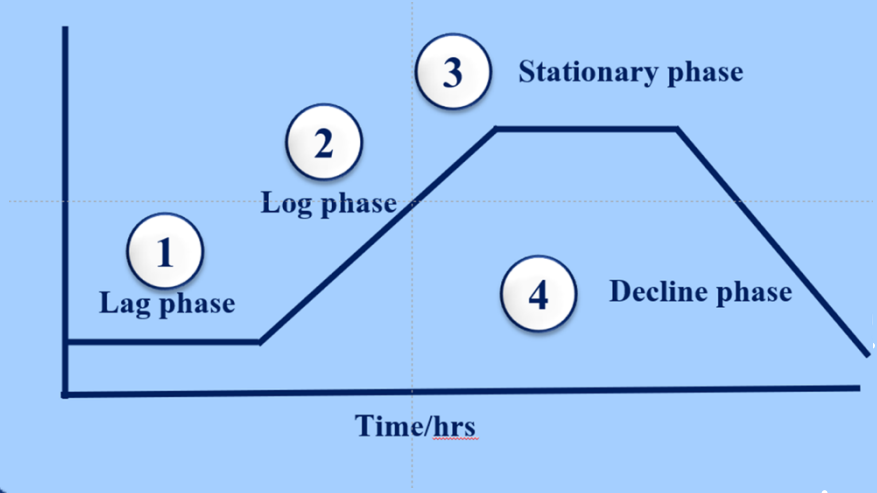


Bacterial growth curve

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

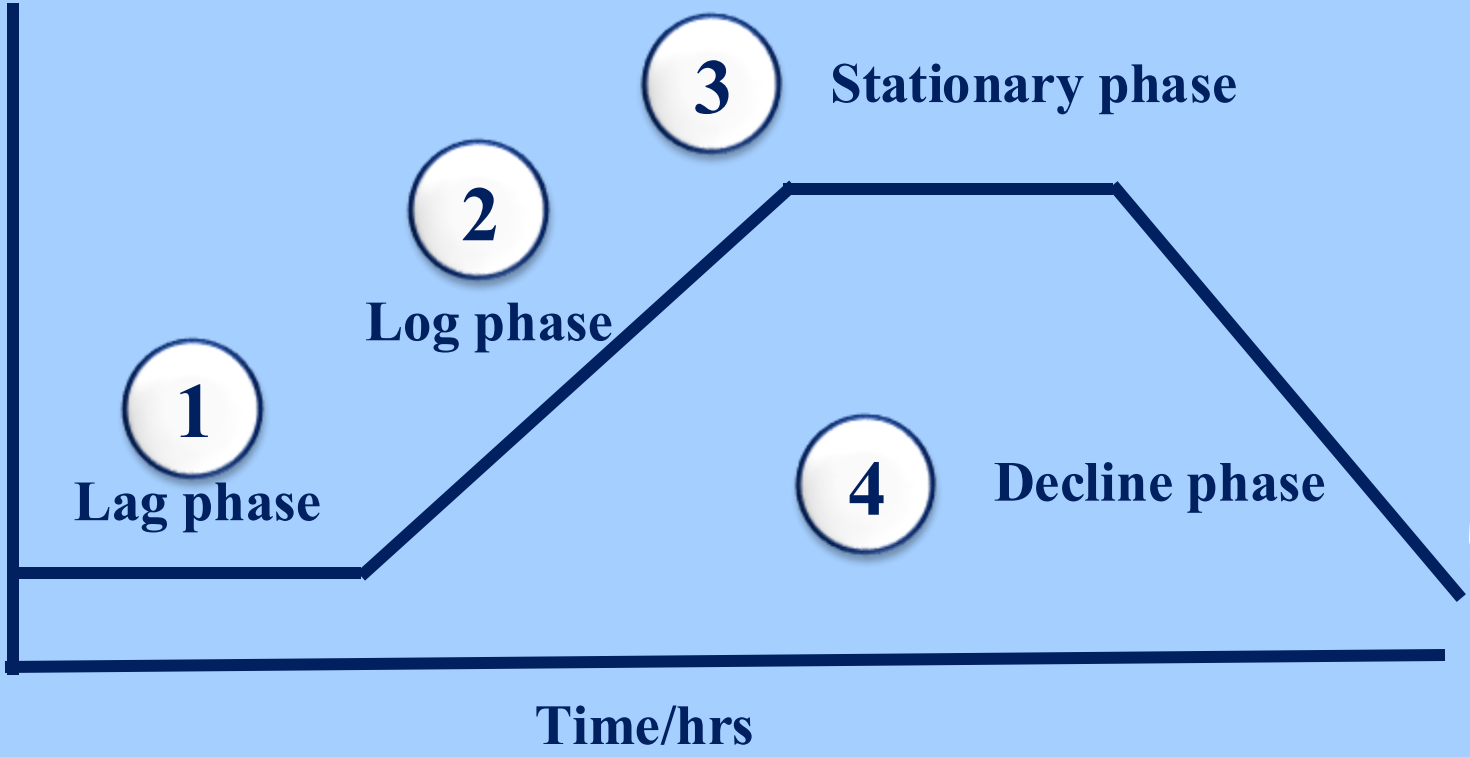
Bacterial growth curve

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

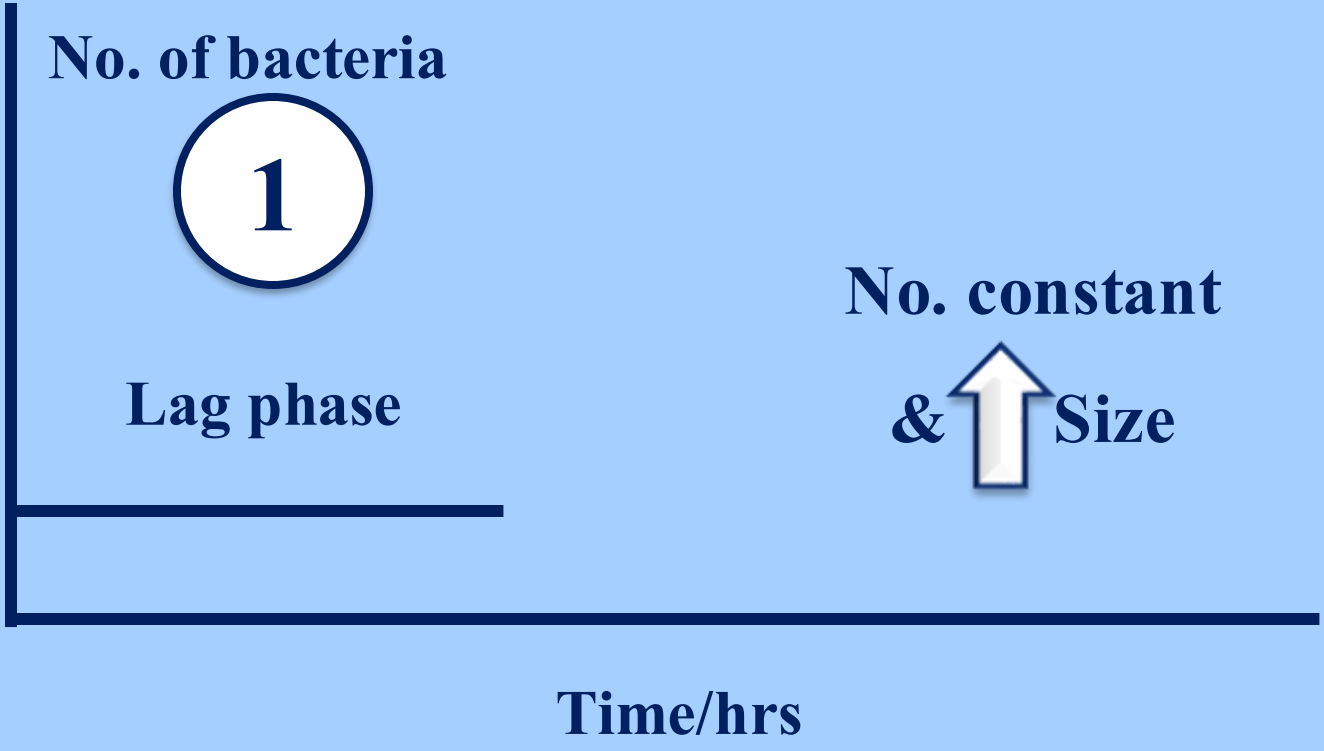


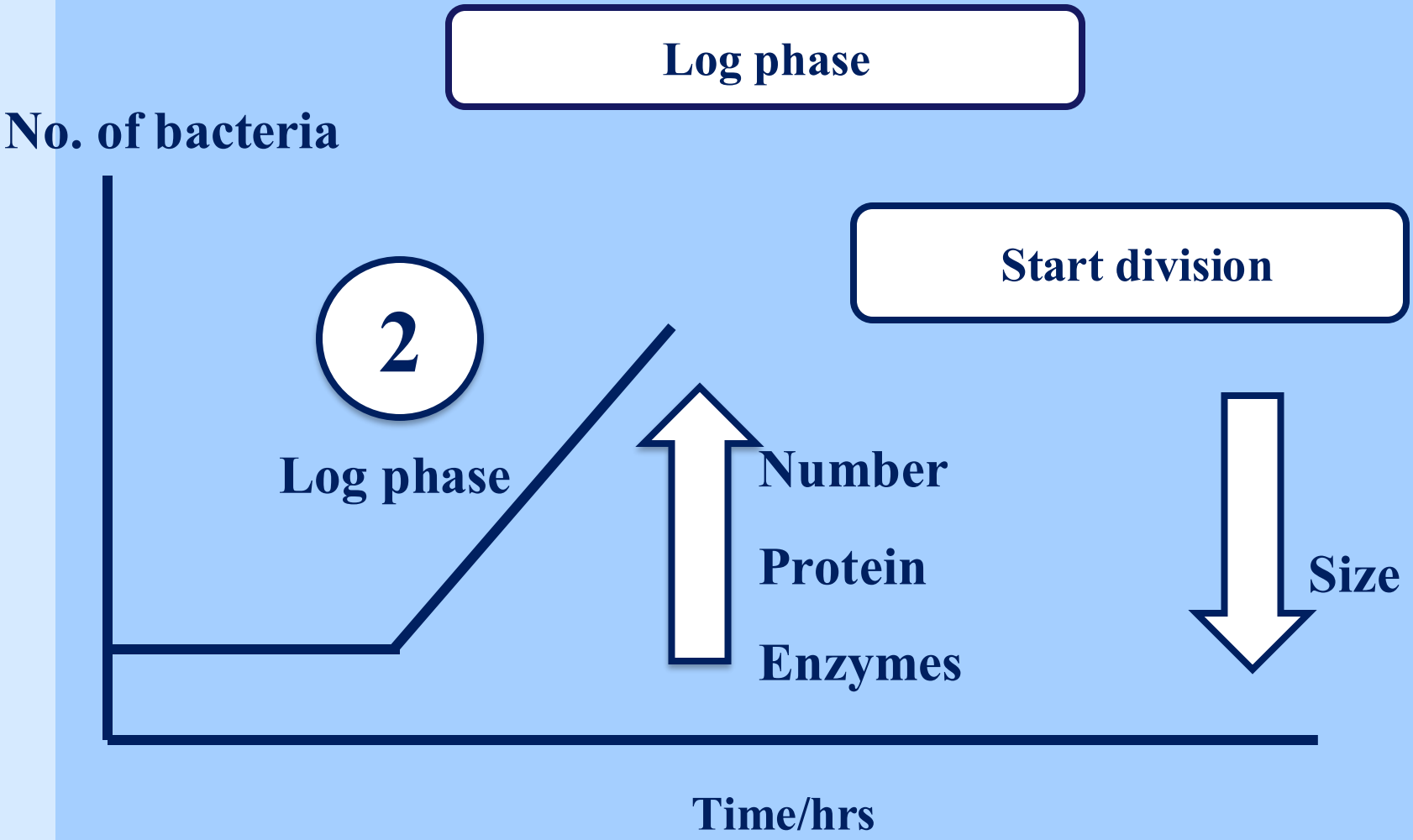
72h

Bacterial growth curve

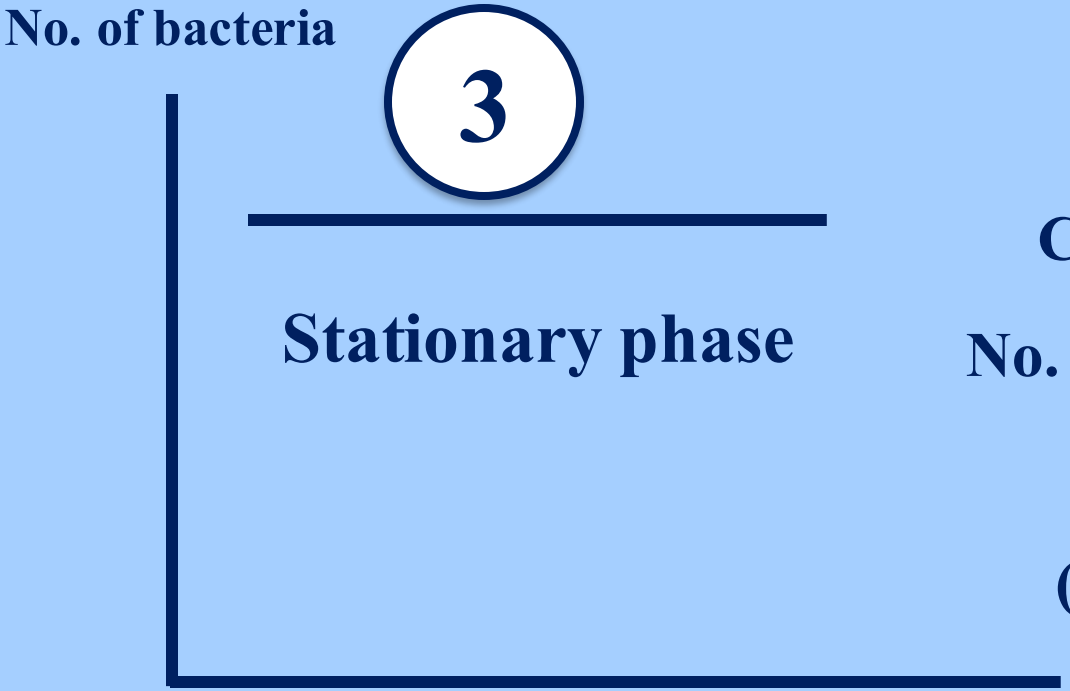


Lag phase




Log phase
No. of bacteria
Start division
2
Log phase
Number
Protein
Enzymes
Size
Time/hrs

Stationery phase

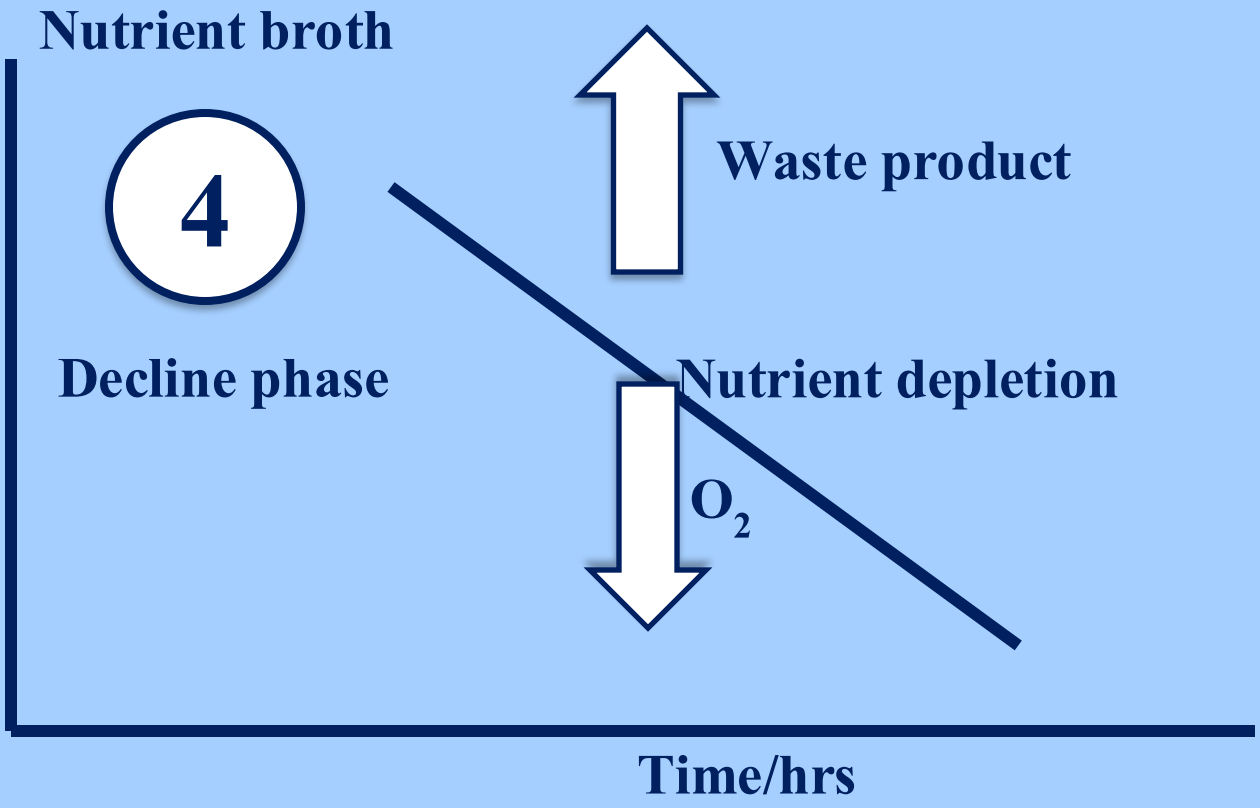


Constant number

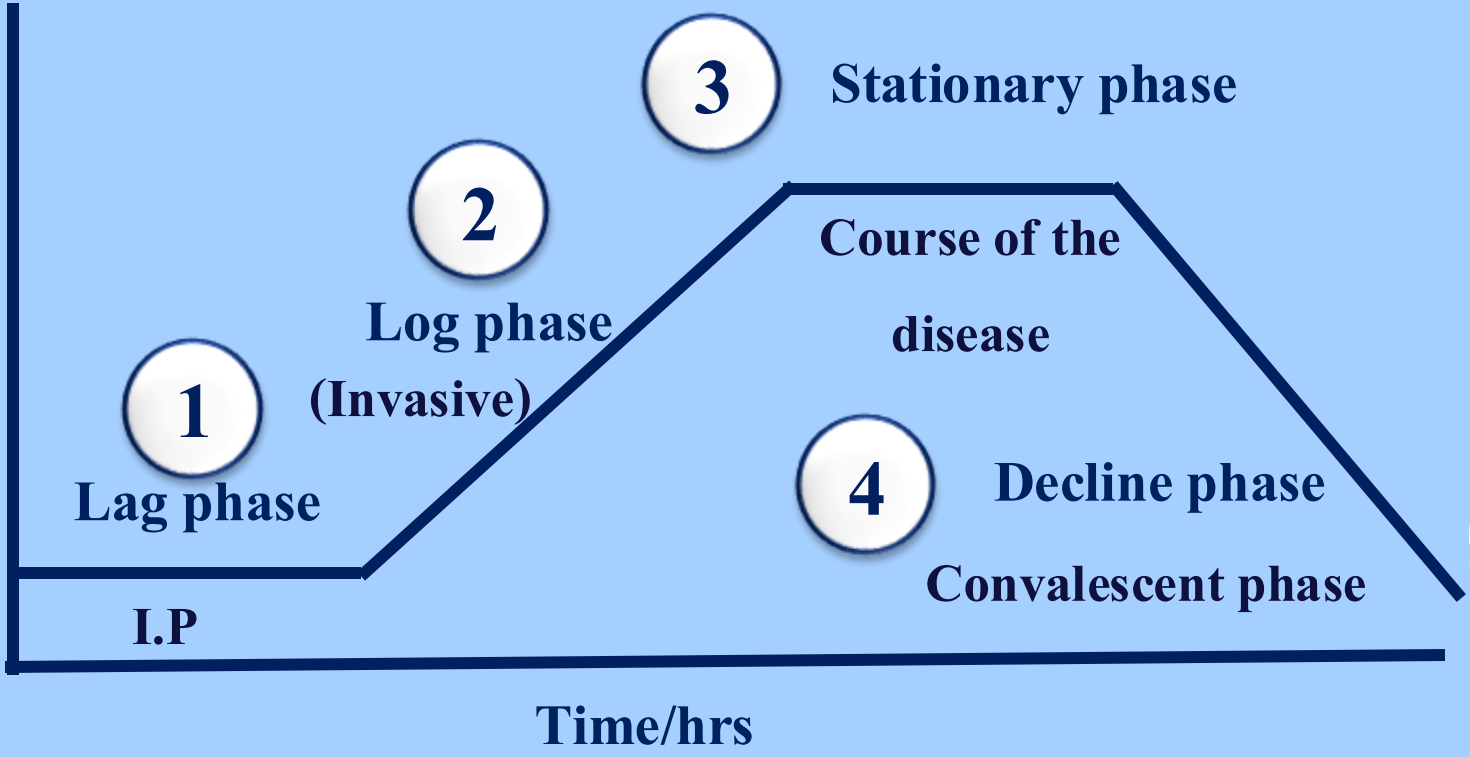
No. of division = No. of death

(Waste product)

Decline phase



Bacterial growth curve



Bacterial growth requirements

Growth Requirements

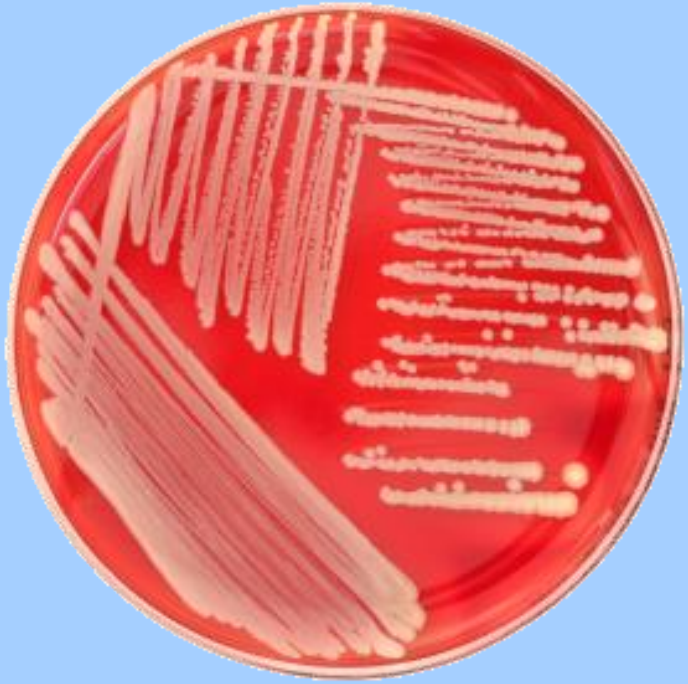
A) Nutrition

B) Gaseous

C) Temp. & pH

A) Nutrition

Maintenance of bacterial growth



A) Nutrition

1- Autotrophic

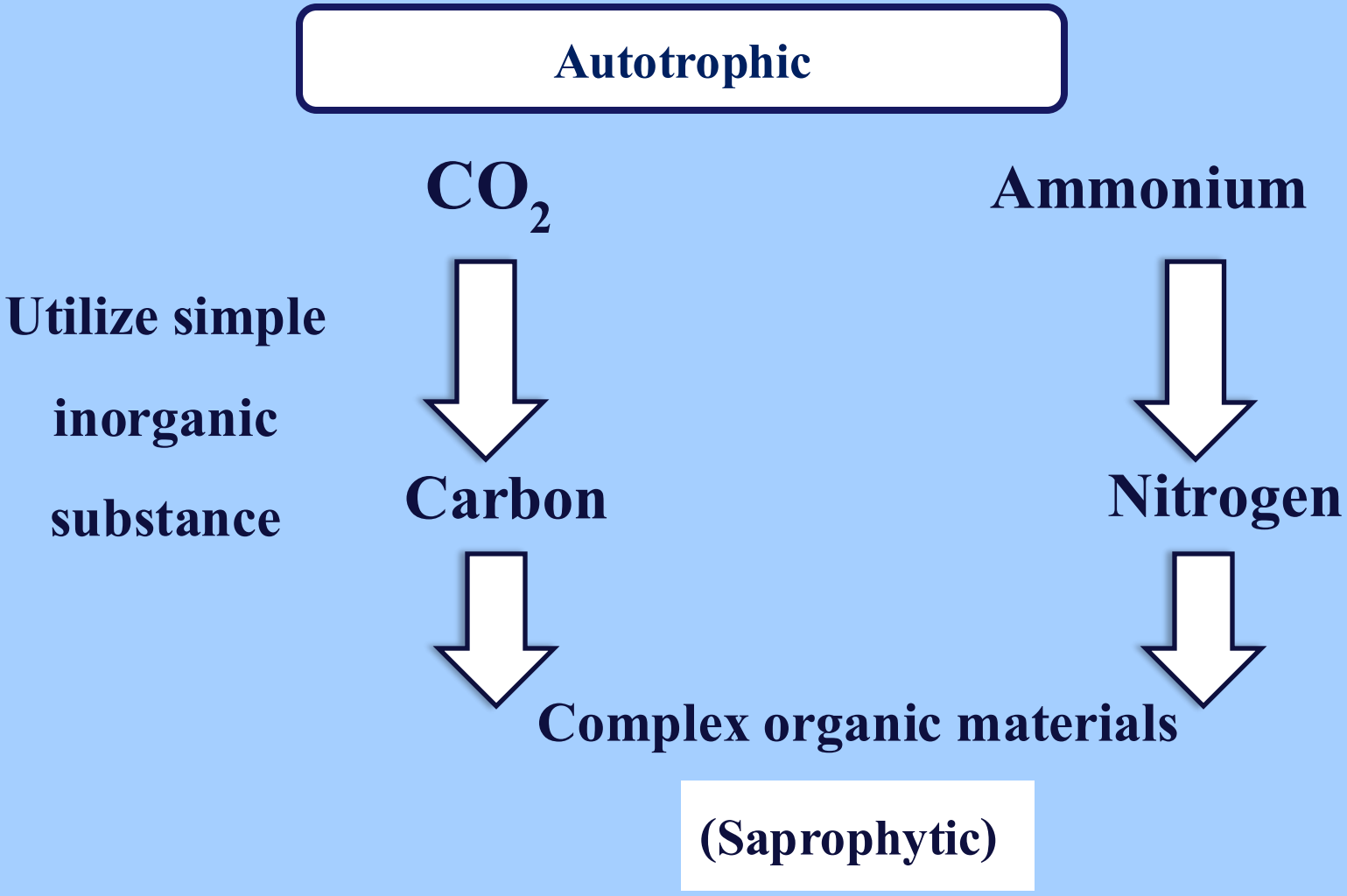
auto = self

Trophic=nutrition

2- Heterotrophic

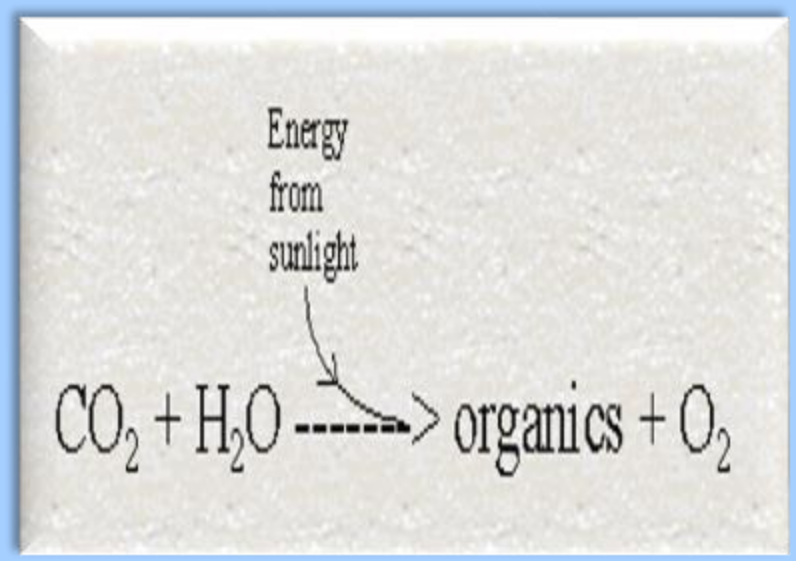
hetero = different

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

O_2 requirement, bacteria are classified into 5 groups

O2 requirement

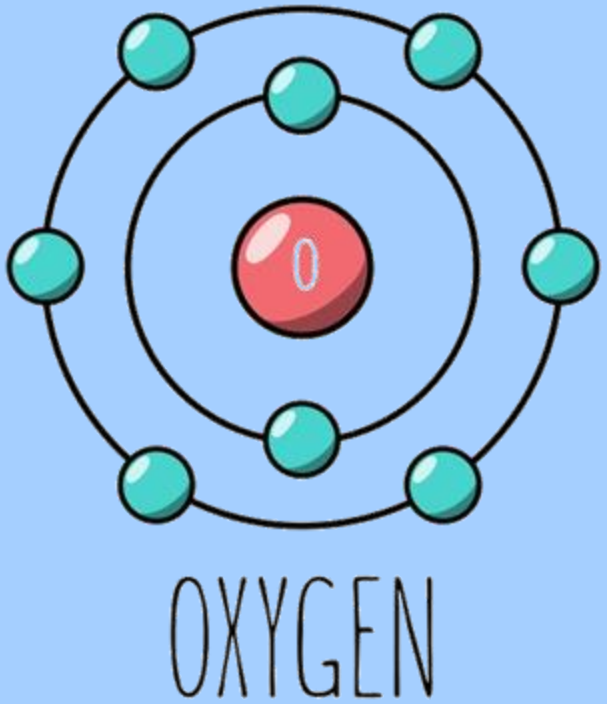
1) Obligate aerobes

2) Obligate anaerobes

3) Facultative anaerobes

4) Micro-aerophilic

5) Aero-tolerant



Respiration

Glucose catabolism

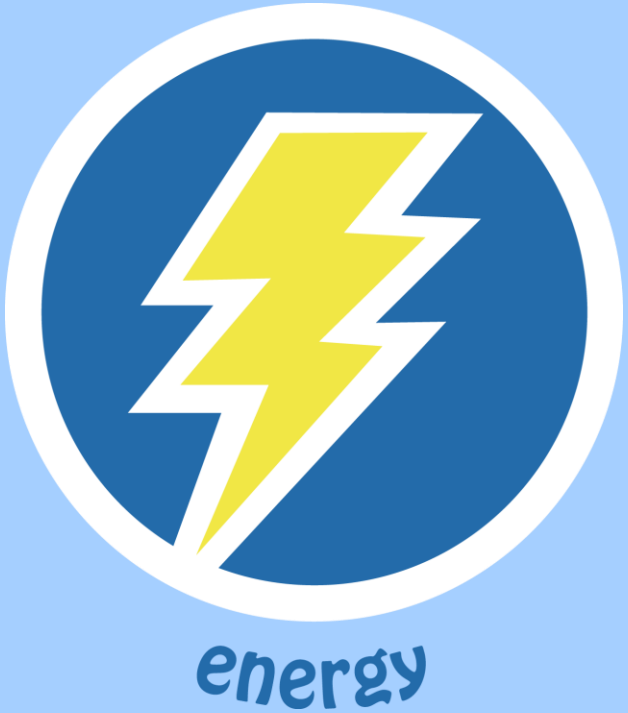
Energy production

Aerobic respiration

(O_2)

Anaerobic respiration

(No O_2)



1- Obligate aerobes (Aerobic respiration)

Presence of O_2

Growth

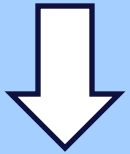
Absence of O_2

No growth

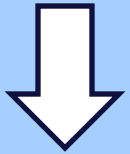
e.g. Pseudomonas aeruginosa

1- Obligate aerobes (Aerobic respiration)

Aerobic respiration



For production Energy (ATP)



Glucose catabolism (glycolysis)

1- Obligate aerobes (Aerobic respiration)

Glucose + ADP → (2NAD+ → 2NADH) → 2 pyruvate + 2 ATP

2 pyruvate —Kreb's Cycle→ $2FADH_2$ + 8NADH + 2 ATP

Oxidative phosphorylation

O_2 → Carry $2H^+$ → H_2O + 34 ATP

38 ATP

1- Obligate aerobes

Highly toxic molecules

Superoxide (O_2) → **Superoxide dismutase**

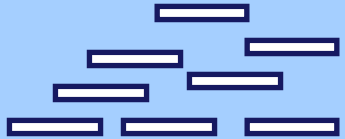
(H_2O_2) → **Catalase**

2- Obligate anaerobes

Presence of O2

No growth

Absence of O2



Growth

Bacteroides fragilis

2- Obligate anaerobes(Anaerobic respiration)

Glucose +ADP → 2 pyruvate + 2 ATP

$2NAD^+$ → 2NADH

2 pyruvate —Kreb's Cycle→ $2FADH_2$ +8NADH + 2 ATP

4 ATP

O_2 ⇨ Other pathway

Lack Superoxide dismutase &Catalase

2- Obligate anaerobes(Anaerobic respiration)

The organism used inorganic molecules

Nitrate

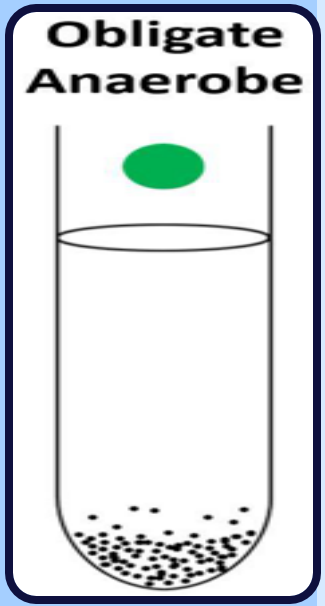
Sulfate

Co2

Carry H^+

13 ATP + 4 ATP

17 ATP



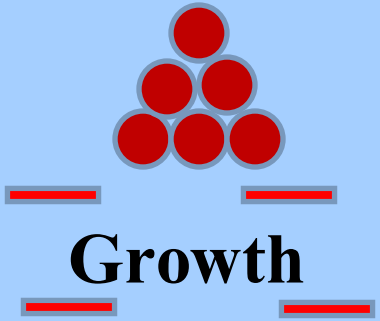
Lack

Superoxide dismutase

Catalase

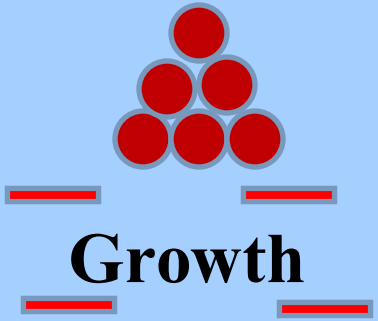
3- Facultative anaerobes

Presence of O_2



Growth

Absence of O_2

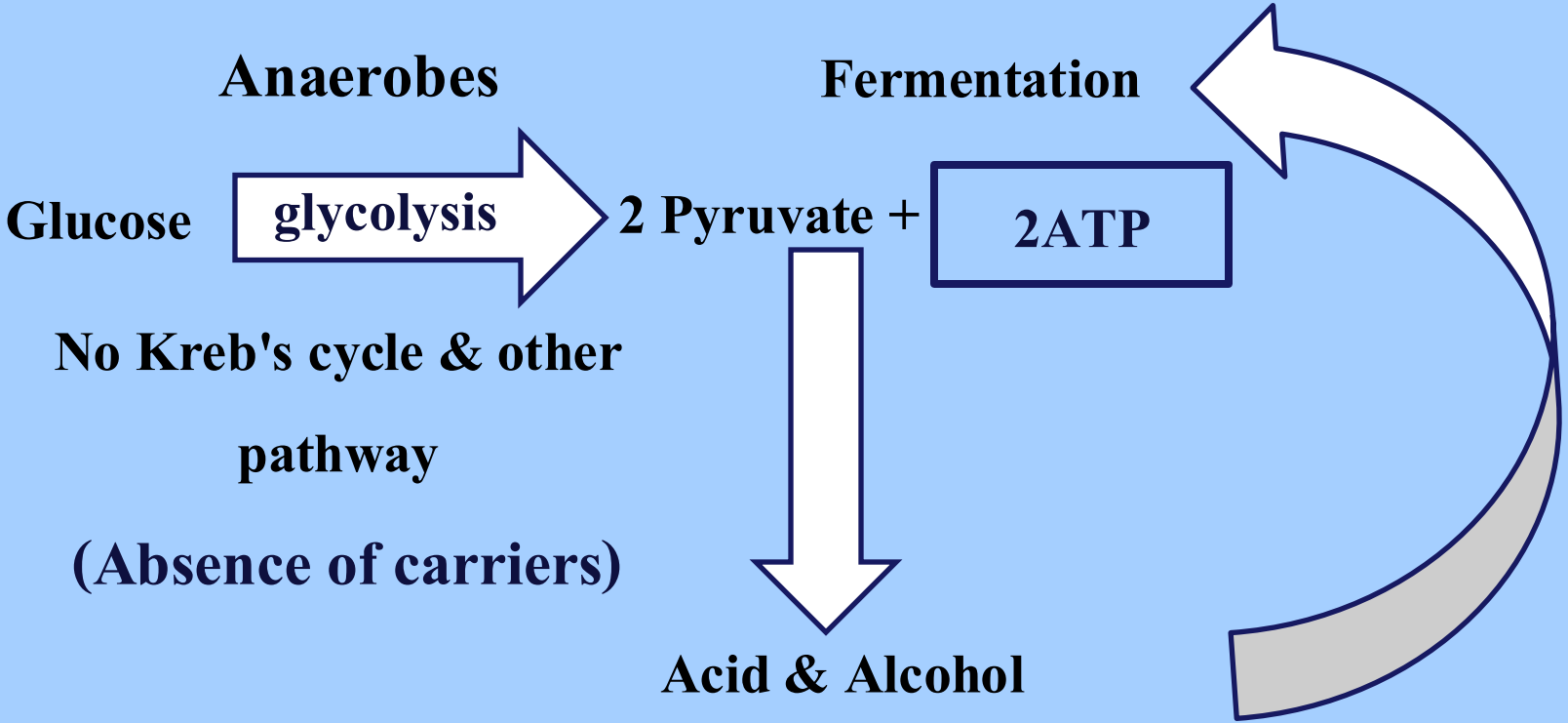


Growth

Rate of growth

Most bacteria

3- Facultative anaerobes



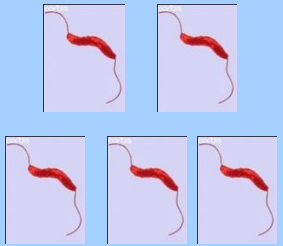
4- Micro-aerophilic

Presence of O_2

superoxide & H_2O_2

No growth

Low O_2



2-10% O_2

Growth

Low superoxide dismutase & catalase

Campylobacter

Helicobacter

5- Aero-tolerant anaerobes

Low O2

Absence of O2

Superoxide dismutase

$O_2^{\cdot}$ → H_2O_2

Tolerate

Growth

Cl.perfringens

Growth Requirement: CO2 requirements

CO_2 (0.03%)

Present in air

is sufficient

CO_2 (5-10%)

(Capnophilic)

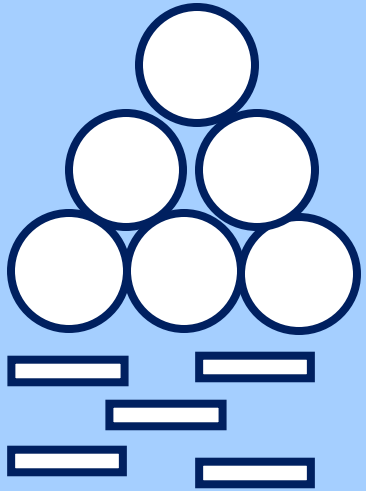
Neisseria

Brucella

Growth Requirement: Hydrogen ion (pH)

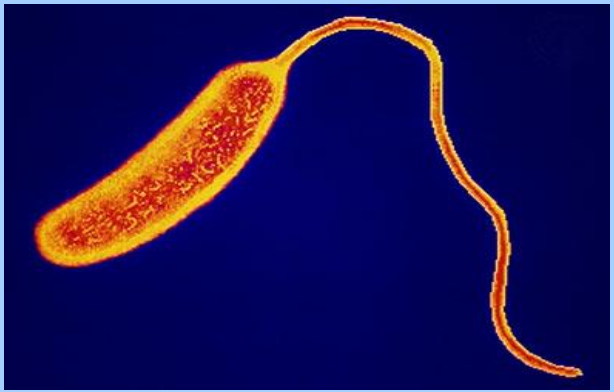
pH (7.2 – 7.4)

(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)