علم الأحياء الدقيقة

Microbiology

Introduction to Bacteriology

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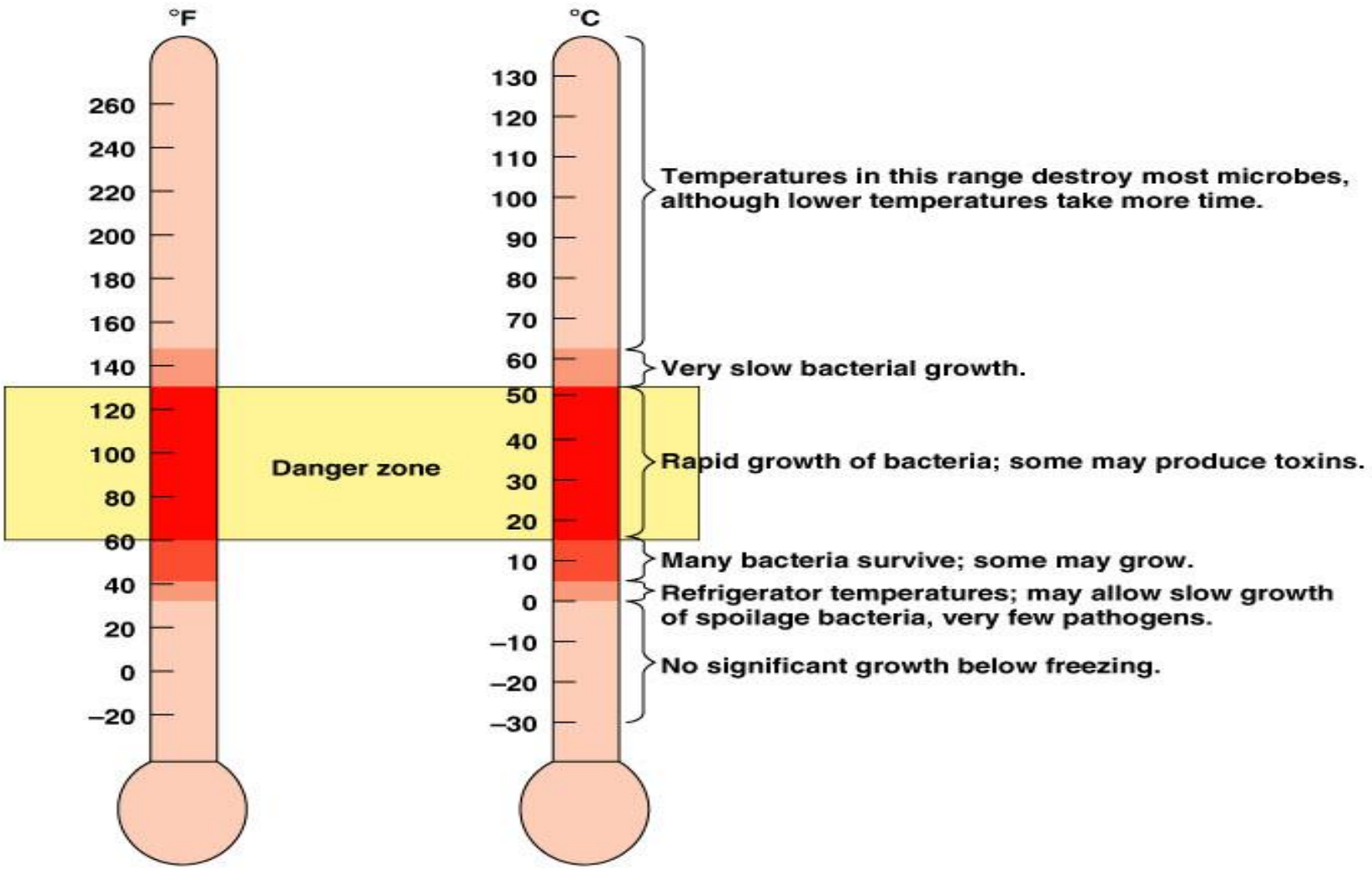
مكتب ٢ ب ٤٥

Factors affecting bacterial growth

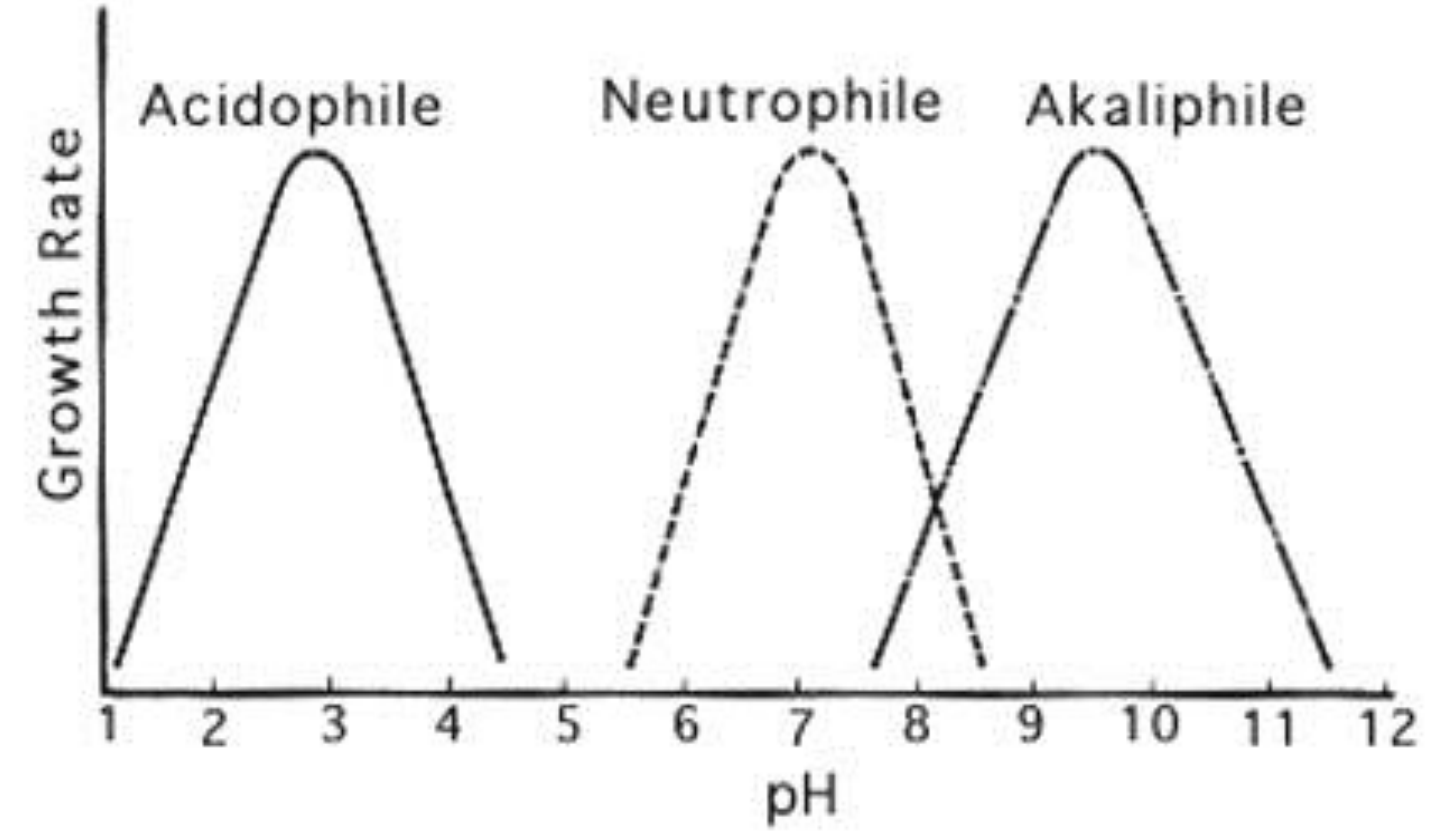
- Many factors affect the generation time of the bacterium:
    - Temperature.
    - pH.
    - Oxygen.
    - Nutrient.
    - Salt concentration.
- Most bacteria grow best when these parameters are optimum.

Temperature



pH

- According to the pH degree that bacteria can grow and/or survive, they can be classified to:



pH

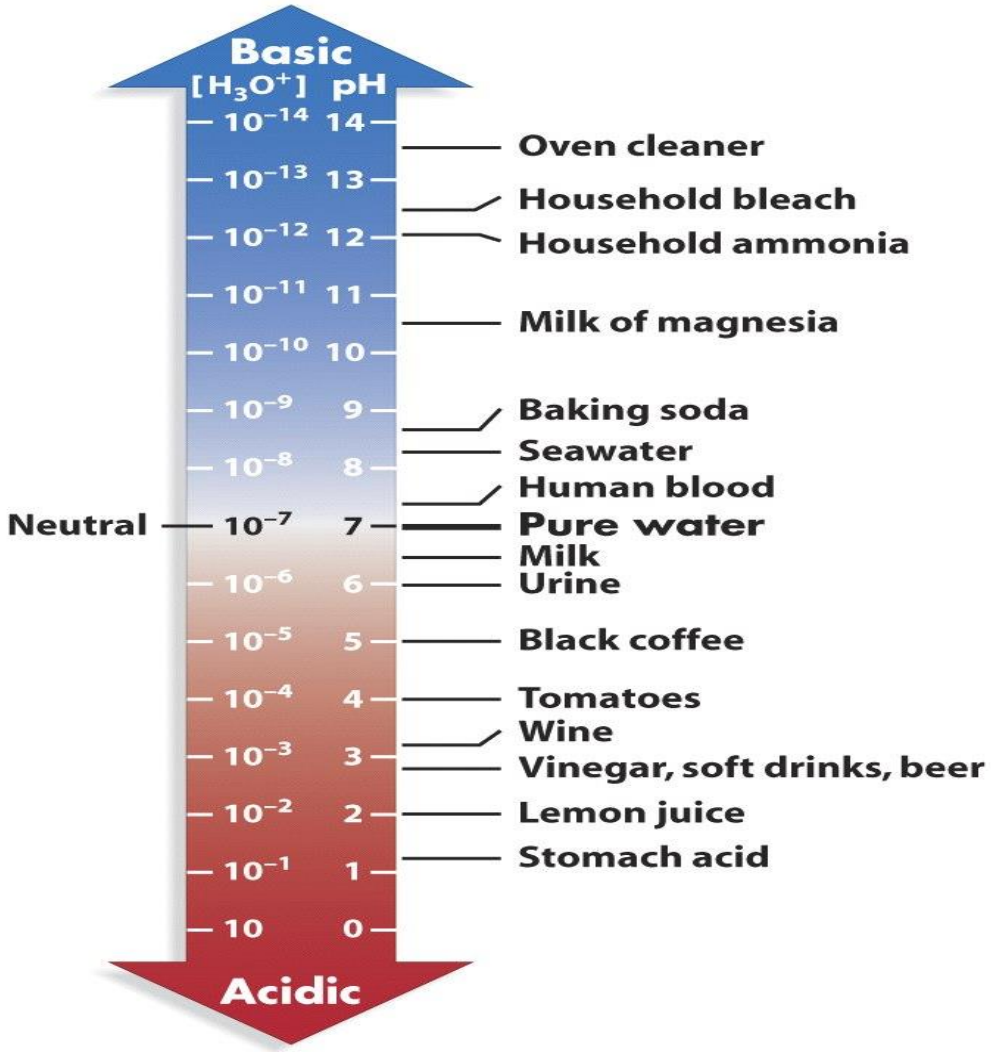
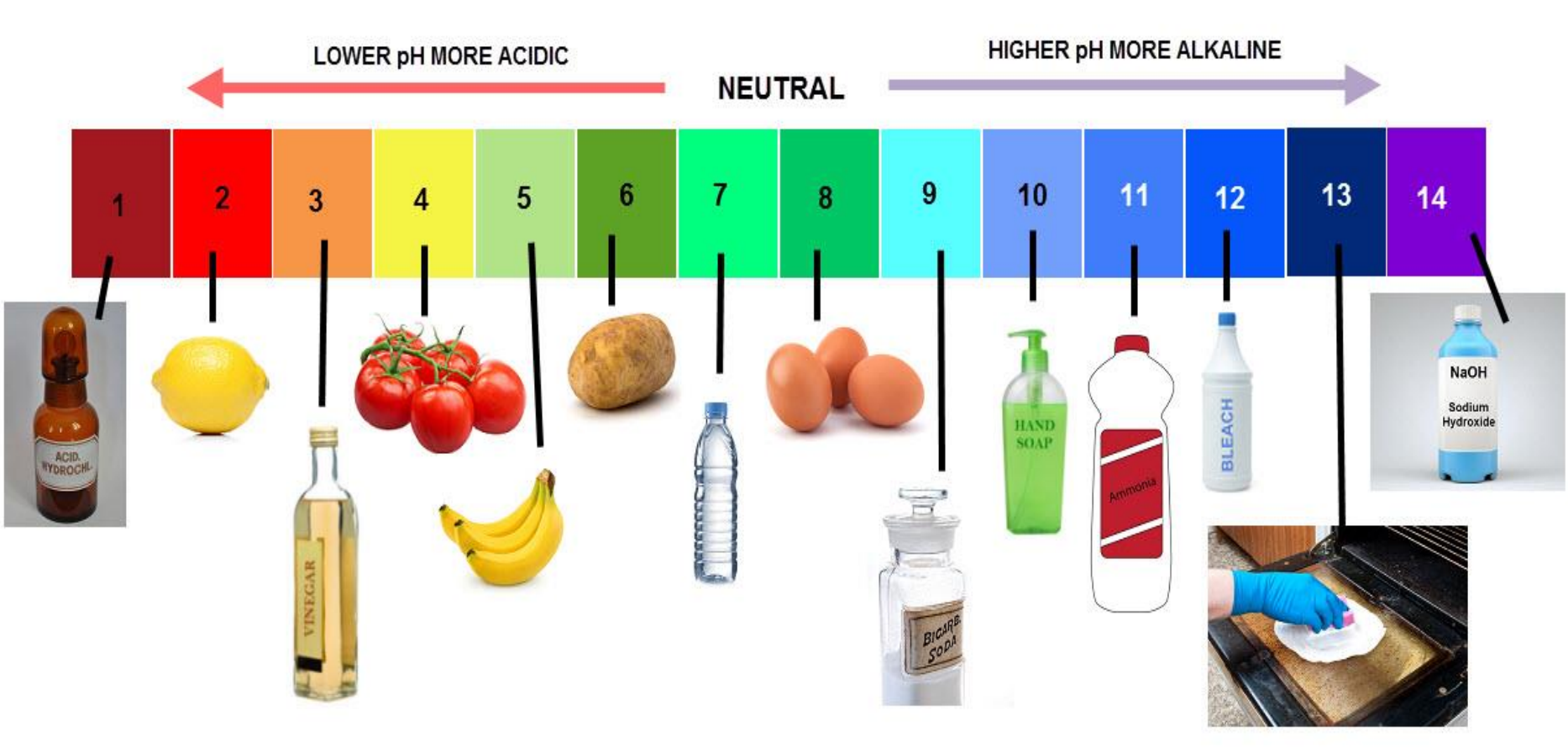


Figure 2-28 Biological Science, 2/e

pH


LOWER pH MORE ACIDIC
NEUTRAL
HIGHER pH MORE ALKALINE
1
2
3
4
5
6
7
8
9
10
11
12
13
14
ACID. HYDROCHL.
VINEGAR
HAND SOAP
Ammonia
BLEACH
NaOH
Sodium Hydroxide

Oxygen

Considering the oxygen demands of bacteria, it can be classified into:

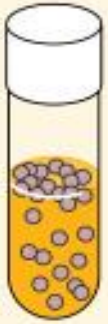
- **Aerobes**: Grow in air, which contains 21% oxygen and small amount of (0.03%) of carbon dioxide.
- **Obligate aerobes**: They have absolute requirement for oxygen in order to grow.
- **Anaerobes**: Usually can not grow in the presence of oxygen.
- **Obligate anaerobes**: These bacteria grow only under condition in which oxygen is toxic.
- **Facultative anaerobes**: They are capable of growh under both aerobic and anaerobic conditions.
- **Aerotolerant anaerobes**: Are anaerobic bacteria that are not killed by exposure to oxygen.

Oxygen

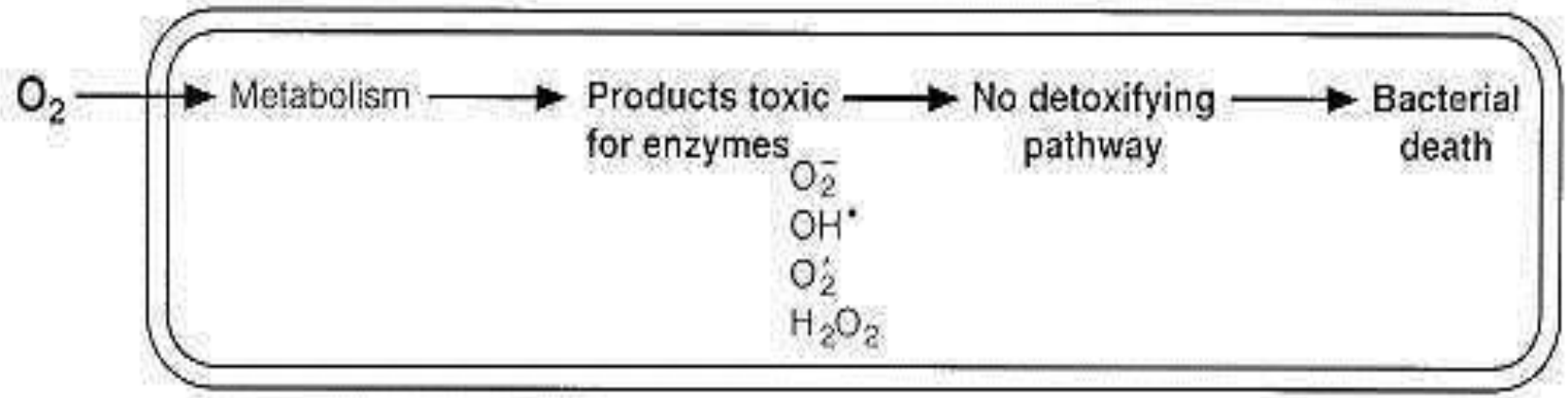
- Microaerophiles: are those groups of bacteria that can grow under reduced oxygen (5% to 10%) and increased carbon dioxide (8% to 10%). Higher oxygen tensions may be inhibitory to them.

- Capnophiles: Capnophilic bacteria require increased concentration of carbon dioxide (5% to 10%) and approximately 15% oxygen. This condition can be achieved by a candle jar (3% carbon dioxide) or carbon dioxide incubator, jar or bags.

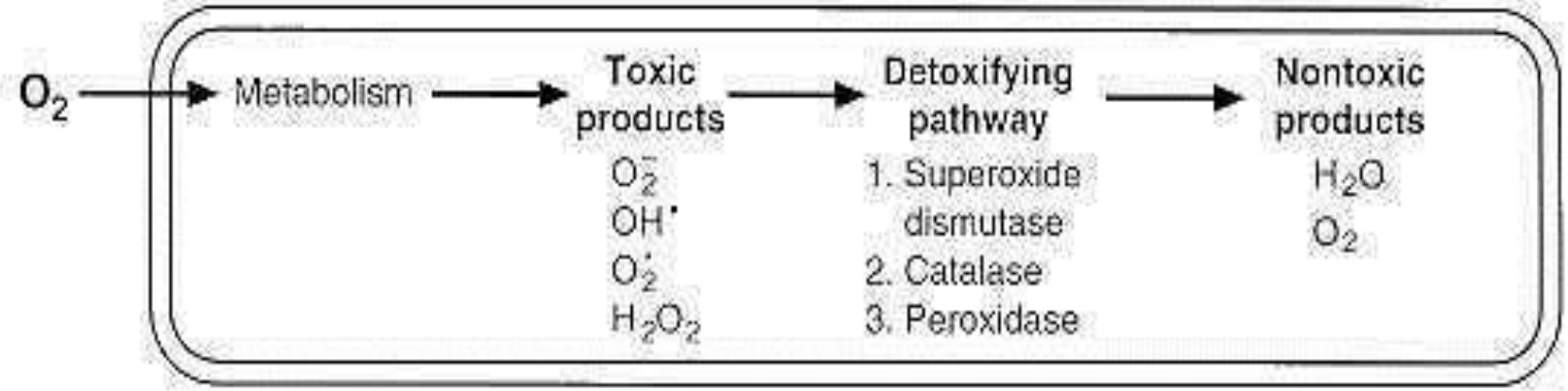
TABLE 6.1 **The Effect of Oxygen on the Growth of Various Types of Bacteria**

	a. Obligate Aerobes	b. Facultative Anaerobes	c. Obligate Anaerobes	d. Aerotolerant Anaerobes	e. Micro-aerophiles
Effect of Oxygen on Growth	Only aerobic growth; oxygen required.	Both aerobic and anaerobic growth; greater growth in presence of oxygen.	Only anaerobic growth; ceases in presence of oxygen.	Only anaerobic growth; but continues in presence of oxygen.	Only aerobic growth; oxygen required in low concentration.
Bacterial Growth in Tube of Solid Growth Medium					
Explanation of Growth Patterns	Growth occurs only where high concentrations of oxygen have diffused into the medium.	Growth is best where most oxygen is present, but occurs throughout tube.	Growth occurs only where there is no oxygen.	Growth occurs evenly; oxygen has no effect.	Growth occurs only where a low concentration of oxygen has diffused into medium.
Explanation of Oxygen's Effects	Presence of enzymes catalase and superoxide dismutase (SOD) allows toxic forms of oxygen to be neutralized; can use oxygen.	Presence of enzymes catalase and SOD allows toxic forms of oxygen to be neutralized; can use oxygen.	Lacks enzymes to neutralize harmful forms of oxygen; cannot tolerate oxygen.	Presence of one enzyme, SOD, allows harmful forms of oxygen to be partially neutralized; tolerates oxygen.	Produce lethal amounts of toxic forms of oxygen if exposed to normal atmospheric oxygen.

Anaerobic Bacteria



Aerobic or Facultative Bacteria



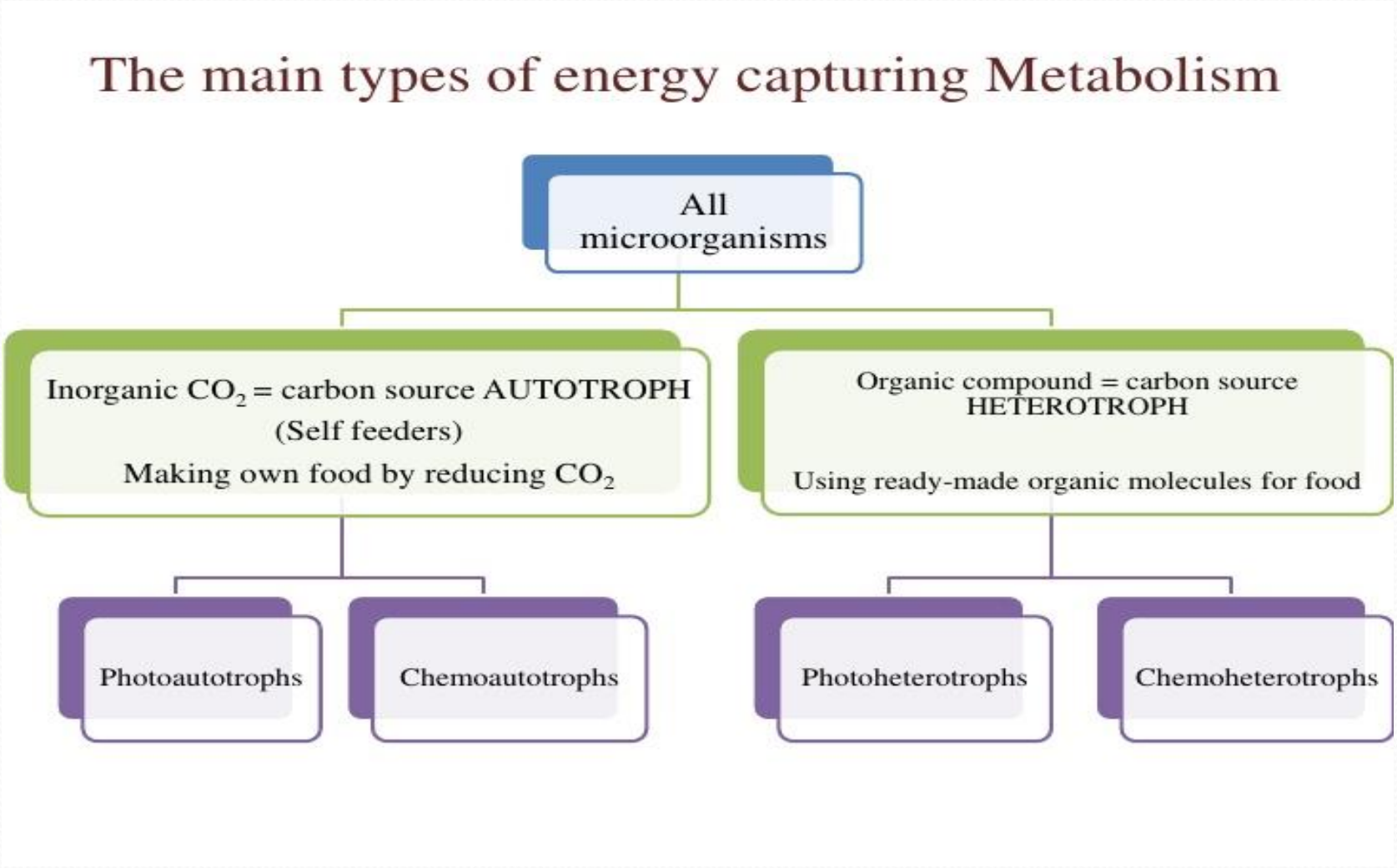
Mode of living in Bacteria

- If we consider the mode of nutrition, bacteria can be divided into two categories:

- **Autotrophic**. They can build up complex organic substances such as carbohydrates from simple inorganic sources (CO_2 and water).

- **Heterotrophic**. They cannot build up carbohydrates from simple inorganic sources. They depend on ready made organic materials derived from plants , animals of humans. They can live on such compounds , break it down , enzymatically.

Mode of living in Bacteria



Mode of living in Bacteria

- Photoautotrophs: They contain in their cells a chlorophyll known as bacterial chlorophyll by which they can perform photosynthesis. Here, the energy used in building up processes is derived from light. As an example of such bacteria is the green sulphur bacteria.

Mode of living in Bacteria

- **Chemoautotrophs**: Here the cells lack chlorophyll. Accordingly the source of energy should be something else than light. The energy used here is released from chemical reactions carried out by such bacteria.

Three examples of bacterial using oxidizing reactions to gain Energy:

- ***Nitrosomonas***, oxidizes ammonia or ammonium salts to nitrites with a release of energy :

$$2\ NH_3 + 3O_2 \longrightarrow 2\ HNO_2 + 2\ H_2o + \text{Energy}$$

- ***Nitrobacter***, oxidizes nitrites to nitrates with a release of energy :

$$2\ HNO_2 + O_2 \longrightarrow 2\ HNO_3 + \text{Energy}$$

Mode of living in Bacteria

- ***Thiobacillus thiooxidans***, oxidizes sulphur with a release of energy:

$$2S + 3O_2 + 2H_2O \longrightarrow 2\,H_2SO_4 + \text{Energy}$$

The energy released from any of these oxidation reactions is utilized by the specific organism in building up organic carbohydrates from the simple inorganic sources.

QUESTIONS??