Microbes

Growth ⇒ ↑ cell number

Requirement for Growth

Physical Requirements

Temperature

- **Psychrophiles** 0°C — Cold-loving
  - **True psychrophiles** 15°C or below
    - cause disease or food spoilage
  - **Psychrotrophs** 20°-30°C
    - Responsible for most low temperature food spoilage.
- **Mesophiles** 25°-40°C (37°*)
  - Middle-loving
  - Most bacteria
  - Many have adapted to live in the bodies of animals.
- **Thermophiles** 50-60°C
  - Heat-loving
  - adapted to live in sunlit soil, compost piles & hot springs
- **Extreme-Thermophiles** 80°C
  - Hyperthermophiles
  - Archaebacteria → most live in volcanic & ocean vents.

pH

- **Acidophiles** 0.1-5.4
  - Grow at low pH
  - Lactobacillus produces lactic acid, tolerates mild acidity.
  - Acid-loving.
- **Neutrophiles** 5.4-8.5
  - Includes most human pathogens.
- **Alkaliphiles** 7-12 or higher
  - Alkali-loving.
  - Grow at alkaline or high pH.
  - Vibrio cholerae → 9

Osmotic pressure

cells → 80-90% water

- **Halophiles**
  - Require moderate to large salt [ ]
  - Most bacteria in ocean (3.5% salt)
- **Extreme or obligate Halophiles**
  - Require very high salt [ ] → 20-30%
  - Bacteria in dead sea
- **Facultative Halophiles**
  - Don't require high salt [ ] for growth, but tolerate 2% salt or more.

Chemical Requirements

Carbon 50%

- % dry weight of cell.
- structural backbone of all organic compounds
- **Chemoheterotrophs**
  - obtain carbon from their energy source:- [Lipid, proteins & carbohydrates]
- **Chemoautotrophs & Photoautotrophs**
  - obtain carbon from carbon dioxide CO_2

Oxygen bacteria

- **Aerobes**
  - utilize O_2 & can detoxify it.
  - **obligate aerobes** — Can't grow without O_2
  - **facultative anaerobes** — utilize O_2 but can also grow in its absence
  - **microaerophilic** — requires only a small amount of O_2
- **Anaerobes**
  - Don't utilize O_2
  - **obligate anaerobes** — lack the enzymes to detoxify O_2.
  - **aerotolerance** — Don't utilize O_2 but can survive & grow in it's absence.

Oxygen free radicals ↓ *oxidize other molecule to be saturated.

the toxic form of oxygen

Hydrogen peroxide (H_2O_2)

* 2 enzymes that break down H_2O_2

Catalase

$2H_2O_2 \xrightarrow{\text{catalase}} 2H_2O + O_2$ (g)

Produced by humans as well as many bacteria

Peroxidase

$H_2O_2 + 2H \xrightarrow{\text{peroxidase}} H_2O$

Superoxide Free Radicals (O_2^-)

* Extremely toxic & reactive form of O_2
* All organisms growing in atmospheric oxygen must produce an enzyme dismutase (SOD)

SOD ~made by~ aerobes, facultative anaerobes & aerotolerant anaerobes.

$O_2^- + O_2^- 2 + H^+ \xrightarrow{SOD} H_2O_2 + O_2$