

pH

- **pH** stands for **potential** or **power** of **Hydrogen**.
- pH is a measure of the hydrogen ion activity of a solution and is defined as the negative logarithm of hydrogen ion concentration (expressed in terms of molarity “moles per liter”).
$$\text{pH} = -\log_{10}[\text{H}^+]$$
- The pH scale extends from pH 0.0 (1.0 M H⁺) to pH 14.0 (10⁻¹⁴ M H⁺).

pH and microbial growth

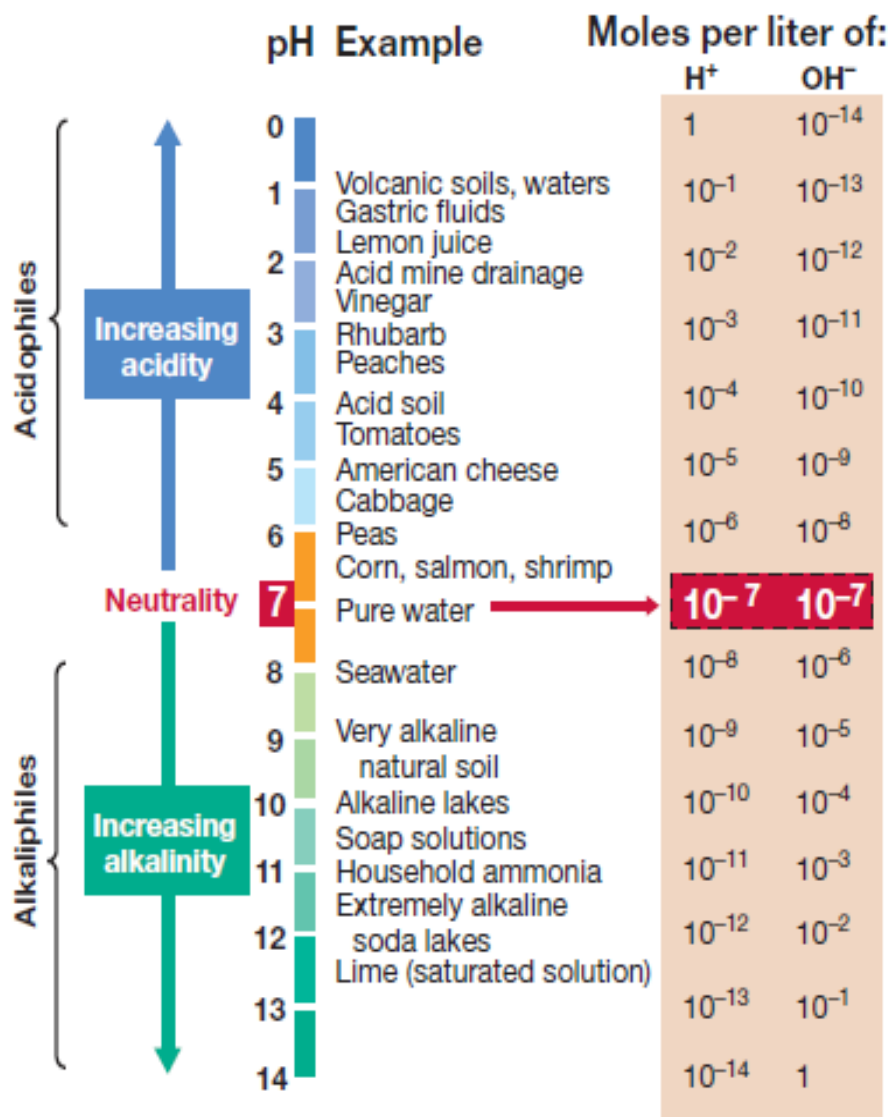
- Another way of effecting the growth of microorganisms is by changing its pH level.
- Each microorganism has an optimal pH it grows best and most microorganisms can grow over range of 2-3 pH units.
- Very few species can grow at pH values below 2 or above 10.

The effects of hydrogen ion concentration

1. Affect proteins and other charged molecules in the cell.
2. It can directly affect the charged amino acids in proteins and result in denaturation and loss of enzymes activity.
3. Alter the ionization of nutrient molecules and thus reduce their availability to the organism.

Classification of microorganisms according to pH requirements

- **Acidophiles**: few microbes that grow best in acidic habitats such as sulfuric lake, prefer pH range of 0 - 5.5, e.g., *Lactobacillus acidophilus* and *Thiobacillus thiooxidans*.
- **Neutrophiles**: most microbes prefer a pH near neutrality, which grow in a pH range of 5.5 – 8.5. Majority of neutrophiles found in soil and water. Most of pathogenic bacteria are neutrophiles.
- **Alkalophiles (Alkaliphiles)**: few microbes that grow best in alkaline habitats such as Soda Lake which prefer pH range 8.5 – 11.5, e.g., *Alkaligenes faecalis* and *Bacillus alcalophilus*.



Extracellular versus intracellular pH

- The optimal pH for growth of any organism is a measure of the pH of the **extracellular environment** only.
- The intracellular pH must remain near neutrality to prevent destruction of acid- or alkali-labile macromolecules in the cell.
- In extreme acidophiles and extreme alkalophiles the intracellular pH may vary by several units from neutrality.
- The internal pH of an extreme acidophile has been measured at 4.6 units while the internal pH of an extreme alkalophile has been measured at 9.5 units.
- Microorganisms frequently change the pH of their own habitat by producing acidic or basic metabolic waste products.
 - *Helicobacter pylori* as a neutrophilic bacterium produces urease enzyme; generates ammonia and raises pH of environment.

Aim

In this experiment, we will test the degree of inhibition of microorganisms that result from media containing different hydrogen ions concentrations.

Materials

- Nutrient agar plates or nutrient broth tubes of five different pHs (3.0, 5.0, 7.0, 9.0, 11.0).
- Fresh nutrient broth bacterial cultures of
 - *Bacterial Sample 1*
 - *Bacterial Sample 2*
 - *Bacterial Sample 3*
 - *Bacterial Sample 4*
- Micropipette.
- Swabs.

Procedure

1. Label each nutrient agar plate or nutrient broth tube (with specific pH) with bacterial sample no.
2. Inoculate plate of each of these nutrient agar media with appropriate microorganism
3. Incubate all the plates at 37° C for 24 hours.
4. After incubation time, observe the effect of pH on these bacteria by the presence or absence of growth in each plate.

Results

Observations and Interpretations

Microorganisms	pH					Classification
	3	5	7	9	11	
<i>Bacterial Sample 1</i>						
<i>Bacterial Sample 2</i>						
<i>Bacterial Sample 3</i>						
<i>Bacterial Sample 4</i>						