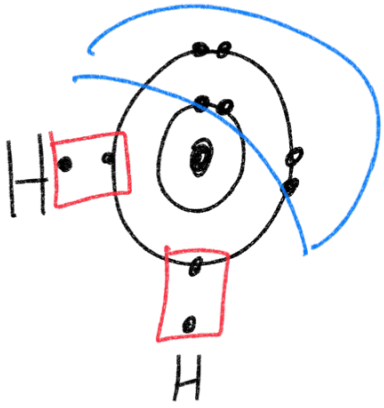
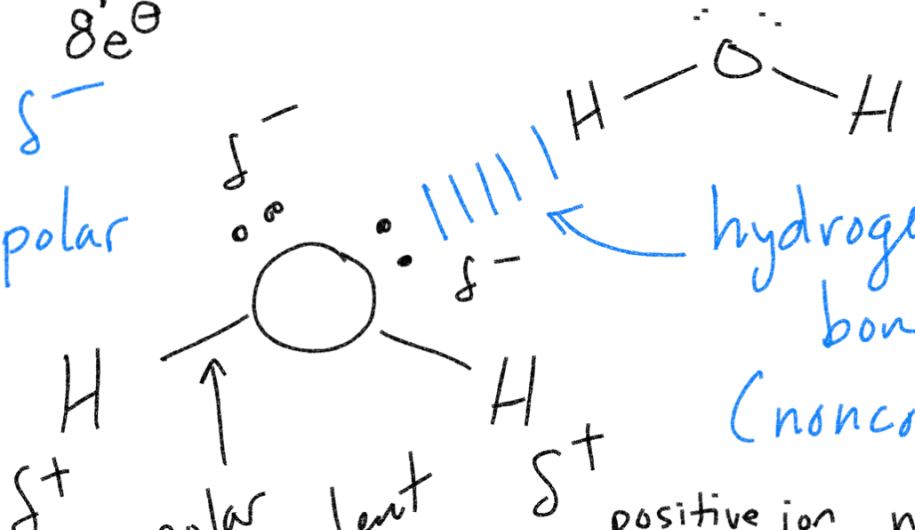
T-GB General Biology Week 5 10/3

Orbital Oxygen $8p^{\oplus}$ $8e^{\ominus}$



$\delta-$

polar

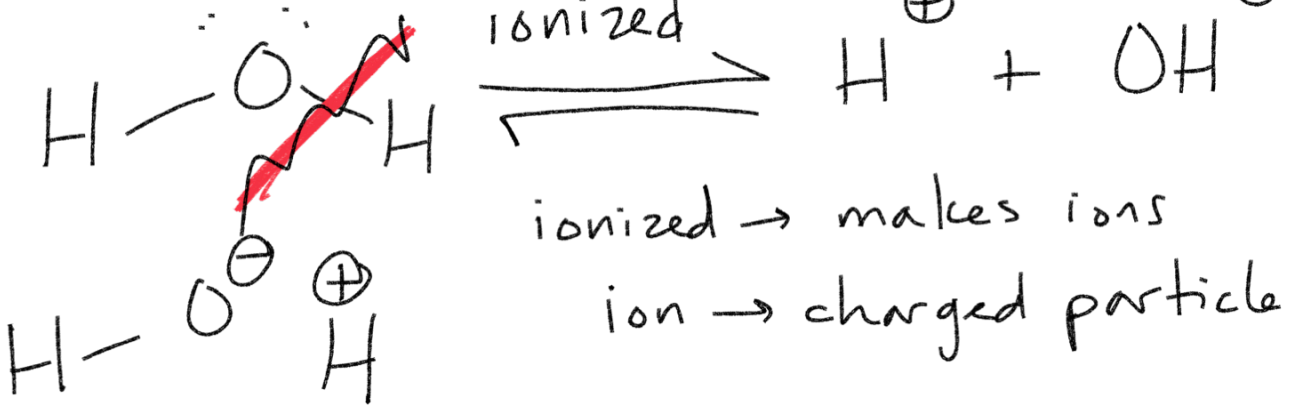


hydrogen bond (noncovalent)

polar covalent bond

positive ion negative ion

water



ionized → makes ions

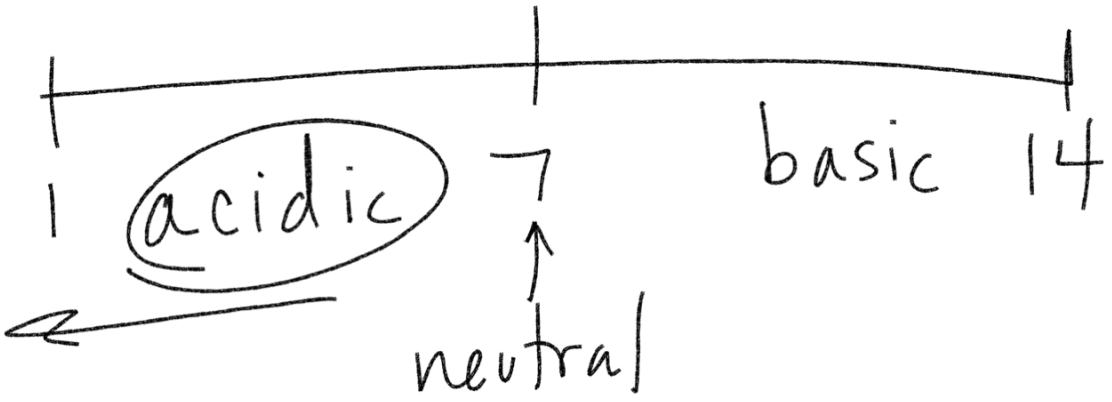
ion → charged particle

water is both an acid and a base

acid → donates proton

base → accepts proton

Neutral pH pH = 7



$-\log [H^{\oplus}] = pH$

pH = 7 $H^{\oplus}$ concentration 10^{-7}

pH = 4 $[H^{\oplus}] = 10^{-4}$

pH = 2 $[H^{\oplus}] = 10^{-2}$

Lower the number, the more acidic

pH = 11 $[H^{\oplus}] = 10^{-11}$

pH = 57 $[H^{\oplus}] = 10^{-57}$

very basic

Neutral pH = 7

pH = 7 $[H^{\oplus}] = 10^{-7}$

At pH,

$H^{\oplus} = OH^{\ominus}$

protons ↓ hydroxide ion ↓

$[H^{\oplus}] = 10^{-7}$ $[OH^{\ominus}] = 10^{-7}$

7+7=14

If

pH = 12 $[H^{\oplus}] = 10^{-12}$ $[OH^{\ominus}] = 10^{-2}$ 12+2=14

pH = 3 $[H^{\oplus}] = 10^{-3}$ $[OH^{\ominus}] = 10^{-11}$ 3+11=14

$(10^{-3})(10^{-11}) = 10^{-3+(-11)} = 10^{-14}$

ALWAYS $[H^{\oplus}] * [OH^{\ominus}] = 10^{-14}$

-5+ ___ = -14

pH = 5 $[H^{\oplus}] = 10^{-5}$ $[OH^{\ominus}] = 10^{-9}$ pOH = 9

pH = 1 pOH = 13

pH + pOH = 14

1 + 13 = 14

$pH = 10$

$[H^{\oplus}] * [OH^{\ominus}] = 10^{-14}$

$pH + pOH = 14$

$[H^{\oplus}] = 10^{-10}$

$[OH^{\ominus}] = 10^{-4}$

$pOH = 4$

Neutral $pH = 7$

$[H^{\oplus}] = 10^{-7}$

$10^{-7} = \frac{1}{10^7} = \frac{1}{10{,}000{,}000}$ $H^{\oplus}$ ion

H_2O molecules

$pH = 2$ $[H^{\oplus}] = 10^{-2} = \frac{1}{10^2} = \frac{1}{100}$

more acid

Strong Acid → strong because it is a better acid than water

Ionizes completely

HI H_2SO_4

HBr HNO_3

HCl

Acid → donates proton ($H^{\oplus}$)

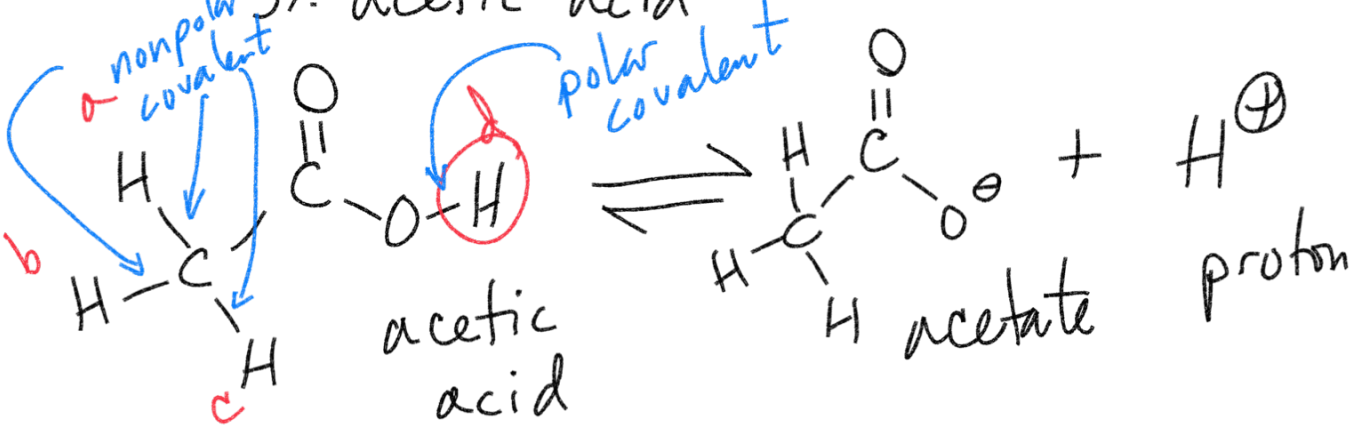
100,000 HCl $\xrightarrow[\text{water}]{}$ 100,000 $H^{\oplus}$ + 100,000 $Cl^{\ominus}$

$pH = -1 \qquad [H^+] = 10^{-(-1)} = 10^1 = 10$

$\frac{10\ H^+}{1\ \text{water}}$

Vinegar 95% water

5% acetic acid



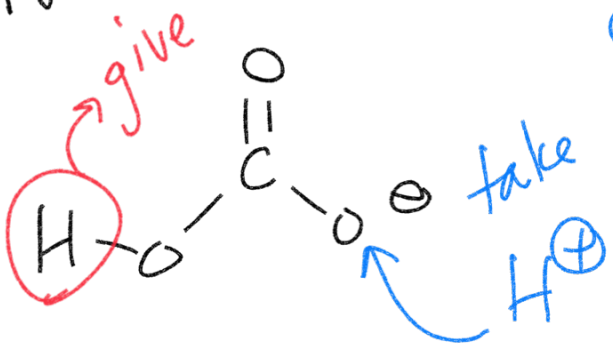
Acids → donate H^+

Blood buffer → Bicarbonate

Acts as both

acid → gives H^+

and base → takes H^+



can do both

physiological pH ≈ 7.4

pH = 9 $\quad 9 + 5 = 14$

$[H^{\oplus}] = 10^{-9}$

$[OH^{\ominus}] = 10^{-5}$

acid/base? base

pOH 5

pOH = 2

$[H^{\oplus}] = 10^{-12}$

$[OH^{\ominus}] = 10^{-2}$

acid/base base

pH = 12

pH + pOH = 14

12 + 2 = 14

Ch. 2 Warm-Up

1. What is the difference between an atom, element and compound?

Elements are specific types of atoms — # of protons

Compound - made up of two or more different atoms (elements)

2. What are the 3 main components of an atom? What are their charges?

neutrons Ø, electron ⊖, protons ⊕

3. What type of bond is found in:
   - H_2O? → polar covalent
   - KCl? → ionic
   - $C_6H_{12}O_6$? → polar covalent
   - N_2? N:N → symmetrical nonpolar
   - $Ba(OH)_2$? → ionic

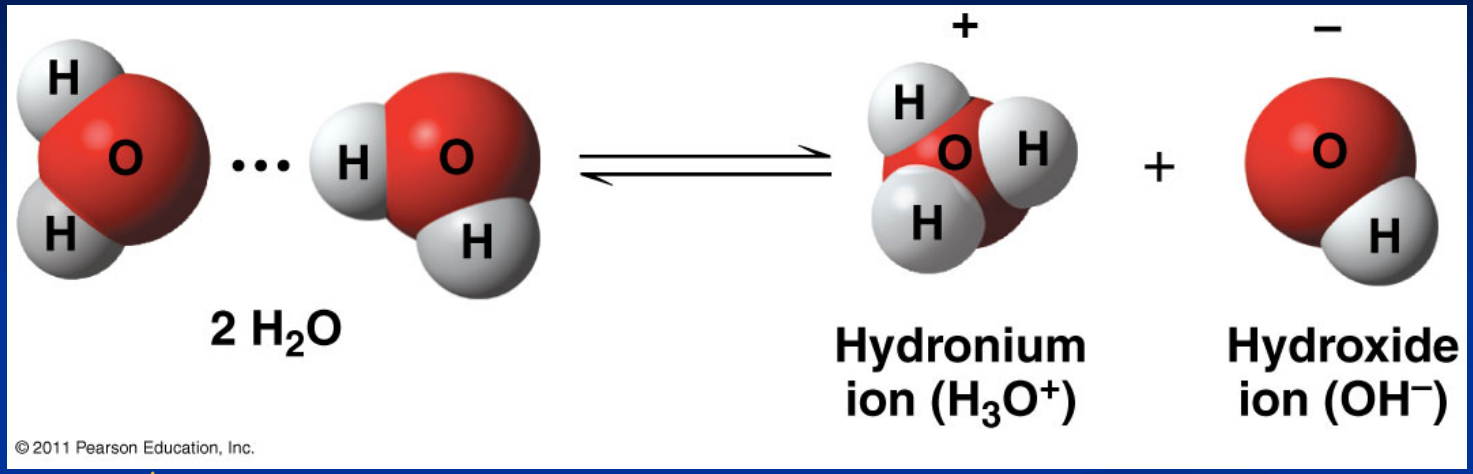
It's OK if this doesn't make total sense

CO_2 → compound

O_2 → element

polar covalent, nonpolar covalent, ionic

Acids and Bases



Acid → donate protons

$H_2O \rightleftharpoons H^+ + OH^-$

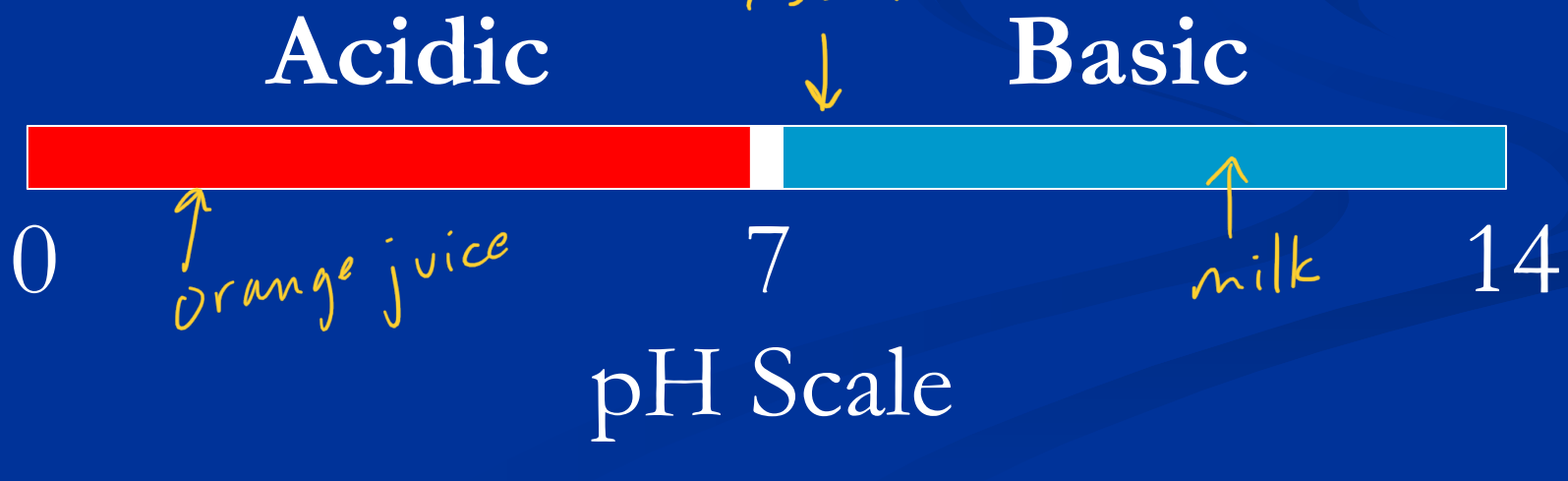
base – accepts proton

(gains proton) $H^+ + H_2O \rightarrow$ **H_3O^+** (hydronium ion)

(loses proton) $H_2O - H^+ \rightarrow$ **OH^-** (hydroxide ion)

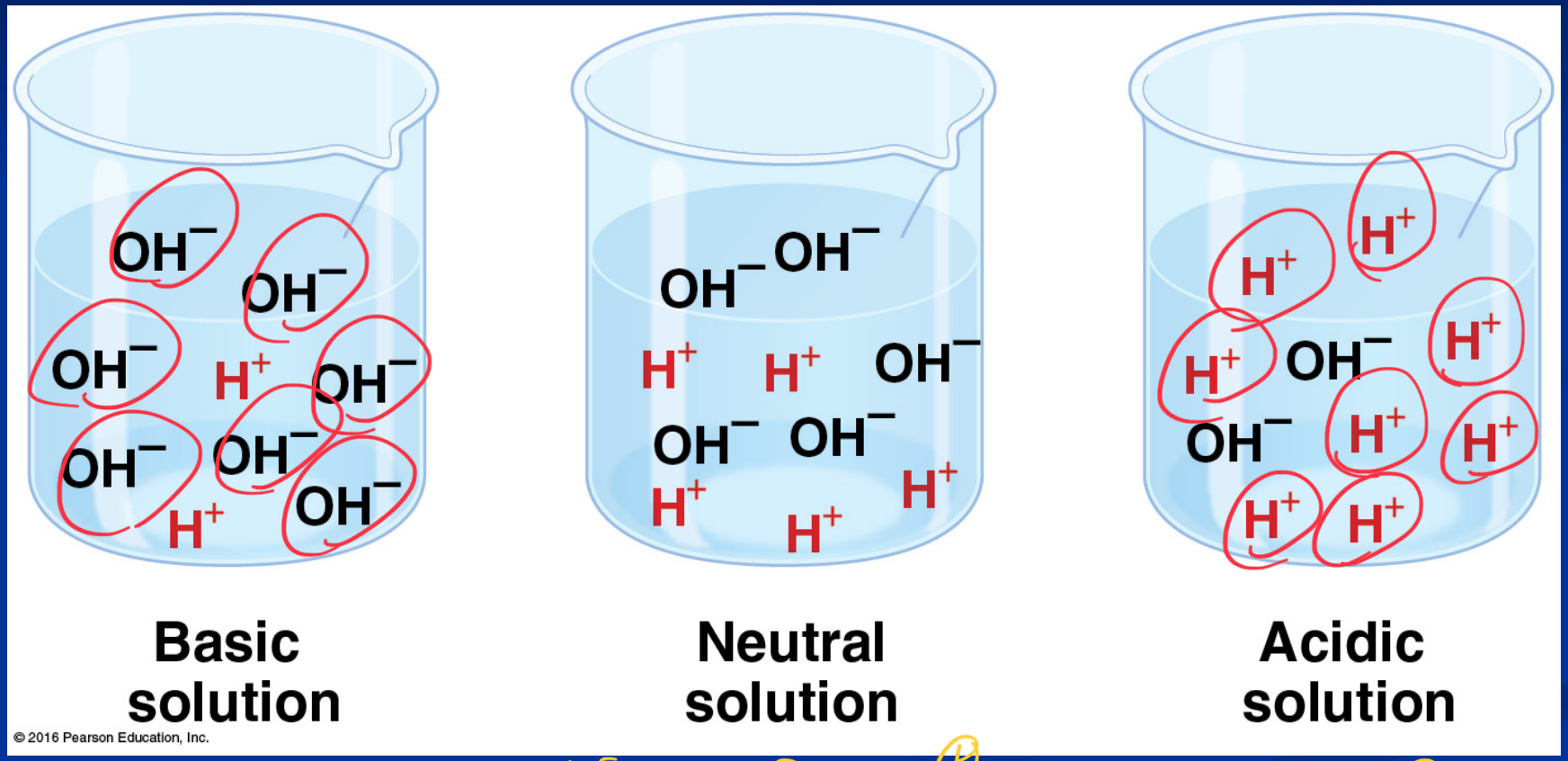
5. Acids and Bases

- **Acid** = increases H^+ concentration (HCl)
- **Base** = reduces H^+ concentration (NaOH)
- Most biological fluids are pH 6-8



H^+ and OH- Ions

$H_2O \rightleftharpoons H^{\oplus} + OH^{\ominus}$

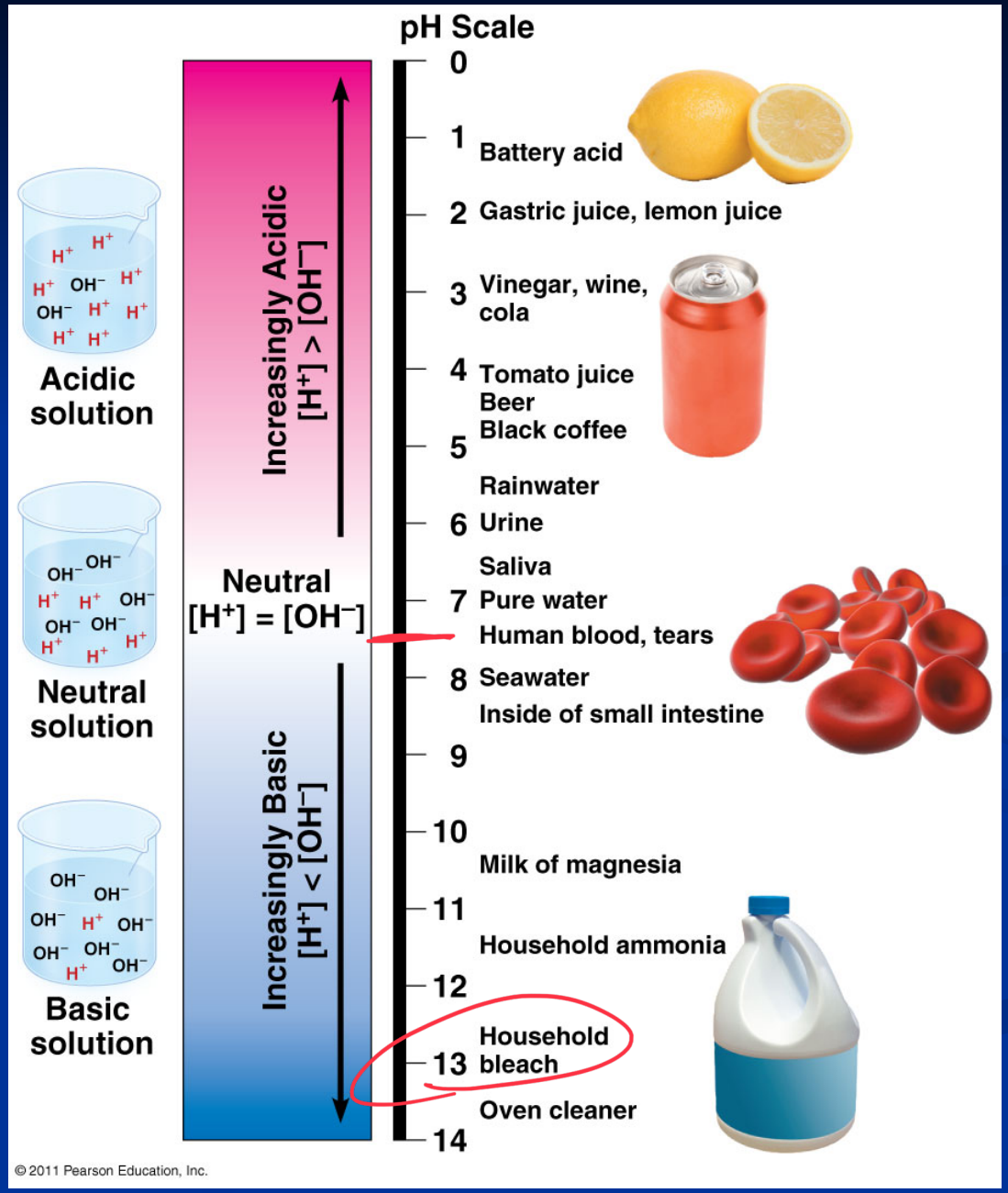


More $OH^{\ominus}$

if $OH^{\ominus} = H^{\oplus}$ Neutral pH = 7

more $H^{\oplus}$

Figure 2.23 The pH scale and pH values of some aqueous solutions



Calculating pH

$[H^+][OH^-] = 10^{-14}$

n If $[H^+] = 10^{-6}$ M, then $[OH^-] = 10^{-8}$

$pH = -\log [H^+]$

1. If $[H^+] = 10^{-2}$
   - $-\log 10^{-2} = -(-2) = 2$
   - Therefore, pH = 2
2. If $[OH^-] = 10^{-10}$
   - $[H^+] = 10^{-4}$
   - $-\log 10^{-4} = -(-4) = 4$
   - Therefore, pH = 4

Buffers

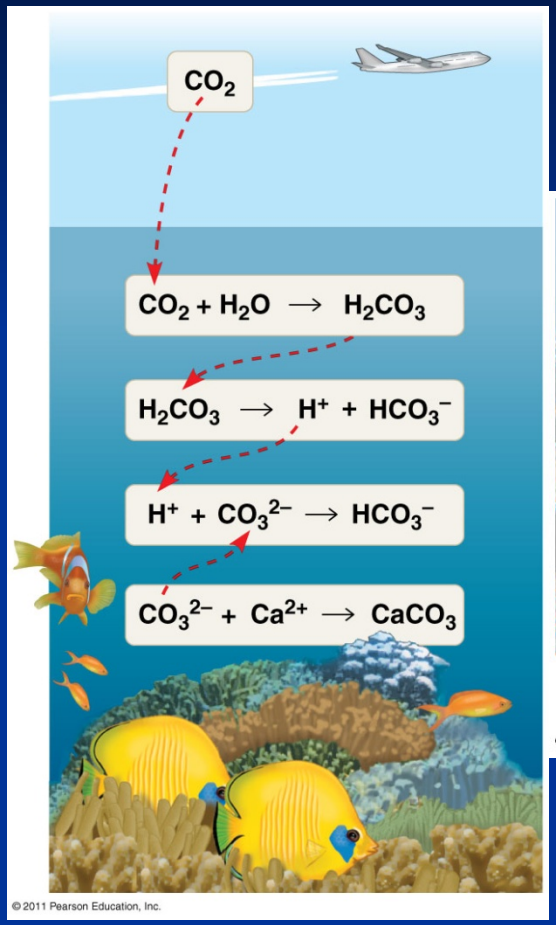
Buffers: minimize changes in concentration of H^+ and OH^- in a solution (weak acids and bases)

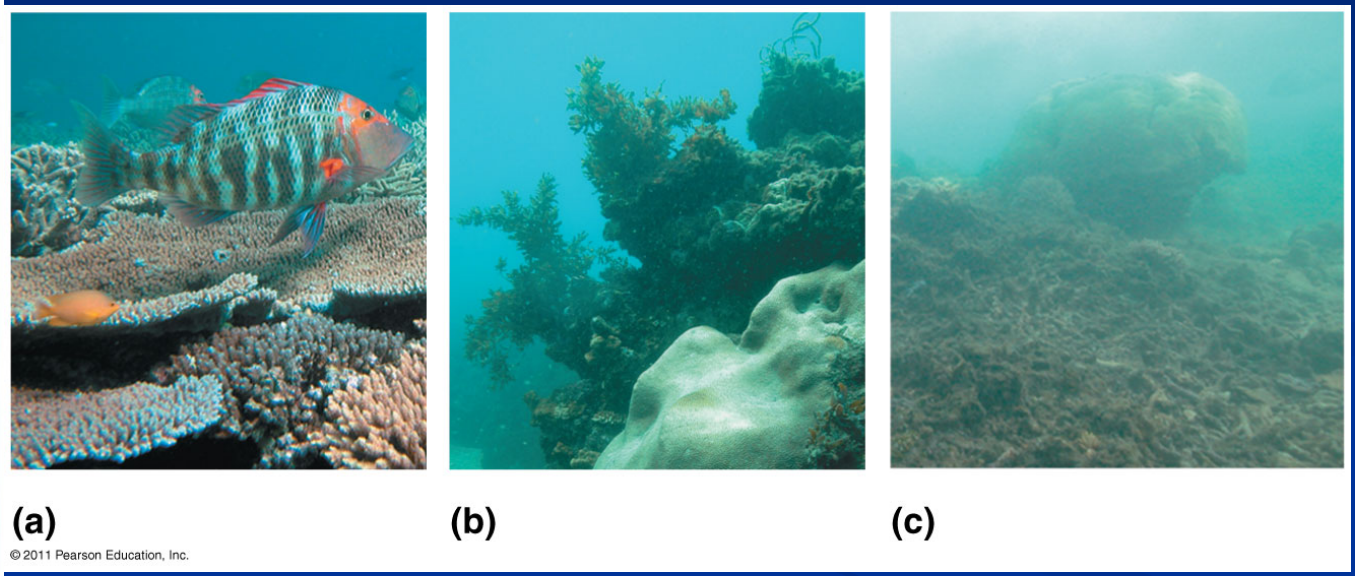
- Buffers keep blood at pH ~7.4
- If blood drops to 7 or up to 7.8 → death

Carbonic Acid – Bicarbonate System: important buffers in blood plasma

H_2CO_3 (carbonic acid) → HCO_3^- (bicarbonate) + H^+

Ocean Acidification:
Threat to Coral Reef Ecosystems





CO_2 + Seawater → Carbonic acid → Lowers ocean pH

H_2O Property	Chemical Explanation	Examples of Benefits to Life
Cohesion	•polar •H-bond •like-like	↑gravity plants, trees
Adhesion	•H-bond •unlike-unlike	plants→ xylem blood→veins
Surface Tension	•diff. in stretch •break surface •H-bond	bugs→water
Specific Heat	•Absorbs & retains E •H-bond	ocean→mod temp →protect marine life
Evaporation	•liquid→gas •KE	Cooling Homeostasis
Universal Substance	•Polarity→ionic •H-bond	Good dissolver solvent