Acids and Bases

H^+

OH^-

- Refresher Overview
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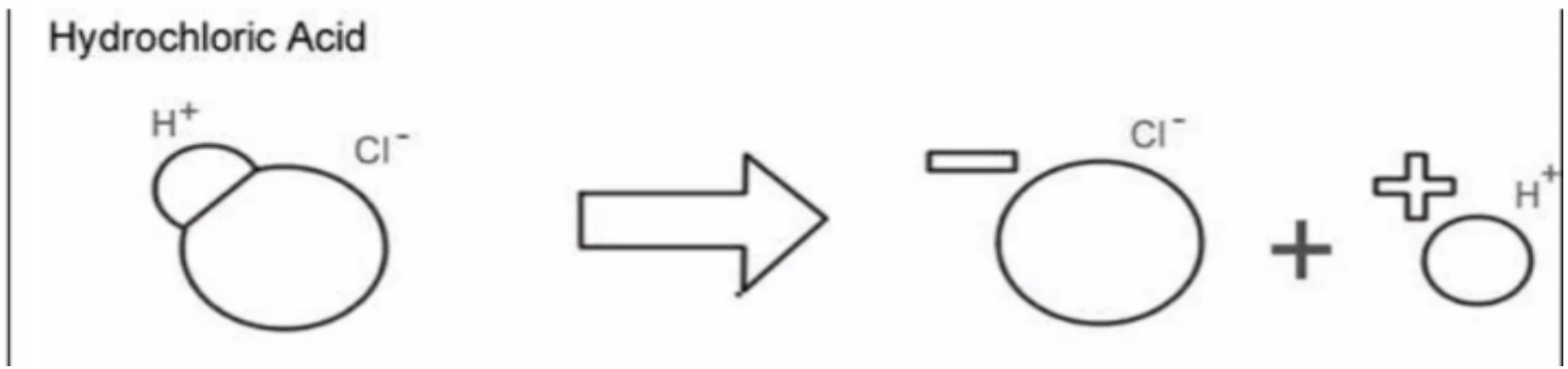
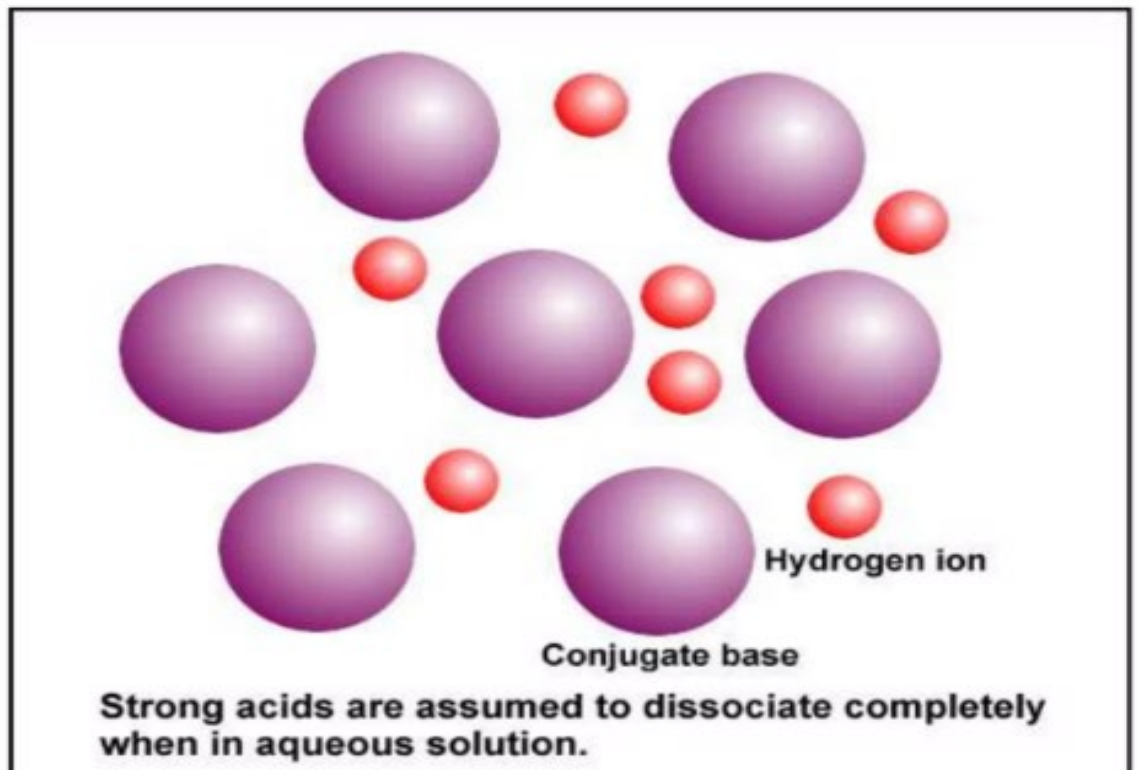
Acids

- An **acid** is a substance that releases H+ ions in an aqueous solution
  - **Aqueous** means water
- Example: when hydrochloric acid is dissolved in water, the compound separates into chlorine ions (Cl-) and hydrogen ions (H+)



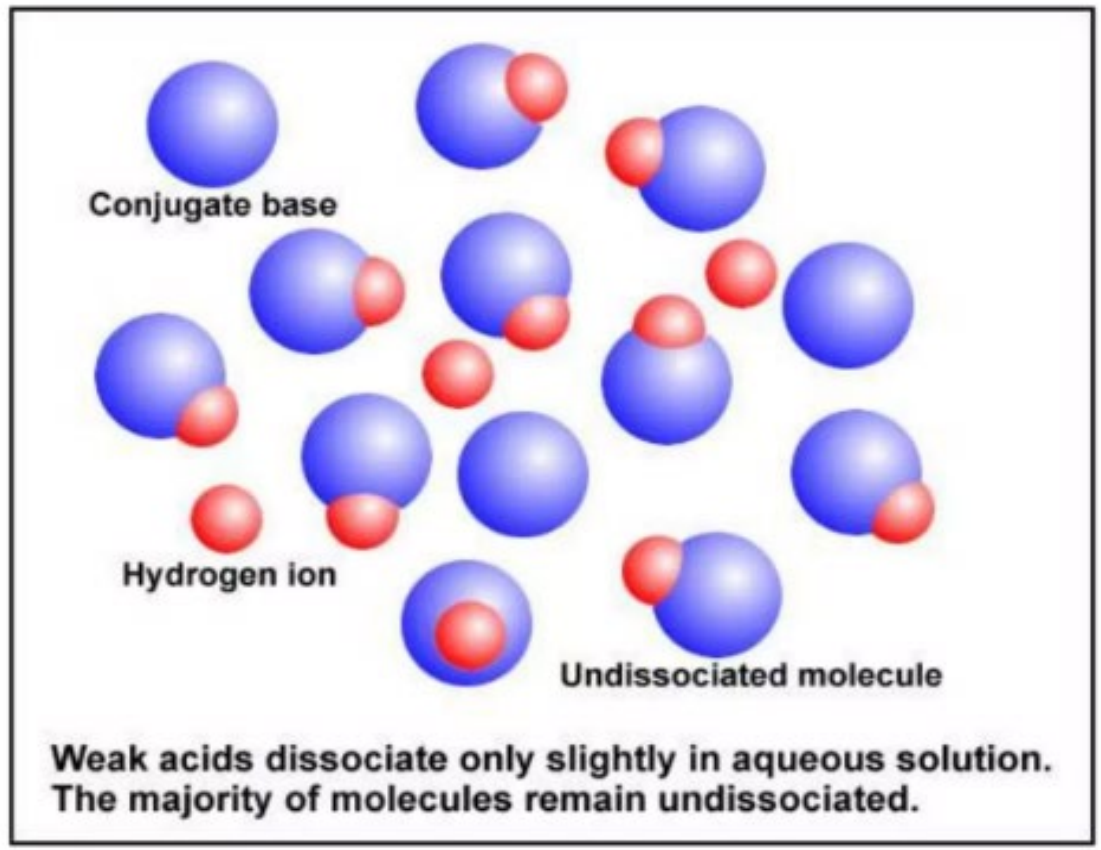
Strong Acids

- A **strong acid** breaks down completely in water and gives off many H+ ions



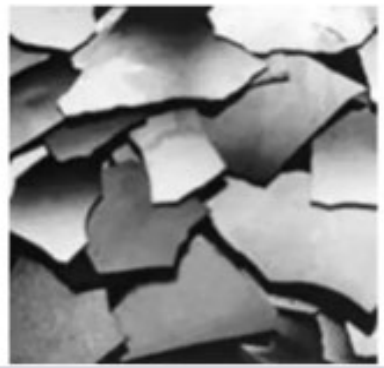
Weak Acid

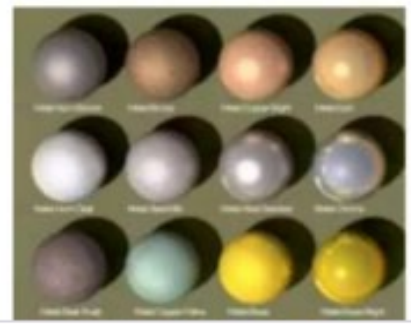
- A **weak acid** only partially breaks down. It gives off much less H+ than a strong acid.



Characteristics of Acids

- Acids have a sour taste
- Acids react with metals & carbonates to produce gas
- Acids contain hydrogen





H

Characteristics of Acids: Taste Sour

- Acids in foods taste sour and produce a burning or prickling feeling on the skin

Characteristics of Acids

- Since tasting or touching an unknown chemical is ***extremely dangerous***, other methods are needed to tell whether a solution is an acid

Characteristics of Acids: Reacts with Carbonate

- A safe way to test to see if a solution is an acid is to place a few drops on a compound that contains a carbonate (CO_3)
- Example: limestone is a rock that contains calcium carbonate ($CaCO_3$) When an acid touches a piece of limestone, a reaction occurs that produces carbon dioxide gas

Characteristics of Acids: Reacts with Metal

- Acids also reacts with most metals
- The reaction produces hydrogen gas, which you can see as bubbles

Uses for ACIDS

- Sulphuric acid:
  - Detergents
  - Car batteries
- Ethanoic acid:
  - Vinegar to preserve food
  - Adhesives (glue)
- Hidrochloric Acid:
  - Cleaning metals
  - Leather processing

Characteristics of Acids: Contain Hydrogen

HCl
Hydrochloric acid

$HC_2H_3O_2$
Acetic acid

H_2SO_4
Sulfuric acid

$H_3C_6H_5O_7$
Citric acid

HNO_3
Nitric acid

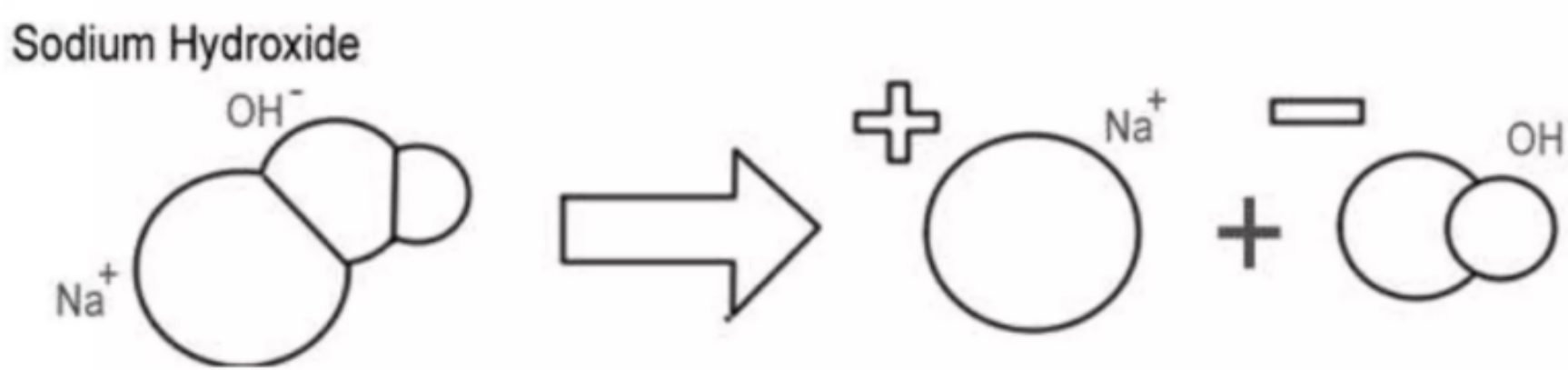
H_3PO_4
Phosphoric acid

H_2CO_3
Carbonic acid

$H_2C_2O_4$
Oxalic acid

Bases

- A **base** is a substance that releases hydroxide (OH-) ions in an aqueous solution
- Example: When sodium hydroxide (NaOH) is dissolved in water, the compound separates into sodium ions (Na+) and hydroxide ions (OH-)



Characteristics of Bases

- Bases usually taste bitter
- Bases feel slippery
- Bases contain hydroxide ions (OH-)

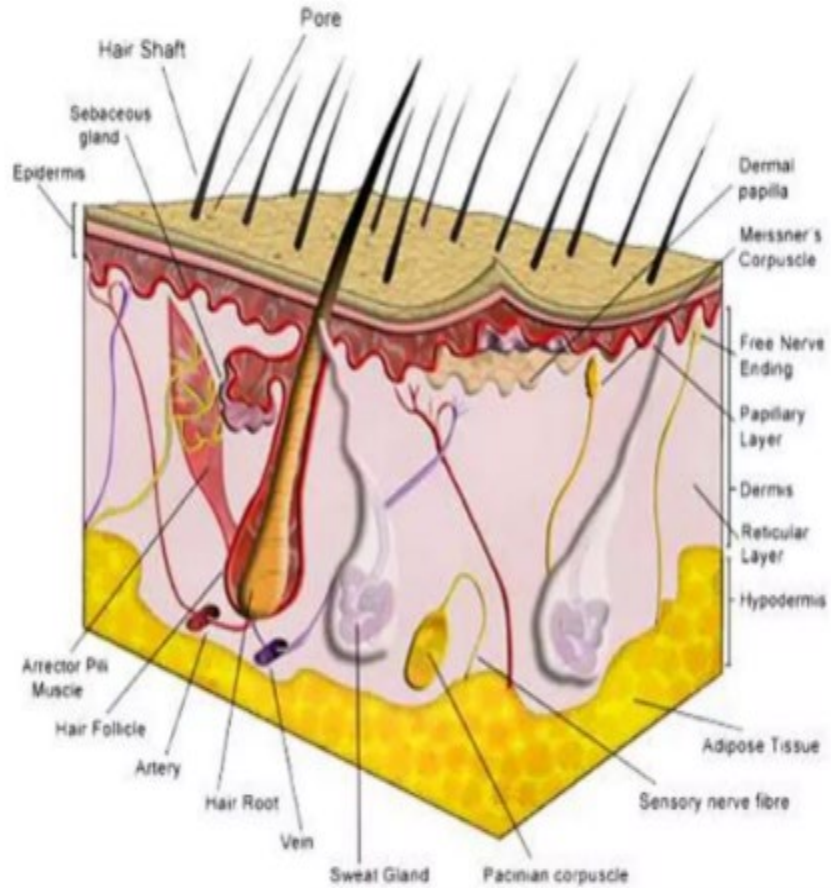
Characteristics of Bases: Taste Bitter

- Example: Baking soda

Characteristics of Bases: Taste Bitter

- Mild bases in foods taste bitter and feel slippery, but as with acids, ***tasting and touching are not safe*** ways of testing whether a solution is a base
- In fact, some strong bases can burn the skin as badly as strong acids

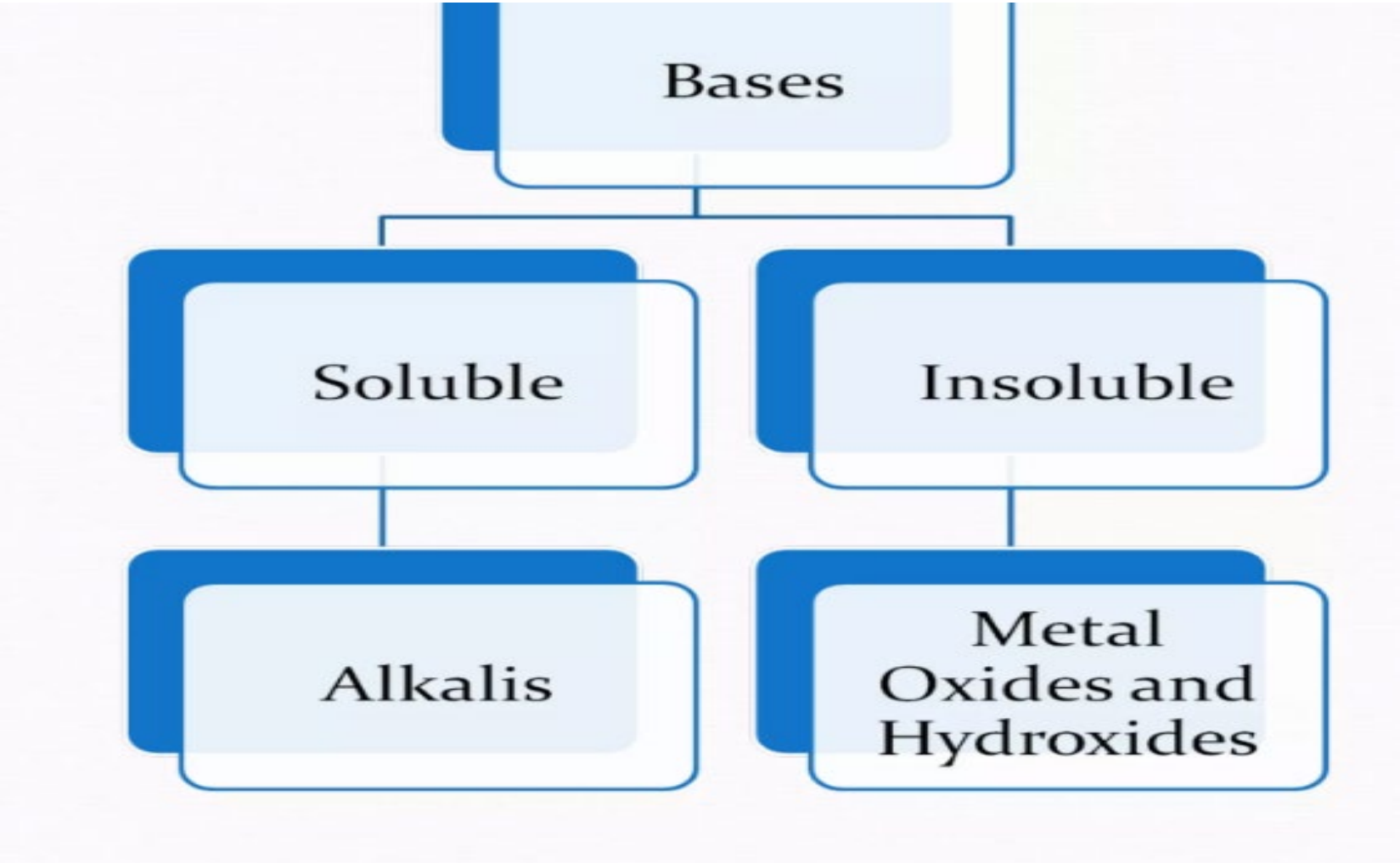
- Bases feel soapy or slippery because they react with acid molecules in your skin called fatty acids



Characteristics of Bases: Feel Slippery

- In fact, this is exactly how soap is made. Mixing base- usually sodium hydroxide – with fatty acids produces soap
- So when a base touches your skin, the combination of the base with your own fatty acids actually makes a small amount of soap

Family of Bases



Characteristics of Bases: Contain Sodium Hydroxide (OH-)

Strong Bases	The Formulae
Lithium hydroxide	LiOH
Sodium hydroxide	NaOH
Potassium hydroxide	KOH
Rubidium hydroxide	RbOH
Caesium hydroxide	CsOH
Barium hydroxide	$Ba(OH)_2$
Calcium hydroxide	$Ca(OH)_2$
Strontium hydroxide	$Sr(OH)_2$

Properties of Acids and Bases

ACIDS	BASES
taste **sour**	taste **bitter**
do not feel slippery	feel **slippery**
pH < 7	**pH > 7**
release hydrogen (**H^+**) ions in aqueous solution	release hydroxide (**OH^-**) ions in aqueous solution
corrode metals	do not corrode metals
react with metals to produce a compound and **hydrogen gas**	do not react with metals to produce a compound and hydrogen gas
turn litmus **red/pink**	turn litmus **blue**

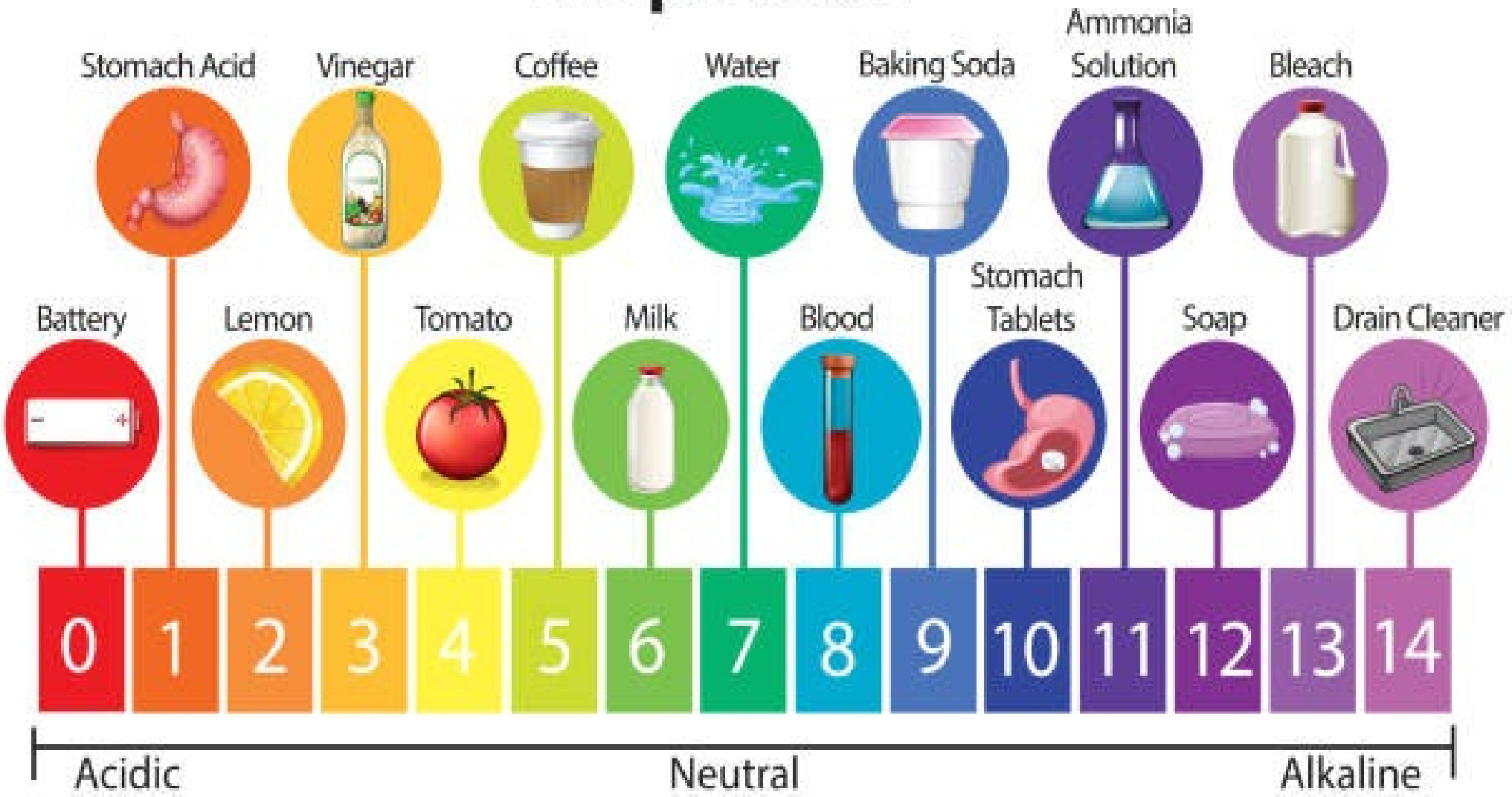
Properties of Acids & Bases

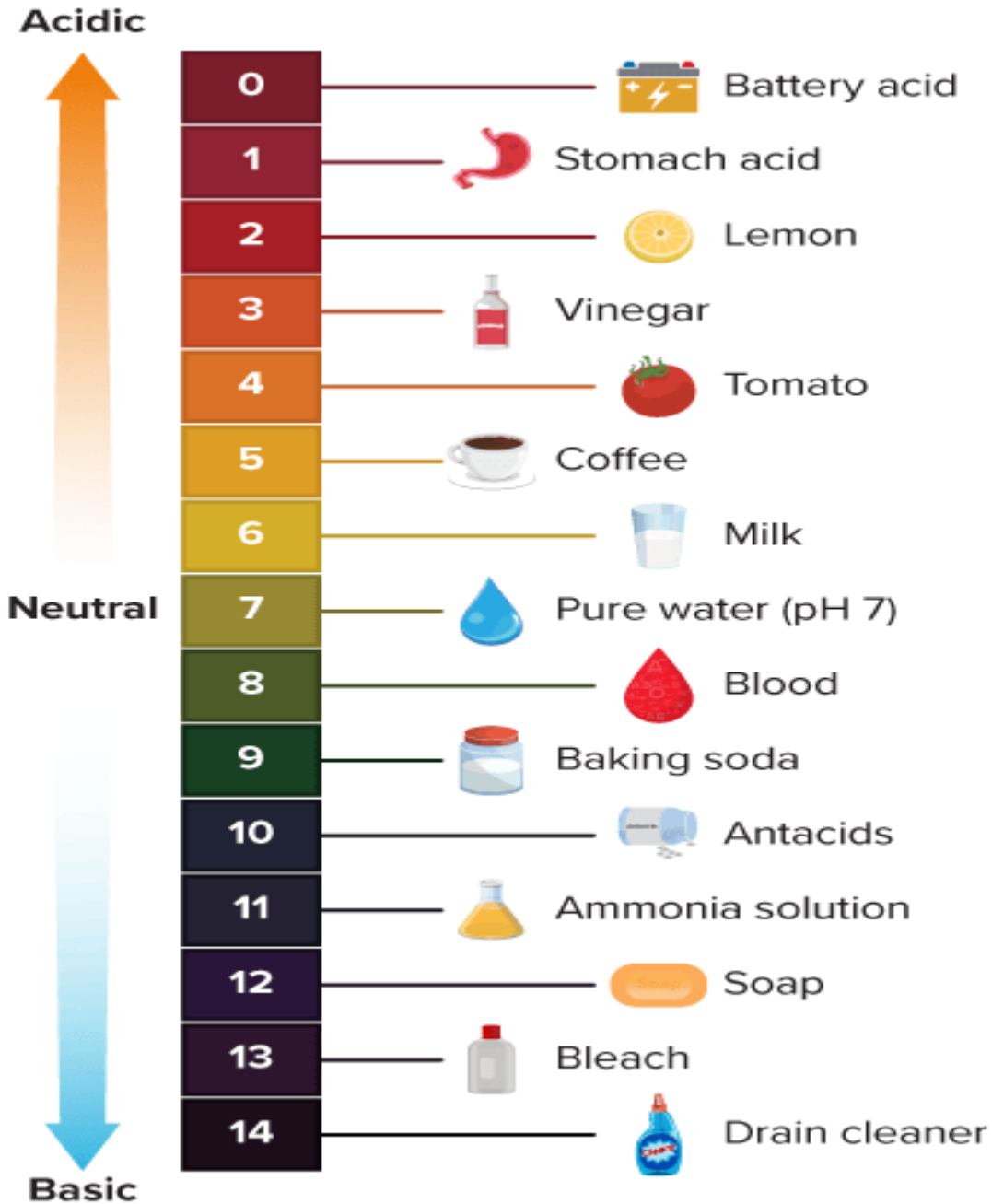
- Similarities between acids and bases
  - Dissolve in water
  - Conduct electricity in aqueous solution
  - Can irritate or burn skin

Acid-Base Strength

- **pH** stands for “potential hydrogen” and is a measure of how many H+ ions there are in solution.
- The strength of an acid or base is usually measured using a **pH scale**
- The more H+ there are, the lower the pH will be

The pH Scale


Stomach Acid
Vinegar
Coffee
Water
Baking Soda
Ammonia Solution
Bleach
Battery
Lemon
Tomato
Milk
Blood
Stomach Tablets
Soap
Drain Cleaner
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Acidic
Neutral
Alkaline


Acidic
Neutral
Basic
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Battery acid
Stomach acid
Lemon
Vinegar
Tomato
Coffee
Milk
Pure water (pH 7)
Blood
Baking soda
Antacids
Ammonia solution
Soap
Bleach
Drain cleaner

Acid-Base Strength

- The numbers of the pH scale usually range from 0 – 14, but numbers outside this range are possible
- The middle number, 7, represents a neutral solution
- A **neutral** substance is neither an acid nor a base. Pure water has a pH of 7

Acid-Base Strength

- pH < 7 indicate acidic solution
- pH = 7 indicate neutral solution
- pH > 7 indicate basic solution

Acid-Base Strength

- A concentrated strong acid has a low pH value
- A concentrated strong base has a high pH value

Acid-Base Indicators

- An **acid-base indicator** is a compound that will change color in the presence of an acid or base
- **Litmus** is a plant extract that can be blue or red (pink)
  - Litmus turns red/pink in an acidic solution
  - Litmus turns blue in a basic solution

Acid-Base Indicators

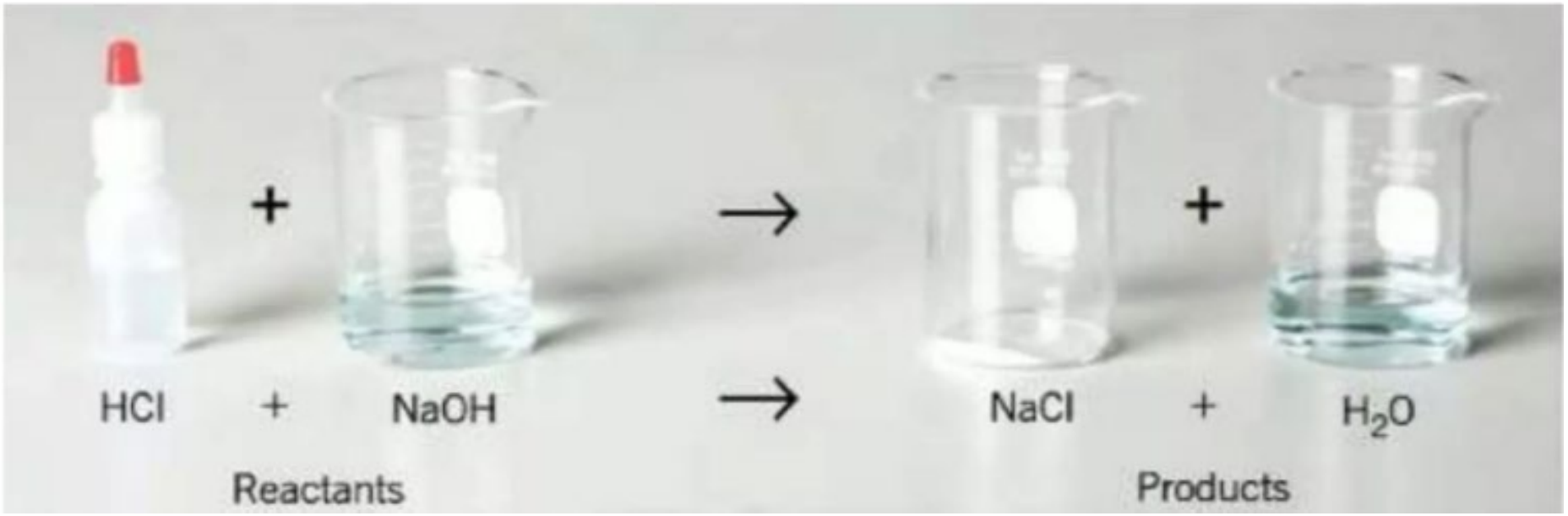
- The color of hydrangea flowers is dependent upon the pH of soil

Acid-Base Indicators

- It would be impossible to determine the pH of all solutions using just one indicator, such as litmus
- Several other acid-base indicators exist, each producing a color change at a specific pH level

Acids and Bases Neutralize Each Other

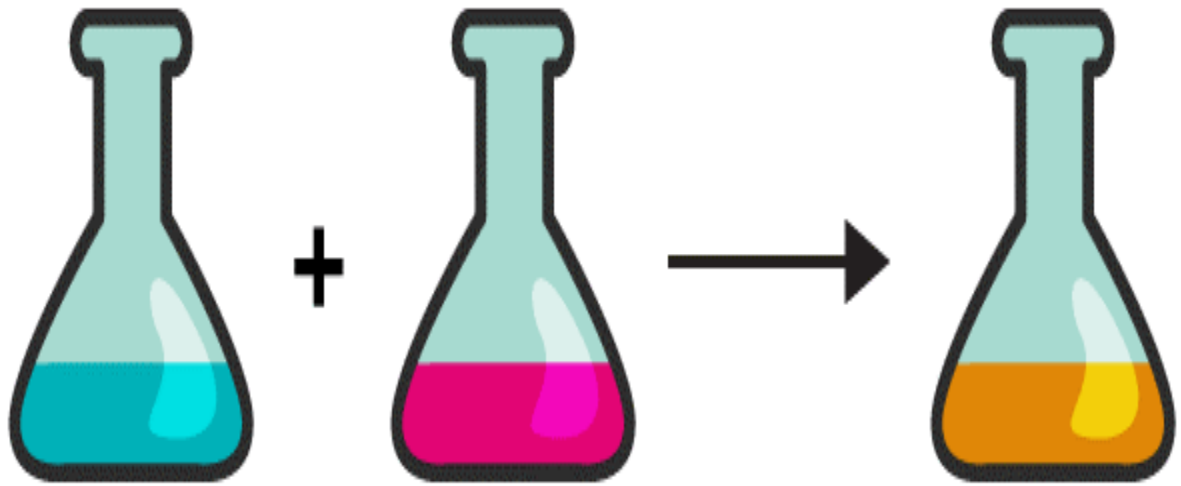
- When an acid and base react with each other, the characteristic properties of both are destroyed. This is called **neutralization.**



Acids and Bases Neutralize Each Other

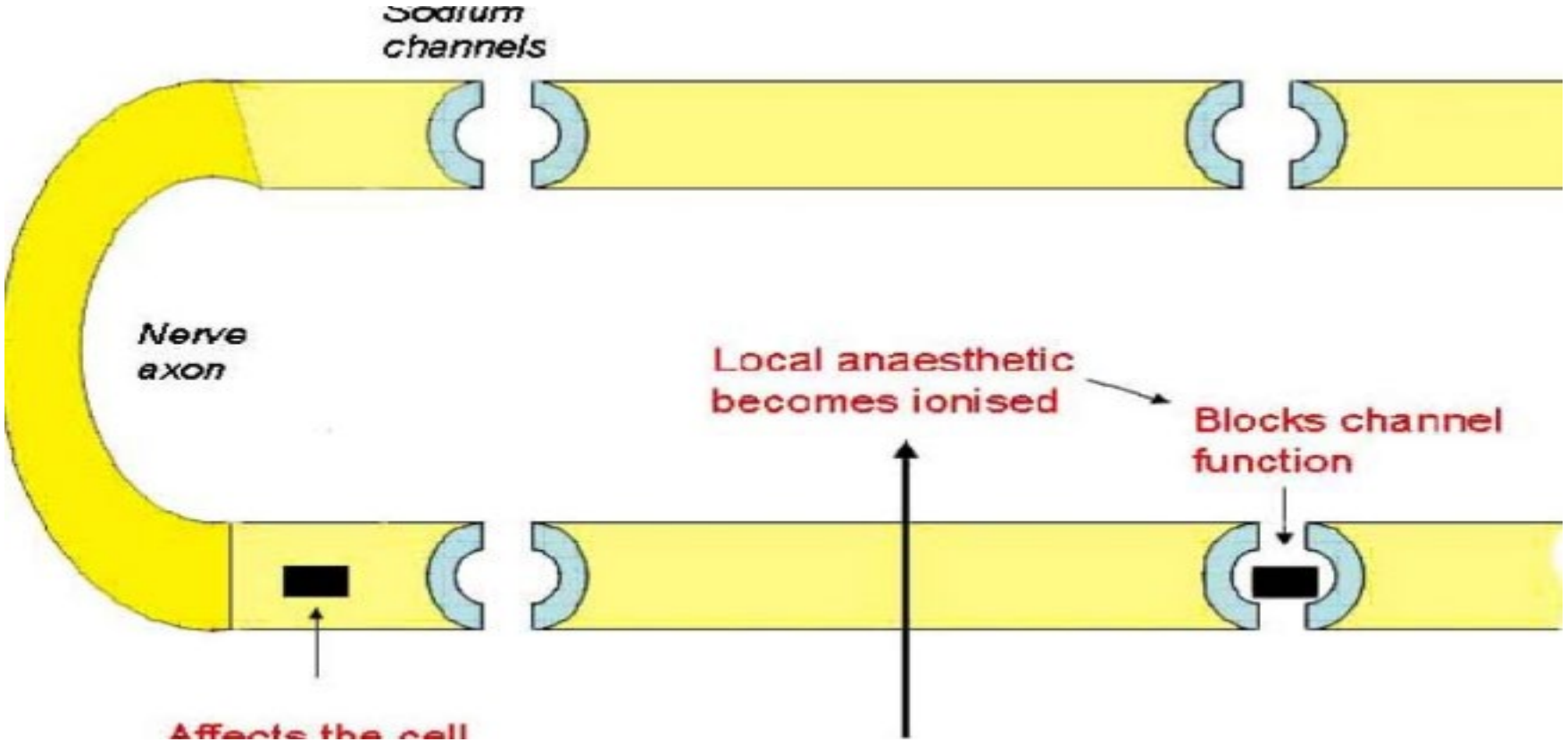
- The salts formed may be soluble in water or can be insoluble
- If the salt is insoluble, a precipitate will form
- Recall: a **precipitate** is a suspension of a small, solid particles formed during a chemical reaction

NEUTRALIZATION REACTION EQUATION

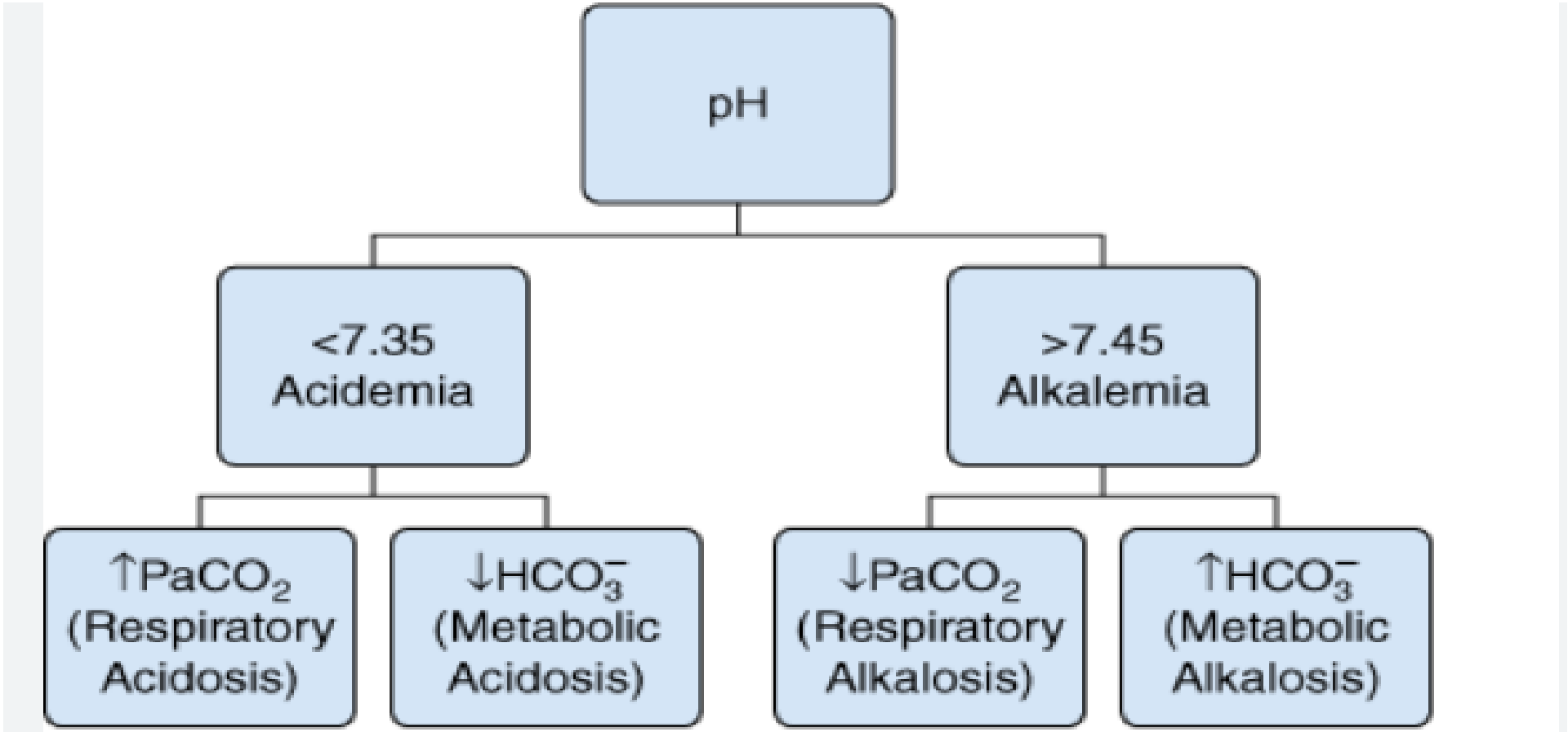


ACID + BASE ⟶ H^+OH^- + SALT

How Do Local Block Nerve Cells?



Acid & Bases in Blood Gases



Source: McKean S, Ross JJ, Dressler DD, Brotman DJ, Ginsberg JS: *Principles and Practice of Hospital Medicine*: www.accessmedicine.com

Blood Gases

Respiratory/Metabolic
Acidosis/Alkalosis

State the patient's disorder:

pH 7.38, PCO_2 49, HCO_3^- 34

pH 7.55, pCO_2 25, HCO_3^- 26

pH 7.31, pCO_2 49, HCO_3^- 23

pH 7.44, pCO_2 48, HCO_3^- 32

Blood Gas Compensation

Compensatory mechanisms

1. Chemical buffering-immediate

2. Respiratory compensation

Renal compensation

-more gradual

Acidosis & Alkalosis Physiological Effects

SYMPTOMS OF ACIDOSIS

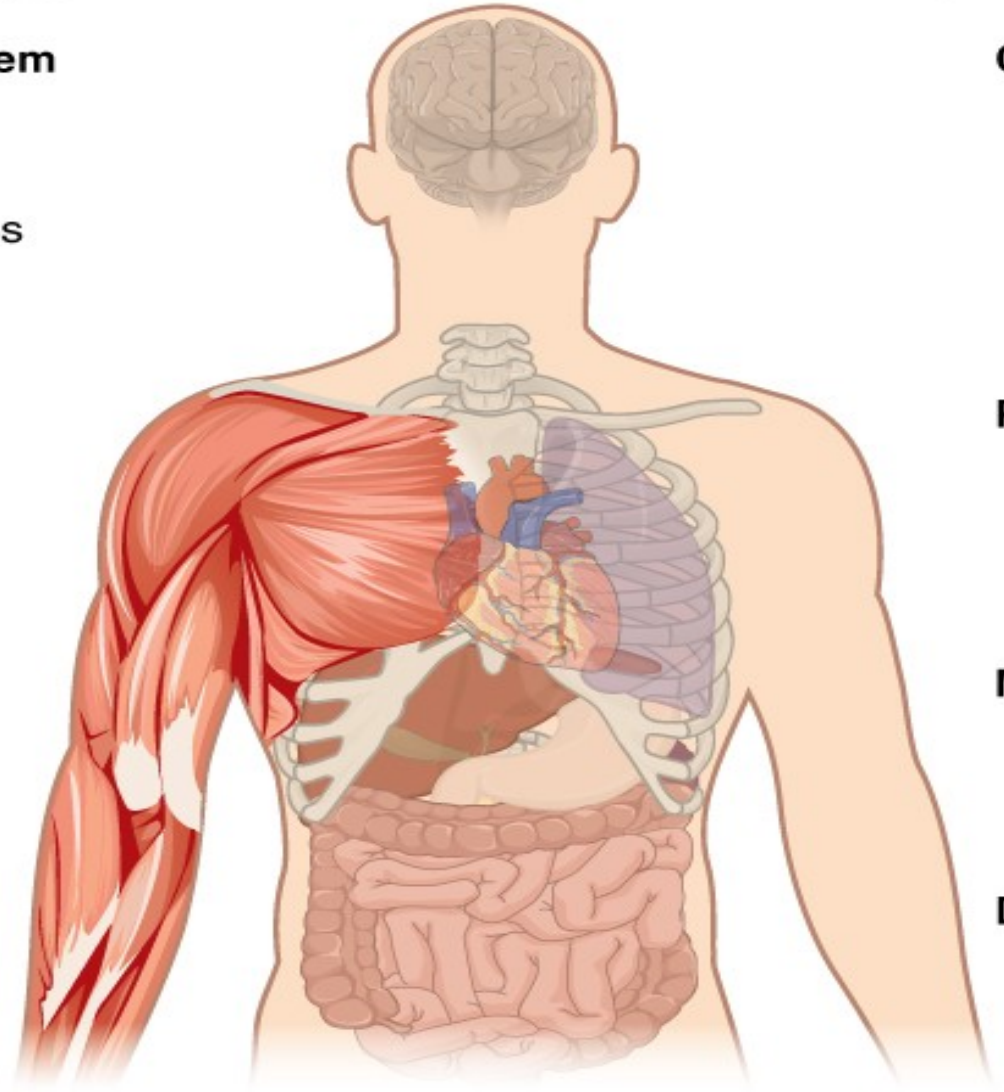
Central Nervous System
- Headache
- Sleepiness
- Confusion
- Loss of consciousness
- Coma

Respiratory System
- Shortness of breath
- Coughing

Heart
- Arrhythmia
- Increased heart rate

Muscular System
- Seizures
- Weakness

Digestive System
- Nausea
- Vomiting
- Diarrhea



SYMPTOMS OF ALKALOSIS

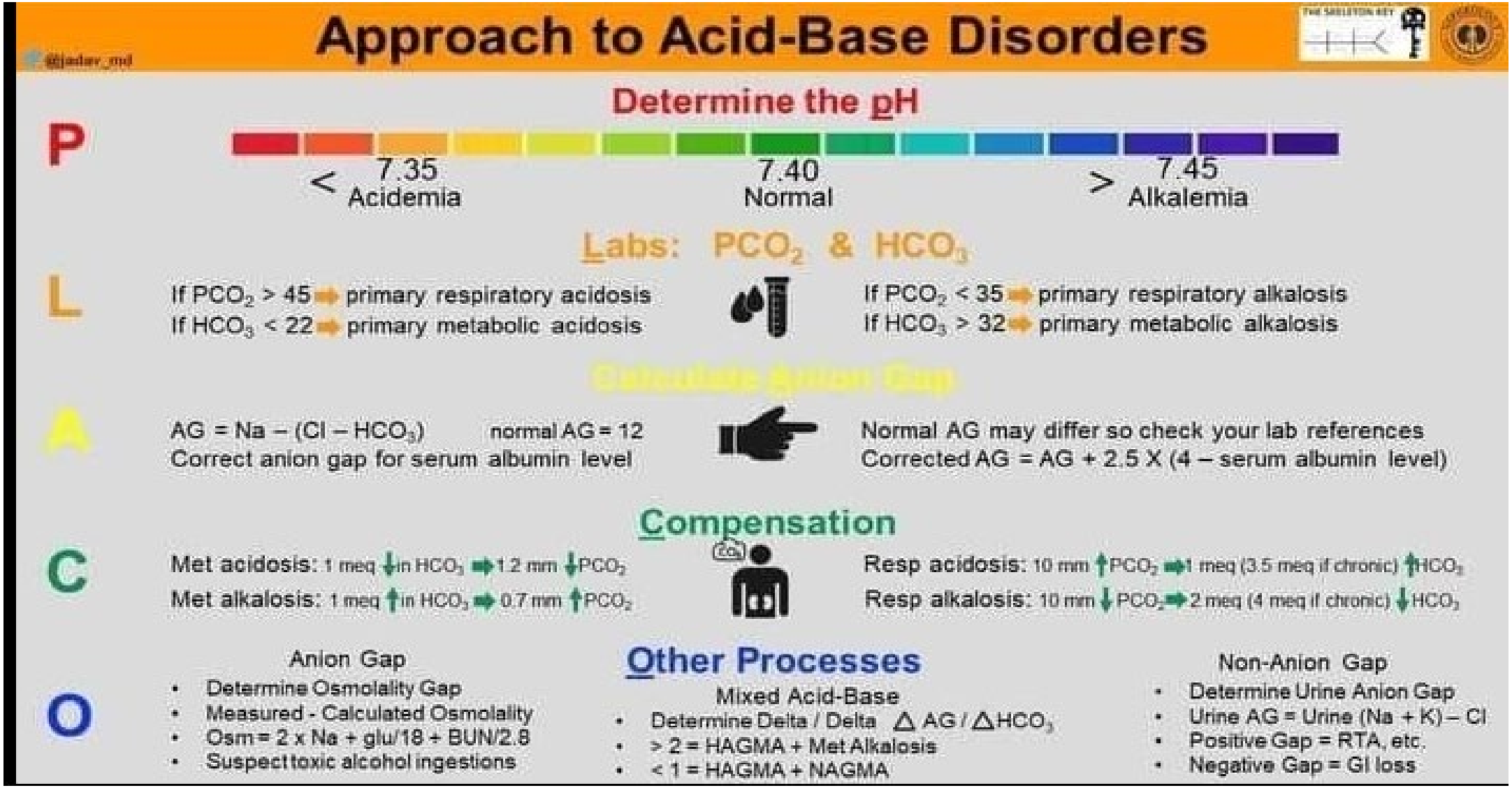
Central Nervous System
- Confusion
- Light-headedness
- Stupor
- Coma

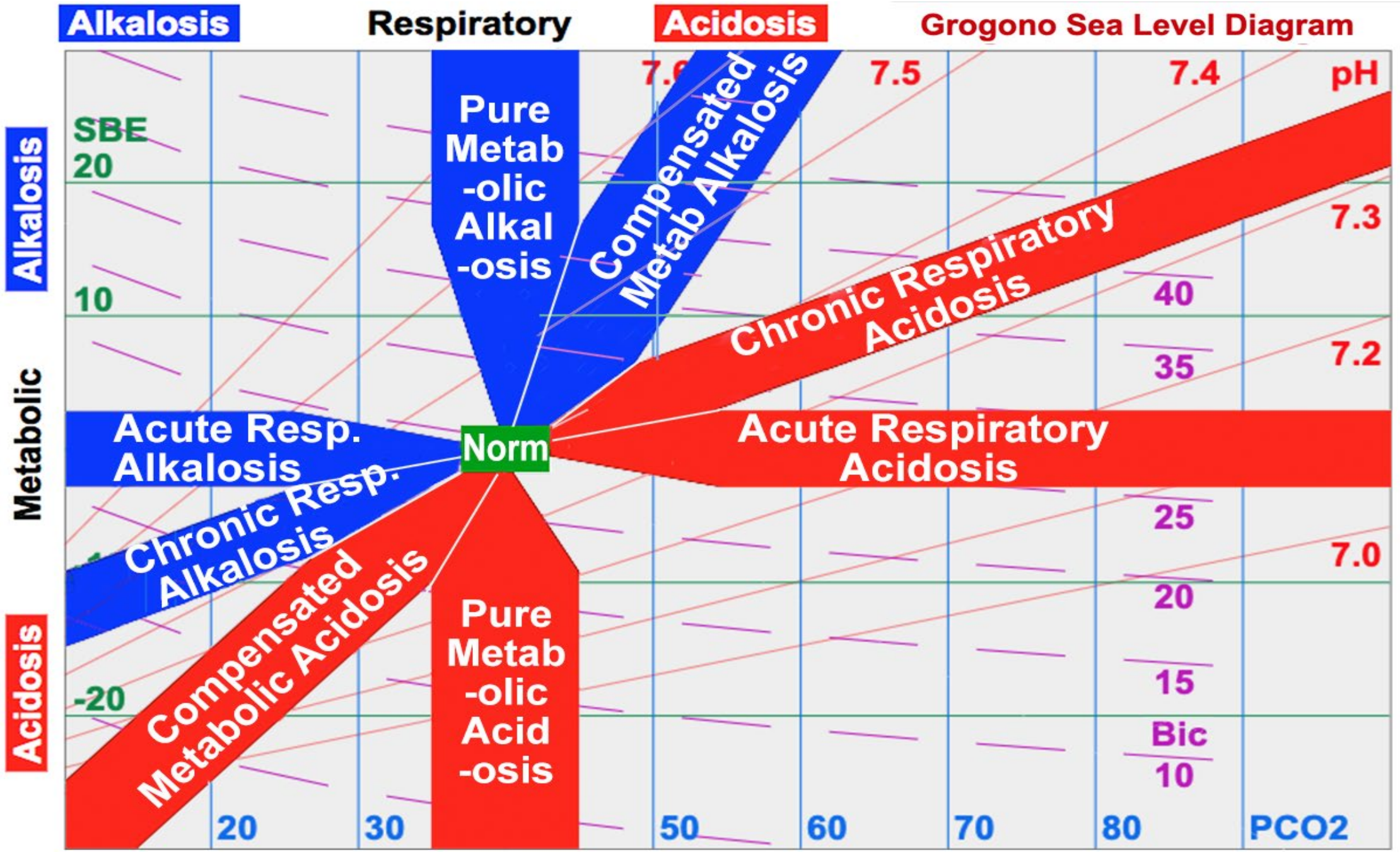
Peripheral Nervous System
- Hand tremor
- Numbness or tingling in the face, hands, or feet

Muscular System
- Twitching
- Prolonged spasms

Digestive System
- Nausea
- Vomiting

Blood Gases: Acid Base Dilemma




Alkalosis
Respiratory
Acidosis
Grogono Sea Level Diagram
Alkalosis
Metabolic
Acidosis
SBE
20
10
-20
Pure Metab -olic Alkal -osis
Compensated Metab Alkalosis
Chronic Respiratory Acidosis
Acute Resp. Alkalosis
Norm
Acute Respiratory Acidosis
Chronic Resp. Alkalosis
Compensated Metabolic Acidosis
Pure Metab -olic Acid -osis
7.5
7.4
pH
7.3
40
7.2
35
25
7.0
20
15
Bic
10
20
30
50
60
70
80
PCO2

Pka is the Ph in Which 50% of Drug Ionized & 50% Non Ionized

Weak

Strong

Bases	pK_a	Acids	pK_a
Diazepam	3.7	Salicylic Acid	3
Etomidate	4.1	Frusemide	3.9
Midazolam	6.15		
Alfentanil	6.5		
Ketamine	7.5	Thiopentone	7.6
Lignocaine	7.8	Methohexitone	7.9
Bupivacaine	8.2	Atropine	8.9
Fentanyl	8.4	Paracetamol	9.5
Morphine	8.6		
		Propofol	11

Strong

Weak

QUESTIONS?