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Respiratory Module

1st Year MBBS(SKL)

pH Meter

H.O.D
Department of Biochemistry
Rawalpindi Medical University
Rawalpindi

Presenter: Dr. Sana Latif
(Senior Demonstrator)

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Motto, Vision, Dream

- To impart evidence based research oriented medical education
- To provide best possible patient care
- To inculcate the values of mutual respect and ethical practice of medicine

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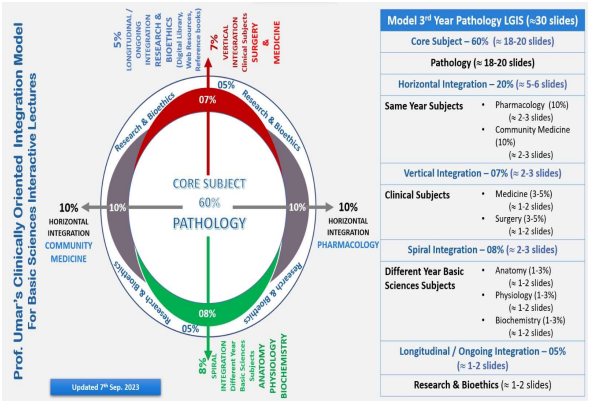
Professor Umar Model of Integrated Lecture



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Skill Lab Assessment

Question 1:

Which of the following is a characteristic finding in a patient with an anion gap metabolic acidosis?

A) Decreased bicarbonate level
B) Elevated $PaCO_2$
C) Decreased anion gap
D) Elevated serum lactate
E) Respiratory alkalosis

Question 2:

A patient with chronic kidney disease presents with a blood pH of 7.30 and an HCO_3^- of 18 mEq/L. Which type of acid-base disorder is most likely present?

A) Respiratory acidosis
B) Metabolic acidosis
C) Metabolic alkalosis
D) Respiratory alkalosis
E) Compensated respiratory acidosis

Question 3:

What is the primary respiratory compensatory mechanism in response to metabolic alkalosis?

A) Decreased ventilation
B) Increased ventilation
C) Increased tidal volume
D) Decreased bicarbonate excretion
E) Increased respiratory rate

Question 4:

Which of the following would likely lead to respiratory acidosis?

A) Hyperventilation
B) Asthma exacerbation
C) Excessive sweating
D) Administration of bicarbonate
E) Metabolic alkalosis

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Skill Lab Assessment

Question 5:

In a case of metabolic acidosis with a normal anion gap, which of the following is a likely cause?

A) Lactic acidosis
B) Diarrhea
C) Diabetic ketoacidosis
D) Renal failure
E) Salicylate toxicity

Question 6:

What does a pH meter primarily measure?

A. Enzyme concentration
B. Osmotic pressure
C. Electric conductivity
D. Hydrogen ion activity
E. Redox potential

Question 7:

The electrode commonly used in pH meters is made of:

A. Zinc
B. Mercury
C. Silver
D. Platinum
E. Glass

Question 8:

The reference electrode in a typical pH meter setup is usually a:

A. Calomel electrode
B. Silver electrode
C. Glass electrode
D. Carbon electrode
E. Platinum electrode

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Skill Lab Assessment

Question 9:

Before measuring a sample, a pH meter must be:

A. Recharged
B. Lubricated
C. Calibrated
D. Incubated
E. Disassembled

Question 10:

Which of the following will most likely cause inaccurate pH readings?

A. Use of distilled water
B. Using buffer solution
C. Dirty or damaged electrode
D. Using standard calibration
E. Measuring at room temperature

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Key

1. B
2. D
3. A
4. B
5. B
6. D
7. E
8. A
9. C
10. C

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Learning Objectives

At the end of the Skill Lab, students will be able to learn and explain:

1. The Normal Anatomy of the Body Buffer systems.
2. Physiology of the Acid Base Balance.
3. The Assembly of pH meter, its calibration, working and maintenance, applications and limitations.
4. Measurement of the pH of a Given Solution using the Ph meter.
5. Skill lab Assessment.
6. The Use of Digital Library.

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Core Knowledge

Definition of pH

- A unit of measure that measures the acidity or alkalinity of a solution using a logarithmic scale with seven as neutral, where lower values are more acidic, and higher ones are more alkaline, is known as pH.
- The pH equals negative log10 of the hydrogen ion concentration (c), given in moles per liter (c).

pH = -log10[H+]

where, [H+]= the solution's hydrogen ion concentration, expressed in moles per liter.

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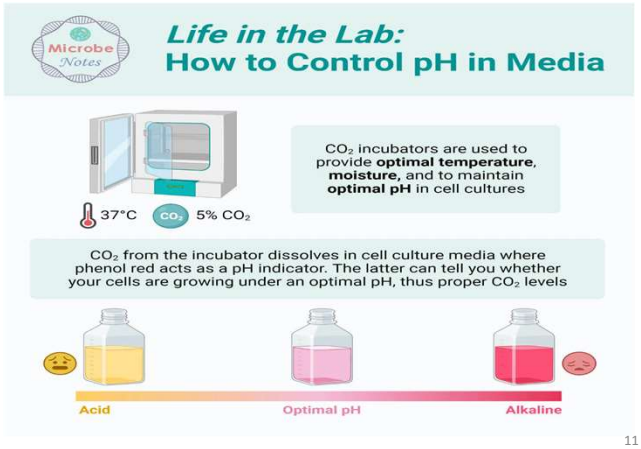
Core Knowledge



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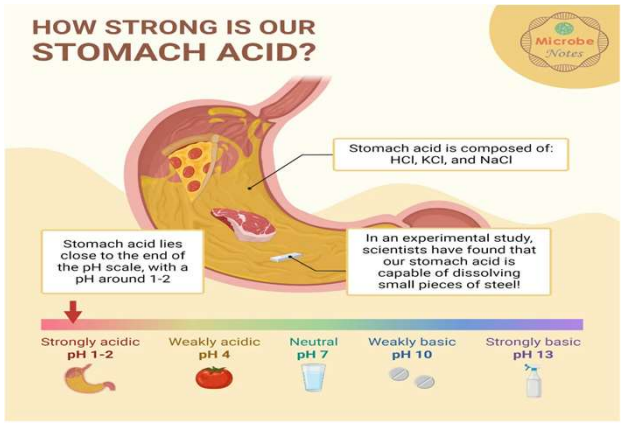
Core Knowledge



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Core Knowledge

pH Meter

A statistical tool that monitors the hydrogen-ion activity in water-based solutions, determining its acidity or alkalinity represented as pH.

1. It measures pH on a scale of 0 to 14. Where 7 is neutral value, <7 Acidic and >7 Alkaline, respectively.
2. It is also referred to as a "potentiometric pH meter" since it gauges the difference in electrical potential between a pH electrode and a reference electrode.

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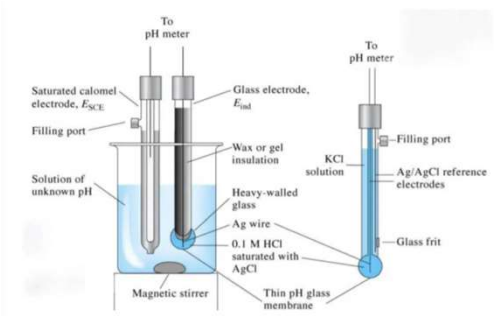
Core Knowledge

Parts of a pH meter



Parts of a pH meter

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Core Knowledge

Parts of a pH meter

1. A high input impedance meter

- the key component
- holds the microprocessor to process extremely small electrode voltages and to display measurements in pH units.
- The microchip reads the pH of the solution, calculates the measurement temperature, and translates the amplifier voltage value.

2. The combined electrode

- two electrodes, where the actual measurement takes place.
- the most expensive, sensitive, and consumable component of the meter and needs to be handled carefully.

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Core Knowledge

Parts of a pH meter Contd.

3. Amplifier

- a voltage amplifier.
- increases the accuracy of the pH reading
- To precisely measure the amount of acidity, basicity, and neutrality in a solution, this component ensures that the voltage count is in the pH range of 0–14.

4. Thermometer probe

- Some pH meters can measure the temperature of the solution being sampled.
- the temperature of the solution directly influences pH.
- This feature is termed "Automatic Temperature Compensation (ATC)".

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Core Knowledge

The Combined Electrode

Reference electrode:

- made up of a reference material (such as mercury, mercury chloride, and saturated solution of potassium chloride)
- submerged in a specific electrolyte which needs to be interacting with the measured solution most frequently through a porous ceramic junction.
- has a low electrical resistance due to a high ion concentration and adequate stability across a broad temperature range.
- It has a known and constant potential.

pH glass /Sensor / Indicator Electrode :

- a glass bulb sensitive to hydrogen ions
- when the relative concentration of hydrogen ions within and outside its bulb changes, so does the millivolt output.

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Core Knowledge

Calibration Of pH Meter

Materials :

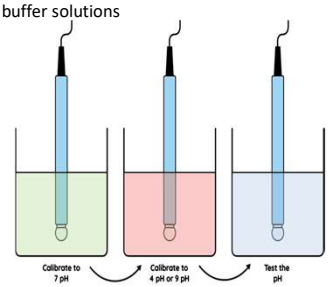
1.pH meter

2.Standard pH buffer solutions (typically pH 4.00, 7.00, and 10.00)

3.Clean beakers or containers for buffer solutions

4.Distilled or deionized water

5.Soft lint-free cloth or tissue



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Core Knowledge

Calibration Of pH Meter

Procedure

1.Preparation:
- Turn on the pH meter and allow it to warm up (if required).
- Rinse the electrode with distilled water and gently blot dry.

2.First Calibration Point:
- Immerse the electrode in the first calibration standard (e.g., pH 7.00).
- Allow the reading to stabilize. Adjust the meter to the standard value.
- Remove the electrode, rinse with distilled water, and blot dry.

3.Second Calibration Point:
- Immerse the electrode in the second calibration standard (e.g., pH 4.00 or pH 10.00).
- Allow the reading to stabilize and adjust to the standard value.
- Rinse and dry the electrode again.

4.Optional Third Point:
- For enhanced accuracy, repeat with a third standard, ensuring coverage across the expected pH range.

5.Final Check:
- After calibration, check the pH meter with a standard solution to verify accuracy.

6.Documentation:
- Record calibration results and date for future reference.

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Core Knowledge

Principle

- The working principle of the pH meter relies on the ions exchange from the sample solution to the inner solution (pH 7 buffer) of the glass electrode via the glass membrane.

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Core Knowledge

Procedure

1. Since pH readings rely on temperature, if measuring more than one sample, let all attain the same temperature i.e 25 C.
2. Uncover the sample beaker and prepare the sample.
3. Rinse the pH electrode with **deionized water** in a beaker labelled, waste beaker.
4. Rinse the pH electrode in the sample beaker, with the electrode tip and junction completely submerged in the sample.
5. Stir the sample moderately and uniformly.
6. Set the meter to begin taking a reading.
7. Record the pH and temperature of the sample after waiting at least 1 to 2 minutes for a stable reading in the sample.
8. Interpret the Result depending upon the pH value recorded.

- **If more samples are needed, repeat steps 3 through 6 again.**
- **For the most accurate sample measurements, submerge the electrode in each sample to the same depth.**
- **After measuring the samples, clean the electrode with deionized water and put it in a pH electrode storage solution.**

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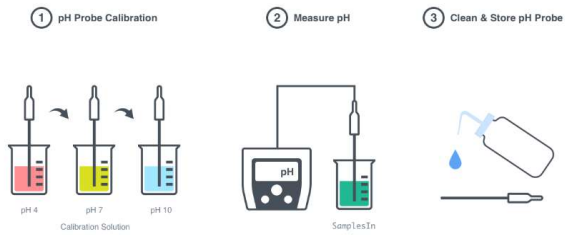
Core Knowledge

Procedure



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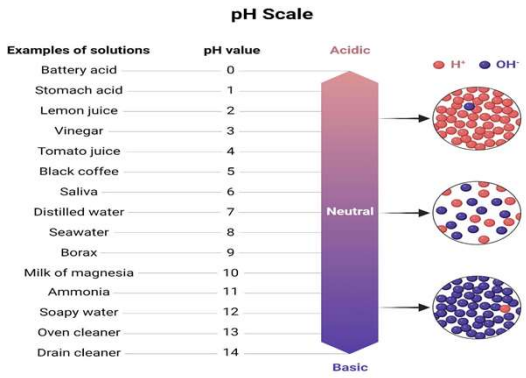
Core Knowledge

Result



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Core Knowledge

Precautions

1. pH electrodes are sensitive and fragile, so one should not use them as a glass rod to stir the solution while measuring pH.
2. pH meters should be calibrated daily before use with the help of standard buffer solutions.
3. pH readings are temperature sensitive, so pH meters shouldn't be exposed to sunlight.
4. All the test tubes and glass apparatus used in measurement should be cleaned with distilled water before use.
5. For each new sample, either use a brand-new fine dropper or glass rod or thoroughly wash the dropper or rod in water between uses.
6. All the solutions used in measurement should be freshly prepared.

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Core Knowledge

Applications of pH Meter

1. A pH meter is essential for assessing soil in the agricultural sector.
2. Monitoring pH level is essential in water treatment facilities and RO water purifiers.
3. Chemical industries use pH meters to neutralize wastewater from the steel, pulp, paper, pharmaceutical, biotech, and petrochemical industries.
4. A pH meter determines the pH value of chemical compounds and food products to ensure their quality and safety specially in context of dairy products.
5. To determine the type of biological conditions by measuring the pH of biological fluids such as blood, urine, gastric acid, etc.
6. Employed in detergent manufacturing.

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Core Knowledge

Advantages of pH Meter

1. Well-matched for continuous automatic recording and control of industrial and commercial processes
2. Permits rapid and reproducible measurements
3. Simple to control and operate.
4. Used for both oxidizing and reducing solutions
5. Does not affect the solution under examination.
6. Suitable for use in colloidal, turbid, and colorful solutions.
7. This device gives the most accurate and precise value of pH.
8. pH meters are portable, so they can be easily used everywhere while traveling.

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Core Knowledge

Limitations of pH Meter

1. pH meters should be regularly cleaned to avoid possible contamination of samples. When exposed to corrosive chemicals, the glass tip of the probe used in pH meters can easily break or get damaged.
2. External factors like temperature impact the output readings of the pH meter. Thus, pH meters must be calibrated before use to obtain accurate results unless our results may be distorted.
3. Deposits on electrode membranes can affect the processes.
4. A special buffer solution is needed to calibrate the pH meters.

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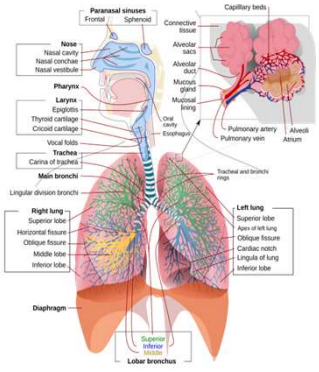
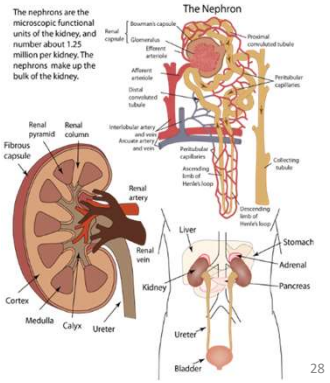
Horizontal Integration

Anatomy of the Body pH Regulatory Systems

Respiratory System



Renal System



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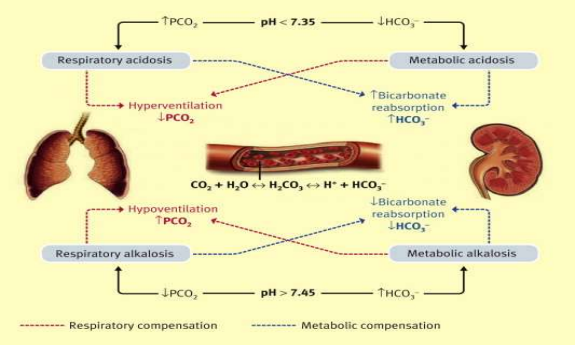
Horizontal Integration

Physiology of the Acid Base Balance



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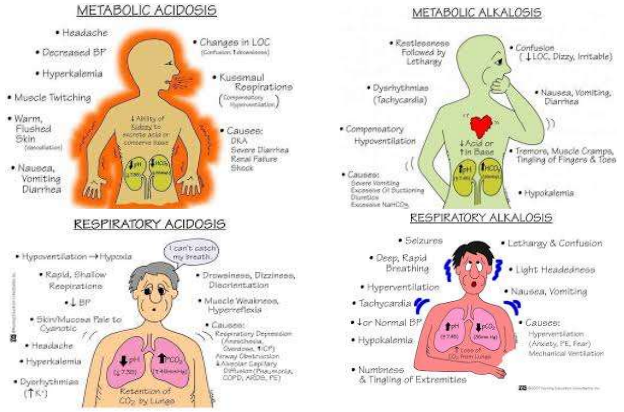
Vertical Integration

Acid Base Disorders



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Spiral Integration — Family Medicine

Management of Acid Base Disorders

Family Medicine plays important role in following manner:

- Diagnosis
- Education
- Dietary Guidance
- Monitoring
- Refer to Specialists

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Spiral Integration — Artificial Intelligence

Role of AI in Management

Artificial Intelligence plays role in following aspects:

- Personalized Nutrition
- Diagnostic Tools
- Food Recommendations
- Drug Development

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Spiral Integration | Research Article

Metabolic Acidosis

MacKenzie Burger; Derek J. Schaller.
Bookshelf
https://www.ncbi.nlm.nih.gov/

Objectives:

- Outline the causes of metabolic acidosis.
- Describe the presentation of a patient with metabolic acidosis.
- Summarize the treatment options for metabolic acidosis.
- Explain the importance of enhancing coordination amongst the interprofessional team to enhance the delivery of care to patients with metabolic acidosis.

Introduction:

Acid-base disorders, including metabolic acidosis, are disturbances in the homeostasis of plasma acidity. Any process that increases the serum hydrogen ion concentration is a distinct acidosis. The term acidemia is used to define the total acid-base status of the serum pH. For example, a patient can have multiple acidoses contributing to a net acidemia. Its origin classifies acidosis as either a respiratory acidosis which involves changes in carbon dioxide, or metabolic acidosis which is influenced by bicarbonate (HCO_3).

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Spiral Integration | Bioethics

Ethical Consideration

- Informed Consent
- Health care must allocate sources fairly, transparently and equitably
- Maintaining patient's confidentiality
- Research ethics

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How to use HEC Digital Library

Steps to Access HEC Digital Library

1. Go to the website of HEC National Digital Library http://www.digitallibrary.edu.pk
2. On Home Page, click on the INSTITUTES.
3. A page will appear showing the universities from Public and Private Sector and other Institutes which have access to HEC National Digital Library (HNDL).
4. Select your desired Institute.
5. A page will appear showing the resources of the institution
6. Journals and Researches will appear
7. You can find a Journal by clicking on JOURNALS AND DATABASE and enter a keyword to search for your desired journal.

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Learning Resources

- Journal of Practical Biochemistry volume II
- https://microbenotes.com/ph-meter-principle-parts-procedure-types-uses-examples/
- Google scholar
- Google images

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