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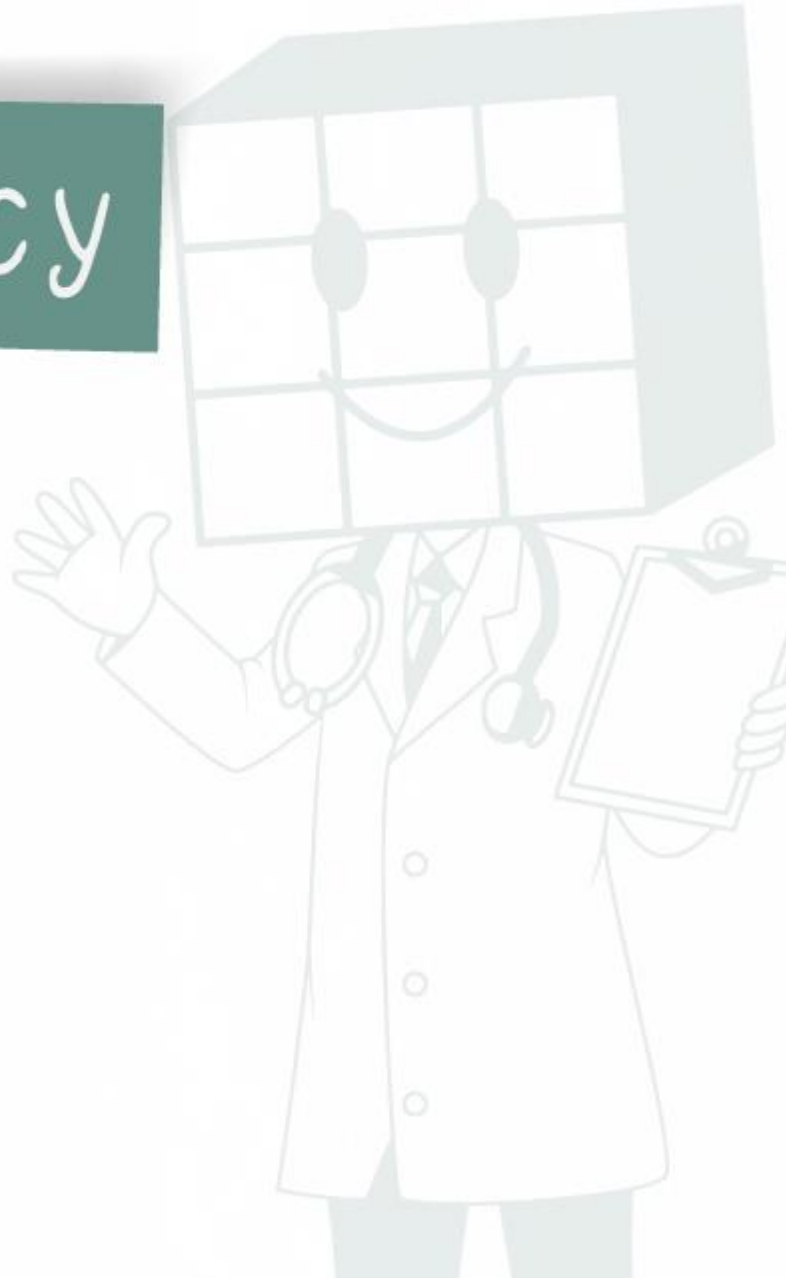
Physical Pharmacy

Buffers 4

PH

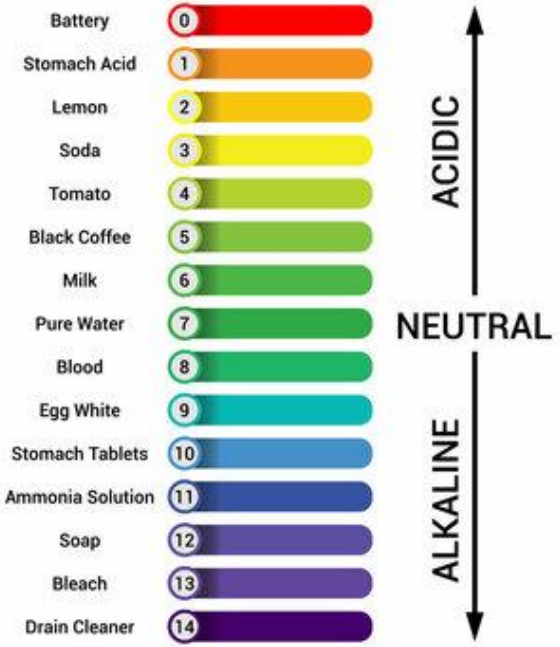


Buffers

Measurement of pH of a solution

1. **The colorimetric method for the determination of pH is:- By pH Indicators**

- Indicators may be considered as weak acids or weak bases that act like buffers and also exhibit color changes as their degree of dissociation varies with pH.



- **For example:**

1. Methyl red shows its full alkaline color, yellow, at a pH of about 6and its full acid color, red, at about pH 4. **(pH range 4.2-6.2)**

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Measurement of pH of a solution

2. Phenol red shows its full alkaline color, red, at a pH of about 8.4 and its full acid color, yellow , at about pH 6.8 **(pH range 6.8- 8.4)**

3. Phenolphthalein shows its full alkaline color, red, at a pH of about 10 and its full acid color, colorless , at about pH 8.3 **(pH range 8.3-10)**

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Ex :

If an acid - base titration experiments with pH change /range From

pH5 -pH7

Both phenol red and Phenolphthalein will remain in their acidic color
The best is methyl red

pH 9 – pH 11

Both methyl red and phenol red will remain in their basic color
The best is Phenolphthalein

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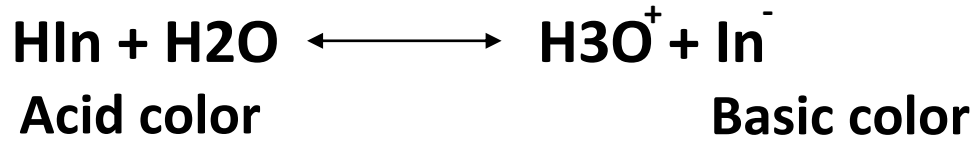
How Indicator work?

- **The dissociation of an acid indicator is given in simplified form as**



$$K\ In = \frac{[H3O^+][In^-]}{[HIn]}$$

- HIn is the un-ionized form of the indicator, which gives the acid color, and In- is the ionized form, which produces the basic color.

- KIn is referred to as the indicator constant.

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If an acid is added to a solution of the indicator

- The hydrogen ion concentration term on the right-hand side of equation is increased.
- To keep KIn constant, the ionization is decreased due to the common ion effect.
- Thus the indicator is predominantly in the form of HIn, the acid color.

$$\underset{\text{Acid color}}{HIn} + H_2O \longleftrightarrow \underset{\text{Basic color}}{H_3O^+ + In^-}$$

$$\underset{\text{Added acid}}{H_3O^+}$$

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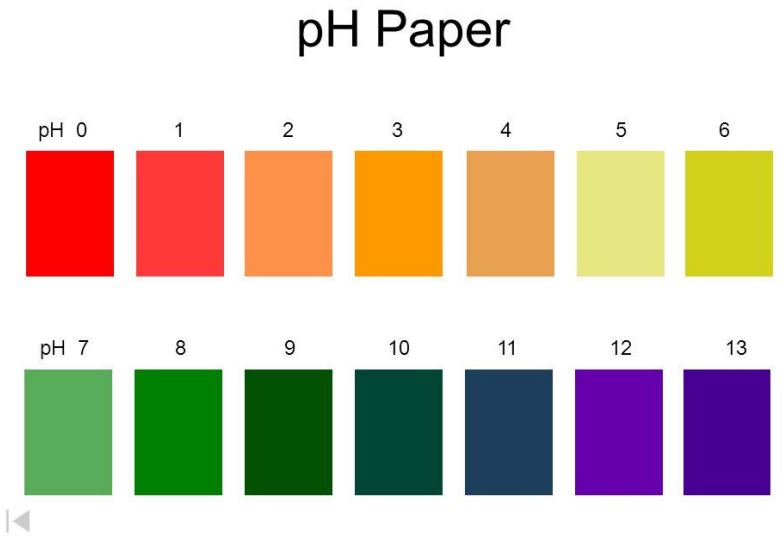
If an acid is added to a solution of the indicator

- So the addition of an acid leads to increase in [H3O+] that result in increase in Kin.
- To keep KIn constant the reaction should go back to the left, so we get acidic color



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If base is added :

- [H3O+] is reduced by reaction of the acid with the base, reaction proceeds to the right, yielding more ionized indicator In-, and the base color predominates

$$HIn + H_2O \longleftrightarrow H_3O^+ + In^-$$

Acid color — Basic color

$$OH^- + H_3O^+ \longrightarrow H_2O$$

Added base — From indicator

- The added will react with H_3O^+ (from indicator) results in decrease [H3O+]and decrease in KIn.

- To keep KIn constant , the reaction should go to the right , so we get the basic color

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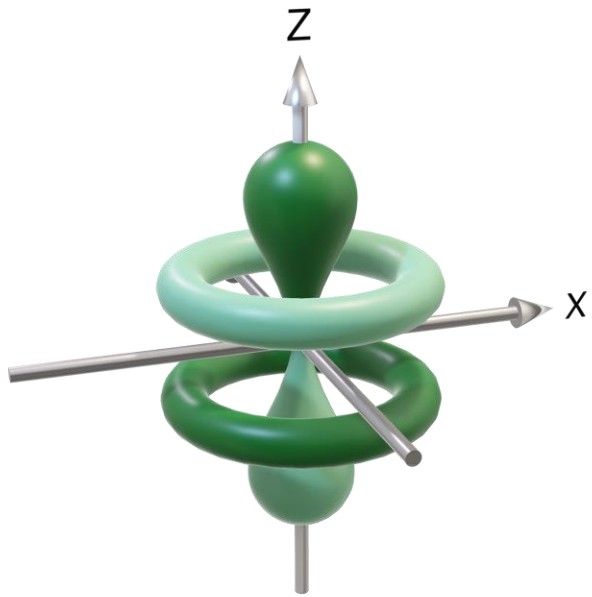
The advantages of the colorimetric method are:

1. Simple with low coast

The disadvantages of the colorimetric method are:-

1. Probably less accurate and less convenient than electrometric methods

2. It can be used in the determination of the pH of aqueous solutions that are not colored or turbid.



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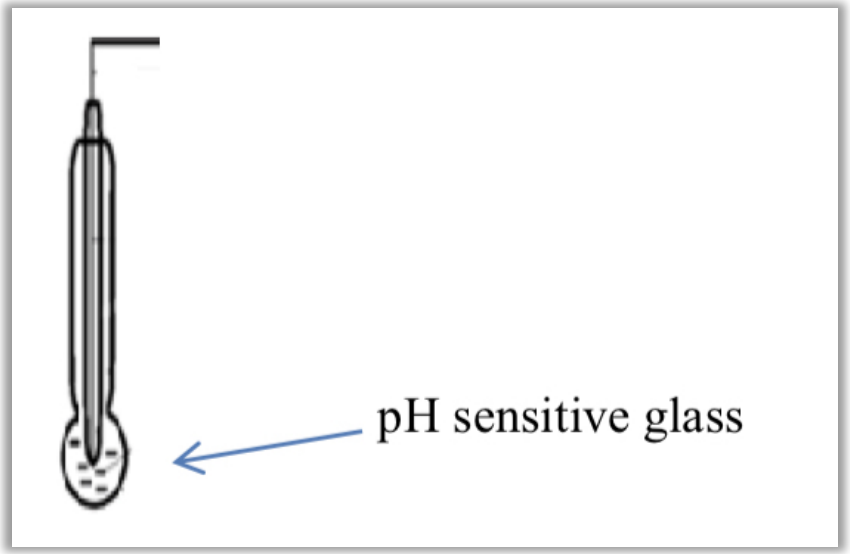
Measurement of pH of a solution

2. Electrometric methods

- This done by using pH-meter:- which is an instrument that measure the pH of the solution by immersing the pH sensitive electrode in the solution.



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Buffers

Buffers in Biologic Systems

- **Blood is maintained at a pH of about 7.4 by :-**

1. **Primary buffers in the plasma:**

   - The plasma contains carbonic acid/bicarbonate and acid/alkali sodium salts of phosphoric acid as buffers.

   - Plasma proteins, which behave as acids in blood, can combine with bases and so act as buffers.

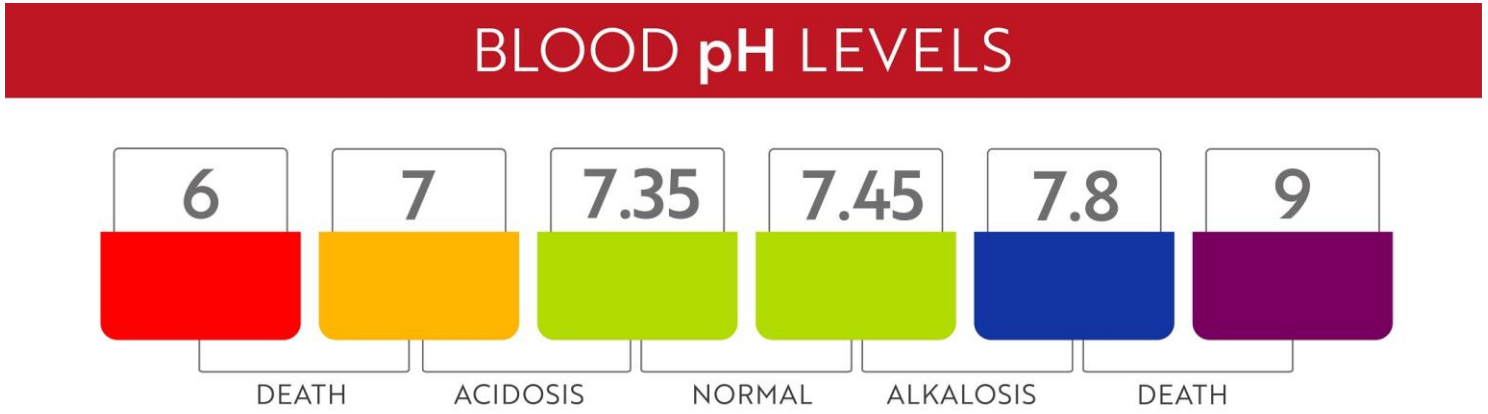
2. **Secondary buffers in the erythrocytes:**

   - In the erythrocytes, the two buffer systems consist of hemoglobin/oxyhemoglobin and acid/alkali potassium salts of phosphoric acid

Buffers

Buffers in Biologic Systems

- It is usually life-threatening for the pH of the blood to go below 6.9 or above 7.8
- The pH of the blood in diabetic coma is as low as about 6.8.



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Buffers in Biologic Systems

- **Lacrimal fluids :** or tears, have been found to have a great degree of buffer capacity, allowing a dilution of 1:15 with neutral distilled water before an alteration of pH
- The pH of tears is about 7.4, with a range of 7 to 8 or slightly higher.
- It is generally thought that eye drops within a pH range of 4 to 10 will not harm the cornea.
- However, discomfort and a flow of tears will occur below pH 6.6 and above pH 9.0 noticed

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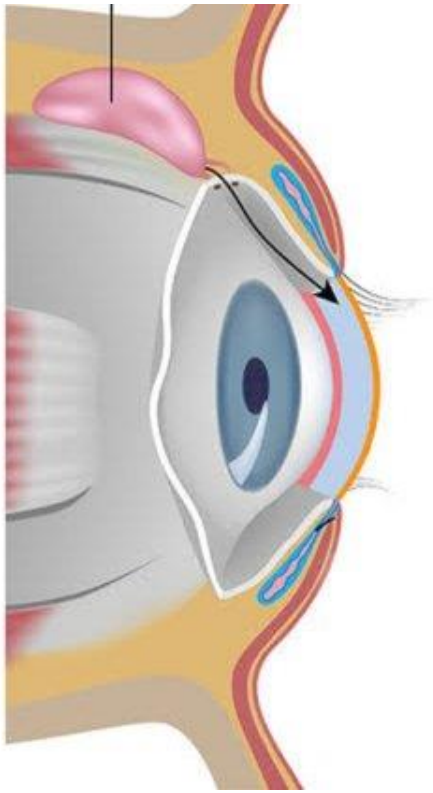
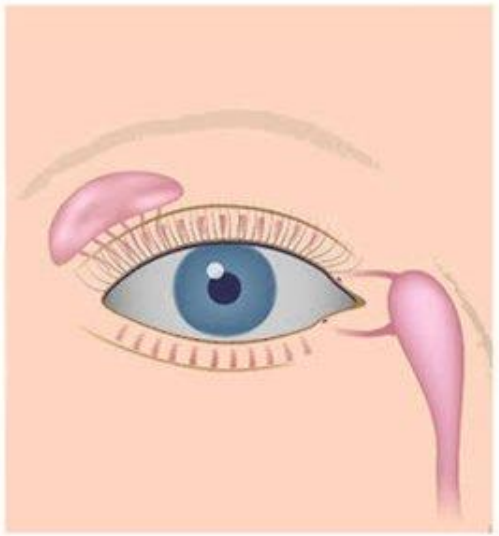
Buffers in Biologic Systems





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Influence of Buffer Capacity and pH on Tissue Irritation

- Solutions to be applied to tissues or administered parenterally are liable to cause irritation if their pH is greatly different from the normal pH of the relevant body fluid.

- Consequently, the pharmacist must consider this point when formulating ophthalmic solutions, parenteral products, and fluids to be applied to abraded surfaces.

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The most important points that should be taken in formulation:-

1. Buffer capacity of the solution to be used and the buffer capacity of the body fluid.

2. The volume to be used in relation to the volume of body fluid with which the buffered solution will come in contact

Tissue irritation will be minimal:-

a. The lower is the buffer capacity of the solution
b. The smaller is the volume used for a given concentration
c. The larger are the volume and buffer capacity of the physiologic fluid.

Buffers

1. For eye solutions

- The pH of solutions for introduction into the eye may vary from 4.0 to 10 without marked pain or damage.

- This statement evidently would be true only if the buffer capacity were kept low.

- **For example**

  a) **Sörensen's phosphate buffer produced irritation in the eyes of a number of individuals when used outside the narrow pH range of 6.5 to 8,**

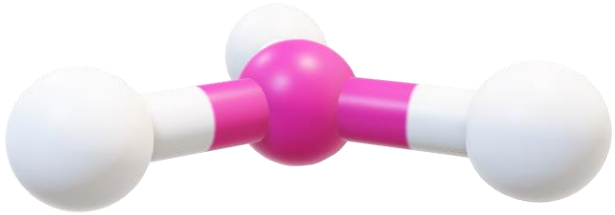
  b) **whereas a Boric acid solution of pH 5 produced no discomfort in the eyes of the same individuals.**

Buffers

1. For eye solutions

- So it is concluded that a pH range of nonirritation cannot be established absolutely but instead depends upon the buffer employed.

- In light of the previous discussion, this can be explained partly in terms of the low buffer capacity of boric acid as compared with that of the phosphate buffer and partly to the difference of the physiologic response to various ion species



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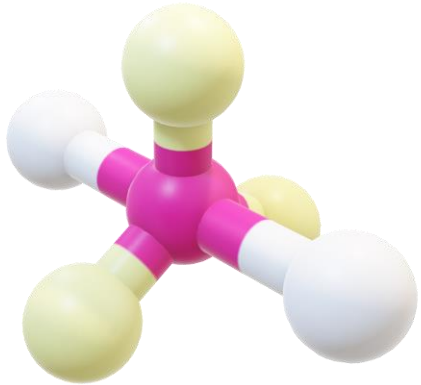
2. Parenteral solutions for injection into the blood

- They are usually not buffered, or they are buffered to a low capacity so that the buffers of the blood may readily bring them within the physiologic pH range.

- If the drugs are to be injected only in small quantities and at a slow rate, their solutions can be buffered weakly to maintain approximate neutrality.



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Thank You !

https://t.me/Dr_Cube