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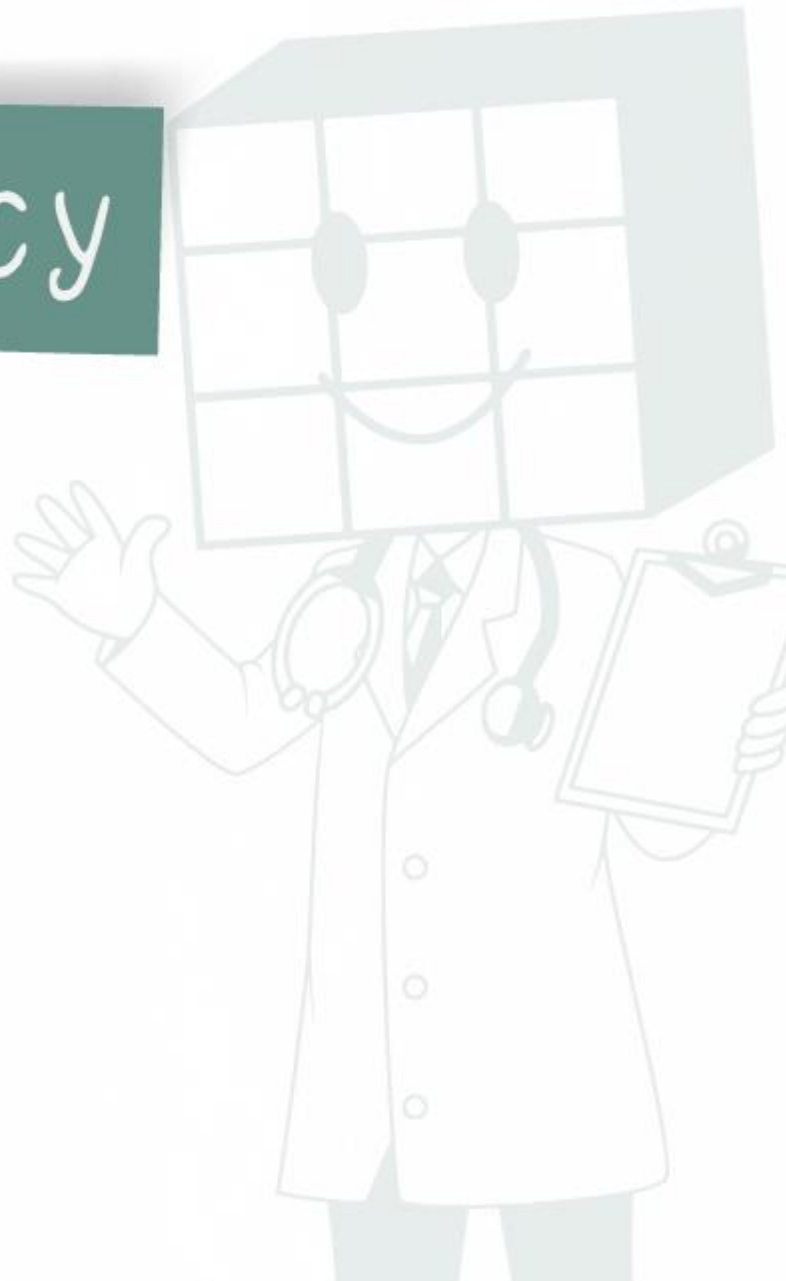
Physical Pharmacy

Buffers 3

PH



Buffers

General Procedures for Preparing Pharmaceutical Buffer Solutions

- The pharmacist may be called upon at times to prepare buffer systems for which the formulas do not appear in the literature.

- The following steps should be helpful in the development of a new buffer.

1. Select a weak acid having a pKa approximately equal to the pH at which the buffer is to be used

- This will ensure maximum buffer capacity.

2. From the buffer equation, calculate the ratio of salt and weak acid required to obtain the desired pH

- The buffer equation is satisfactory for approximate calculations within the pH range of 4 to 10

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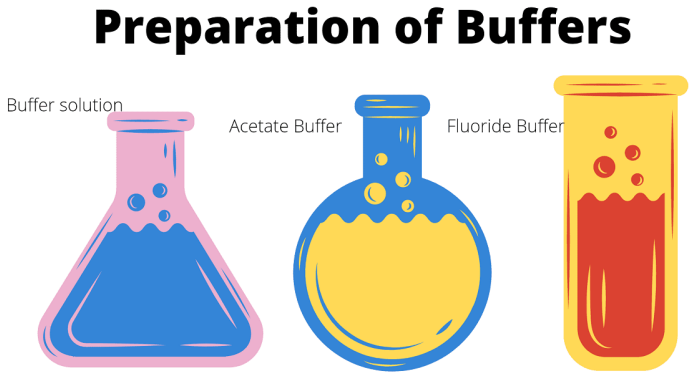
General Procedures for Preparing Pharmaceutical Buffer Solutions

3. Consider the individual concentrations of the buffer salt and acid needed to obtain a suitable buffer capacity.

- A concentration of 0.05 to 0.5 M is usually sufficient, and a buffer capacity of 0.01 to 0.1 is generally adequate.

- Finally, determine the pH and buffer capacity of the completed buffered solution using a reliable pH meter



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Buffers

General Procedures for Preparing Pharmaceutical Buffer Solutions

- Other factors of some importance in the choice of a pharmaceutical buffer include availability of chemicals, sterility of the final solution, stability of the drug and buffer on aging, cost of materials, and freedom from toxicity.

- **For example:** a borate buffer, because of its toxic effects, certainly cannot be used to stabilize a solution to be administered orally or parenterally.

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Example 1

You are asked to prepare a buffer solution of pH 4 having a buffer capacity of 0.1 and you have the following materials in your lab.

Materils	Ka of the acid	pKa of the acid
1. Acetic acid/Sodium acetate	1.75×10^{-5}	4.76
2. Lactic acid/Sodium lactate	1.39×10^{-4}	3.86
3. Tartaric acid/Sodium tartarate	9.60×10^{-4}	3.02

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Buffers

Example 1

A. Which combination do you prefer and why?
B. What will be the total buffer concentration?
C. What will be the concentration of each constituent?
D. Calculate the maximum buffer capacity

Solution

The steps in the solution of the problem are as follows:

1. Choose a weak acid having a pKa close to the pH desired.
2. Calculate the ratio of salt and acid required to produce a pH of 4.
3. Use the buffer capacity equation to obtain the total buffer concentration,C = [Salt] + [Acid]:
4. Finally calculate [Salt] & [Acid]

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Example 1

Solution

A/ We choose Lactic acid / Sodium lactate because its pKa≈ the required pH to get maximum buffer capacity

B/ $pH = pKa + \log [salt] / [acid]$

$4 = 3.86 + \log [salt] / [acid]$

$4 - 3.86 = \log [salt] / [acid]$

$0.14 = \log [salt] / [acid]$

$[salt] / [acid] = 1.38$

Therefore; $[salt] = 1.38\ [acid]$

$\beta = 2.3\ C\ Ka\ [H_3O^+] / (Ka + [H_3O^+])^2$

$0.1 = 2.3\ C\ 1.39 \times 10^{-4} [1 \times 10^{-4}] / (1.39 \times 10^{-4} + [1 \times 10^{-4}])^2$

$0.1 = 2.3\ C\ 1.39 \times 10^{-8} / (2.39 \times 10^{-4})^2$

$0.1 = 2.3\ C\ 1.39 \times 10^{-8} / 5.712 \times 10^{-8}$

$0.1 = 2.3\ C \times 0.243$

$0.1 = 0.559\ C$

$C = 0.179M$

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Example 1

Solution

C/ C= [salt] +[acid]

Since, salt = 1.38 [acid]

Therefore; C= 1.38 [acid] +[acid]

0.179 = 2.38 [acid]

[acid]= 0.075 M

So [salt]= 1.38 x 0.075

≈ 0.104M

OR

[salt]= C - [acid]

= 0.179 – 0.075

= 0.104M

D/ β_{max}= 0.576 C

= 0.576 x 0.179

= 0.103

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Note

- The same above example may be asked as follow
- A buffer solution consisting of lactic acid and its salt was prepared with [salt]/[acid] = 1.38 and the total concentration of its constituent is 0.179 M.
- If you know that the pka of lactic acid is 3.86
- **Calculate :**
  A/ The pH of this buffer

  B/ The concentration of each constituent

  C/ Maximum buffer capacity

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Note

- **OR it may be asked as follow :**

- It is required to prepare a buffer solution consisting of 0.075M lactic acid and 0.104M sodium lactate If you know that the pka of lactic acid is 3.86 .

- **Calculate**

A/ The pH of this buffer

B/ Maximum buffer capacity

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Example 2

It is required to prepare citric acid/sodium citrate buffer with maximum buffer capacity, If you know that the pKa of citric acid = 3.15 ($Ka=7 \times 10^{-4}$) and the total concentration of the buffer constituents = 0.08. Answer the followings:-

A/What will be the ratio of its salt/ acid? And what will be the concentration of each?

B/ What will be the pH of this buffer?

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Example 2

Solution

(As mentioned in the last lecture)

A/ Since we want to prepare a buffer with maximum buffer capacity,
So the salt/ acid should equal to 1 and [salt] = [acid]
Since the total concentration is 0.08
Therefore, 0.08/ 2 = 0.04 M is the concentration of each constituent

B/ For buffer with maximum buffer capacity pH= pKa
So the pH of this buffer = 3.15

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Example 9-7

You are asked to prepare a buffer solution of pH 5.00 having a capacity of 0.02.You have the following materials in your lab.

Materils	Ka of the acid	pKa of the acid
1. Benzoic acid/Sodium benzoate	6.30×10^{-5}	4.2
2. Acetic acid/Sodium acetate	1.75×10^{-5}	4.76
3. Formic acid/Sodium formate	1.77×10^{-4}	3.75

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Example 9-7

A/ Which combination do you prefer and why?

B/ What will be the total buffer concentration?

C/ What will be the concentration of each constituent?

D/ Calculate the maximum buffer capacity

Solution

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Example 9-7

Solution

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Thank You !

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