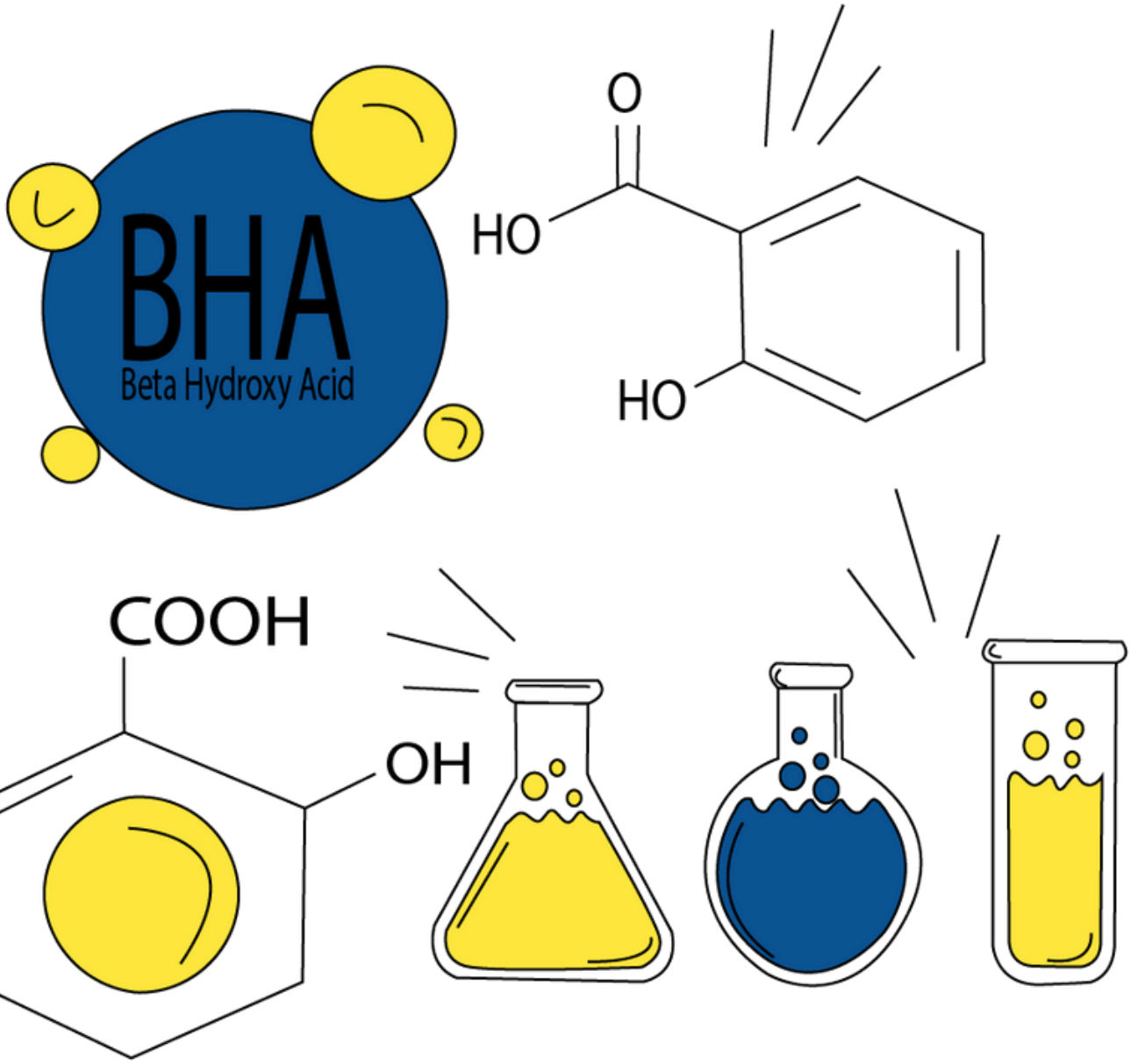
PreMed.PK

CARBOXYLIC ACIDS



SINDH BOARD

SINDH BOARD TOPPER PERSPECTIVE

INTRODUCTION

- This chapter is important for both MDCAT and FSC as a lot of questions are asked in the Organic section. This chapter comprises high-yield topics. This Guide has important points that you must cover, to ace your exam.

1. HOW TO APPROACH THE TEXTBOOK?

1- Basic chapter:

This chapter is mainly based on theoretical questions and basic definitions.

2- Watch YouTube videos:

I would suggest watching videos for the entire organic chemistry to have a solid understanding of the concepts and then practice questions to check how much information you have retained.

3- Practice Questions:

This chapter can be covered by practicing past paper questions and a thorough reading of the book.

2. CHAPTER CONTENT

9.1 Physical Properties:

9.1.1 Color and odor:

- Aliphatic monocarboxylic acids are generally colorless.
- They have a pungent odor.

9.1. 2- Solubility:

- Carboxylic acids are soluble in polar solvents such as water and alcohol due to their ability to form hydrogen bonds with these solvents.

9.1. 3- Boiling Points:

- Carboxylic Acids have a high tendency to form hydrogen bonds among themselves. As a result, carboxylic acids generally have higher boiling points.

9.2 Structure of Carboxylic Acids:

- The carbonyl carbon is sp2 hybridized, possessing three sp2 hybrid orbitals and one pz2 unhybridized orbital.
- These three sp2 hybrid orbitals are oriented at an angle of 120° to give trigonal geometry.

9.3 Acidity of Carboxylic Acids:

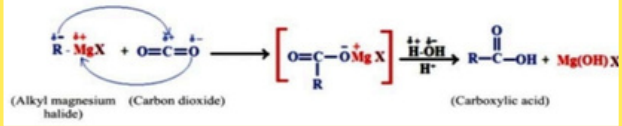
- Carboxylic Acids are considerably stronger acids than alcohols, Phenols, and water.
- However, they are weaker acids compared to mineral acids.

Comparative acid strength of carboxylic acid with alcohol, phenol and water

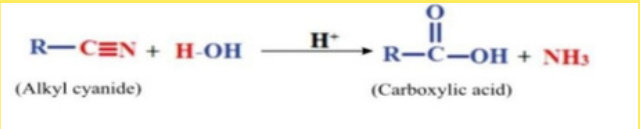
Name of Compound	Molecular Formula	pKa Value
Acetic acid	CH_3COOH	5
Phenol	C_6H_5OH	10
Ethyl alcohol	C_2H_5OH	16
Water	H_2O	15.7

9.4 Preparation of Carboxylic Acids and their derivatives:

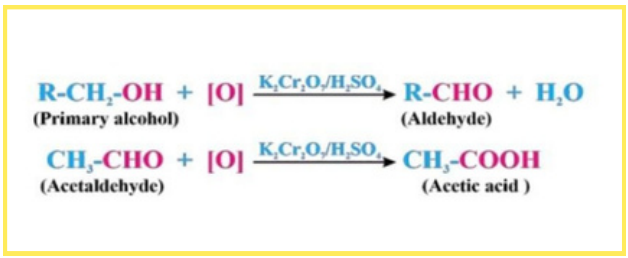
9.4.1 By the Carbonation of Grignard's Reagent:



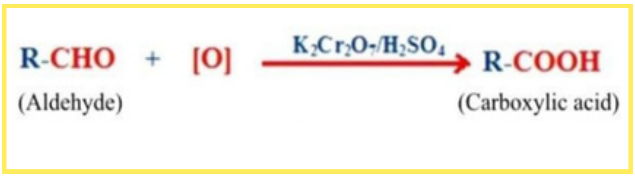
9.4.2 By the Hydrolysis of Nitriles:



9.4.3 By the Oxidation of Primary Alcohols:



9.4.4 By the Oxidation of Aldehyde:



9.4.5 By the Oxidation of Alkyl Benzene:

9.5 Reactions of Carboxylic Acids and their derivatives:

1- Esters:

- They are formed by replacing the hydroxyl group of carboxylic acid with an alkyl or aryl group.

2- Acid Halides:

- They are formed by replacing the hydroxyl group of the carboxylic acid with a halogen atom.

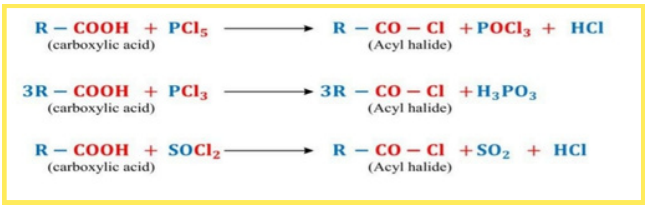
3- Amides:

- They are formed by replacing the hydroxyl group of a carboxylic acid with an amino group.

4- Anhydrides:

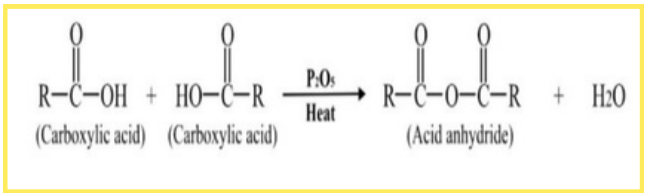
- They are formed by removing a water molecule from two carboxylic acid molecules.

9.5.1 Conversion of Carboxylic Acids into Acyl Halides:



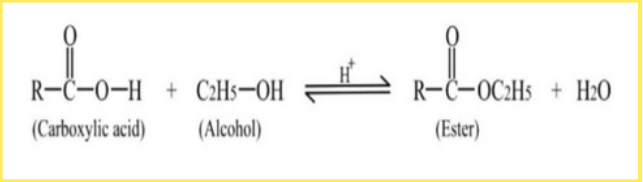
9.5.2 Conversion of Carboxylic Acids into Acid Anhydrides:

- The formation of an Acid Anhydride involves a condensation reaction between two carboxylic acid molecules.

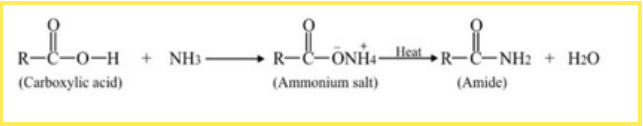


9.5.3 Conversion of Carboxylic Acids into Ester:

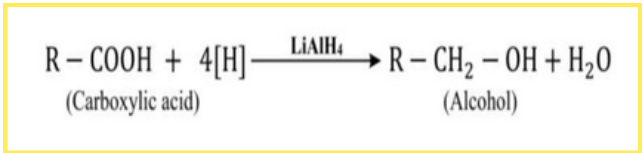
- Esters are produced from carboxylic acids through a reaction called esterification.



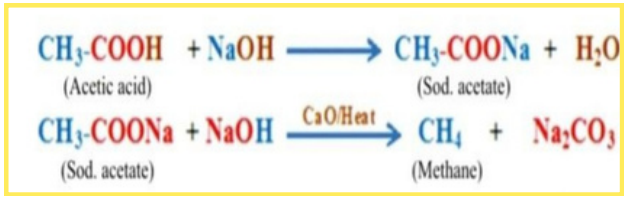
9.5.4 Conversion of Carboxylic Acids into Amides:



9.5.5 Conversion of Carboxylic Acids into Alcohols:



9.5.6 Conversion of Carboxylic Acids into Alkane:



- Uses of Some Common Carboxylic Acids and their Derivatives:

1- Citric Acid (C6H8O7):

- It is used as a preservative
- It is also used as a flavor enhancer.
- It acts as an acidity regulator.

2- Malic Acid (C4H6O5):

- It is used as a food additive.
- Also used as a pH control agent.

3- Tartaric Acid (C4H6O6):

- It is commonly used in the food and beverage industry.

4- Acetic Acid (CH3COOH):

- It is used as a preservative and as a raw material for various chemicals.

5- Salicylic Acid (HOC6H4COOH):

- It is used in the preparation of skin care products.
- Also used in the production of aspirin.

6- Benzoic Acid (C6H5COOH):

- It is used in the preparation of dyes, perfumes, and plastics.

7- Acetamide (CH3CONH2):

- It is used as raw material in pharmaceuticals and drug synthesis.

8- Acetic Anhydride (C4H6O3):

- It is used in making cellulose acetate and in the manufacturing of dyes.

Comparative acid strength of carboxylic acid with alcohol, phenol and water

Common name	Structure	Occurrence and derivation of name	Application
Formic acid	HCOOH	Ants (Latin; Formica)	Preservative and antibacterial agent in Livestock feed
Acetic acid	CH_3COOH	Vinegar (Latin; Acetum)	Vinegar production, food preservative and flavoring agent
Propionic acid	CH_3CH_3COOH	Milk, butter and cheese (Greek protos, First; pion, fast)	Animal feed additive for preventing mold growth
Butyric acid	$CH_3(CH_2)_2COOH$	Butter Latin; Butyrum)	Flavoring agent in food products
Valeric acid	$CH_3(CH_2)_3COOH$	Valerian root (Latin; valere, to be strong)	Manufacture of valerate esters used in perfumes
Caproic acid	$CH_3(CH_3)_4COOH$	Goat (Latin, caper)	Pharmaccuticals and plasterizers

6. IMPORTANT TABLES:

Comparative acid strength of carboxylic acid with alcohol, phenol and water

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Caproic acid	$CH_3(CH_3)_4COOH$	Goat (Latin, caper)	Pharmaccuticals and plasterizers

7 .SAMPLE MCQS:

Q. An ester is prepared by the reaction of:

- ○ Two alcohols
- ✓ Carboxylic acid and alcohol
- ○ ketone and alcohol
- ○ Aldehyde and alcohol
- ○ All of these

Explanation:

- When a carboxylic acid is treated with an alcohol and an acid catalyst, an ester s formed (along with water):

Q. Hydrolysis of acyl chloride results in the formation of:

- ○ Acidic anhydide
- ✓ Carboxylic acid
- ○ Amides
- ○ Esters

Explanation:

- Aqueous acid chlorides is a very acidic solution due to formation of a mixture of strong acid and a weak acid. This hydrolysis reaction is an elimination reaction and water is participated as a reagent. This reaction completely converts acid chloride to a carboxylic acid and HCl (Hydrochloric acid).

Q. Which of these in an aqueous solution of equal concentration has the lowest PH?

- ✓ Choloroethanoic acid
- ○ Ethanoic acid
- ○ Ethylamine
- ○ Phenol

Explanation:

- Chloroethanoic acid [$ClCH_2COOH$] is a stronger acid than the other option due to the electron with drawing effect of the chlorine atom, which stabilizes the negative charge on the conjugate base [$ClCH_2COO^-$]. This stabilization makes it easier for the acid to donate a proton [H^+ ion] and result in a lower pH in an aqueous solution of equal concentration compared to the other options.

Q. The reaction CHCH +H_2O + 3(O) shows the formation of --------- .

- ○ Acetic acid
- ○ Picric acid
- ✓ Oxalic acid
- ○ Formic acid

Explanation:

- For this question, we must assume CHCH to be ethyne. The(O) implies oxidation and water indicates that the oxidizing agent is dilute. Based on that we would be getting CHOHCHOH as an intermediate as hydroxyl groups are added to each carbon. This is similar to how we obtain diols from alkenes by oxidizing them through dilute potassium magnate. Further oxidation takes place and since we have 2 aldehyde groups, each is oxidized to give a carboxylic acid thus 2 carboxylic acid groups which is oxalic acid.

8. SOME HELPFUL RESOURCES:

1- YouTube videos:

9.1 Physical Properties:
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9.2 Structure:
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9.3 Acidity:
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9.4 Preparation of Carboxylic Acids and their derivatives:
The Organic Chemistry Tutor

9.5 Reactions of Carboxylic Acids and their derivatives:
The Organic Chemistry Tutor

2- Guides and Notes:

- Redspot Chemistry
- Anees Hussain MDCAT notes
- Doctor's Inn Chemistry Worksheets.

9. TOPICAL QUESTIONS ON PREMED.PK:

- Studying the chapter is not enough- you need to be able to keep that information stored in your memory for a long time (at least till the MDCAT). The best way to do this is by practicing as many questions as possible. The PreMed.PK question bank was of invaluable help to us during our preparation. Solve the topical sets, learn from the explanations provided, and save the questions that you find challenging. You must familiarize yourself with the types of questions asked because the goal is to be able to solve the MCQs on the MDCAT. We simply cannot emphasize this enough!

10. IMPORTANT TOPICS:

- 9.1 Physical Properties
- 9.2 Structure
- 9.4 Preparation of Carboxylic Acids and their derivatives
- 9.5 Reactions of Carboxylic Acids and their derivatives

11. TIPS AND TRICKS:

1- Shortlisting:

After you've finished reading the chapter, shortlist points that you keep forgetting and those that you think are important on a single sheet of paper and revise it every few days.

2- Mistake Notebooks:

Keep a notebook titled "MISTAKE NOTEBOOK" with you whenever you are solving MCQs, and note down the MCQs that you find difficult (weak concepts). Next time, when you practice questions from this chapter, go through the notebook first so you can have a grip on these questions too.

12. STUDY HACKS:

1- Flashcards:

Use flashcards for revision in which you write important definitions.

2- Animation:

Watching animated videos can be helpful for better topic understanding.

3- Study Plan:

Make a proper study plan on which you stick.

4- Revision:

Revise the chapter frequently so that you will not forget the main points.

13. REVISION TIPS FOR LAST MINUTE:

Not having enough time for revision is a common problem (we faced it too). Here's what we recommend:

1- Shortlisted notes:

- Read your shortlisted notes.

2- Key points:

- Read the key points given at the end of each chapter.

3- Practice questions:

- Solve the questions given at the end of the chapter. Solve any questions you might have saved while covering the topic from the PreMed.PK question bank.

4- YouTube video:

- Watch Competition Wallah's One-Shot video at 2x the speed.

5- Focus on Weak Areas:

- Focus on high-yield information during the final revision and prioritize the topic in which you are less confident.

9.14. CONCLUSION:

- This chapter is about understanding basic concepts. If you find it difficult to understand just by reading textbooks, watch YouTube videos regarding the topics, so that it will be beneficial for you. It's an important chapter from Organic Chemistry so make sure to have a grip on this chapter as a lot of MCQ can be asked.

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A little about the author

Guidance is like a beacon in the storm, especially in challenging times. PreMed is like a treasure trove of wisdom, experience, and innovation, perfect for going through the twists and turns of the medical entrance journey. It's a game-changer, right? The best feature for me was chapter wise past papers with their correct answers. The Qbank, mocks, flashcards, timed tests, daily quizzes - so no more flipping through endless books. Trust me it's a best platform. I wholeheartedly endorse PreMed.pk to all my fellow students out there. I made the most of every tool PreMed offered, and now it's your turn to shine. I've seen firsthand how PreMed can elevate your journey. Be motivated and focused. Let your passion shine through your medical journey.