MODULE-2

PHARMACY INDIA

Rapid Revision Notes

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## PHARMACEUTICAL CHEMISTRY

- Medicinal Chemistry
- Organic Chemistry
- Physical Chemistry
- Inorganic Chemistry
- Biochemistry

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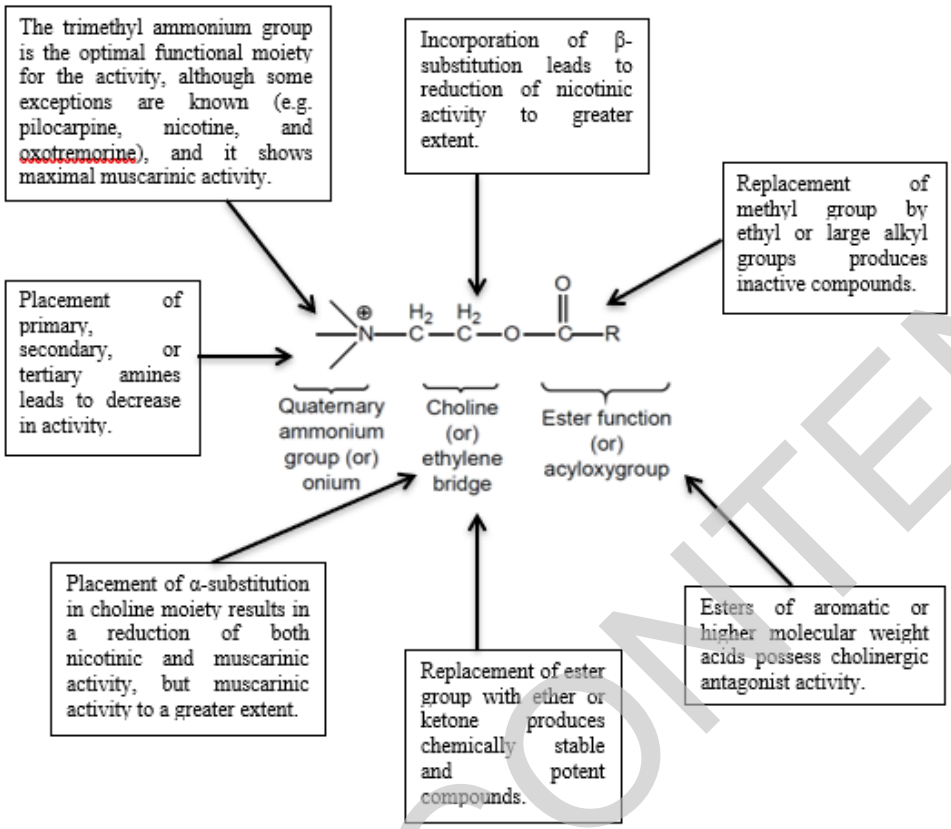
# 1

# Medicinal Chemistry

- Drugs acting on autonomic nervous system (ANS)
- Drugs acting on central nervous system (CNS)
- Drugs acting on cardiovascular system (CVS)
- Drugs acting on inflammation/ allergy
- Drugs acting on endocrine system
- Drugs acting on respiratory system
- Drugs acting on urinary system
- Drugs acting on blood and blood forming organs
- Chemotherapeutic agents

**Structure activity relationship**



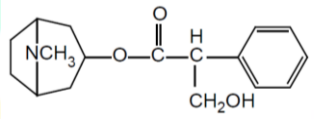
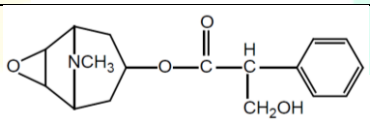
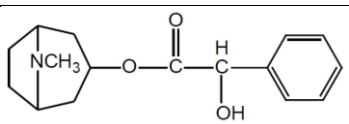

# Anticholinergic Drugs

## Introduction

- The parasympatholytics or cholinergic blocking agents include atropine and related alkaloids obtained from plants, such as *Atropa belladona, A. accuminata, Hyosyamus niger, Scoplola carniolica, Datura strammonium,* and synthetic or semisynthetic atropine substitutes.
- The antinicotinic drugs consist of ganglion blockers and neuromuscular junction blockers.
- Muscarinic antagonists are often called as parasympatholytics.

## Classification

1. **Solanaceous alkaloids and analogues**

| Drug name | Structure |
|---|---|
| Atropine |  |
| Scopolamine |  |
| Homatropine |  |

Chapter 2

# DRUGS ACTING ON CENTRAL NERVOUS SYSTEM

**Introduction**

- These drugs can selectively relieve pain, reduce fever, suppress disordered movement, induce sleep or arousal, and reduce the desire to eat or ally the tendency to vomit.

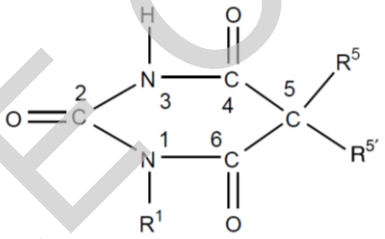
## Sedative and Hypnotics

**Introduction**

- Sedatives are central nervous system (CNS) depressant drugs that reduce excitement, tension, and produce relaxation.
- Hypnotics are drugs that depress the CNS and produce sleep similar to that of natural sleep.
- Both sedative and hypnotic action may reside in the same drug.

**Classification**

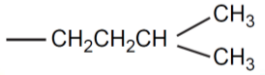
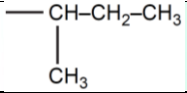
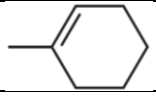
1. **Barbiturates →** Barbiturates are further classifi ed on the basis of duration of their action.

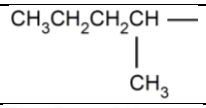
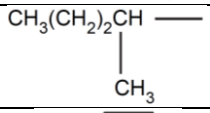
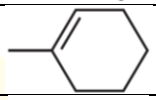
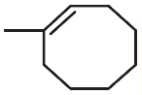



**a. Long-acting barbiturates (6 h or more than 6 h)**

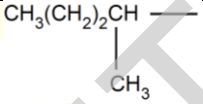
| Drug name | $R^1$ | $R^5$ | $R^{5'}$ |
|---|---|---|---|
| Barbital | –H | $–C_2H_5$ | $–C_2H_5$ |
| Phenobarbital | –H | $–C_2H_5$ | $–C_6H_5$ |
| Mephobarbital | $–CH_3$ | $–C_2H_5$ | $–C_6H_5$ |
| Metharbital | $–CH_3$ | $–C_2H_5$ | $–C_2H_5$ |

b. **Intermediate-acting barbiturates (3–6 h)**

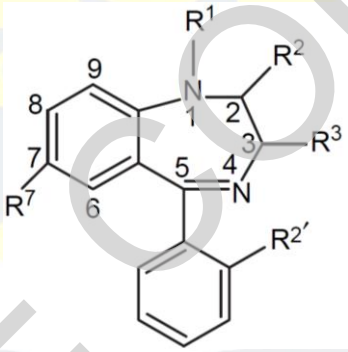
| Drug name | $R^1$ | $R^5$ | $R^{5'}$ |
|---|---|---|---|
| Amobarbital | –H | $–C_2H_5$ |  |
| Butabarbital | –H | $–C_2H_5$ |  |
| Aprobarbital | –H | $CH_2$= CH–$CH_2$– | $(CH_3)_2CH–$ |
| Talbutal | –H | $CH_2$= CH–$CH_2$– | $CH_3CH_2CH(CH_3)–$ |
| Butalbital | –H | $CH_2$= CH–$CH_2$– | $(CH_3)_2CHCH_2–$ |
| Hexobarbital | $–CH_3$ | $–CH_3$ |  |

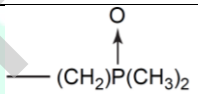
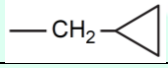
| | | | |
|---|---|---|---|
| Pentobarbital | –H | $–C_2H_5$ |  |
| Secobarbital | –H | $CH_2$= CH–$CH_2$– |  |
| Cyclobarbital | –H | $–C_2H_5$ |  |
| Heptabarbital | –H | $–C_2H_5$ |  |

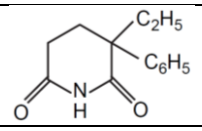
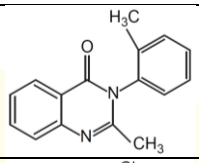
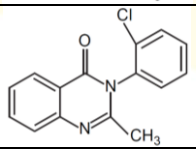
c. **Short-acting barbiturates (less than 3 h)**

| Drug name | $R^1$ | $R^5$ | $R^{5'}$ |
|---|---|---|---|
| Thiopentone | –H | $–C_2H_5$ |  |

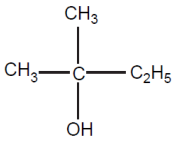
**2. Benzodiazepines**

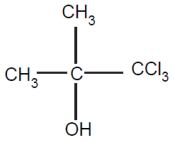


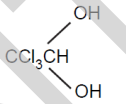
| Drug name | $R^1$ | $R^2$ | $R^3$ | $R^7$ | $R^{2'}$ |
|---|---|---|---|---|---|
| Diazepam | $–CH_3$ | = O | –H | –Cl | –H |
| Oxazepam | –H | = O | –OH | –Cl | –H |
| Chlordesmethyl diazepam | –H | = O | –H | –Cl | –Cl |
| Fosazepam |  | = O | –H | –Cl | –H |
| Prazepam |  | = O | –H | –Cl | –H |
| Nitrazepam | –H | = O | –H | $–NO_2$ | –H |
| Nordiazepam | –H | = O | –H | –Cl | –H |
| Nimetazepam | $–CH_3$ | = O | –H | $–NO_2$ | –H |
| Flunitrazepam | $–CH_3$ | = O | –H | $–NO_2$ | –F |
| Flurazepam | $–(CH_2)_2N(C_2H_5)_2$ | = O | –H | –Cl | –F |
| Quazepam | $–CH_2CF_3$ | = S | –H | –Cl | –F |
| Halozepam | $–CH_2CF_3$ | = O | –H | –Cl | –H |
| Temazepam | $–CH_3$ | = O | –OH | –Cl | –H |
| Lorazepam | –H | = O | –OH | –Cl | –Cl |
| Clonazepam | –H | = O | –H | $–NO_2$ | –Cl |
| Doxefazepam | $–CH_2OH$ | = O | –OH | –Cl | –F |

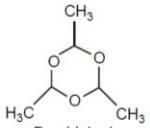
| | |
|---|---|
| • Glutethemide |  |
| **Quinazolinones** | |
| • Methaqualone |  |
| • Mecloqualone |  |

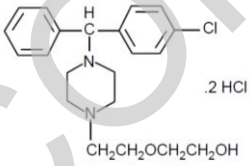
## 5. Alcohols and aldehydes


Amylene hydrate


Chlorbutanol


Chloral hydrate


Paraldehyde


Hydroxyzine HCl

## 6. Miscellaneous

**a) Inorganic salts →** KBr, magnesium sulphate

b) **Acids and esters →** Tryptophan, 5-hydroxy tryptophan**,** Etomidate

c) **Antihistamines and anticholinergics →** Doxylamine, Diphenhydramine, Pyrilamine

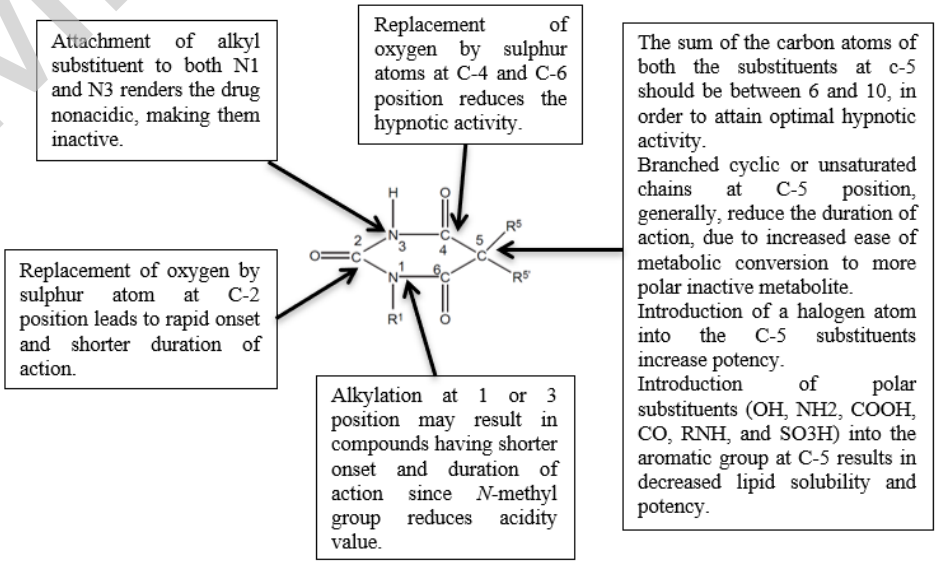
**d) Sulphones →** Toxic-not used

**e) Plant extracts →** *Radix valerianae***,** *Rauwolfia serpentine***,** *Avana sativa***,** *Glandula lupuli*

**f) Endogenous substances: peptides**

## 7. Newer agents → Zaleplon, Zopiclone, Zolpidem

**SAR of Barbiturates**



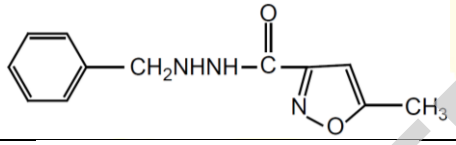
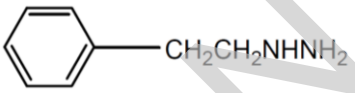
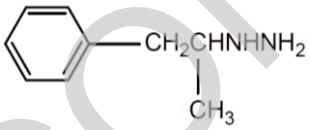
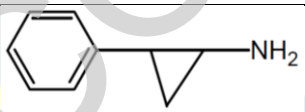
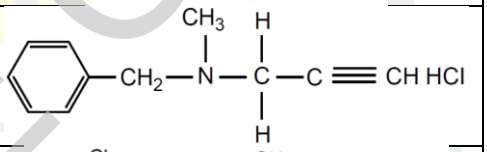
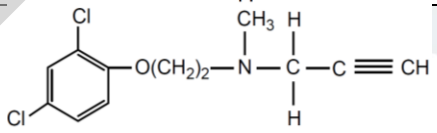
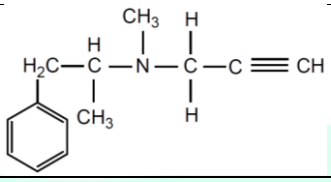
# Antidepressants

## Introduction

- Antidepressants are drugs, which enhance alertness and may result in an increased output of behaviour.
- They are used for the relief of symptoms of moderate and severe depressive disorder.

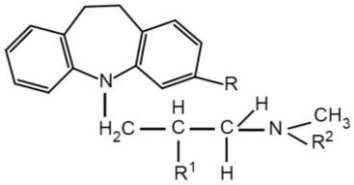
## Classification

### 1. Monoamine oxidase inhibitors (MAOIs)

| Drug name | Structure |
|---|---|
| Isocarboxazide |  |
| Iproniazid |  |
| Phenelzine |  |
| Pheniprazine |  |
| Tranylcypromine |  |
| Pargyline HCl |  |
| Clorgyline |  |
| Deprenyl |  |

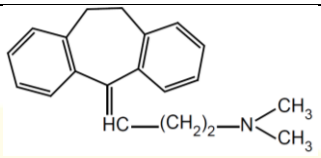
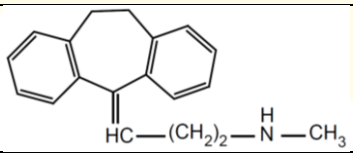
### 2. Tricyclic antidepressants (TCAs)

#### a. Imino dibenzyl derivatives

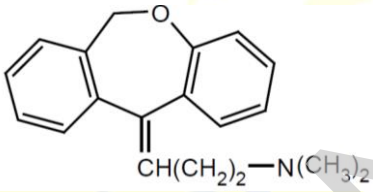


| Drug name | R | $R^1$ | $R^2$ |
|---|---|---|---|
| Imipramine | –H | –H | – $CH_3$ |
| Desipramine | –H | –H | –H |
| Trimipramine | –H | –$CH_3$ | – $CH_3$ |
| Chlorimipramine | –Cl | –H | – $CH_3$ |

**b. Dibenzo cycloheptane derivatives**

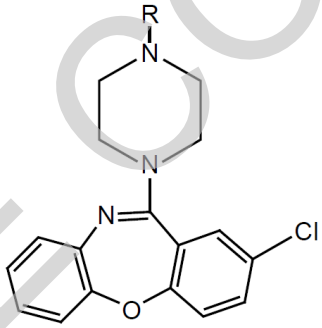
| Drug name | Structure |
|---|---|
| **Amitryptyline** |  |
| **Nortryptyline** |  |

**c. Dibenzoxepine derivatives**



**Doxepin**

**d. Dibenzoxazepine derivatives**

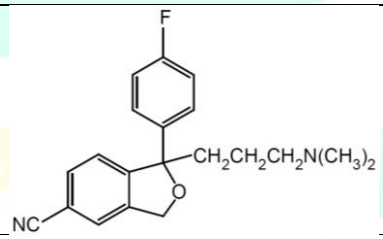
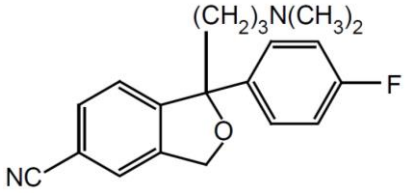


**a. Amoxapine** R = H
**b. Loxapine** R–$CH_3$

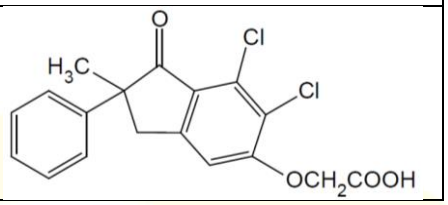
**3. Second-generation antidepressants**

a. Bicyclic: Viloxamine, Zimeldine
b. Tricyclic: Dibenzepine, Amoxapine, Imprindole
c. Tetracyclic: Mamprotiline, Mianserin

**4. Selective serotonin reuptake inhibitors (SSRIs)**

| Drug name | Structures |
|---|---|
| Citalopram(±) Isomer |  |
| Escitalopram (+) Isomer |  |

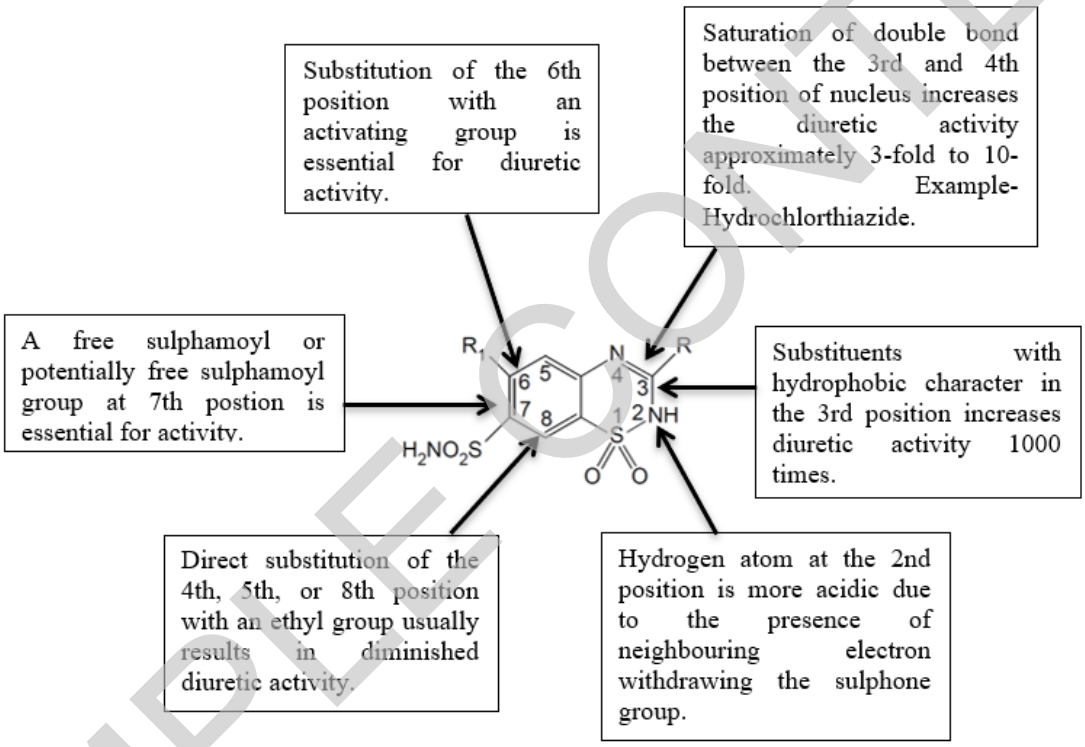
**k. Uricosuric diuretics**

| Drug name | Structure |
|---|---|
| Indacrinone |  |

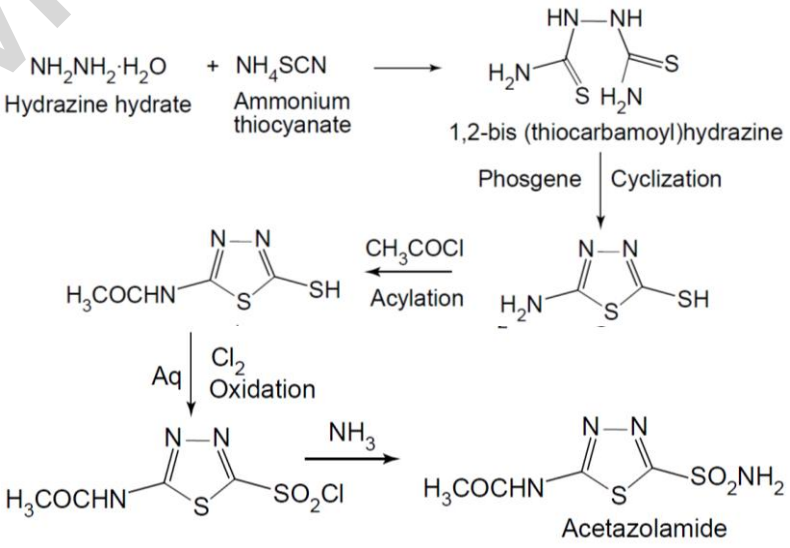
**l. Acidic diuretics →** Ammonium chloride

**m. Miscellaneous →** Muzolimine

**SAR of Thiazide Diruretics**




1. **Acetazolamide** [N-(Sulphonamido-1,3,4-thiadiazol-2-yl)acetamide]



# SECTION

# 2

# Organic Chemistry

- Heterocyclic Compounds
- Aromaticity Compounds
- General Principles
- Important Name Reactions
- Isomerization

Chapter 1

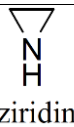
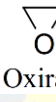
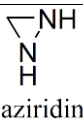
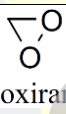
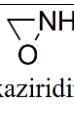
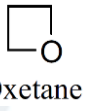
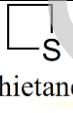
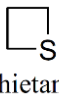
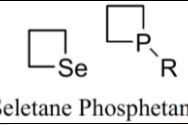
# HETEROCYCLIC COMPOUNDS

## Introduction

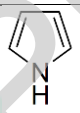
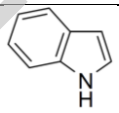
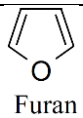
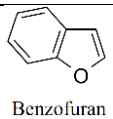
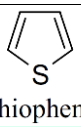
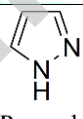
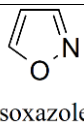
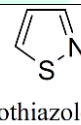
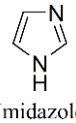
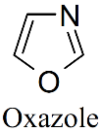
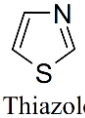
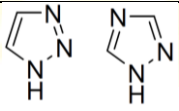
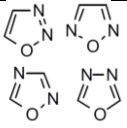
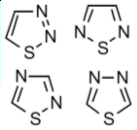
- Heterocyclic compounds are organic compounds that contain a ring structure containing atoms in addition to carbon, such as sulfur, oxygen or nitrogen, as the heteroatom.
- Carbocyclic compounds are organic compounds that contain ring system made up entirely of carbon atoms.

## Classification

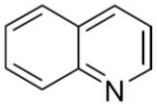
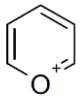
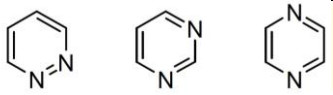
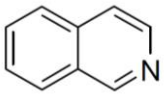
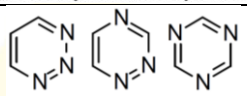
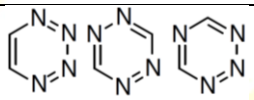
### 1. Three and four membered heterocycles

| Ring size | Heteroatoms | | | |
|---|---|---|---|---|
| | N | O | S | Other |
| 3 |  Aziridine |  Oxirane |  Thiirane | |
| |  Diaziridine |  Dioxirane | |  Oxaziridine |
| 4 |  Oxetane |  Thietane |  Thietane |  Seletane Phosphetane |

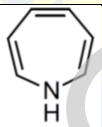
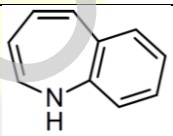
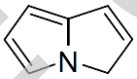
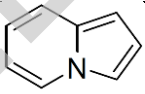
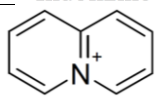
### 2. Five membered heterocycles

| Ring size | Heteroatoms | | | | |
|---|---|---|---|---|---|
| | N | Benzo | O | Benzo | S |
| 5 |  Pyrrole |  Indole |  Furan |  Benzofuran |  Thiophene |
| 5 |  Pyrazole | |  Isoxazole | |  Isothiazole |
| |  Imidazole | |  Oxazole | |  Thiazole |
| |  Triazoles | |  Oxadiazoles | |  Thiadazoles |
| |  Tetrazole | | | | |

### 3. Six membered heterocycles

| Ring size | Heteroatoms | | |
|---|---|---|---|
| | N | Benzo | O |
| 6 |  Pyridine |  Quinoline |  Pyrilium |
| |  Diazines<br>Pyridazine Pyrimidine Pyrazine |  Isoquinoline | |
| |  Triazines | | |
| |  Tetrazines | | |

### 4. Other simple heterocycles

| Ring size | Heteroatoms | |
|---|---|---|
| | N | Benzo |
| 7 |  Azepine |  Benzoazepine |
| 5-5 |  Pyrroline | |
| 5-6 |  Indolizine | |
| 6-6 |  Quinolizinium | |

## Nomenclature of Heterocyclic Compounds

### 1. Prefix for Hetero Atoms

| Hetero atoms | Valence | Prefix |
|---|---|---|
| O | 2 | Oxa |
| N | 3 | Aza |
| S | 2 | Thia |
| Se | 2 | Selena |
| Te | 2 | Tellura |
| P | 3 | Phospha |
| As | 3 | Arsa |
| Si | 4 | Sila |
| Ge | 4 | Germa |

| Hybridization of central atom | % of s, p, and d characters | No. of hybrid orbitals | Shape and bond angle of hybrid orbital | Examples |
|---|---|---|---|---|
| sp | 50% s and p character | 2 | Linear/ 180º | $BeF_2$, $BeH_2$, $BeCl_2$, $C_2H_2$ |
| $sp^2$ | 33.33% s and 66.66% p character | 3 | Trigonal planar/ 120º | $BeF_3$, $BH_3$, $C_2H_4$ |
| $sp^3$ | 25% s and 75% p character | 4 | Tetrahedron/ $109.28^0$ | $C_2H_6$, $CH_4$ |
| $sp^3d$ | - | 5 | trigonal bipyramidal / 120º and 90º | $PCl_5$, PF5 |
| $sp^3d^2$ | - | 6 | Octahedron/ 90º | $SF_6$ |

**Relative size of sp, $sp^2$ and $sp^3$ -orbitals**

- s-orbital, character, in the three hybrid orbitals varies in the following manner:

**sp >$sp^2$ >$sp^3$**

- Since, & s-orbitals are closer to the nucleus than p-orbitals, it is, thus, expected that **greater the s-character of the hybrid orbital the smaller is its size**. Therefore, the order of the size of the three hybrid orbitals is:

**$sp^3$ >$sp^2$ >sp**

- On the basis of the sizes, sp-orbital forms shortest and *sp3* -orbital longest bonds with other atoms.

**Bond Length**

- The average distance between the centres of the nuclei of the two bonded atoms in a molecule is called the **bond length**.
- It also depends on the type of hybridization and the resonance.
- The bond length is:

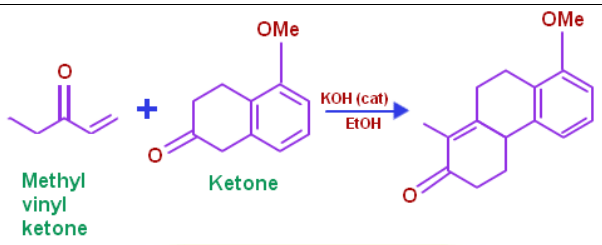
**Single bond > Double bond > Triple bond**

- The bond length of the sigma bond in, different types of hybridization follows the following order:

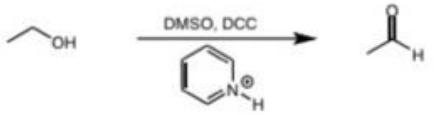
**σ-bond (sp3) > σ-bond (sp2) > σ-bond (sp)**

- The bond length is expressed in angstrom units (A) or picometre (pm), (lA 10-10 m, 1 pm 10-12 m).
- The bond lengths are measured by X-ray crystallography and by microwave spectroscopy.

| Bond | Bond length (A) |
|---|---|
| C-C | 1.54 |
| C=C | 1.34 |
| C≡C | 1.20 |
| C-H($sp^3$-s) | 1.112 |
| C-H($sp^2$-s) | 1.103 |
| C-H(sp-s) | 1.08 |
| C-O | 1.40 |




**60. Pfitzner –Moffatt oxidation→** It is a chemical reaction for the oxidation of primary and secondary alcohols to aldehydes and ketones, respectively. The oxidant is a combination of dimethyl sulfoxide (DMSO) and dicyclohexylcarbodiimide (DCC).




# NAME REACTIONS

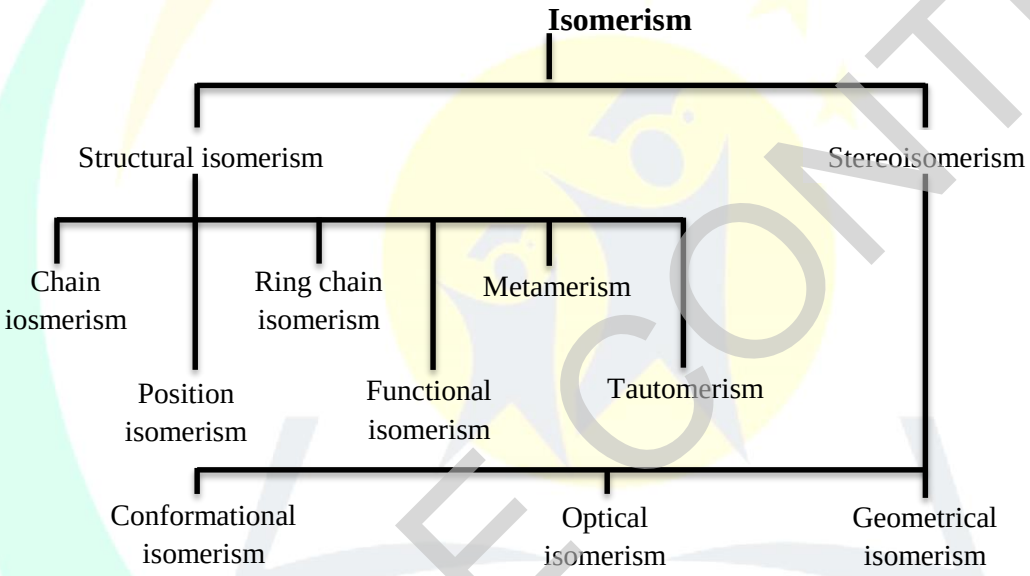
| Name reactions | Starting materials | Catalyst | End product |
|---|---|---|---|
| Wolff Kishner reduction/ Hung-milnon reaction | Aldehydes and ketones | $H_2NNH_2$; $C_2H_5ONa$; Glycol | Methylene group |
| Meerweili-Ponndorf-Verley (MPV) reduction | Ketones | $[(CH_3)_2CHO]_3Al$; $(CH_3)_2CHOH$ | $2^o$ alcohol |
| Pinacol-pinacolone rearrangement | Ketones | Mg/ Hg; mineral acid | 2,3-dimethyl butane-2,3-dilol(Pinacol); 3,3-dimethyl butan-2-one (Pinacolone) |
| Beckmann rearrangement | Ketoximes | conc. $H_2SO_4$, $PCl_5$, $H_3PO_4$, $SOCl_2$ or $C_6H_5SO_2Cl$ | N-methyl acetamide |
| Aldol condensation | carbonyl compounds | NaOH, $Ba(OH)_2$ or $K_2CO_3$ | Aldol |
| Baeyer Villiger oxidation | Aliphatic ketones | (per monosulphuric acid, $H_2SO_4$) or per benzoic acid ($C_6H_5CO_3H$) or m-chloro perbenzoic acid or per acetic acid ($CH_3CO_3H$) or $CF_3CO_3H$ | Esters |
| Cannizzaro's reactions | Aldehydes (with no α-hydrogen) | Conc. Alkali | Carboxylic acids |
| Tischenko's reaction | Aldehydes (with or without α-hydrogen) | $(C_2H_5O)_3Al$ | Ester |
| Claisen-Schmidt reaction | aliphatic aldehyde or ketone (with α-hydrogen) | Dil. NaOH | α,β-unsaturated compound |
| Schmidt reaction | Carbonyl compounds | conc. $H_2SO_4$ | Alkyl cyanide and N-alkyl formamide |
| Lederer Manase's reaction | Phenol | dilute acid or alkali | o- and p-hydroxy benzyl alcohol |

Chapter 5

# ISOMERIZATION

## Introduction

- Two or more than two organic compounds having the **same molecular formula and molecular weight but different physical and chemical proper ties** are called **isomers** and the phenomenon is called **isomerism.**




**Structural isomerism:**

- It is due to the difference in the manner in which the constituent atoms or groups are linked to one another within the molecule, without any reference to space.
- Structural isomers are compounds having same molecular 'formula' but different structural formulae.

1. **Chain or nuclear isomerism**

- This type of isomerism is due to difference in the arrangement of carbon atoms constituting the chain, *i. e.*, straight or branched chain of carbon atoms. It is also known as, nuclear or skeletal isomerism. The isomers showing chain isomerism belong to same homologous series.
- **Examples-**

$C_4H_{10}$ (butane) exists in two forms-

$CH_3CH_2CH_2CH_3$ ; $CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_3$

*n*-Butane (Butane) (Straight carbon chain)

Isobutane (2-Methylpropane) (Branched carbon chain)

Pentane ($C_5H_{12}$) exist in three isomers-

# SECTION 3

# Physical Chemistry

➡ Complete Topic

# PHYSICAL CHEMISTRY

## STATES OF MATTER

| PARAMETER | SOLID | LIQUID | GAS |
|---|---|---|---|
| **Shape** | Definite shape | Indefinite shape | Indefinite shape |
| **Volume** | Definite Volume | Indefinite Volume | Indefinite Volume |
| **Inter particular Forces** | Strong Inter particular Forces | Comparatively weaker Inter particular Forces | Inte rparticular forces are negligible |
| **Inter particular Space** | Negligible inter particular space | Comparatively large inter particular space | Very large Inter particular space |
| **Packing of Particles** | Particles are very Closely packed | Particles are loosely packed | Particles are loosely packed |
| **Density** | Very High Density | Low Density | Very low density |

## INTRAMOLECULAR FORCES OF ATTRACTION

| Type of Bond | Definition/ Description | |
|---|---|---|
| **Ionic bond** | This bond is formed by the complete transfer of valence electron(s) between atoms. | |
| **Covalent bond** | This bond is formed between atoms that have similar electronegativities. | |
| | **Nonpolar covalent bond** | A nonpolar covalent bond is formed between same atoms or atoms with very similar electronegativities. |
| | **Polar covalent bond** | A polar covalent bond is formed when atoms of slightly different electronegativities share electrons. |
| **Metallic bonding** | This type of covalent bonding specifically occurs between atoms of metals, in which the valence electrons are free to move through the lattice | |

## INTERMOLECULAR FORCES OF ATTRACTION

| Force/ Interaction | Description |
|---|---|
| **Dipole-dipole interactions** | These forces occur when the partially positively charged part of a molecule interacts with the partially negatively charged part of the neighboring molecule. |
| **Ion-Dipole Interactions** | These interactions are similar to dipole-dipole interactions except for the fact that they arise between ions and polar molecules. |
| **Ion Induced Dipole Interactions** | In this type of interaction, a non-polar molecule is polarized by an ion placed near it. The non-polar molecules, upon obtaining a charge, behave as induced dipoles |
| **Hydrogen bonding** | This is a special kind of dipole-dipole interaction that occurs specifically between a hydrogen atom bonded to either an oxygen, nitrogen, or fluorine atom. |
| **London dispersion forces** | These are the weakest of the intermolecular forces and exist between all types of molecules, whether ionic or covalent—polar or nonpolar. |

| | |
|---|---|
| **Isobaric process** | In this process the pressure remains constant throughout the change i.e., dP = 0. |
| **Isochoric process** | In this process volume remains constant throughout the change, i.e., dV = 0. |
| **Cyclic process** | When a system undergoes a number of different processes and finally return to its initial state, it is termed cyclic process. For a cyclic process dE = 0 and dH = 0. |
| **Reversible process** | A process which occurs infinitesimally slowly, i.e. opposing force is infinitesimally smaller than driving force and when infinitesimal increase in the opposing force can reverse the process, it is said to be reversible process. |
| **Irreversible process** | When the process occurs from initial to final state in single step in finite time and cannot be reversed, it is termed an irreversible process. |

## LAWS OF THERMODYNAMICS

| Law | Description |
|---|---|
| **Zero law of thermodynamics** | "If a system A is in thermal equilibrium with a system C and if B is also in thermal equilibrium with system C, then A and B are in thermal equilibrium with each other whatever the composition of the system." |
| **First law of thermodynamics** | "Energy can neither be created nor destroyed although it can be converted from one form into another." **E2 – E1 = ΔE = q +w**<br>(Change in internal energy) = (Heat added to the system) + (Work done on the system) |
| **Second law of thermodynamics** | **Kelvin statement: "**It is impossible to derive a continuous supply of work by cooling a body to a temperature lower than that of the coldest of its surroundings."<br>**Clausius statement:** "It is impossible for a self-acting machine, unaided by any external agency, to transfer heat from one body to another at a higher temperature or Heat cannot itself pass from a colder body to a hotter body, but tends invariably towards a lower thermal level." |
| **Third law of thermodynamics** | "The entropy of all perfectly crystalline solids is zero at the absolute zero temperature. Since entropy is a measure of disorder, it can be interpretated that at absolute zero, a perfectly crystalline solid has a perfect order of its constituent particles." |

## TERMS USED IN THERMODYNAMICS

| Terms | Description |
|---|---|
| **Enthalpy** | Heat content of a system at constant pressure is called enthalpy denoted by 'H'. |
| **Enthalpy change** | Heat change at constant pressure can be given as<br>$\Delta q = \Delta E + P\Delta V$<br>Difference between ΔH and ΔE is significant when gases are involved in chemical reaction. |

# INORGANIC CHEMISTRY

## INDIAN PHARMACOPOEIA

| EDITION | YEAR & VOLUME | CHAIRMANSHIP | SUPPLEMENT | ADDENDUM |
|---|---|---|---|---|
| 1st | 1955 | Dr. B. N. Ghosh | 1960 | - |
| 2nd | 1966 | Dr. B. Mukherjee | 1975 | - |
| 3rd | 1985 (2 volumes) | Dr. Nityanand | | 1989 & 1991 |
| 4th | 1996 (2 volumes) | Dr. Nityanand | | 31st December 2000 & 30th June 2003 |
| 5th | 2007 (3 volume) | Dr. Nityanand | | 2008 |
| 6th | 2010 (3 volume) | Shir K. Chandramouli | 2012 | - |
| 7th | 2014 (4 volume) | Nabi Azad (Health Minister) | 2015 | 2016 |
| 8th | 2018 (4 volume) | Dr. C.K. Mishra | 2019 | 2021 |

## LIMIT TEST

| TEST | DESCRIPTION |
|---|---|
| **Chloride** | Limit test of chloride is based on the reaction of soluble chloride with silver nitrate in presence of dilute nitric acid to form silver chloride, which appears as solid particles (Opalescence) in the solution. |
| **Sulphate** | Limit test of sulphate is based on the reaction of soluble sulphate with barium chloride in presence of dilute hydrochloric acid to form barium sulphate which appears as solid particles (turbidity) in the solution. |
| **Iron** | Limit test of Iron is based on the reaction of iron in ammonical solution with thioglycollic acid in presence of citric acid to form iron thioglycolate which is pale pink to deep reddish purple in color. |
| **Lead** | Limit test of lead is based on the reaction of lead and diphenyl thiocabazone (dithizone) in alkaline solution to form lead dithizone complex which is read in color. Dithizone is green in color in chloroform and lead-dithizone complex is violet in color, so the resulting color at the end of process is red. |
| **Arsenic** | Limit test of Arsenic is based on the reaction of arsenic gas with hydrogen ion to form yellow stain on mercuric chloride paper in presence of reducing agents like potassium iodide.<br>It is also called as **Gutzeit test** and requires **Gutzeit apparatus.** |
| **Heavy Metals** | Limit test of heavy metals is based on the reaction of metallic impurities with hydrogen sulfide in acidic medium to form brownish colour solution. |

## ACID BASE & BUFFER

| Acids | Bases |
|---|---|
| ○ Which converts blue litmus paper to red<br>○ Having the PH <7<br>○ Sour taste<br>○ React with bases to form salts and water.<br>Example :- **Hydrochloric acid (HCl)** | ○ Which converts red litmus paper to blue<br>○ Having the PH >7<br>○ Bitter taste<br>○ React with Acids to form salts and water.<br>Example: **Sodium Hydroxide** |

### THEORY OF ACID AND BASE

| Theory | Acids | Base |
|---|---|---|
| **Arrhenius theory** | An Acid is a substance that can release hydrogen ion (H+) when dissolved in water.<br>Example: Hydrochloric acid.<br>**$HCl \rightarrow H^+ + Cl^-$** | A Base is a substance that can release a Hydroxyl ion (OH-) when dissolved in water.<br>Example: Sodium Hydroxide.<br>**$NaOH \rightarrow Na^+ + OH^-$** |
| **Bronsted Lowry theory** | Acid is the substance which donate proton.<br>**Conjugate acid**: species that forms after a base accepts an $H^+$. | Base is the substance which accept proton.<br>**Conjugate base**: species that remains after an acid donates its $H^+$. |
| **Lewis theory** | Acid: Acid is the molecule or ion that accept the lone pair of electrons. Example: **$H^+$, $NH_4^+$, $Na^+$, $Cu^{++}$, $Al^{+++}$** | Base: Base is the molecule or ion that donate the lone pair of electrons. Example: **$OH^-$, $Cl^-$, $CN^-$** |

### BUFFERS

| Acidic buffers | Basic buffers | Neutral buffers |
|---|---|---|
| It is combination of weak acid and its corresponding salt. | It is combination of weak base and its corresponding salt. | It is single substance showing properties of buffers. |
| Example: Mixture of acetic acid, sodium acetate | Example: Mixture of Ammonium hydroxide and ammonium chloride | Example : Ammonium acetate |

### SODIUM DEFICIENCY

| Condition | Hyponatremia | Hypernatremia |
|---|---|---|
| Reason | Low level of Na+ | High level of Na+ |
| Symptoms | Extreme urine loss, diarrhea, kidney damage, vomiting, excessive sweating | Dehydration. High sodium intact. Intense thirst, fatigue |

### CHLORINE DEFICIENCY

| Condition | Hypochloremia | Hyperchloremia |
|---|---|---|
| Reason | Decrease calcium level in body | Increase calcium level in body |
| Symptoms | Metabolic acidosis, Vomiting, Lack of reabsorption | Excess loss of bicarbonate ions and dehydration Symptoms |

| | | | |
|---|---|---|---|
| | | | Iron metabolism |
| **Vitamin $B_1$ (Thiamine)** | Pyrimidine ring | Beri-beri | Carbohydrate metabolism |
| **Vitamin $B_2$ (Riboflavin)** | Dimethyl isoalloxazine ring | Glossitis, Cheilosis, Angular stomatitis | Flavin adenosine dinucleotide (FAD) and Flavin mono-nucleotide(FMN) |
| **Vitamin $B_3$ (Niacin)** | Pyridine | Pellagra | Nicotinamide adenine dinucleotide (**NAD+**) and Nicotinamide adenine dinucleotide phosphate (**NADP+**). |
| **Vitamin $B_5$ (Pantothenic acid)** | Alanine and D-pantoic acid | Gopalan's Burning Foot Syndrome (Paresthesia) | Coenzyme A or CoA (A for acetylation) |
| **Vitamin $B_6$ (Pyrridoxine)** | Pyridine | Neurological symptoms, hypochromic microcytic anaemia | transamination, decarboxylation, deamination, transsulfuration, condensation |
| **Vitamin $B_7$ (Biotin)** | Imidazole and thiophene rings | Anemia, Dermatitis, Loss of appetite | Serves as a carrier of $CO_2$ in carboxylation reactions. |
| **Vitamin $B_9$ (Folic acid)** | Pteridine ring | Macrocytic anemia | Serves as an acceptor or donor of one carbon units |
| **Vitamin $B_{12}$ (Cyanocobalamin)** | Corrin ring | Pernicious anemia | Synthesis of methionine from homocysteine, lsomerization of methymalonyl CoA to rrccinyl CoA |

## CLASSIFICATION OF ENZYMES

| S.No. | Enzyme class | Examples |
|---|---|---|
| **1.** | **Oxidoreductases:** Transfer of hydrogen or addition of oxygen | Lactate dehydrogenase (NAD); Glucose-6-phosphate dehydrogenase (NADP); Succinate dehydrogenase (FAD); di-oxygenases |
| **2.** | **Transferases**: Transfer of groups other | Aminotransferase. |

| | | |
|---|---|---|
| | than hydrogen | (Subclass: Kinase, transfer of phosphoryl group from ATP; e.g. Hexokinase) |
| **3.** | **Hydrolases**: Cleave bond and add water. | Acetyl choline esterase; Trypsin |
| **4.** | **Lyases**: Cleave without adding water. | Aldolase; HMG CoA lyase; ATP Citrate lyase. (Subclass: Hydratase; add water to a double bond) |
| **5.** | **Isomerases**: Intramolecular transfers. They include racemases and epimerases. | Triose phosphate isomerase |
| **6.** | **Ligases**: ATP dependent condensation of two molecules. | Acetyl CoA carboxylase; Glutamine synthetase; PRPP synthetase |

**ENZYMES WITH THEIR RESPECTIVE SUBSTRATE AND COMPETITIVE INHIBITORS**

| S. No. | ENZYME | SUBSTRATE | INHIBITOR | SIGNIFICANCE OF INHIBITION |
|---|---|---|---|---|
| **1.** | **Acetylcholine Esterase** | Acetylcholine | Succinyl choline | Used in surgery for muscle relaxation in anaesthetized patient |
| **2.** | **Dihydrofolate reductase** | Dihydrofolic acid (DHF) | Aminopterin Amethopterin Methotrexate | Employed in the treatment of leukemias and other cancers |
| **3.** | **Dihydropteroate synthase** | Para-amino benzoic acid (PABA) | Sulphonamides | Prevent bacterial synthesis of folic acid |
| **4.** | **HMG COA Reductase** | HMG CoA | Lovastatin | Inhibit cholesterol biosynthesis |
| **5.** | **Monoamine oxidase** | Catecholamines (epinephrine, norepinephrine) | Ephedrine Amphetamine | Useful in elevating catecholamine levels |
| **6.** | **Vitamin K epoxide reductase** | Vitamin K | Dicumarol | Act as coagulant |
| **7.** | **Xanthine oxidase** | Hypoxanthine | Allopurinol | Used in control of gout to reduce excess production of uric acid from hypoxanthine |

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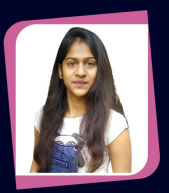
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SURENDRA
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KRUSHNA
AIR - 204


ADITYA
AIR - 223


YASH
AIR - 223


MAYURI
AIR - 251


AMRENDRA
AIR - 424


AZAR RAZAK
AIR - 468


KHLANDAR
AIR - 497


PRIYANKA
AIR - 556


KAJOL
AIR - 604


SATA DEEP
AIR - 629


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