Synthetic Dyes and Drugs

Synthetic Dyes - Definition, colour and constitution (electronic concept) of dye, classification based on chemical constitution, synthesis of methyl orange, Congo red, malachite green, crystal violet, Alizarin and indigo dyes.

Synthetic Drugs - Defination, introduction, classification of drugs. Properties of ideal drug. Synthesis of chloromycetien,paracetamol,phenacetien,

sulphaguainidine.

Synthetic dyes & drugs.

(A) Defination, colour & constitution (electronic concept) of dyes.
Classification based on chemical constitution.
Synthesis of 1) Methyl orange
2) Congo red
3) Malachite green
4) Crystal violet
5) Alizarin
6) Indigo dye.

(B) Defination, introduction, classification of drugs, properties of ideal drugs,
Synthesis of ideal drugs 1) chloromycetin.
2) paracetamol.
3) phenacetin.
4) sulphaguinidine.

(A) Synthetic Dyes

Introduction:- Dye is coloured organic compounds or mixture that may be used for imparting colour to a substance such as cloths, papers, plastics & leather for fashion.

In old days dye were obtained from natural sources like animals & plants these are known as Natural Dyes. which have limited colours & low fastness properties.

Now a day wide range of colours & good fastness properties such dye are prepared from chemicals are called as the Artificial Dyes. or Synthetic Dyes.

Generally all coloured substances are not dyes.

True dye have some properties such as,

i) It must have suitable Dye
ii) It must be able to fix itself to the material from solution (liquid Heel)
iii) when fixed, it must be fast to light & washing It must be resistant to acid, alkali & water.

Biological sensation which is produced when the light of certain wavelength reaches to the eyes is known as the colours colours depends upon the nature of light reflected from the substances, thus colour is not intrinsic property of the substance. colour observed with naked (मुक्त) eyes due to visible light.

Visible light consist of electromagnetic radiation of wavelength 400 – 750 nm. when visible light falls on a substance it may be

a) Totally reflected
b) Partially reflected
c) Totally absorbed.

when the light totally reflected the substance appears white
If the light totally absorbed the substance to be black.
If light Partially absorbed & partially reflected it gives different colours like Voilet ; Blue ; green ; orange red etc.

* Relation bet colour & constitution (Electronic concept) of dye

The colour & constitution (02) Relation between colour & constitution was pointed out for the first time in 1876 by the German chemist Otto Wilt, & he put theories for colour constitution as follows ;

(A) Valence Bond Theory (Resonance Theory)
(B) Molecular Orbital Theory.

(A) Valence Bond Theory (02) Resonance Theory (VBT) :-

The various postulates of this theory are as follows,

(I) **Chromophores** - (chroma - colour ; phorein - to bear) -
The colour of organic compounds appear due to the presence of certain multiple bonded group called as chromophore.

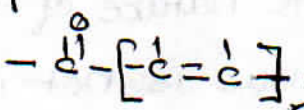
(II) **Auxochromes**

e.g. → 

P-quinoid

Nitroso gp

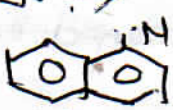
Azo gp.



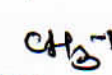
etc.

Un-keto compounds

e.g. →



1- Nitro-Naphthalene
Yellow colour
(A)



Nitromethane
colourless,
(B)

(A)  - Colourless

(B)  - Coloured

In compound (A) $-NO_2$ gp (chromophores) has to be conjugated with alternate double single bonds are exit in aromatic rings so that comp (A) in yellow coloured.
In comp (B) no conjugation so it is colourless.

Auxochromes - The above groups which tend to increase resonance by interacting the unshared pair of electrons on nitrogen or oxygen atoms of the auxochromes, with the π-electrons of the aromatic rings. (i.e chromophores)

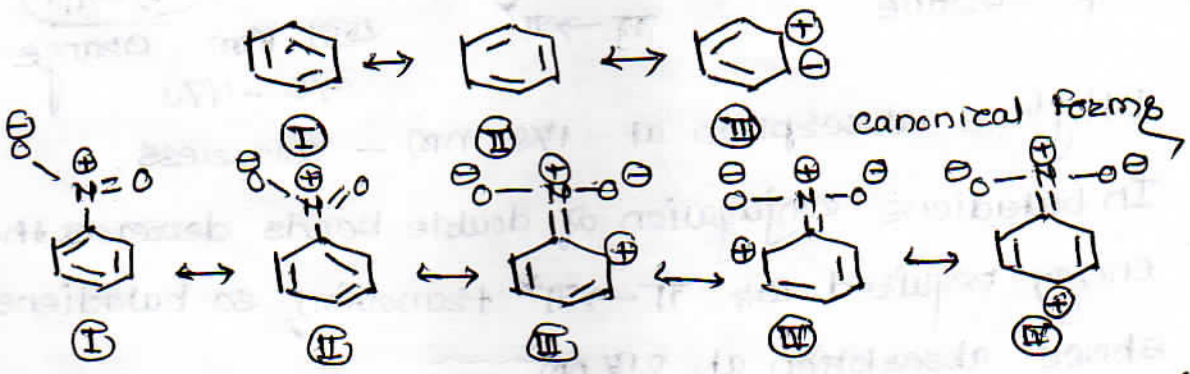
Increase the resonance increase the intensity of absorption of light & also shifts the absorption band to longer wavelength hence deepens the colour of compound.

(III) The dipole moment changes as a result of oscillation of electrons pairs. The following order has been observed, for the ease of excitation of different groups.

$$-\overset{\oplus}{N}=O > -\overset{\oplus}{C}=S > -N=N- > -\overset{\oplus}{C}=O > -C\equiv N > -\overset{\oplus}{C}=\overset{\ominus}{C}-$$ etc.

(IV) According to the Resonance theory the relation of the colour & symmetry of the molecule of transition dipole of the molecule because as the number of charged canonical structures increases the colour of the compound deepens.

e.g (a) Benzene is colourless, (b) Nitrobenzene is pale yellow colour & (c) P-Nitroaniline is dark yellow.



More canonical forms therefore the absorption is shifted to longer wave lengths, hence deepens the colour of compound.

(B) Molecular Orbital theory :-

In this theory excitation of electrons means transfer of electron from lower to higher energy level (or) ground state to the excited state. These electrons may be σ, π or n (nonbonding) Lower energy state are called as bonding orbitals & The higher energy states are called as antibonding orbitals.

The electronic transition occurs by absorption of ultra voilet or visible radiations. The following transitions are takes place

$\sigma \rightarrow \sigma^*$, $n \rightarrow \sigma^*$, $\pi \rightarrow \pi^*$, & $n \rightarrow \pi^*$

The various transitions may be arranged in their decreasing order of energy.

$\sigma \rightarrow \sigma^* > n \rightarrow \sigma^* > \pi \rightarrow \pi^* > n \rightarrow \pi^*$ etc.

Sr. No.	Compound	Transition	Absorption Band λ_{max}	colour
1)	$CH_2 = CH_2$ ethylene	$\sigma \rightarrow \sigma^*$	165 nm	($\sigma - \sigma^*$)
		$\pi \rightarrow \sigma^*$	175 nm	($n - \sigma^*$)
2)	$CH_2 = CH - CH = CH_2$ Butadiene	$\pi \rightarrow \pi^*$	217 nm	($\pi - \pi^*$)
3)	β-carotine	$\pi \rightarrow \pi^*$	270 - 470	($n - \pi^*$) Orange

Ethylene absorption at 175 nm - colourless.

In butadiene conjugation of double bonds decreases the energy required for $\pi \rightarrow \pi^*$ transition. so butadiene shows absorption at 217 nm,

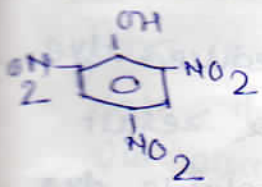
If no. of double bonds are present in β-carotene the absorption is shifted to visible range so the compound is orange colour.

b) Their chemical constitution.

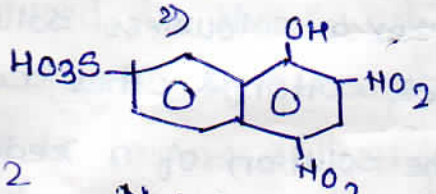
A) **Classification of dyes :→** (by presence of chromophores)

Dyes may be classified according to the type of chromophores present in their structures. By this method dyes classified by following ways.

(I) **Nitro & Nitroso dyes-** In this dyes presence of $-NO_2$ & $-NO$ group are chromophores e.g.

1) 

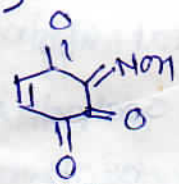
Picric acid

2) 

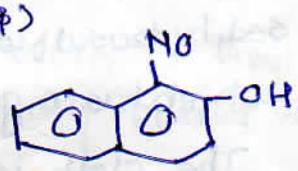
Naphthol Yellow-S

(2,4-dinitro 7-Sulphonic acid 1-naphthol)

← Nitro Dye →

3) 

(Fast green)

4) 

Mordant green 4

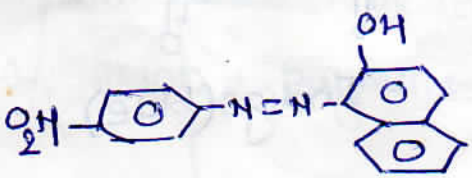
(2-Nitroso naphthol)

← Nitroso Dye →

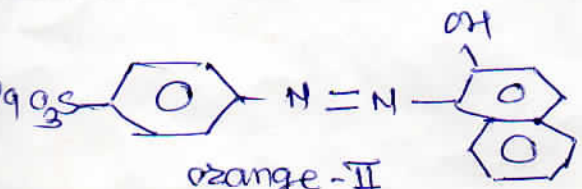
(II) **Azo dyes :-** The azo dyes contains one or more azo gr. [$-N=N-$] as the primary chromophores. The common auxochromes are $-NH_2$ $-NR_2$ $-OH$ $-SO_3H$ etc.

The azo dyes ~~are~~ form the largest & most important group of synthetic dyes. These are highly coloured & can be easily prepared by diazotization method.

e.g.

1) 

Para red.

2) 

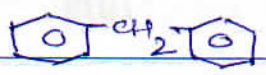
orange-II

Diazodye - congo red.

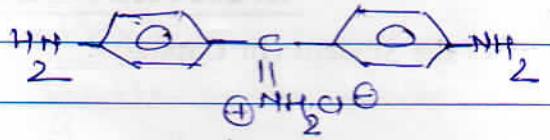
See on back Page

Classification of Dye on chemical constitutions -

(III) Diphenyl methane Dye:- These are derivatives of diphenyl methane & used as salt,

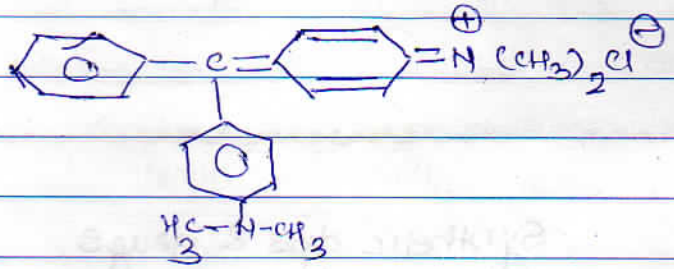
e.g. 1) 

Diphenyl methane

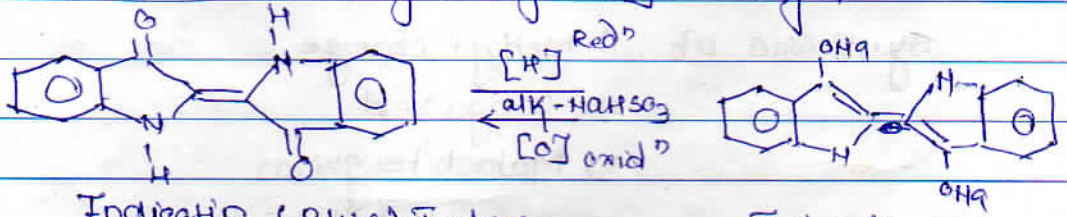
2) 

Auramine-O

(IV) Triphenyl methane Dye - These dye are derivatives of triphenyl-methane & contain $-NH_2$ & $-OH$ gr. e.g. Malachite green.

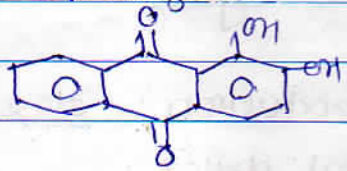


(V) Indigoid dyes - Indole is parent compound of these dyes. Indigo & its imp derivatives act as Indigoid dye e.g. Indigo.



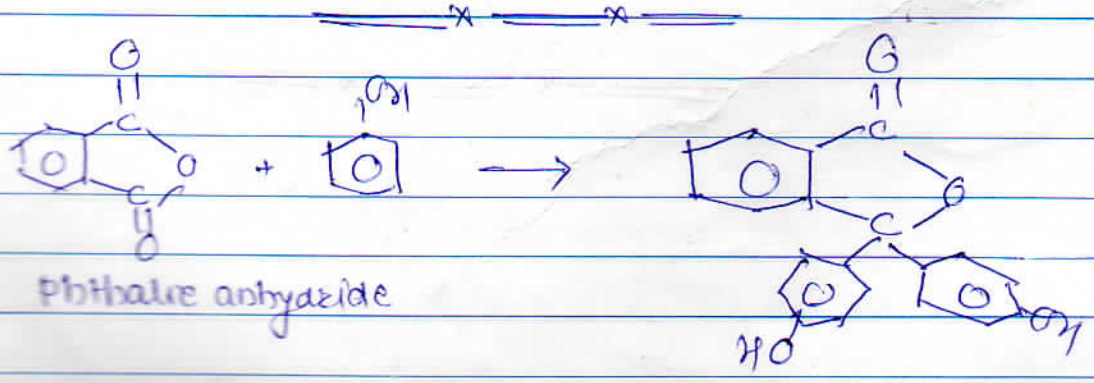
Indigotin (Blue) Indigo Indigotin-white.

(VI) Anthraquinone Dye:- These are commercially Imp dye & are derivative of anthraquinone. e.g. Alizarin.



Alizarin.

(VII) phthaleins & Xanthene Dyes:- phthalein dyes are imp dye by condensing phthalic anhydride & phenols in ptce of conc. H_2SO_4 & An-$ZnCl_2$ e.g. phenolphthalein. Xanthene dye are derivative of xanthene e.g. fluorescein.

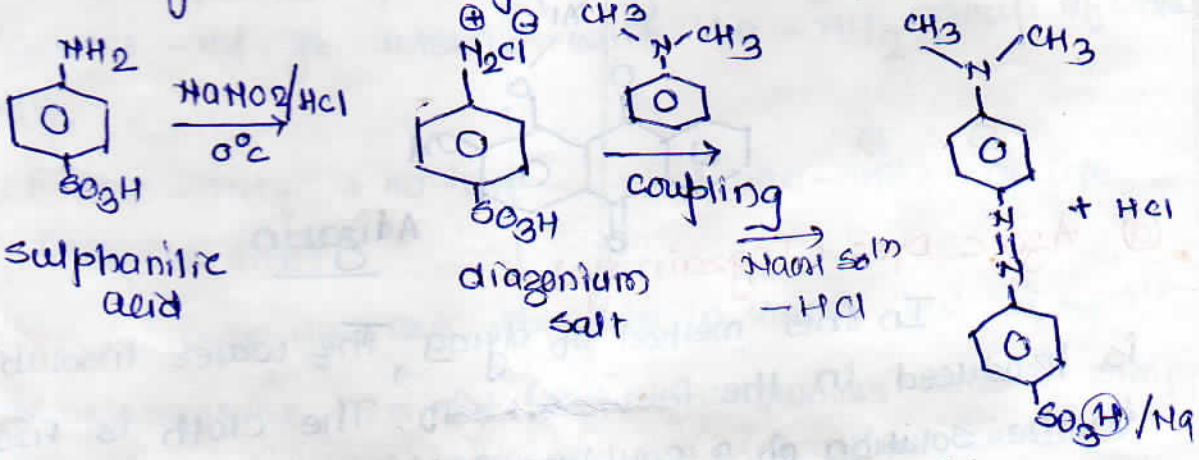


phthalic anhydride

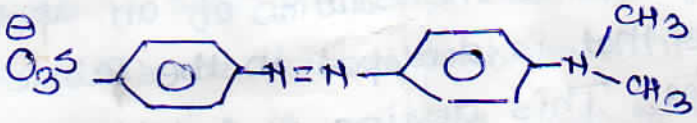
phenolphthalein

Chemistry & synthesis of dyes:- In recent days no. of dyes are prepared in laboratory some of examples are given below;

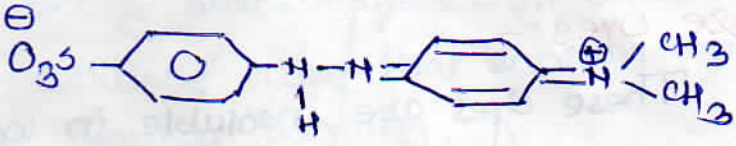
(I) **Methyl orange:-** It is good dye or indicator used in diff^{nt} titration. The methyl orange obtained from sulphanilic acid by the following steps; i.e diazodization & coupling reaction. methyl orange dye is applied to wool & silk but the colour is not fast to sunlight or washing. It is valuable indicator in acid-base titration. It gives yellow colour in basic solution & red colour in acidic soln. colour change due to change in the structure of the ion.



Methyl orange.



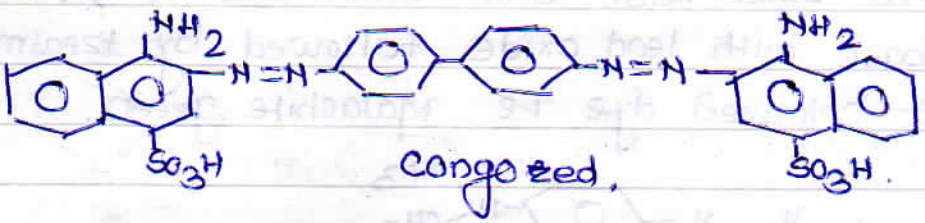
Acid ↓ ↑ Base (yellow in base).



(Red in acid)

Methyl orange

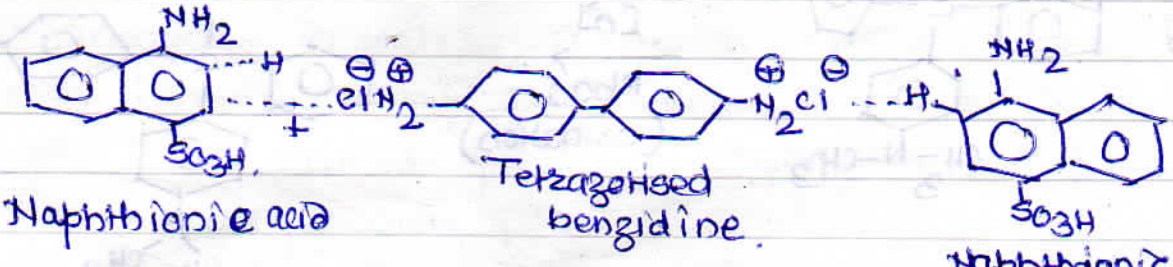
(ii) **Congo Red :-** It is one of the important dyes. The congo red contains two azo group; Structure given below



Congo red.

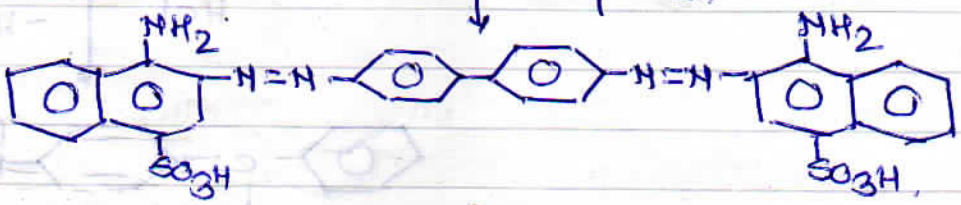
Congo red dye is direct dye & its sodium salts used for dyeing cotton red from aq. solution. Congo red is also used as an indicator being red in alkali & blue in acid solution.

Congo red can be obtained by coupling tetrazot-ised benzidine with two molecule of naphthionic acid.



Naphthionic acid — Tetrazotised benzidine — Naphthionic acid

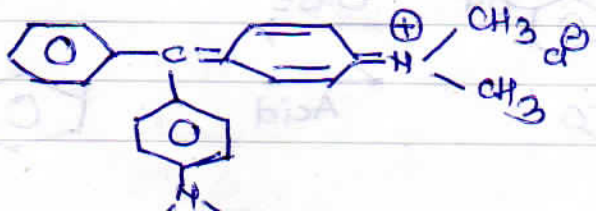
coupling



Congo red.

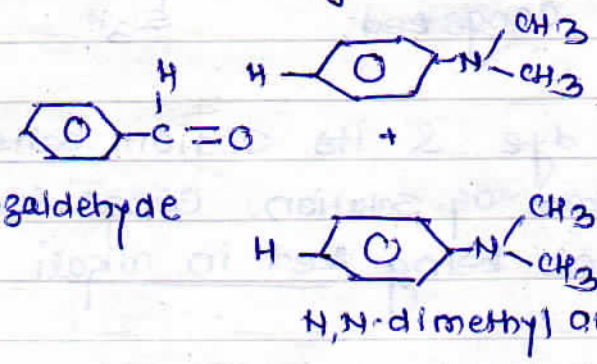
(iii) **Malachite green :-** Malachite green has a deep green-blue colour. Although the colour fades in light. Malachite green is used as a direct dye for wool & silk. Malachite green contain three aryl ring bonded through a central carbon one ring is in quinoid form (the chromophore) & some auxo-chromes are $-NH_2$; $-NR_2$ & $-OH$ group.

Structure of chalachite green.



Malachite green obtained by treating benzaldehyde (1 mole) with N,N-dimethyl aniline (2 moles) in the presence of conc. H_2SO_4 to give Leuco base (Gr. leuco = colourless). Oxidation of the leuco base with lead oxide followed by treatment with HCl yields coloured dye i.e Malachite green.

(I)

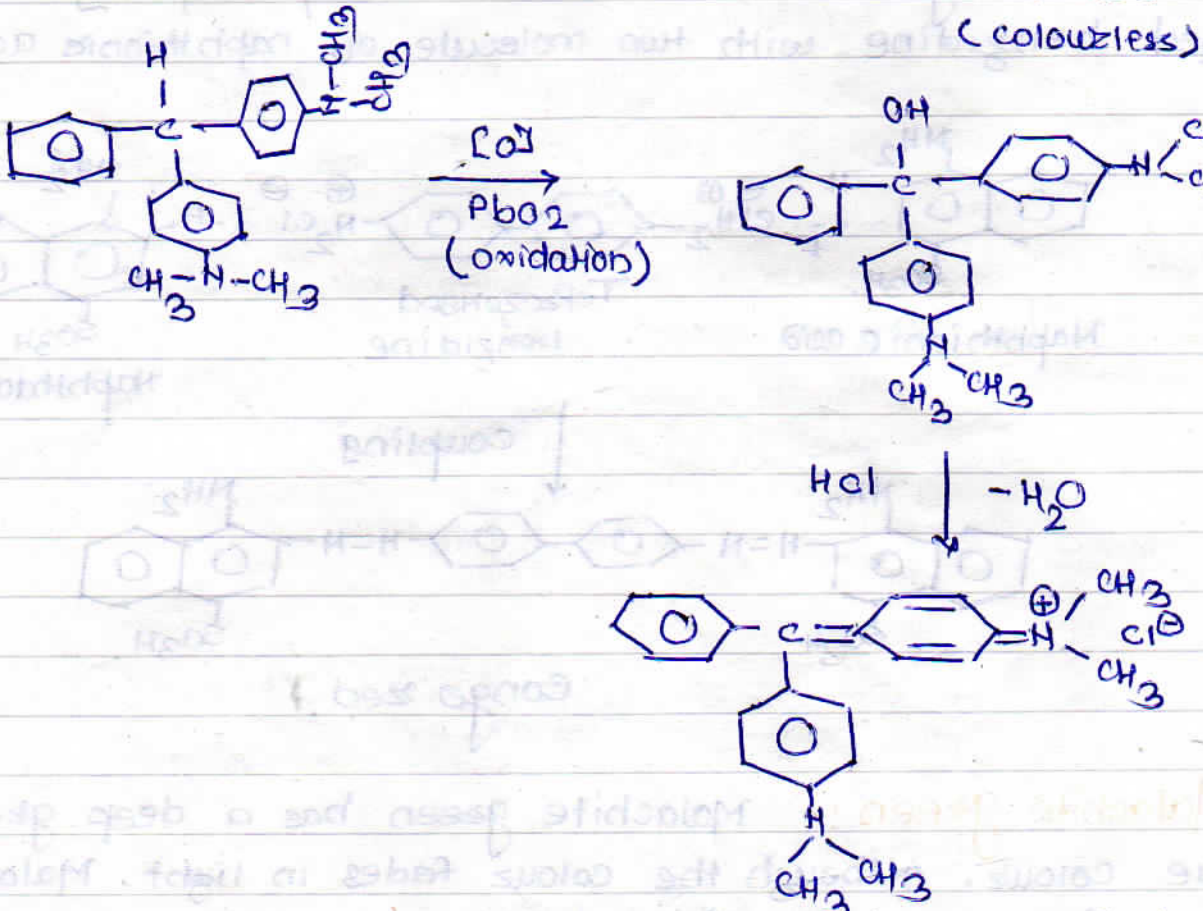


Benzaldehyde

N,N-dimethyl amine

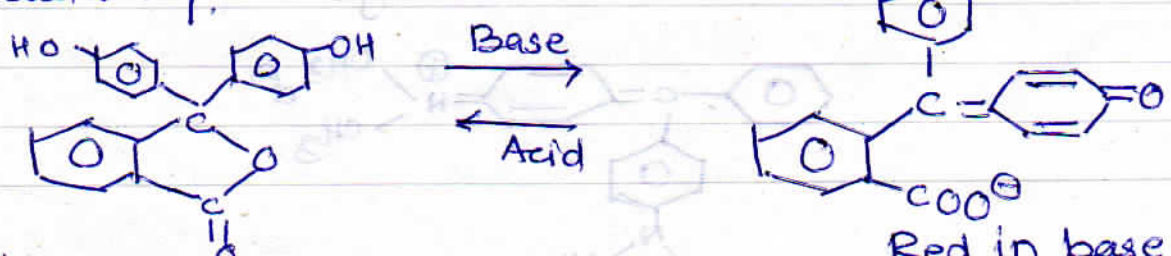
Leuco base (colourless).

(II)



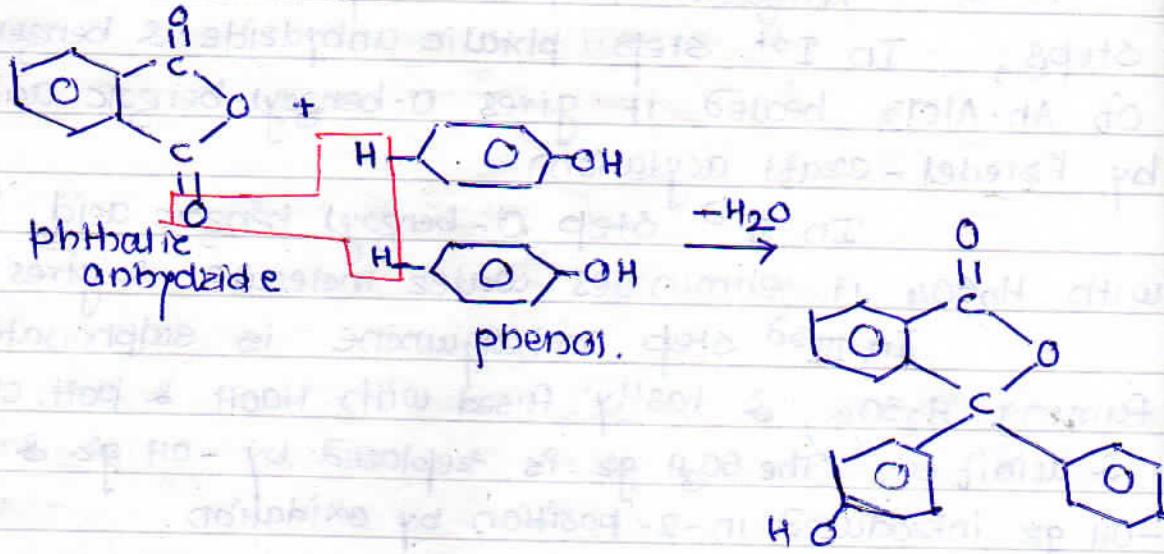
Malachite green (coloured)

(IV) **Phenolphthalein :-** It is well known as acid-base indicator. it is triaryl methane dye. It gives pink colour in base & colourless in acidic medium, it show by structurally.



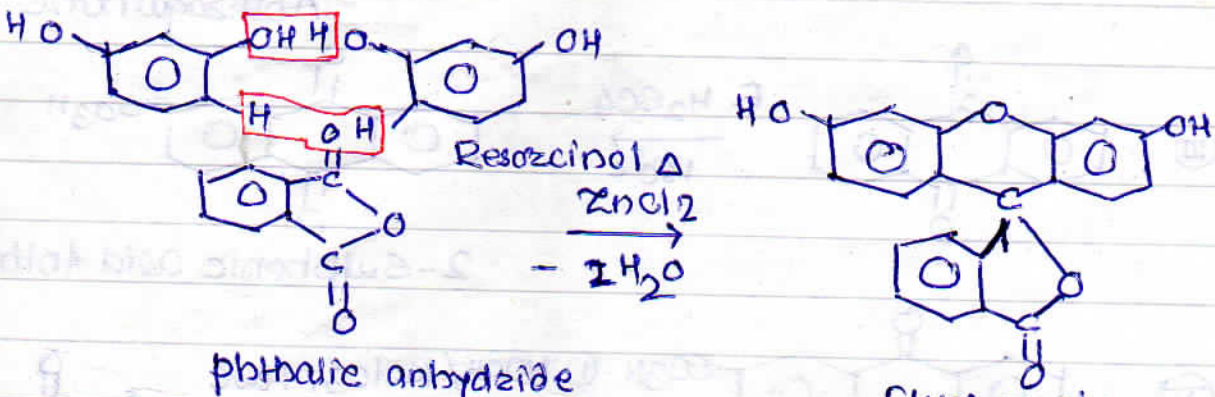
Red in base

Phenolphthalein can be prepared by heating phthalic anhydride (1 mole) & phenol (2 mole) in the of anhydrous Zinc chloride at 120°C



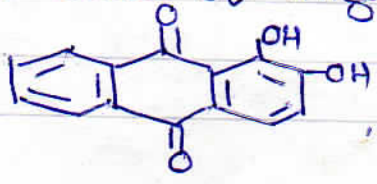
(I) Fluorescein: It is one of the best dye, it is orange powder insoluble in water. It dissolves in dil. alkali & gives the beautiful yellow-green fluorescence. The sodium salt of fluorescein is known as Uzaine, which is used for dyeing wool or silk yellow.

It is obtained by heating resorcinol (2 mole) & phthalic anhydride (1 mole) with zinc chloride at 190°C



(II) Alizarin:- It is anthraquinone dyes, the para-quinoid chromophore is present in these anthracene-type dyes. its commonly called as Alizarin. Alizarin is typical anthra-quinone dye.

Structure of Alizarin.



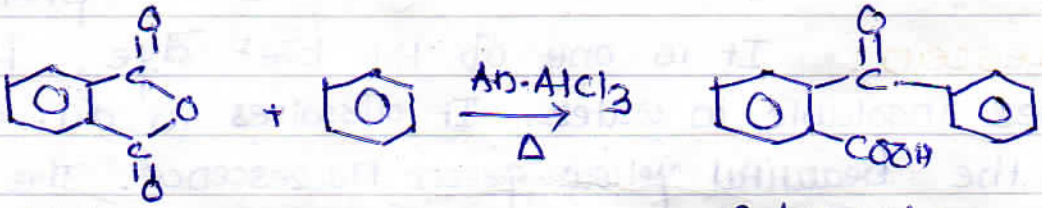
Alizarin forms ruby red crystals which dissolved in alkali to give purple solution. It is used to dye wool & cotton.

Alizarin prepared by no. of following - steps; In I^st step phtalic anhydride & benzene in the of An. $AlCl_3$ heated it gives O-benzoyl benzoic acid (i.e by Friedel - Craft acylation)

In II^nd step O-benzoyl benzoic acid heated with H_2SO_4 it eliminates water molecule & gives anthraquinone

In III^rd step anthraquinone is sulphonated by fuming H_2SO_4, & lastly fused with NaOH & pott. chlorate & acidified. The SO_3H gr is replaced by -OH gr & another -OH gr introduced in-2- position by oxidation.

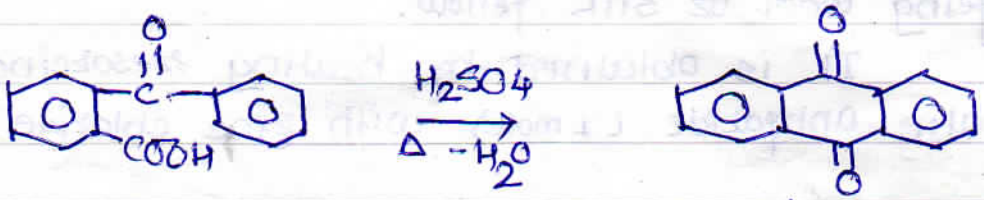
(I)



phthalic anhydride

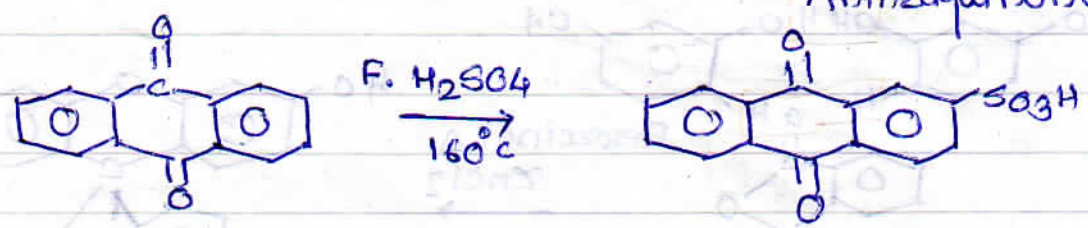
O-benzoyl benzoic acid.

(II)



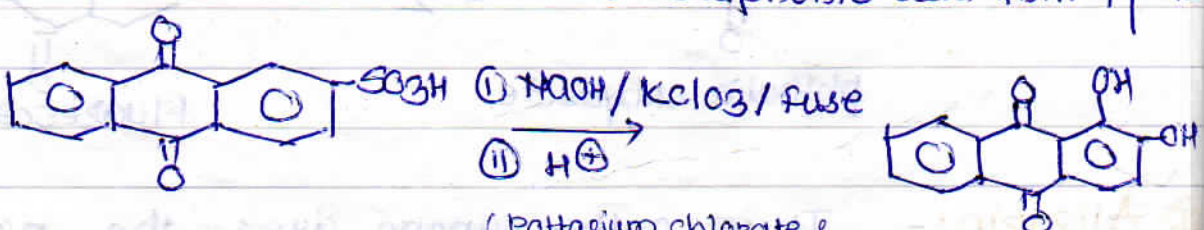
Anthraquinone.

(III)



2-Sulphonic acid Anthraquinone

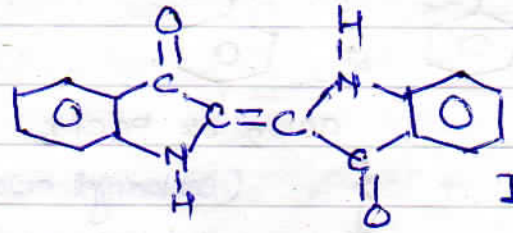
(IV)



(Pottasium chlorate & acidified).

Alizarin.

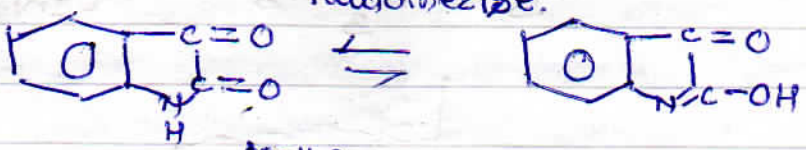
Indigo Dyes:- In indigo dyes carbonyl chromoph are present. It is dark-blue crystalline compound insoluble in water. It is used for dyeing cotton by the vat process. Structure of indigo dye,



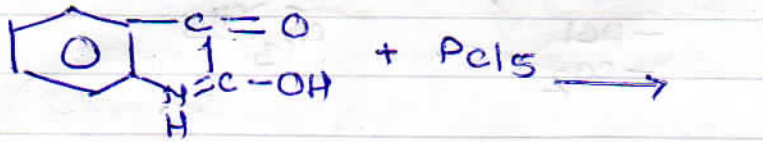
Indigo.

The synthesis of indigo dye & confirmation of ind by following methods or steps. In 1872 by Baeyer synthesize indigo from isatin.

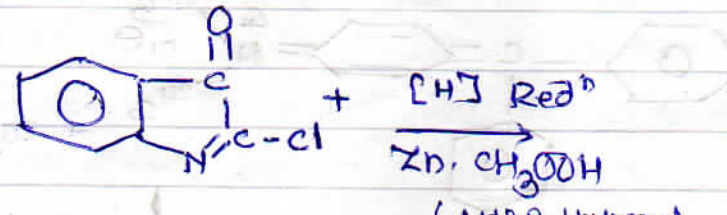
Tautomerize.

(I) 

Isatin Keto form Enol form

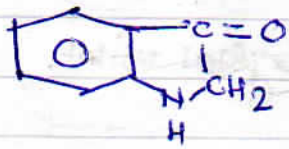
(II) 

+ PCl_5 → + $POCl_3$ + HC

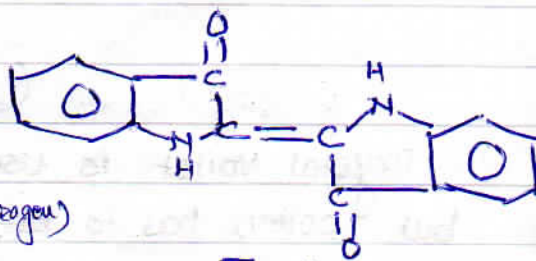
(III) 

[H] Red^n Zn, CH_3COOH (Add^n of Hydrogen).

Indoxyl.

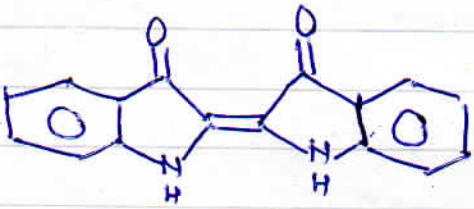
(IV) 2 

Indoxyl (2 mole) $\xrightarrow[(-2H_2O)]{O_2}$ [O] oxidn (Remove hydrogen)

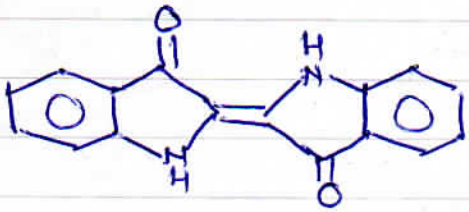


Indigo (Trans

Geometrical Isomerism of Indigo.



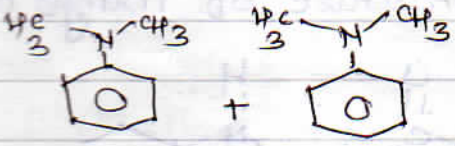
Cis-form



Trans form (More stable).

(VIII) **Crystal Voilet :-** It is prepared by heating Michler's ketone with N,N - Dimethyl aniline in presence of phosphoryl chloride or, carbonyl chloride, as follow,

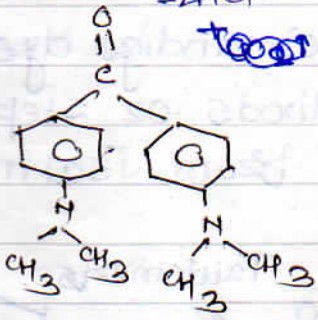
Reaction



$COCl_2$ or $POCl_3$

(carbonyl chloride or phosphoryl chloride)

$-2HCl$

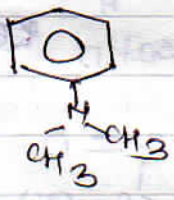


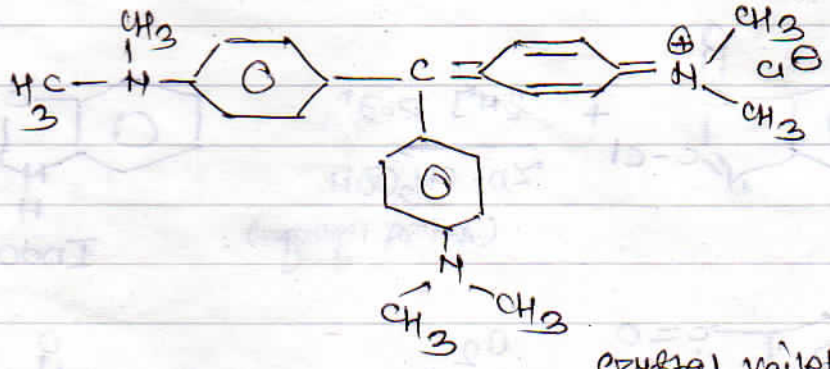
Michler's Ketone (Intermediate)

$COCl_2$

$-HCl$

$-CO_2$





$+ CO_2 \uparrow + HCl$.

Crystal voilet.

(It's hydrochlorides ions)

Crystal voilet is used for dyeing wool & silk directly but cotton has to be mordanted before dyeing.

(B) Synthetic Drugs

(A) **Defination:-** "In a general way a drug may be defined as a substance used in the prevention, diagnosis, treatment or cure of disease in man or other animals." called as the drugs.

(B) **Introduction:-** The word drug is derived from the french word drogue which means a dry herb. According to WHO a drug may be defined as any substance or product which is used or intended to be used for modifying or exploring physiological systems or pathological state for the benefit of the receipient.

(C) **Properties of ideal drugs:-**

Ideal drugs should satisfy the following requirement

i) when drugs administrated to the ailing individual or host, its actions should be localised at the side where it is desired to act. In actual practice there is no drugs which behaves in this way. It generally tends to distribute itself any where in the tissues of the host.

ii) It should act in a system with efficiency & safety.

iii) It should not have any toxicity.

iv) It should have minimum side effects.

v) It should not injure host tissues or physiological processes.

vi) The cells should not acquire tolerance or resistance to the drug after some time. In actual practice the cells which were originally susceptible to the action of a particular drugs may after some time acquire a tolerance or resistant to that drugs.

Very few drugs satisfy all the above condition However, the search for ideal drugs continues.

(D) Classification of Drugs :-

Drugs can be classified according to various criter Usually they may be classified in the following two ways,

1) on the basis of their chemical structures.
2) on the basis of their therapeutic actions.

1) On the basis of their chemical structures,

This classification was extensively used some years ago & it is still used by some authers. Following the classification drugs m come in one of more of these categories such as, acetals, acids alcohols, amides, amidines, amines, amino acids, amino alcohols, amino ethers, amino ketones, ammonium compounds, azo compounds, hydrocarbons, Ketones, Lactams, Lactones, Mustards, nitro comp nitroso compounds, organominerals, phenols, quinones, semicarbazid semicarbazones, Stilbenes, Sulfonamides, Sulfones, thiols, thioamide thiourea, Urea, Ureides, Urethanes etc.

2) On the basis of their therapeutic actions.

Whenever on the other hand the classification of drugs is done on the basis of their therapeutic action this will tend to obscure their chemical resemblances & thus it would be difficult to give description of chemistry of various groups of drugs.

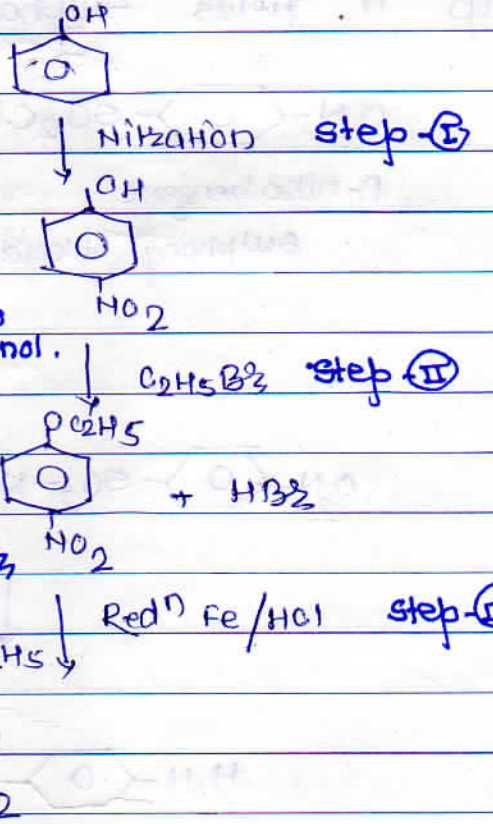
According to their therapeutic actions the drugs are classified into following broad types,

a) CNS agents
b) Pharmacodynamics agents
c) Chemotherapeutic agents
d) Metabolic diseases & Endocrine functions.

(1) Synthesis of phenacetein :-

It may be prepared from phenol. Phenol on nitration gives p-nitrophenol again it treated with ethyl bromide it gives corrosponding ethers. This compound on reduction with iron & HCl gives p-phenetidine. This on acylation with acetic anhydride yields phenacetein.

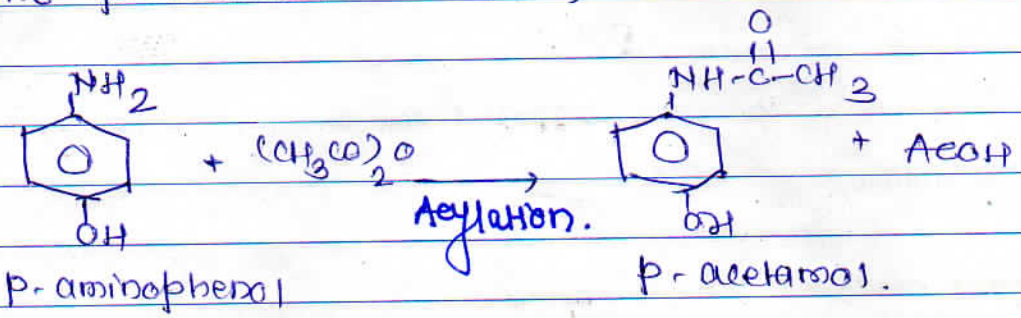
e.g.



phenacetein.

(2) Synthesis of p-Acetamol (Paracetamol) :-

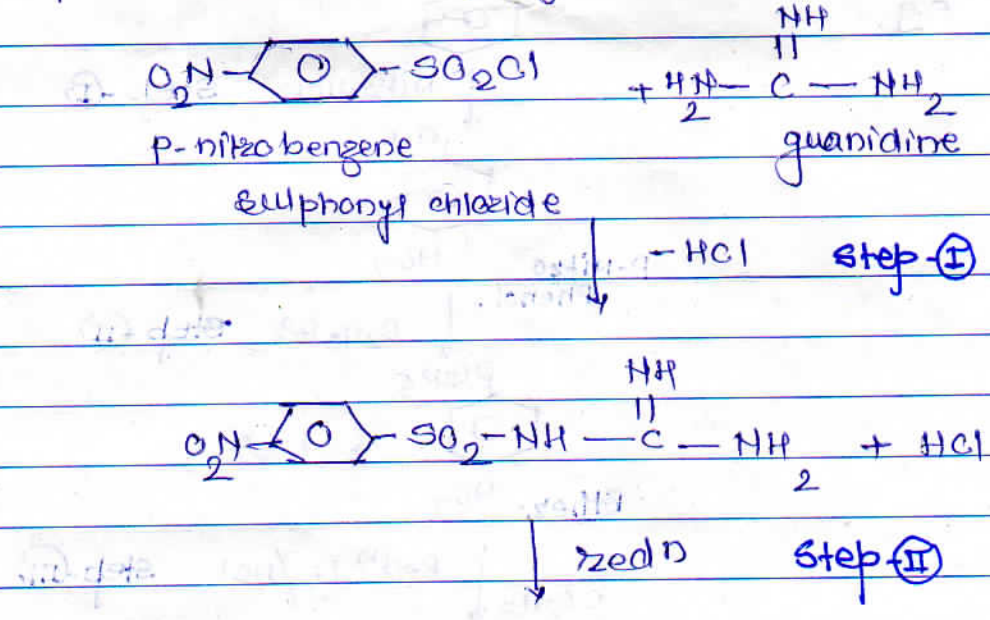
When p-aminophenol on acylation by acetic anhydride it gives the p-acetamol as follows,



p-aminophenol — p-acetamol.

(3) Synthesis of Sulphaguanidine :-

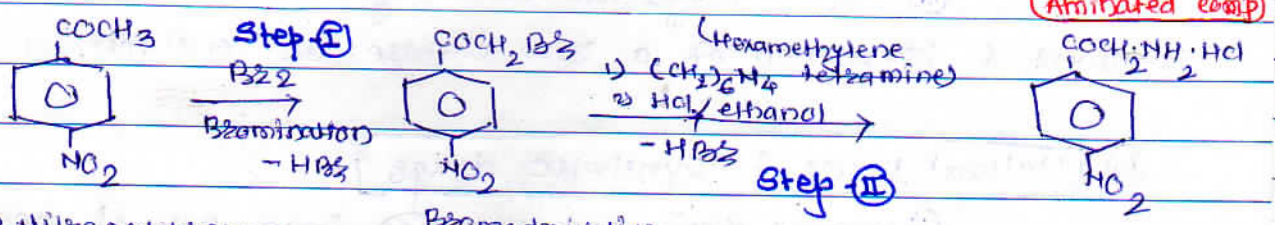
It is prepared by condensing guinidine with p-nitro benzene sulphonyl chloride followed by the reduction of the nitro group it yields sulphaguanidine as follows,



Sulphaguanidine.

④ Synthesis of chloramphenicol :-

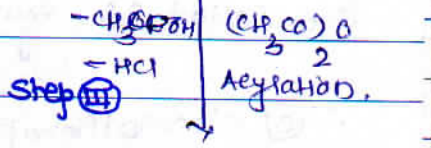
Chloramphenicol is a levorotatory broad spectrum antibiotic originally produced from several streptomycetes. It has been reported to be a drugs of choice for the treatment of typhus & typhoid fever. It can be prepared in laboratory by following methods -

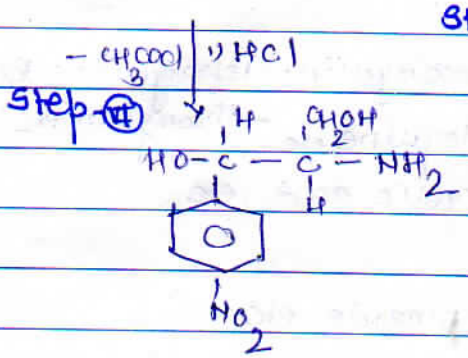


P-Nitro acetophenone

Bromo derivative
P-Nitro phenacyl bromide
(Bromination)

2-Amino-p-Nitro acetophenone hydro-chloride.

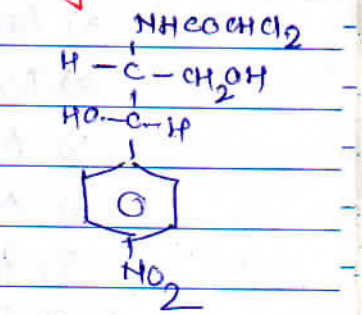


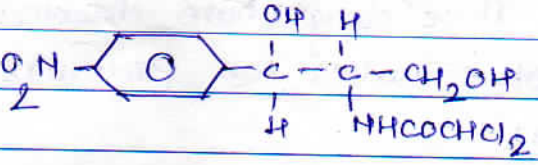


1) Resolution with D-camphoric acid
2) $Cl_2CH\text{-}COOCH_3$ - dichloro methyl acetate
(Addition to the side chain)

$[-CH_2OH]$

Step-(VII)





Chloramphenicol structure

(A) Essential drugs & Orphan drugs :-

(i) Essential drugs are defined by WHO as "These drugs satisfy the priority health care needs of the population Essential drugs are intended to be available with in the context of functioning health system at all times in such amounts"

(ii) Orphan Drugs are the biological products for the diagnosis treatment & prevention of a rare disease or condition.

(B) Natural Drugs & synthetic drugs :-

(i) Natural drugs are extracted from natural resources such as plants, animals or nonliving natural materials.

(ii) Such drugs can be synthesized in Laboratory are called as synthetic drugs.

(C) Chemotherapuetic agents :-

These drugs are used in the treatment & cure the specific disease. These drugs attack & destroy microorganism without affecting the cell of host. e.g.

1) Antimalerial → chlorogwin
2) Antibiotic → penicillin, amoxycilin, chloromycetin, Tetracycline, Erythromycin etc
3) Antiprotozoals → Metrodiazole, Diadoquine etc
4) Antifungal → Benzoic acid, Salicylic acid etc.
5) Antiseptic → Boric acid, H_2O_2
6) Antitubercular → streptomycin, Isoniazide etc
7) Antileprosy →
8) Organomatrics → Arsenobenzene comp

(D) Pharmacodynamic Agent :-

These drugs have characteristic effect upon the animal organism but are not remedies for particular disease, These drugs further classified as

I) Depressents → These drugs are also called as non-selective central nervous system

Sedation ⇌ Hypnosis ⇌ Anaesthesia ⇌ coma ⇌ Death.

II) Tranquilizer :→ Drugs used for mental disorders

e.g. Reserpine, promazine etc

(Speace for Writing)

III) Antidepresents :→ These drugs are mood elevators e.g. Meprobamate benzodiazepines.

IV) CNS-Stimulants :→ Drugs which increase the activity of various part of CNS e.g. amphetamine, Ipronagide.

V) Adrenergic Stimulants →. which are mimic stimulants e.g. Adrenaline, isoproterenol etc.

VI) Cardiovascular → Drugs used for working on hearts e.g. Cardiotonic; cardio-vascular drugs etc.

VII) Diuretics → These drugs increase the output of urine by the kidney e.g. Xanthene derivatives.

VIII) Anaesthetic → These drugs create temporary insensibility to pain e.g. methyl-n-propyl ether, cyclopropane etc.

IX) Antipyretic & Analgesic :→ These substance lowers the body temp in fever & painkillers e.g. Aspirin, paracetamol.

X) Antihistamines :— Histamines causes the contraction of involuntary muscles, the dilation of arteries & capillaries etc, & hence low B.P. e.g. Antergan, Benadryl, Dimenhydrinate etc