

# Pollution

Pollution can be defined as any undesirable change in physical, chemical and biological characteristics of air, water and soil which harmful effect on living beings. Agents causing pollution are known as pollutants.

In view of serious consequences of the pollution and in order to control it, the Govt of India has passed the Environment (Protection) Act, 1986 to protect and improve the quality of our environment.

Pollution can be discussed under the following heads —

1. Water Pollution
2. Air Pollution
3. Soil Pollution

1. Water Pollution — According to V.P. Kudesia (1990) water pollution means the addition of any foreign material (inorganic, biological or radiological) or any physical change in the natural water which may harmfully affect the living life (human, agricultural, biological), directly or indirectly.

In simpler words, however, water pollution is may be defined as any undesirable change in the natural change qualities of water which may harmfully affect the living

life.

In order to control Water Pollution, the Government of India passed the Water (Prevention and Control of Pollution) Act, 1974 to safeguard our water resources.

Sources of Water Pollution :- Various sources of water pollution are discussed under two heads :-

- A. Domestic Sewage
- B. Industrial Sewage

A. Domestic Sewage - Domestic Sewage is nothing but domestic waste passed down into sewer system. Domestic Sewage includes wastes from kitchens, washings, Toilets etc. which are usually released in rivers on the banks of which most of the cities are located.

The drinking water from these sources contains high amount of - nitrite, nitrate, BOD (Biochemical Oxygen Demand), COD, chloride, Sulphate and total dissolved solids. These effluents in high concentration are toxic and destroy fish and other plant life.

Effects of Domestic Sewage → The adverse effects of domestic sewage on river water are as below -

and streams which is very harmful to aquatic life.

4. Alcohol industry - In the fermentation of molasses, besides alcohol we get glycerine, succinic acid, acetaldehyde, acetic acid etc as byproduct which play an important role in polluting rivers.

5. Cane Sugar industry - The sugar industry in India plays an important role in the economic development of the country. However its effluents are discharged in water during manufacture of sugar and they contain high polluted contents like sulphur, nitrogen, suspended solids as well as high values of BOD and COD. The dissolved oxygen is exhausted which is injurious to aquatic life.

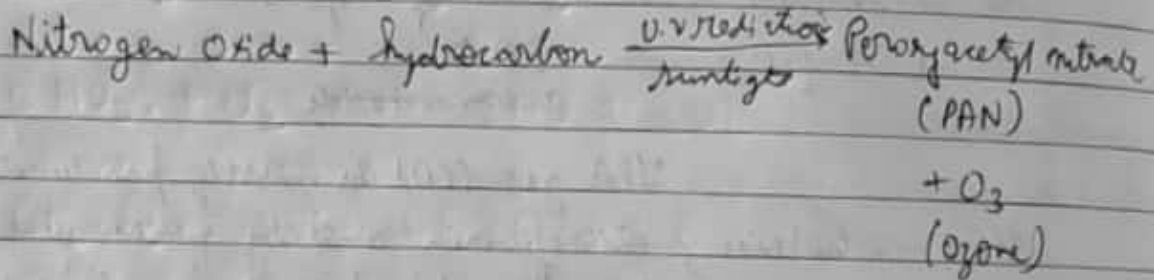
6. Oils - Oils are toxic substances which affect the living organisms in water. Oil pollution in the sea generally occurs during loading and unloading of oil for transport. Oil pollution has created an alarming situation. According to report, about 300000 tonnes of oil residue was discharged in the AT Mediterranean sea in 1970.

Further in 1968 Oil pollution of Ganges near Barauni Oil refinery set the river to on fire causing destruction of aquatic life.

The hazardous effects of oil pollution are as follows -

v) Fluorides - Fluoride containing rocks, soils, minerals etc release hydrogen fluoride in the atmosphere on hitting. Besides fluoride is also released from a large variety of industrial processes in which fluoride compounds are manufactured. Hydrogen fluoride is a phytotoxic gas which causes necrosis and chlorosis of tips and margins of leaves.

v) Hydrocarbons - Hydrocarbons are released in the atmosphere in huge quantity by the burning of petrol in the automobiles. These are quite harmful. Hydrocarbons combine with  $\text{NO}_2$  to produce photochemical smog which causes necrosis of the -



PAN and  $\text{O}_3$  cause eye-watering and respiratory distress apart from being toxic to plants. PAN also causes blockage of Hill reaction in photosynthesis.

vi) Suspended particulate matter (SPM) - Most of the particulate matter in the environment is contributed by dust particles derived from mining operations, asbestos industries, stone crushers. Larger particles (more than  $10\mu\text{m}$ ) settle down but smaller particles (less than  $10\mu\text{m}$ ) remain suspended in the air and are called SPM.

On the surface of such smaller suspended particles  $\text{SO}_2$  and other gases are adsorbed



discharges from industries are often spread over the soil. Such effluents contain heavy metals like nickel, cadmium, chromium, aluminium, zinc etc and toxic chemicals like cyanides, organic solvents etc. Such effluents become part of the soil and harmfully affect the organisms growing there.

2. Agricultural activity — Now a days use of pesticides and fertilizers has become common which also act as pollutants. They not only change chemical properties of the soil but also affect soil organisms, surface water and ground water resources.

Pesticides are chemicals used for killing pathogens, pests etc. Some of them, apart from killing pathogens, also adversely affect the useful organisms living in the soil. Not only this plants absorb many of these pesticides and when they decompose, they cause soil pollution since they become part of the soil after decomposition.

Fertilizers also play a role in soil pollution. Fertilizers are concentrated chemicals which are added to soil or spread over plants to provide them required essential minerals. However, repeated use of fertilizers produce a number of harmful effects. It reduces soil microflora, it destroys basic structure of soil, it increases soil salination and so on.

- a) The oil stick on the water surface prevents water oxygenation and instead consumes oxygen itself for its own degradation.
- b) Oil pollution is a serious obstacle to photosynthesis on which depends the life and growth of the minute phytoplankton.
- c) Absorbed by fish, the pollutants eventually <sup>reach</sup> ~~reach~~ and endanger human life.

7. Pesticides and herbicides - The use of pesticides and herbicides has increased all over the world due to in order to increase the production of agricultural yields. Such compounds when spread on plants percolate through the soil and get dissolved in soil water and pollute it. Examples of such compounds are DDT, Endrin, heptachlor, toxaphene etc. These compounds are washed down with rain water and find their way to sea water through rivers and streams. These compounds accumulate in the body of aquatic plants and animals and thus, the aquatic living system is badly affected.

8. Radioactive wastes - In this atomic waste radioactive substances are used for various purposes like power industry, preserving food and as medicines. They can also be used to prepare bombs etc. The radioactive wastes released are most dangerous because they destroy the aquatic plants and animals.

and thus they provide a surface for various types of harmful chemical reactions. These particles also block the solar radiations reaching the earth, thus causing a drop in earth temperature. Moreover they also cause respiratory disorders.

- vii) Radioactive material - Now a days there is frequent testing of atomic weapons by advanced countries. Such testing releases radioactive materials in the atmosphere which generally settle down on the leaves of plants and harm them.

### Effects of Air Pollution

Some of the important harmful effects of air pollution are as follows -

1. Fog and Smog - The term smog was coined by ~~des~~ Desvoix (1905) for the fog mixed with smoke. It is formed due to household and industrial burning of coal. It contains particulate matter and  $SO_2$ . It ~~contains~~ causes respiratory troubles. It is ~~It~~ per report in 1952, due to smog about 350 people lost their lives.
2. Acid rain - More concentration of  $SO_2$  in the atmosphere is caused by the combustion of coal and petroleum fuels.  $SO_2$  is oxidised to  $SO_3$  which reacts with water to produce  $H_2SO_4$ .  $H_2SO_4$  comes on earth along with rain water, the pH of which may be as low as 3.0 and therefore it is called 'acid rain'.

The latter loses two more hydrogen atoms through the agency of the enzyme  $\beta$ -hydroxyacyl dehydrogenase and a keto group is formed.

The product reacts with a molecule of coenzyme A and split into acetyl coenzyme A and fatty acyl CoA (-2C).

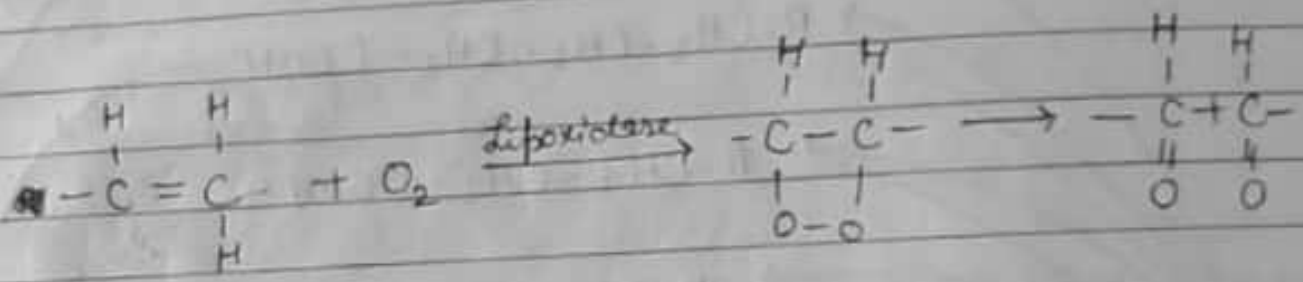
### \* Importance of $\alpha$ -oxidation

1. The potential energy released during  $\alpha$ -oxidation of fatty acid chain is trapped by dehydrogenase. However the system is highly wasteful since the loss of one carbon group produces only one  $NADH_2$  molecule.
2.  $\alpha$ -oxidation can explain the occasional occurrence of odd number of carbon atoms in fatty acid chain.
3. It may help produce long chain alcohol by the conversion of aldehydes formed during the oxidation process.



2. Peroxidation pathway - It occurs in the Oxidation of unsaturated fatty acids. Unsaturated fatty acid possess 1 or more double bond (C=C).

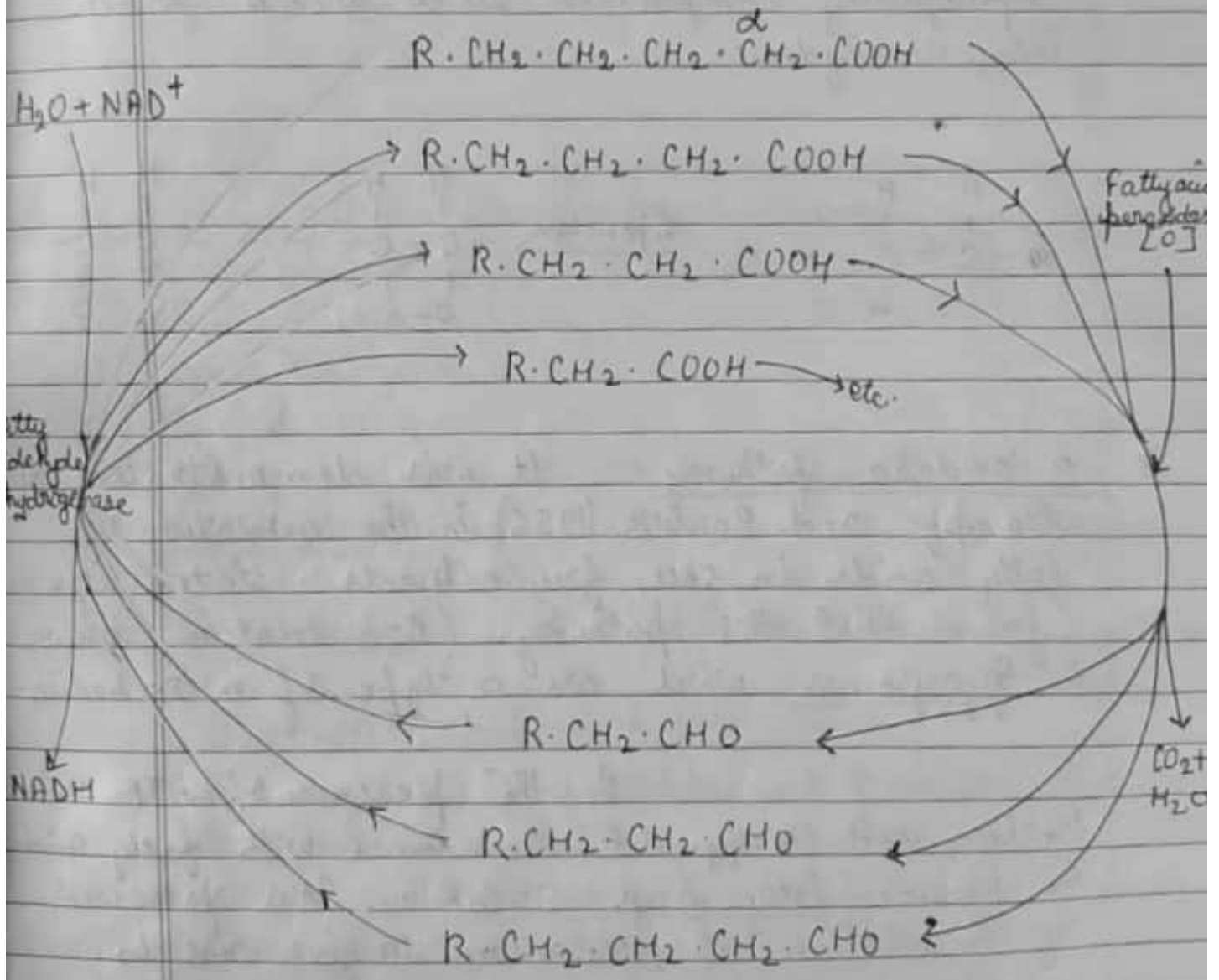
Here molecular oxygen is directly involved in the oxidation in the presence of the enzyme Lipooxidase or lipoygenase. It gives rise to hydroperoxy compound. Hydroperoxy compounds which break further into aldehydes.



3. β-oxidation pathway - It was demonstrated by Stumpf and Barber (1956) in the oxidation of fatty acids in cell free extracts. Later it was found that this pathway (β-oxidation) occurs in Glyoxysomes which are a type of micro bodies.

In the presence of ATP and MgCl<sub>2</sub>, CoA coenzyme A combines with fatty acid to produce fatty acyl-S-CoA. It is followed by the oxidation at β-carbon to give rise to carbonyl group.

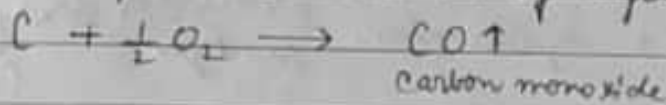
1.  $\alpha$ -oxidation, <sup>fatty</sup> — In the presence of an enzyme complex peroxidase, the terminal acidic group is lost and aldehyde group is generated at the alpha carbon ( $\alpha$ -carbon). Further the aldehyde group is oxidised to the acidic group in the presence of water and  $\text{NAD}^+$ . This cycle is repeated and ultimately total oxidation occurs.



$\alpha$ -oxidation of fatty acids

- a)  $\text{CO}_2$  is produced by the combustion of the fuel in the home, industries, power stations etc.
- b) It is also released by plants and animals including human beings in the process of respiration.
- c) Although photosynthesis of green plants balances to a large extent the ratio of  $\text{CO}_2$  and  $\text{O}_2$  of the atmosphere, the amount of  $\text{CO}_2$  content of the atmosphere has gone up by 15% in recent years which is harmful for the health of living beings.

(i) Carbon monoxide ( $\text{CO}$ ) - It is a poisonous gas and considered a chief air pollutant. It is produced by the incomplete combustion of hydrocarbons -



This gas ( $\text{CO}$ ) is mostly produced in steel industries, oil refineries and by motor vehicles. Besides, the incomplete burning of coal for domestic use also adds to  $\text{CO}$ .

(ii) Sulphur dioxide ( $\text{SO}_2$ ) - Sulphur dioxide is also considered as an air pollutant. The industrial expansion in the modern times today has resulted in large scale production of sulphur dioxide in the atmosphere. The sulphur content of ores of copper, zinc, lead, nickel and iron is oxidised in the smelters to produce  $\text{SO}_2$  which is released in the atmosphere.

$\text{SO}_2$  is quite harmful causing diseases of eyes, throat and lungs. It is also very injurious for plants. High conc. of  $\text{SO}_2$  causes rapid disappearance of chlorophyll (chlorosis), break down of cells and development of necrosis. There are many instances where the entire plant community has been destroyed by



Q-1. Quality of water - As the water becomes odorous and turbid, it becomes unsuitable for drinking, washing, bathing etc.

2. BOD (Biochemical Oxygen Demand) - Due to domestic sewage released in water, BOD increases. It is because the domestic sewage, which mainly consists of biodegradable organic wastes, are decomposed with the help of decomposers which includes various groups of bacteria and fungi. Such decomposers require oxygen for their activity. Therefore the amount of oxygen required by such decomposers is called BOD. Therefore BOD increases.

Gradually most of the dissolved oxygen is consumed by decomposers and so the quantity of dissolved oxygen (DO) decreases. As a result fish and other aquatic organisms do not survive.

Ultimately in the downstream, with the degradation of organic matter, the BOD falls and DO increases. With this the fish and other clean water organisms are found here.

B. Industrial Sewage - The industrial wastes and effluents also play a significant role in water pollution.

While dealing with different causes of water pollution caused by industrial sewage, let us discuss about Biomagnification and



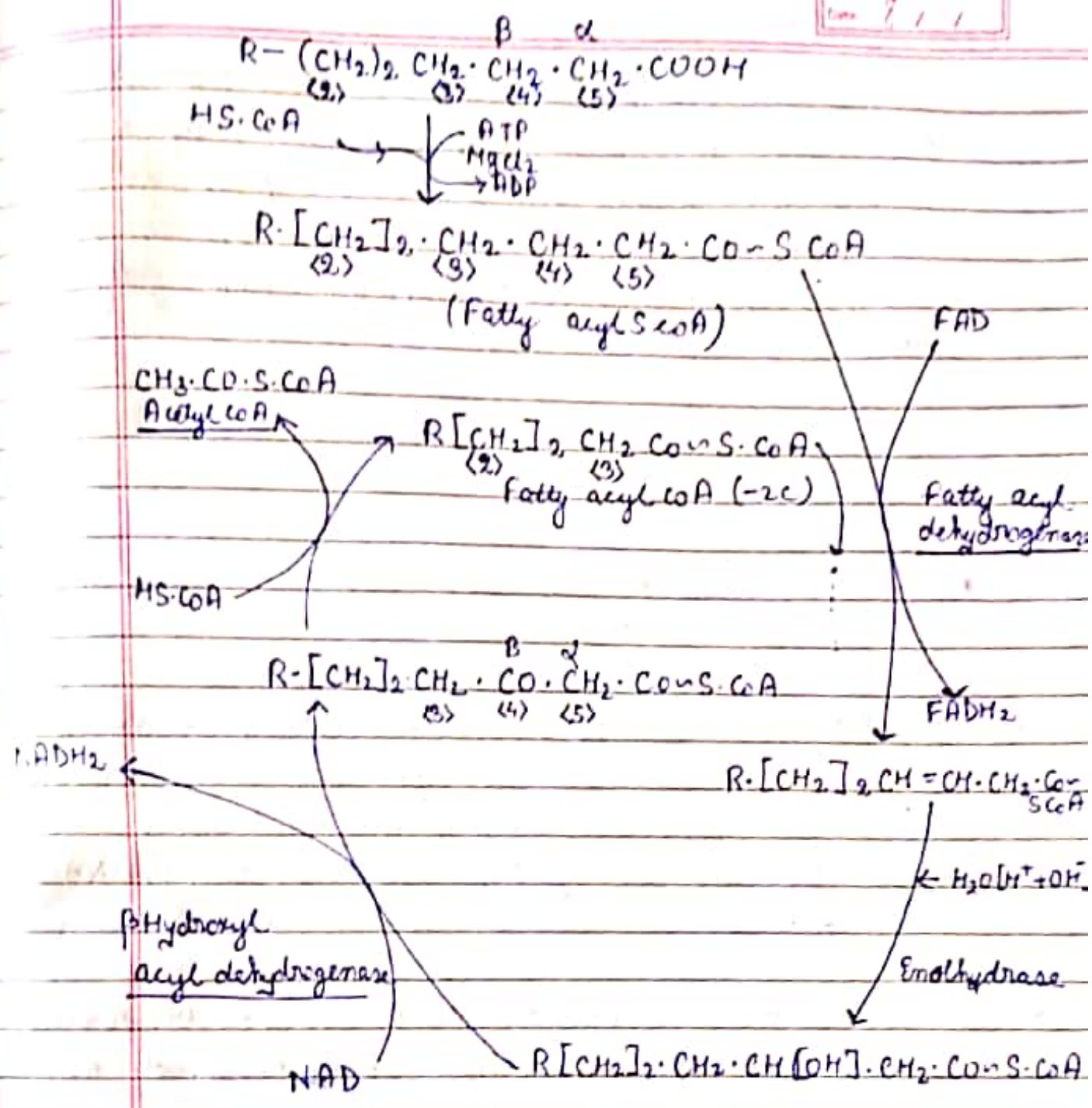
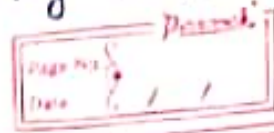


Fig:-  $\beta$ -oxidation of fatty acids.

Oxidation at  $\beta$ -carbon does not occur directly. Initially, a double bond is created with the removal of 2 hydrogen atoms by means of enzyme fatty acyl dehydrogenase.

Now a molecule of water is added in the presence of enzyme enol hydrase and hydroxy group is created.

\* The green house effect was discovered by Irish scientist John Tyndall.



4. Green house effect and global warming —\* The gases like  $\text{CO}_2$ , CFCs, methane and oxides of nitrogen are called green house gases because they behave as glass windows of green houses. These gases allow the solar radiation to reach the solar surface and cause heating effect on earth. However, the heat is not allowed to escape out due to these gases. It thus raises the temperature of the earth. This phenomenon is called global warming.

As estimated if the amount of  $\text{CO}_2$  present in the existing atmosphere becomes double the earth temperature will rise by  $2.0$  to  $5.5^\circ\text{C}$ . It can cause melting of glaciers, polar ice caps and other natural deposits of ice causing global flooding and disappearance of several islands.

## \* Soil Pollution

Soil pollution is defined as any unfavourable alteration in physical, chemical and biological properties of soil due to addition or removal of substances or factors which reduce its productivity.

Main causes of soil pollution are as below —

1. Industrial activities — Industrial activity has been the a main cause of soil pollution. Most of the industries are dependent on extracting minerals from the soil earth, whereas the various kinds of

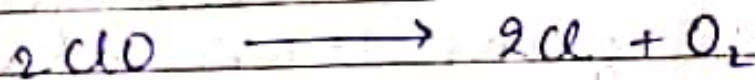
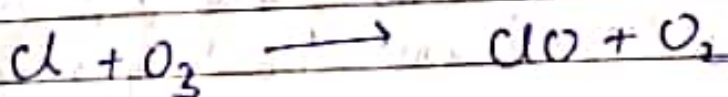
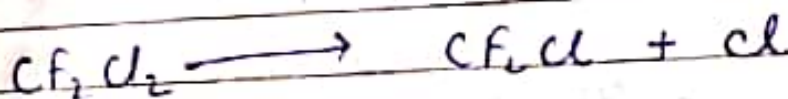
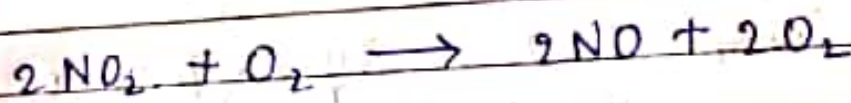
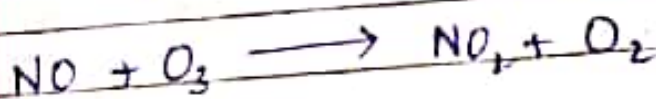
Teacher's Signature.....



The acid rain may cause various problems related to skin and respiratory tract.

B. Ozone hole - In the upper atmosphere called stratosphere a very thin layer of Ozone ( $O_3$ ) is present which absorbs the harmful UV radiation and thus protects the organism on the earth.

The pollutants like Oxides of nitrogen and chlorofluorocarbons (CFCs) decompose Ozone by reacting with it as below -



It is clear from above chemical reaction that NO and Cl which react with Ozone are continuously produced, thus causing depletion of Ozone. It causes the so called "Ozone hole" in the protective covering of Ozone layer around the earth through which UV radiations can reach the earth causing adverse effects on the living beings.

to a great extent. They may also cause gene mutation, chromosomal mutation and ionization of body fluids.

## 2. Air Pollution

Any undesirable change in the normal composition of air which is harmful to living things is known as air pollution.

In order to prevent air pollution in India, the AIR (Prevention and Control of Pollution) Act came into force in 1981. However it was amended in 1987 to include noise, <sup>also</sup> as an air pollutant.

Air normally contains about 78% nitrogen, 21% oxygen, the remaining 1% comprises  $\text{CO}_2$  and other components gases.

### Causes of air pollution

Among the various causes of air pollution a few important are as below —

i) Carbon dioxide ( $\text{CO}_2$ ) — Nitrogen, oxygen and  $\text{CO}_2$  <sup>is</sup> normally present in the atmosphere in the following proportion:

$\text{N}_2$  — 78%

$\text{O}_2$  — 21%

$\text{CO}_2$  — 0.03%

However the above normal ratio of gases to maintain the balance in nature is disturbed by the following —

Teacher's Signature.....



Eutrophication - Eutrophication is the process of nutrient and enrichment of water causing excessive growth of algae forming algal-bloom. The algae undergo decomposition and add toxin in water, it also deoxygenates the water which thus harms the aquatic animals and disturbs the food chain.

Role of different industries causing water pollution may be cited as below -

1. Pulp and Paper factory - A large amount of varieties of waste matter is released in water by such factor pulp and paper factories. These are heavy solids like ~~carbohydrate~~ fibre, bark, wood and dissolved solids like carbohydrates and dissolved wood matters including bleaching chemicals. These pollutants ~~are~~ have disastrous effect on water.
2. Steel factory - The effluents of steel industry act as major pollutant of water. They contain high amounts of phenol, ammonia, thiosulphate, manganese etc. and also high values of BOD and COD. All these factors ~~become~~ are toxic to aquatic life. The high pH value also increases the toxicity of water.
3. Electroplating plants - They contain harmful heavy metals and cyanide cyanides which cause excessive acidity or alkalinity of water of rivers.

## Eutrophication:

Biomagnification - It is the phenomenon in which the harmful pollutants in water bodies can undergo biological magnification in the aquatic food chain. The pollutants which enter the food chain get more and more concentrated at each successive trophic level. This is called biomagnification. It so happens because a toxic substance or pollutant accumulated by an organism cannot be metabolised and is thus passed on to the next higher trophic level and thus becomes much harmful to higher order of consumers. It may be depicted as below:-



13. Calculate the chi-square from the scores given below.

नीचे दिए गए प्राप्ति को से काई-स्क्वियर की गणना करें।

|     | Agree | Neutral | Disagree | Total |
|-----|-------|---------|----------|-------|
| fo: | 80    | 50      | 110      | 240   |
| fe: | 80    | 80      | 80       | 240   |

14. Write short notes :-

दियायी लिखें

(a) Meaning of correlation

सहसंबंध का अर्थ

(b) Difference between Parametric and Non-parametric statistics

पारमेट्रिक एवं अपारमेट्रिक सांख्यिकी के अंतर

(c) Utilities of statistics in psychology

मनोविज्ञान में सांख्यिकी की उपयोगिता

(d) What is correlation co-efficient ?

सहसंबंध गुणांक क्या है ?

15. Compute chi-square for the following data

निम्नलिखित प्राप्ति को से काई-स्क्वियर की गणना करें।

|        | Agree | Disagree | Not decided |
|--------|-------|----------|-------------|
| Male   | 20    | 10       | 20          |
| Female | 10    | 20       | 30          |

Model Questions

1. स्वतंत्र विज्ञान के रूप में मनोविज्ञान के विकास के इतिहास का वर्णन करें।
2. प्रयोगात्मक मनो विज्ञान के विकास में विलियम डेवरी के योगदान को लिखें।
3. प्रकाशवादी विचारधारा के विकास में विलियम जैम्स के योगदान का वर्णन करें।
4. व्यवहारवाद के विकास में वाटसन के योगदान का उल्लेख करें।
5. गैदराल्ड सप्रदाय के जनकता के रूप में प्रेक्स वर्दीइमर के योगदानों का वर्णन करें।

Paper 9th - Statistics

1. प्रसांगिक संगणना का की- उपयोगिताओं का वर्णन करें।
2. प्रसांगिक वक्र क्या है? इसके स्वरूप की व्याख्या करें।
3. सहसंबंध से आप क्या समझते हैं? इसके इतिहास का वर्णन करें।
4. टी. परीक्षण-कितने करते हैं? इसकी उपयोगिता की व्याख्या करें।
5. दो मध्यमों के बीच के अंतर की कार्यविधि को कैसे निश्चित किया जाता है?
6. शून्य परिकल्पना से आप क्या समझते हैं? इसके प्रमुख साधकों को लिखें।
7. कोरे-अन्तर सहसंबंध विधि से आप क्या समझते हैं? कि परिस्थितियों में इसे विधि का व्यवहार किया जाता है?



Department - of Psychology  
Suligama College of Arts  
U.G. - Sem. - VI Paper 601 core 26(a) C-13-T  
Clinical Psychology

Unit I: Schizophrenia

Symptoms of Schizophrenia.  
Cause of Schizophrenia. Treatment  
or remedial of Schizophrenia.

Unit II Mood-Disorders:

What do you mean by mood-disorders,  
Symptoms of mood-disorders.  
Cause of mood-disorders.

Unit III Personality-Disorders.

Anti-social Personality,  
Psychoanalytic model, Cognitive-  
Model, Paraphilias.

Unit IV Behavioural-Model.

Yr. 2020.

Sulbangan Collage. <sup>8021</sup>  
Department of Psychology

Paper Emergence and growth of Psychology.

U.G sem IV Paper - 401 Core - VIII 25(2)

Unit I: History of Psychology  
origin, development - as an independent  
science.

Psychology has a long past but - short  
history.

Unit II

Wilhelm Wundt, and William James  
Contribution

Unit III Objectivity in Psychology

Contribution of Watson and Wundt  
to Behaviorism.

Unit IV Gestalt Psychology

Foundation of Gestalt Psychology  
Contribution of Gestalt Psychology  
Koffka, Kohler contribution

Department of Psychology  
Sahibganj College, Sahibganj

U.G. Sem - IV C.B.C.S. Paper - C.C - 10 (Social Psy)

01. सामाजिक मनोविज्ञान के ऐतिहासिक प्रक्रमों की संक्षिप्त व्याख्या कीजिए।
02. अवधारण-समाज मनोविज्ञान के महत्व की विवेचना करें।
03. भारत में महिलाओं के निरक्षर प्रतिशत की विवेचना करें।
04. भारतीय परिवार की विवेचना एवं सामाजिक व्यवस्था के रूप में करें।
05. शरीर के वजन कारकों में 9 वर्षे बच्चों के उपायों का वर्णन करें।
06. सामाजिक परिवर्तन के स्वतंत्रता का वर्णन करें।
07. बाल अपराध को रोकने के निमित्त उपायों का वर्णन करें।
08. सामाजिक व्यवहार के आन्तरिक कारकों का वर्णन करें।
09. प्राथमिक समूह एवं द्वितीय समूह में अंतरों को विस्तार से बताएं।
10. समाज मनोविज्ञान की प्रकार- एवं क्षेत्र का वर्णन करें।



Department of Psychology  
Sahibganj College, Sahibganj

U.G. Sem-VI C.A.C.S. Paper - Counselling Psychology (C-14)

01. परामर्शन क्या है ? इसके स्वरूप का वर्णन करें।
02. विद्यालयों में परामर्श के माध्यों की विवेचना करें।
03. एक अच्छे परामर्शदाता की दक्षताओं की विवेचना करें।
04. भारत में परिवार परामर्श के माध्यों का वर्णन करें।
05. व्यवहार परिमार्जन की प्रमुख विधियों का वर्णन करें।
06. कार्यस्थलीय परामर्शन क्या है ? कि-प्रकार से चर्चा करें।
07. युवालय परामर्शन को महत्त्वपूर्ण संप्रत्यय का वर्णन करें।
08. किस प्रकार परामर्श में योग एवं दयाग सहायता करता है?



U.5 Sem VI

Department of Psychology  
Sulbaganvi college  
Kannur.

Paper: Human-Resource-management DSE-S.T.

Unit - I Introduction to Human Resource -  
Management and Human Resource Department  
or development. What do you mean by H.R.M.  
and H.R.D. Present issues in HRM.

Unit II Human Resources practice.  
Job-analysis, Recruitment - of Job.  
Job selection.

Unit III Information Human Resource  
Management (IHRM)  
What do you mean by IHRM?

8. Define chi square and explain its assumptions.

काई-वर्ग की परिभाषा दें और इसकी अभिकारणों की व्याख्या करें।

9. Discuss methods of chi-square test.

काई वर्ग परीक्षण की विधियों की-वर्ग की विधि।

10. Following are the scores of students on two sets. Calculate co-efficient of correlation by product moment method.

निम्नलिखित छात्रों द्वारा दिये गये दो परीक्षणों के प्राप्ति हैं। प्रोडक्ट मोमेंट विधि द्वारा उनके सहसंबंध गुणांक निकालें।

Test-I 23, 20, 26, 28, 28, 29, 28, 31, 32, 30

Test-II 14, 12, 15, 19, 16, 15, 14, 18, 17, 22

11. Compute  $\rho$  of the two sets of scores given below:

नीचे दिये गए दो समूहों के प्राप्ति का  $\rho$  निकालें।

Test-I 60, 50, 55, 44, 54, 40, 42, 50, 47, 56

Test-II 50, 40, 45, 35, 51, 30, 37, 47, 36, 35

12. Test statistically whether the following two groups differ significantly:

सांख्यिकीय परीक्षण कर बताएं कि निम्नलिखित दो समूहों के बीच अंतर सांख्यिकीय है।

|           | N   | Mean  | SD   |
|-----------|-----|-------|------|
| Groups-I  | 75  | 50.68 | 7.51 |
| Groups-II | 100 | 60.95 | 4.03 |

Dept. of Psychology  
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UG. Sem. II Paper-3 Biopsychology

1. जीव मनो विज्ञान के स्वरूप एवं क्षेत्रों का वर्णन करें।
2. रसायु कोश के घनांतर एवं कार्यों का वर्णन करें।
3. केन्द्रीय रसायु मंडल की रचना को समझाएँ।
4. सीखना एवं स्मृति के जैविक कारकों का वर्णन करें।
5. वंशानुक्रम से आप क्या समझते हैं? वंशानुक्रमों के नियमों का वर्णन करें।
6. व्यक्तित्व के विकास में वंशानुक्रम के महत्व को लिखें।



(9) Pt-complex (cisplatin) is used to treat germ cell cancers, gestational trophoblastic tumors, epithelial ovarian, small cell lung cancer as well as for the palliation of bladder, cervical, nasopharyngeal, esophageal, head and neck cancer.

(10) Titanium complex like titanocene ( $\text{TiCl}_2$ ,  $\text{TK-4}$ ), ~~Bu~~ Budotitan is used as anticancer activity. Budotitan is used in transplantable tumors and autochthonous colorectal tumour model.

(11) Ruthenium complex like  $\text{NAMI-A}$ , KP 1019 ~~used~~ as anticancer agents.  $\text{NAMI-A}$  is used as ~~used~~ active against lung metastasis in  $\text{in vivo}$  and tumour cell invasion  $\text{in vitro}$ .

(12) Bismuth complex (Bismuth subsalicylate - Pepto Bismol) is used as antacid to treat temporary discomforts of the stomach and gastro intestinal tract like diarrhoea, indigestion, heartburn, nausea.

(13) Gold complexes like [auranofin, aurothioglucose] are known as gold thioglucose are used to treat rheumatoid arthritis, swollen joints, morning stiffness.

(14) In enzymes, metal ions are generally positively charged and act as electrophiles, and thus  $\text{ion} - \text{charge} - \text{charge}$  interaction with any nucleophile.

- ② Pol IV : → ① This enzyme belongs to the  $\gamma$  family of DNA Polymerases.
- ② Pol IV is an error prone polymerase that has no 3' to 5' proofreading activity and is involved in mutagenesis or to allowing of DNA to give rise to a mutation.

- ③ Pol V : → ① Pol V belongs to the  $\gamma$ -family of polymerases and allows DNA damage to be bypassed in order for replication to continue.
- ② It is involved in SOS response and translesion synthesis DNA repair mechanism.

### ② Eukaryotic DNA Polymerase :-

- ① Pol  $\alpha$  : → ① Pol  $\alpha$  is a member of family B polymerases and one of main polymerases involved with nuclear DNA replication.
- ② This unique enzyme has two distinct polymerase activities : a) 5'-3' DNA-dependent DNA polymerase  
b) 5'-3' DNA dependent RNA polymerase.
- The RNA polymerase activity is a primer because this enzyme is often referred to as pol  $\alpha$  : primer and it is the only enzyme known to have both DNA polymerase and primer activities and the only one capable of self primed DNA synthesis on a previous unpaired ssDNA.
- ③ Pol  $\alpha$  does not have an ~~intrinsic~~ intrinsic 3'-5' exonuclease activity and also lacks a 5'-3' exonuclease activity and also lacks a 3' exonuclease activity. In vivo, the primary function of pol  $\alpha$  : primer is to make short RNA/DNA primers for replicative DNA synthesis.

magnesium delivers its energy by activating the production of ATP. which provides energy to trake billions of cells in our body.

eg: The cisplatin ( $\text{cis- Pt}(\text{NH}_3)_2\text{Cl}_2$ ) is the first member of a new class of potent antitumour drugs, belonging to metal co-ordination complexes which are being used in medicine.

eg: 1) metals such as iron, copper all perform important roles in many of the enzymatic steps that fuel the body's metabolism. Ferrioxamine - ferrioxamine can bind to the hemoglobin and myoglobin protein to help transport oxygen to organs in the body.

2) metals like Fe, Zn, Cu are intricately entwined with our bodies. They make vital functions like respiration/ circulation/ reproduction etc

3) 1) hormone action - Ca, I

2) Antioxidants - Cu, Zn

3) Drug components - Gold, Lithium, Platinum

4) Fe or CO reduces to anemia patients

5) Cu - manages heart disease or anemia

6) Ca - maintains bone density

7) Zn - manages glucose tolerance.

8) metals can serve to bind and orient substrate with respect to functional gr- in the active site.



(9) Pt-complex (cisplatin) is used to treat germ

### Role of metal ions in Biological process

metals plays crucial role in life process. metals are involved in cellular and subcellular functions. Fe divalent magnesium and calcium ions play important role in cells. Metallothionein are proteins rich in metal ions found in living systems. The divalent cations  $Zn^{2+}$ ,  $Ca^{2+}$ ,  $Mg^{2+}$  prevent cytotoxicity and in vivo-antagonize Cd-induced carcinogenesis. Lack of body iron is common in cancer patients and it is associated with complications in surgery and in animal experiments.

The transport of iron and other metal ions by the blood plasma is achieved through the formation of protein complex. Copper is an essential metalloelement and is primarily associated with copper dependent cellular enzymes. Metals are also used as inorganic drugs for many diseases.

Calcium builds strong bones and teeth teeth but it also helps to quell muscle ~~cramp~~ cramps and trigger a no. of other reactions in the human body. Our cells also depend on magnesium.  $Ca^{2+}$ ,  $Mg^{2+}$ ,  $Zn^{2+}$ ,  $Cu^{2+}$ ,  $Fe^{2+}$ ,  $Mn^{2+}$  are involved in biological process in the nucleus and present in detectable amounts ( $10^{-2}$  to  $10^{-4}$  mol) and bound to DNA & RNA in the cells. The active configuration of RNA is dependent on  $Mg^{2+}$ ,  $Mn^{2+}$  concentration. Enzymes in both plants and animals depend on the energy to do their work delivered by magnesium.

- ② Pol IV : → ① This enzyme belongs to the  $\gamma$  family of DNA Polymerases.
- ② Pol IV is an error prone polymerase that has no 3' to 5' proofreading activity and is involved in mutagenesis or to allowing of DNA to give rise to a mutation.

- ③ Pol V : → ① Pol V belongs to the  $\gamma$ -family of polymerases and allows DNA damage to be bypassed in order for replication to continue.
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# DNA Polymerases

①

DNA molecules are the transfer of genetic information of an organism. DNA is the basis of life and is transferred from parents to offspring. The DNA content of the parent is doubled by means of replication mechanism aided by a specific enzyme, DNA polymerase. DNA polymerase plays a central role in process of life and carries a weighty responsibility of making an accurate copy of cell's genome. The DNA polymerases are enzymes that create DNA molecules by assembling nucleotides, the building blocks of DNA.

~~Base pairs~~

DNA polymerase moves along the old strand in the 3'-5' direction, creating a new strand having a 5'-3' direction.

## Classification of DNA Polymerases

Based on the sequence homology and the comparison of features of their primary sequence DNA polymerases are classified into seven families as A, B, C, D, X, Y, RT.

| Seq. | Family | Type of DNA Polymerase            | Species                             | Example   |
|------|--------|-----------------------------------|-------------------------------------|---|
| 1    | A      | Replicative and Repair polymerase | Eukaryotic & prokaryotic            | T7 DNA polymerase, Pol I or DNA polymerase, $\gamma$  |
| 2    | B      | Replicative or Repair polymerase  | Eukaryotic and prokaryotic          | Pol II, Pol B, Pol $\epsilon$ , Pol $\alpha$ , $\delta$ & $\epsilon$                              |
| 3    | C      | Replicative polymerase            | Prokaryotic                         | Pol III   |
| 4    | D      | Replicative polymerase            | Euryarchaeota                       | Not well characterized  |
| 5    | X      | Replicative and Repair polymerase | Eukaryotic                          | Pol $\beta$ , Pol $\delta$ , Pol $\lambda$ , Pol $\mu$ and Terminal deoxynucleotidyl transferase. |
| 6    | Y      | Replicative and Repair Polymerase | Eukaryotic and prokaryotic          | Pol $\iota$ (iota), Pol $\kappa$ (kappa), Pol $\nu$ & Pol $\psi$ .                                |
| 7    | RT     | Replicative and Repair polymerase | viruses, retroviruses, & Eukaryotic | Telomerase, Hepatitis B-virus   |



② Pol  $\eta$  is particularly important for allowing accurate ③  
translesion synthesis of DNA damage resulting from ultraviolet  
radiation.

④ Pol  $\kappa$  is thought to act as an extender of an insert  
of a specific base at certain DNA lesions.

⑤ Polymerase  $\epsilon$  ( $\epsilon$ ) :

⑥ Pol  $\epsilon$  another  $\beta$  family polymerase involved in translesion  
synthesis.

⑦ Pol  $\epsilon$  lacks 3' to 5' exonuclease activity and it can  
extend primers with terminal mismatches.

⑧ Polymerase  $\delta$  ( $\delta$ ) Polymerase  $\theta$  :

⑨ Pol  $\gamma$ , Pol  $\theta$  are family A polymerases.

⑩ Pol  $\gamma$  is the only mtDNA polymerase and therefore replicates,  
repairs and has proofreading 3'-5' exonuclease.

⑪ Any mutation that leads to limited or non functioning Pol  $\gamma$   
has a significant effect on mtDNA and is the most  
common cause of autosomal inherited mitochondrial disease.

⑫ Pol  $\theta$  is found in eukaryotes. Pol  $\theta$  belongs to  
family A polymerases.

⑬ Pol  $\theta$  extends mismatched primers from termini and can  
by-pass abasic sites by adding a nucleotide.

(5) DNA Polymerase  $\beta$  (4)

- (a) It belongs to family X polymerase and found mainly in vertebrates and some plants & fungi.
- (b) Pol  $\beta$  is required for short patch base excision repair, a DNA repair pathway which is essential for repairing alkylated or oxidized bases as well as apurinic sites.
- (c) This is the smallest and simplest of the classical eukaryotic polymerases. It is composed of a single ~40-48 kDa protein.
- (d) Pol  $\beta$  is not highly active and is not very processive. It has no intrinsic exonuclease activity.
- (e) ~~can~~ Template is duplex DNA with short gaps, although it can bind a nicked duplex and is capable of some limited displacement synthesis. Pol  $\beta$  is primarily involved in DNA repair.

(4) Polymerases  $\lambda$ ,  $\delta$  &  $\mu$  [Lambda, Sigma & mu]:

- (a) Family X polymerase also contains a well known eukaryotic polymerase Pol  $\delta$  (Sigma), Pol  $\lambda$  (Lambda), Pol  $\mu$  (mu) terminal deoxynucleotidyl transferase [TdT].
- (b) Pol  $\lambda$  and Pol  $\mu$  are involved in non homologous end joining: a mechanism for repairing DNA double strand breaks. due to hydrogen peroxide and ionizing radiation respectively.
- (c) Polymerases  $\eta$ ,  $\theta$ , Pol  $\eta$  (eta), Pol  $\iota$  (iota) or Pol  $\kappa$  (kappa) are family Y DNA polymerases involved in DNA repair by translesion synthesis.
- (d) Polymerases in family Y are low fidelity polymerases and their error may harm as mutations that affect the polymerase which may cause various diseases like -  
Xeroderma pigmentosum variant (XPS)  
Askin-Laneet

# (7) (6)

## Significance of DNA Polymerase in Biotechnology

DNA polymerases play a central role in modern molecular biology and biotechnology, enabling techniques including DNA cloning, PCR (polymerase chain rxn), DNA sequencing, SNP (single nucleotide polymorphism) detection, WGA [whole genome amplification], synthetic biology and molecular diagnostics.

### Thermostable DNA Polymerase [Taq DNA Polymerase]

It is a household word in microbiology world and it was purified from the hot springs bacterium *Thermus aquaticus*.

The thermophilic DNA polymerases like other DNA polymerases, catalyze template-directed synthesis of DNA from nucleotide triphosphates. A primer having a free 3' hydroxyl is required to initiate synthesis and Mg<sup>2+</sup> ion is necessary. They have max<sup>m</sup> catalytic activity at 75 to 80°C & is reduced activities at lower temp. At 37°C, Taq polymerase has only about 10% of its maximal activity.

| Polymerase (3'→5') Exo Nuclease | Source & Properties |   |
|---------------------------------|---------------------|---|
|                                 | Source              | Properties  |
| Taq                             | NO                  | From <i>Thermus aquaticus</i>   Half life at 95°C is 1.6h   |
| Pfu                             | YES                 | From <i>Pyrococcus furiosus</i>   Different to have to lowest error rate of known thermophilic DNA polymerase |
| Vent                            | YES                 | From <i>Thermococcus litoralis</i>   Half life at 95°C is 7h.<br>Tli-polymerase                               |



② pol  $\eta$  is particularly important for allowing accurate <sup>⑤</sup> transcription synthesis of DNA damaged resulting from ultraviolet radiation.

④ pol  $\kappa$  is thought to act as an extender of an insert of a specific base at certain DNA lesions.

⑤ Polymerase  $\zeta$  (zeta):

① pol  $\zeta$  another ~~A~~ B family polymerase involved in transcription synthesis

② pol  $\zeta$  lacks 3' to 5' exonuclease activity and it can extend primers with terminal mismatches.

③ Polymerase  $\gamma$  (gamma) Polymerase  $\theta$ :

① pol  $\gamma$ , pol  $\theta$  are family A polymerases.

② pol  $\gamma$  is the only mtDNA polymerase and therefore replicates, repairs and has proofreading 3'-5' exonuclease.

③ any mutation that leads to limited or non functioning pol  $\gamma$  has a significant effect on mtDNA and is the most common cause of autosomal inherited mitochondrial disorder.

④ pol  $\theta$  is found in eukaryotes. pol  $\theta$  belongs to family A polymerase.

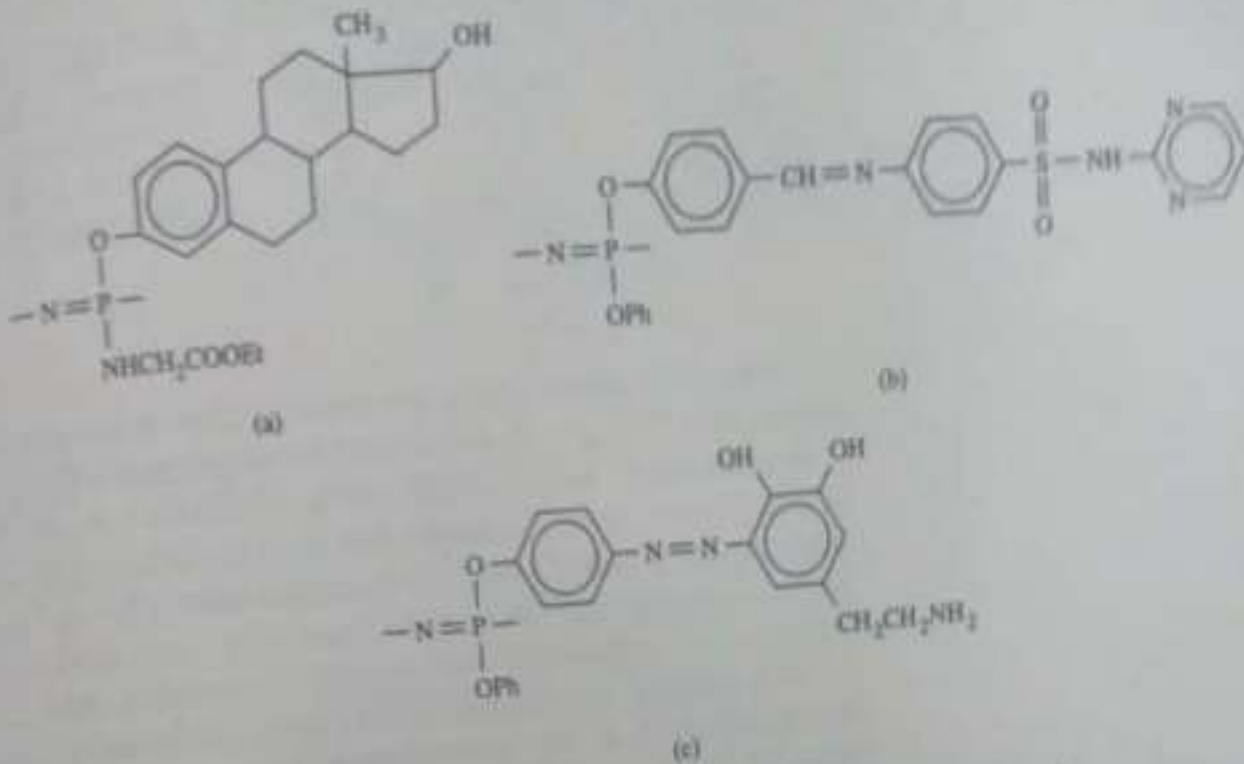
⑤ pol  $\theta$  extends mismatched primers from termini and can bypass abasic sites by adding a nucleotide.

## Future challenges of DNA Polymerases

(7)

- ① It ~~may~~ plays a important role in biotechnology of delivery of health care.
- ② over next several years, molecular methods may be easier
- ③ molecular biology will move toward analysis of low concentration biomolecules.
- ④ Novel DNA amplification systems are needed to accelerate progress in emerging technologies and to make high fidelity in vitro genome analysis.
- ⑤ engineered DNA polymerases or cellular replication machinery capable of amplifying large DNA fragments have the potential to enable single cell genomics, genome synthesis and manipulation.

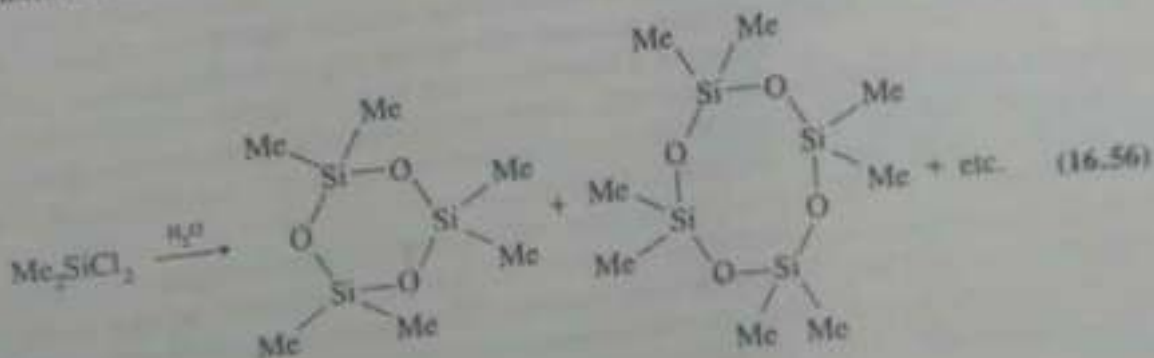
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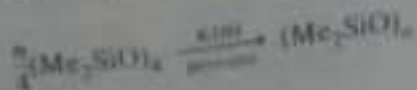
**Fig. 16.27** Polymeric phosphazenes: (a) steroid-bound; (b) sulfadiazine-bound; (c) catecholamine-bound. [From Allcock, H. R. In *Rings, Clusters, and Polymers of the Main Group Elements*; Cowley, A. H., Ed.; ACS Symposium Series 232; American Chemical Society: Washington, DC, 1983. Used with permission.]

rocyclic  
ing

The reaction of  $Me_2SiCl_2$  with water at elevated temperatures gives polymeric  $(Me_2SiO)_n$  (Eq. 16.23), but if hydrolysis is carried out at room temperature, the mixture which results also includes cyclic siloxanes,  $(Me_2SiO)_n$  ( $n = 3, 4, \text{etc.}$ ).



The trimer has a chair structure analogous to cyclohexane and the tetramer has a crown structure analogous to  $S_6$ . In the previous section we saw that cyclophosphazenes could be turned into linear polymers thermally. The same is true for siloxanes. In order to achieve high molecular weights (the production of silicone rubbers), very pure cyclic tetramer is heated with a trace of base (KOH):



06-04-2020 17:22



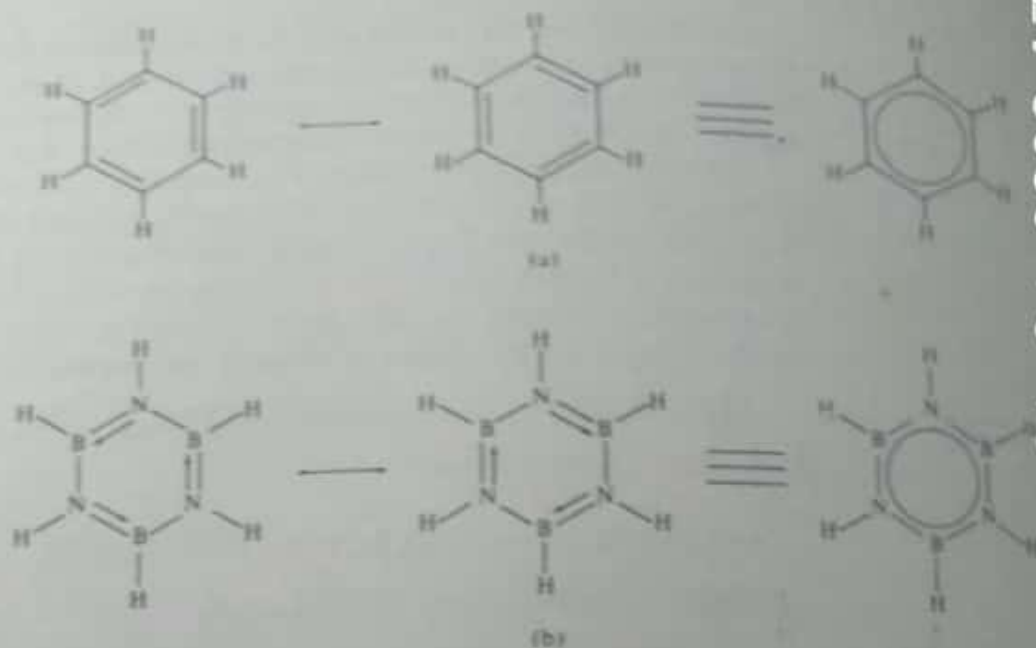
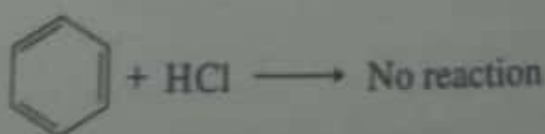
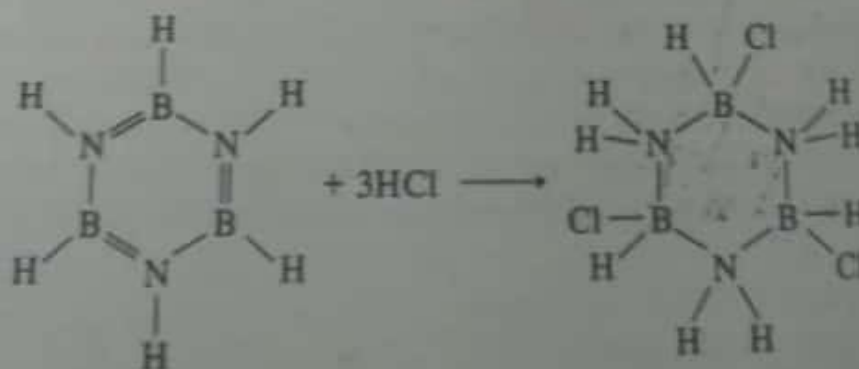


Fig. 16.21 Electronic structures of (a) benzene; (b) borazine.

density is localized on the nitrogen atoms (Fig. 16.22).<sup>70</sup> This partial localization weakens the  $\pi$ -bonding in the ring. Each nitrogen receives more  $\sigma$ -electron density from neighboring boron than it gives away as a  $\pi$ -donor. The net effect is that the charge density on nitrogen increases. In addition, nitrogen retains its basicity and boron its acidity. Polar species such as HCl can therefore attack the double bond between nitrogen and boron. Thus, in contrast to benzene, borazine readily undergoes addition reactions:



<sup>70</sup> Boyd, R. L.; Choi, S. C.; Hale, C. C. *Chem. Phys. Lett.* 1984, 112, 136-141. Fink, W. H.; Knoch