

## ECO-FRIENDLY POLYMERS

many units

→ polymer is made up of many monomers

POLYMER

Natural polymer

- cellulose → monomer is GLUCOSE
- starch → GLUCOSE
- silk fibroin

Synthetic polymer

- rubber (polyisoprene)
- $\eta \text{CH}_2=\text{CH}_2 \rightarrow -\{\text{CH}_2-\text{CH}_2\}$

# DEGREE OF POLY

# FUNCTIONALITY'

→ The no. of repeating units present in a polymer.

- high polymers: high number of monomeric units
- oligomers: 2-10 monomer units.

# FUNCTIONALITY OF POLYMER

- monomer contains some function groups (reactive sites)
 

-OH (hydroxyl)	-NH <sub>2</sub> (amine)
-SH (sulphhydryl)	-COOH (carboxyl)

• Functionality depends on.

1. No. of reactive sites present in compound

Acetic acid  $\text{CH}_3\text{COOH}$

funct<sup>n</sup> = 1

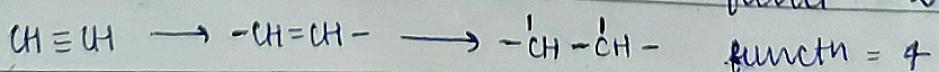
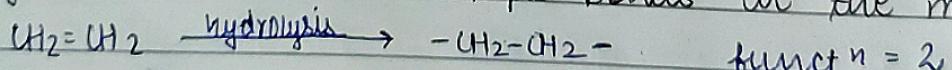
Malonic acid  $\text{HOOCCH}_2\text{COOH}$

funct<sup>n</sup> = 2

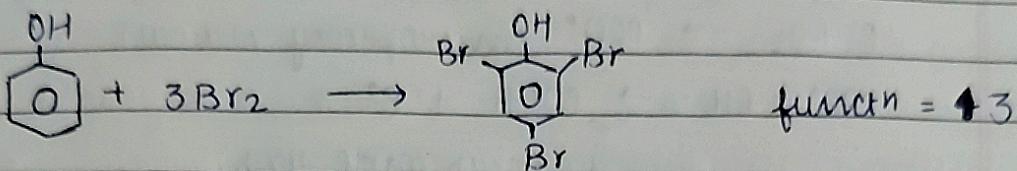
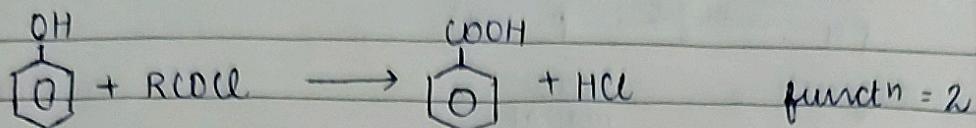
Tartaric acid  $\text{HOOC}(\text{CHOH})_2\text{COOH}$

funct<sup>n</sup> = 4

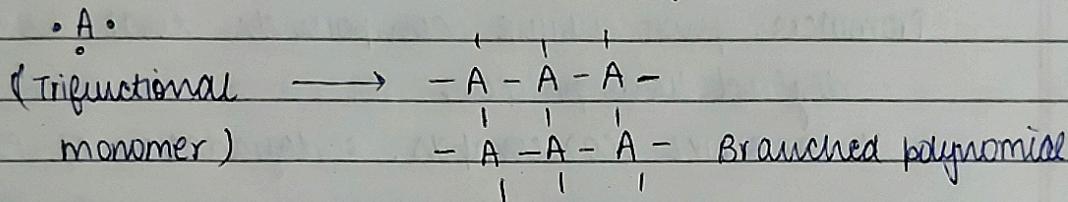
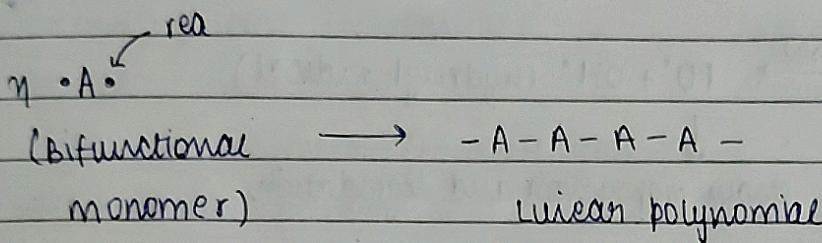
2. No. of double bonds & triple bonds in the molecule



3. No. of replaceable H-atoms in a molecule



4.



## # DEGRADATION OF POLYMER

1. BIODEGRADABLE polymer
2. PHOTOBIODEGRADABLE polymer
3. HYDROBIODEGRADABLE polymer

Biodegradable : degraded by enzymes present in the microorganisms.

end product of degradation :  $\text{CO}_2 + \text{H}_2\text{O}$

Photobio-degradable : degraded by light.

Step 1: Photo-degradation

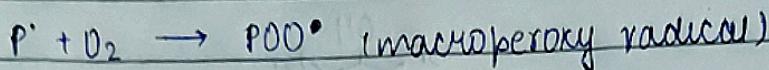
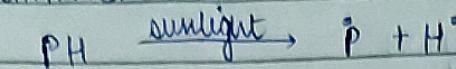
chromophores - The funcn group present in polymers above UV light (visible : 400 nm - 700 nm) ex: CO grp

Step 2: Bio-degradation

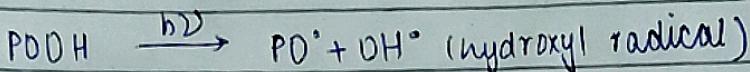
↳ living organism.

peroxide,  
hydroperoxide

## Mechanism



(hydroxyperoxide group)



main propagation and degradation

Promoters: photosensitive compounds that enhance degradation process.

1. CARBONYL (CO) compds. : degradation of POLYTHENE & POLYSTYRENE.

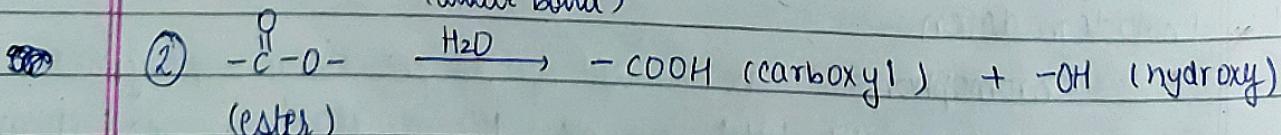
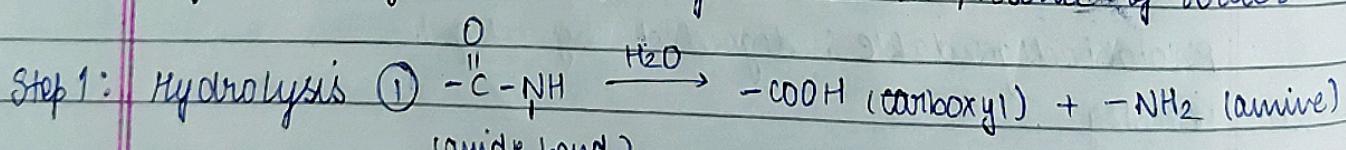
2. METAL COMPLEXES : react with O<sub>2</sub> and form

✓ { Zn, Cu, PEROXIDES } → help in degradation,  
 Fe, ~~Hg~~  
 { Cd, Cr, Hg, Pb, As } X

Photostabilizers : introduced in plastic, to protect from light degradation.

ex: 2,4 dihydroxy benzophenone.

Hydrobiodegradation : degradation in presence of water



degradat<sup>n</sup> should be done to active CO<sub>2</sub> + H<sub>2</sub>O as

U Cholesterol: degraded using nanoparticles but end products are even more harmful.

## # BIO POLYMERS & BIO PLASTICS (GREEN PLASTICS)

↳ obtained from living organisms or polymeric materials (carbs and proteins)

→ obtained from living organisms or biopolymers

→ should not generate waste

→ no toxic products should be generated and should be biodegradable.

example: STARCH - glucose (potatoes, rice)

POLYESTER - bacterial

polyester fermentation

CASEIN - milk protein

SOY PROTEIN - plant protein

CELLULOSE - wood, cotton, plant cell wall

⇒ BIOPOLYMERS are produced by

1. Fermentation process

2. Growing plastics in plants

(using genetic engineering)

### 1. Fermentation

complex substances  $\xrightarrow{\text{micro-organisms}}$  simple organic compounds.  
absence of O<sub>2</sub>

#### a) Bacterial polyester fermentation.

• RALSTONIA EUTROPHIA BACTERIA

Bacteria : corn sugar to catalyse its biochemical rxn  
forms polyester fermentat<sup>n</sup>

#### b) Lactic acid fermentation

sugar → lactic acid  $\xrightarrow{\text{polymerisatn}}$  poly lactic acid (PLA)

## 2. Green plastics in Plants

gene coding enzyme  
that helps in plastic  
formation is removed

from bacteria, it is inserted into plants.

GREEN PLASTIC ← ground ← collect leaves

in solvent

(Gene slicing is done to remove defective gene and combine / insert the useful genes)

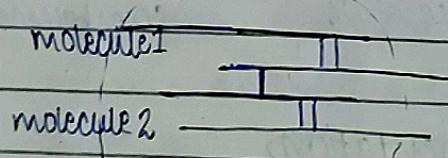
## # NUMBER AVERAGE & WEIGHT AVERAGE MOLECULAR WEIGHT OF POLYMERS

Q. In a polymer sample 30% molecules have MM = 20,000, 40% have MM = 30,000, rest have MM = 60,000. calculate no. avg. and weight avg. molecular masses.

$$\bar{M}_n = \frac{\sum n_i M_i}{\sum n_i} = \frac{(30 \times 20000) + (40 \times 30000) + (30 \times 60000)}{30 + 40 + 30} = \underline{36000}$$

amt. of

$\hookrightarrow$  polymer  $\longrightarrow$  monomers ( $-COOH + NH_2 -$ ) no. avg. MM  
(contains molecules)



POLYMERIC CHAIN : polymeric chains are joined together by bonds.

Polymers have avg. MW b/c it is composed of numerous different molecules.

$$\bar{M}_w = \frac{\sum n_i M_i^2}{\sum n_i M_i} = \frac{30(20000)^2 + 40(30000)^2 + 30(60000)^2}{30 \times 20000 + 40 \times 30000 + 30 \times 60000}$$

$= \underline{43333}$

weight avg. MW of polymer.