

## Polymers

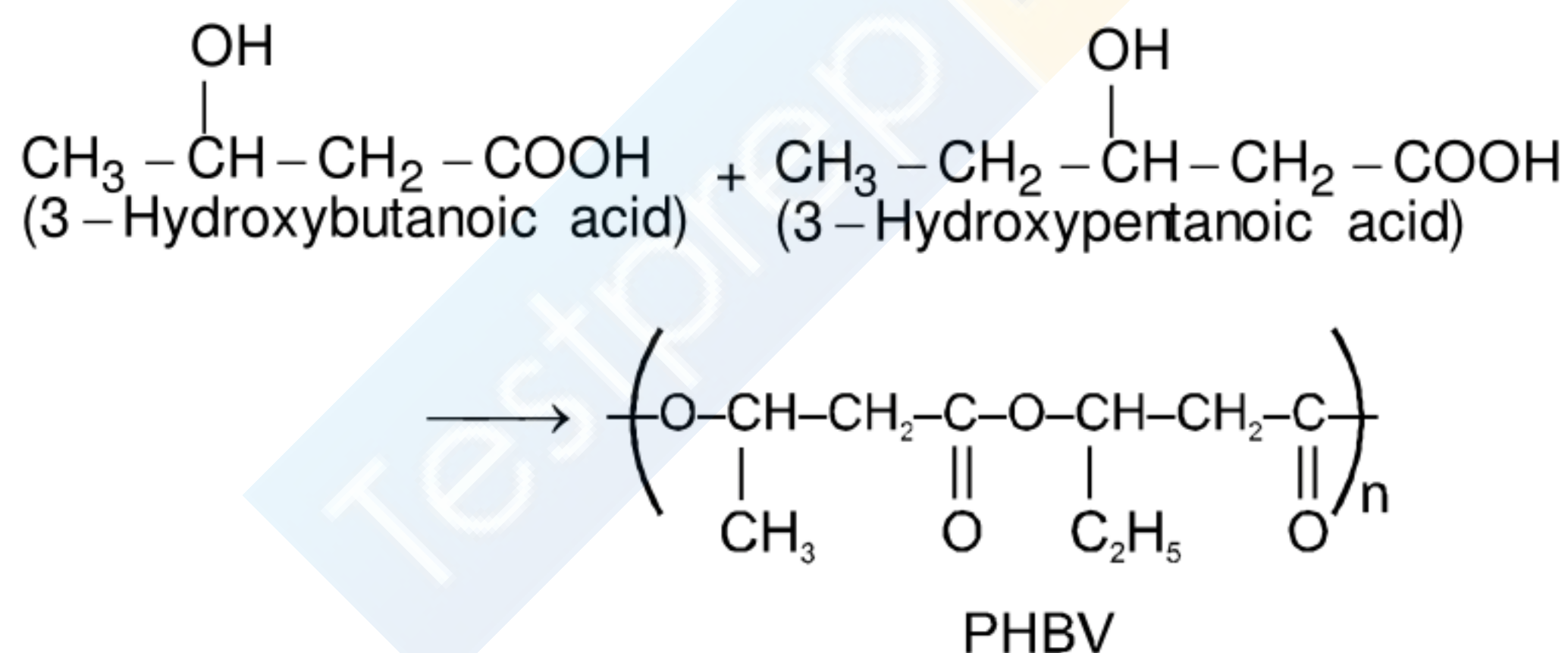
### Biodegradable Polymers :

A large number of polymers are quite resistant to the environmental degradation processes and are thus responsible for the accumulation of polymeric solid waste materials. These solid wastes cause acute environmental problems and remain undegraded for quite a long time. In view of the general awareness and concern for the problems created by the polymeric solid wastes, certain new biodegradable synthetic polymers have been designed and developed. These polymers contain functional groups similar to the functional groups present in biopolymers.

Aliphatic polyesters are one of the important classes of biodegradable polymers. Some examples are given below :

(a) **Poly  $\beta$ -hydroxybutyrate – co- $\beta$ -hydroxy valerate (PHBV) :**

It is obtained by the copolymerisation of 3-hydroxybutanoic acid and 3-hydroxypentanoic acid.

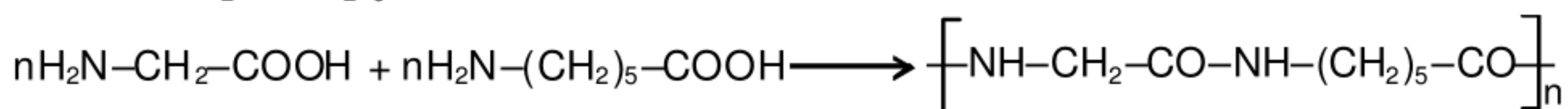


PHBV is used in speciality packaging, orthopaedic devices and in controlled release of drugs. PHBV undergoes bacterial degradation in the environment.

(b) **Nylon-2-nylon-6 :**

It is an alternating polyamide copolymer of glycine ( $\text{H}_2\text{N}-\text{CH}_2-\text{COOH}$ ) and amino caproic acid

( $\text{H}_2\text{N}(\text{CH}_2)_5\text{COOH}$ ) and it is also biodegradable polymer.



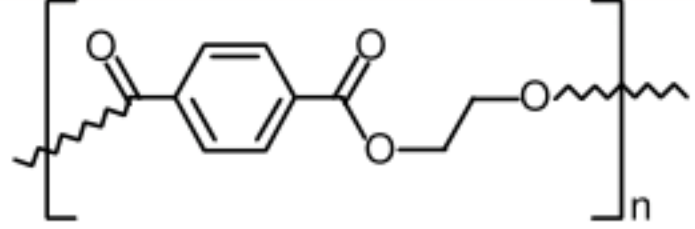
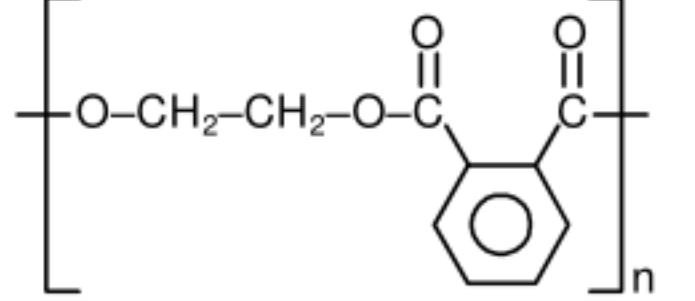
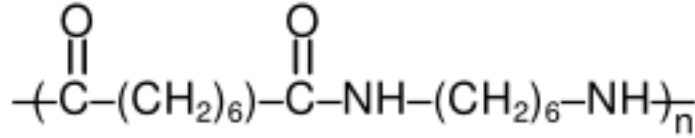
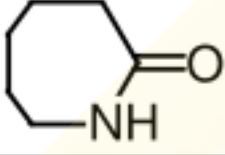
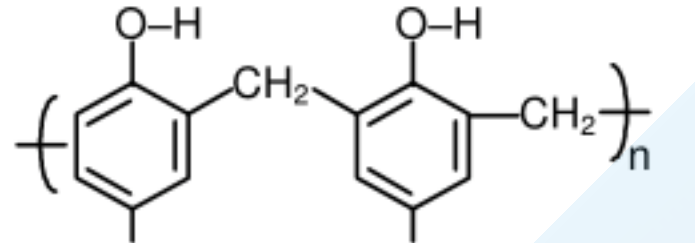
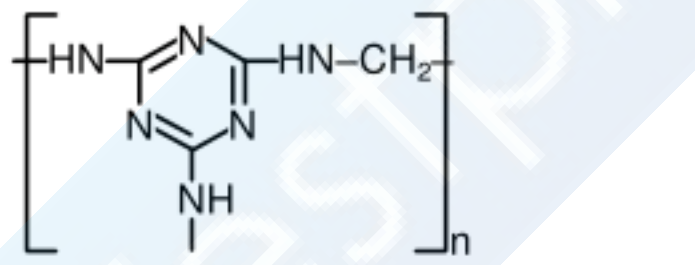
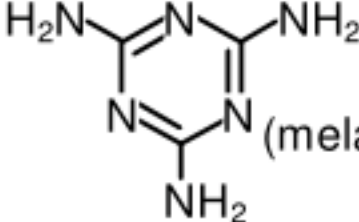
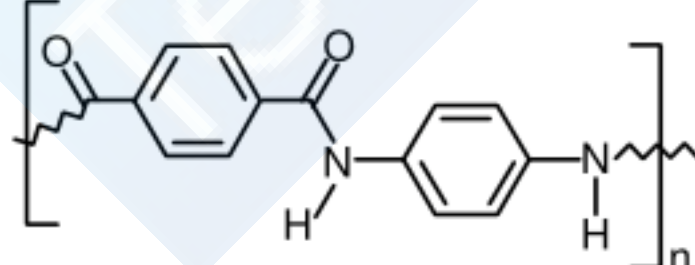
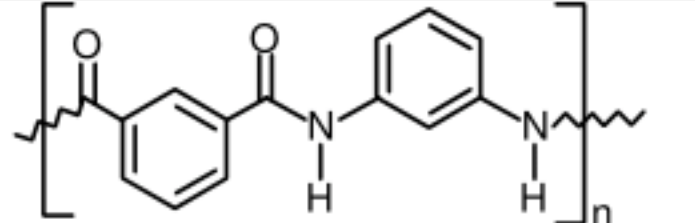
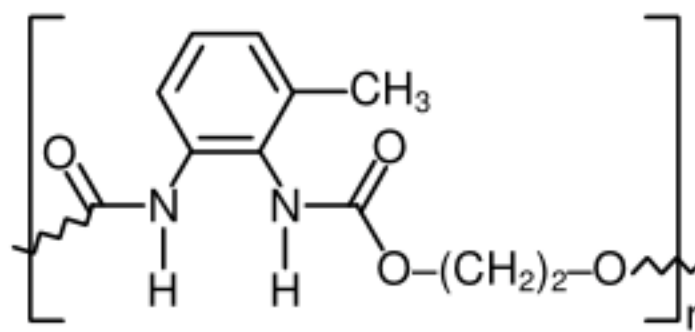
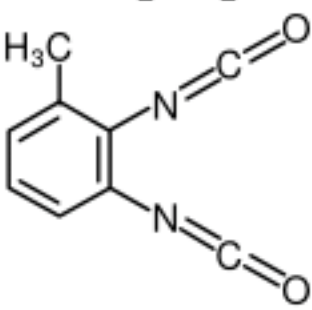
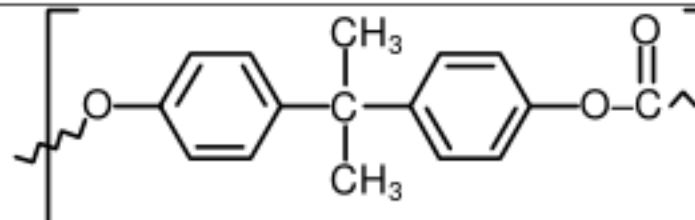


**Some common addition polymers/chain growth polymer**

S. No.	Name(s)	Formula	Monomer	Uses
1.	Polyethylene (low density (LDPE))	$-(\text{CH}_2-\text{CH}_2)_n-$	$\text{CH}_2=\text{CH}_2$ (ethylene)	Film wrap, Plastic Bags
2.	Polyethylene (high density (HDPE))	$-(\text{CH}_2-\text{CH}_2)_n-$	$\text{CH}_2=\text{CH}_2$ (ethylene)	Electrical insulation bottles, toys
3.	Polypropylene (PP) different grades	$\begin{array}{c} \text{CH}_3 \\   \\ \text{---}[\text{CH}-\text{CH}_2]_n \end{array}$	$\text{CH}_2=\text{CHCH}_3$ (propylene)	Manufacture of ropes, toys, pipes, fibres etc.
4.	Poly vinyl chloride (PVC)	$\begin{array}{c} \text{Cl} \\   \\ \text{---}[\text{CH}-\text{CH}_2]_n \end{array}$	$\text{CH}_2=\text{CHCl}$ (vinyl chloride)	Manufacture of rain coats, hand bags, vinyl flooring, water Pipes etc.
5.	Poly vinylidene chloride (Saran A)	$\begin{array}{c} \text{Cl} \\   \\ \text{---}[\text{C}-\text{CH}_2]_n \\   \\ \text{Cl} \end{array}$	$\text{CH}_2=\text{CCl}_2$ (vinylidene chloride)	Seat covers, films & fibers
6.	Polystyrene (Styron)	$\begin{array}{c} \text{---}[\text{CH}_2-\text{CH}]_n \\   \\ \text{C}_6\text{H}_5 \end{array}$	$\text{CH}_2=\text{CHC}_6\text{H}_5$ (styrene)	As insulator, wrapping material, manufactures of toys, radio and Television cabinets
7.	Polyacrylonitrile (PAN, Orlon, Acrilan)	$\begin{array}{c} \text{CN} \\   \\ \text{---}[\text{CH}-\text{CH}_2]_n \end{array}$	$\text{CH}_2=\text{CHCN}$ (acrylonitrile)	Rugs, Blankets clothing
8.	Polytetrafluoroethylene (PTFE, Teflon)	$-(\text{CF}_2-\text{CF}_2)_n-$	$\text{CF}_2=\text{CF}_2$ (tetrafluoroethylene)	Non-stick surfaces electrical insulation
9.	Poly methyl methacrylate (PMMA, Lucite, Plexiglas, perspex)	$-\text{[CH}_2\text{C}(\text{CH}_3)\text{CO}_2\text{CH}_3]_n-$	$\text{CH}_2=\text{C}(\text{CH}_3)\text{CO}_2\text{CH}_3$ (methylmethacrylate)	Lighting covers, signs skylights
10.	Poly vinyl acetate (PVAc)	$-(\text{CH}_2-\text{CHOCOCH}_3)_n-$	$\text{CH}_2=\text{CHOCOCH}_3$ (vinyl acetate)	Latex paints, Adhesives
11.	Natural Rubber	$-\text{[CH}_2-\text{CH}=\text{C}(\text{CH}_3)-\text{CH}_2]_n-$ (cis)	$\text{CH}_2=\text{CH}-\text{C}(\text{CH}_3)=\text{CH}_2$ (isoprene)	Requires vulcanization for practical use
12.	Neoprene	$-\text{[CH}_2-\text{CH}=\text{CCl}-\text{CH}_2]_n-$	$\text{CH}_2=\text{CH}-\text{CCl}=\text{CH}_2$ (chloroprene)	Synthetic rubber, oil resistant seal, gaskets, hoses & conveyor belts
13.	SBR styrene butadiene rubber (Buna-S)	$-\text{[CH}_2-\underset{\text{Ph}}{\text{CH}}-\text{CH}_2-\text{CH}=\text{CH}-\text{CH}_2]_n-$	$\text{H}_2\text{C}=\text{CHC}_6\text{H}_5$ and $\text{H}_2\text{C}=\text{CH}-\text{CH}=\text{CH}_2$	Tyres, floortiles, foot wear & cable insulation
14.	Nitrile Rubber (Buna-N)	$-\text{[CH}_2-\underset{\text{CN}}{\text{CH}}-\text{CH}_2-\text{CH}=\text{CH}-\text{CH}_2]_n-$	$\text{H}_2\text{C}=\text{CHCN}$ and $\text{H}_2\text{C}=\text{CH}-\text{CH}=\text{CH}_2$	Making oil seals, tank lining and hoses



**Some condensation polymers/step growth polymers**

S.	Name(s)	Formula	Monomer	Uses
1.	Polyester/Dacron/ Terylene/Mylar		HO <sub>2</sub> C C <sub>6</sub> H <sub>4</sub> CO <sub>2</sub> H (Terephthalic acid) HO-CH <sub>2</sub> CH <sub>2</sub> -OH Ethylene glycol	Fabric, Tyrecord
2.	Glyptal or Alkyds resin		HO <sub>2</sub> C-C <sub>6</sub> H <sub>4</sub> -CO <sub>2</sub> H (Phthalic acid) HO-CH <sub>2</sub> CH <sub>2</sub> -OH	Paints and Lacquers
3.	Polyamide (Nylon 6,6)	~[CO(CH <sub>2</sub> ) <sub>4</sub> CO-NH(CH <sub>2</sub> ) <sub>6</sub> NH] <sub>n</sub> ~	HO <sub>2</sub> C-(CH <sub>2</sub> ) <sub>4</sub> -CO <sub>2</sub> H H <sub>2</sub> N-(CH <sub>2</sub> ) <sub>6</sub> -NH <sub>2</sub>	Parachutes & Clothing
4.	Nylon 6,10		HOOC-(CH <sub>2</sub> ) <sub>8</sub> -COOH H <sub>2</sub> N-(CH <sub>2</sub> ) <sub>6</sub> -NH <sub>2</sub>	
5.	Polyamide Nylon 6, Perlon-L	~[CO(CH <sub>2</sub> ) <sub>5</sub> NH] <sub>n</sub> ~		Rope & Tyrecord
6.	Bakelite		PhOH + HCHO in (excess)	Electrical Switch, combs, Handle of Utensils, computer discs and Bowling Balls
7.	Urea-formaldehyde resin	(-NH-CO-NH-CH <sub>2</sub> -) <sub>n</sub>	H <sub>2</sub> N-CO-NH <sub>2</sub> (Urea) HCHO (Formaldehyde)	Making unbreakable cups and laminated sheets.
8.	Melamine formaldehyde resin		 + HCHO (melamine) (formaldehyde)	Unbreakabl e crockery
9.	Polyamide Kevlar		Para HO <sub>2</sub> C-C <sub>6</sub> H <sub>4</sub> -CO <sub>2</sub> H	Tyre
10.	Polyamide Nomex		Meta HO <sub>2</sub> C-C <sub>6</sub> H <sub>4</sub> -CO <sub>2</sub> H Meta H <sub>2</sub> N-C <sub>6</sub> H <sub>4</sub> -NH <sub>2</sub>	
11.	Polyurethane Spandex		HOCH <sub>2</sub> CH <sub>2</sub> OH 	Foams, Shoes, Automobile seats and components
12.	Polycarbonate Lexan		(HO-C <sub>6</sub> H <sub>4</sub> -) <sub>2</sub> C(CH <sub>3</sub> ) <sub>2</sub> (Bisphenol A) X <sub>2</sub> C=O (X = OCH <sub>3</sub> or Cl)	Bike helmet, goggles, bullet proof glass