MATERIALS CHEMISTRY

(1) Nanomaterials
↓
One of dimensions < 100 nm

→ scratchproof eyeglass, crack-resistant paints, anti-grafitti coatings of walls, transparent sunscreens, stain-repellant fabric, self-cleaning windows and ceramic coating for solar cells.

→ Drug delivery and gene therapy.
→ Regenerative medicine, cancer treating.
→ Very precise circuits, renewable energy.

(2) Quantum dot
all dimensions are less than 10 nm.

→ biomedical applications such as drug delivery, live imaging
→ Photoconductors and photodetectors.
→ Catalysis and others like photovoltaics.

Photophysical properties
↓
Photon absorbtion, internal conversion with fluorescence etc.

→ Nanomaterials and Quantum dot both have large surface area and surface energy.
↓
PROVIDES SUPERIORITY

◉ [redacted] the process of colloidal synthesis.

Soln is Decomposed by heating
↓
precursors ⟶ monomers
↓
nanocrystals

1) lead selenide
2) lead sulfide
3) Cadmium sulfide

⊙ Bottom-up
↓
Smaller particles
to
bigger materials
(macroscopic)

⊙ Top-down
↓
Material is chopped off
to make smaller particles

(3) Dispersity
↓
measure of heterogeneity of sizes of molecules or particles in a mixture.

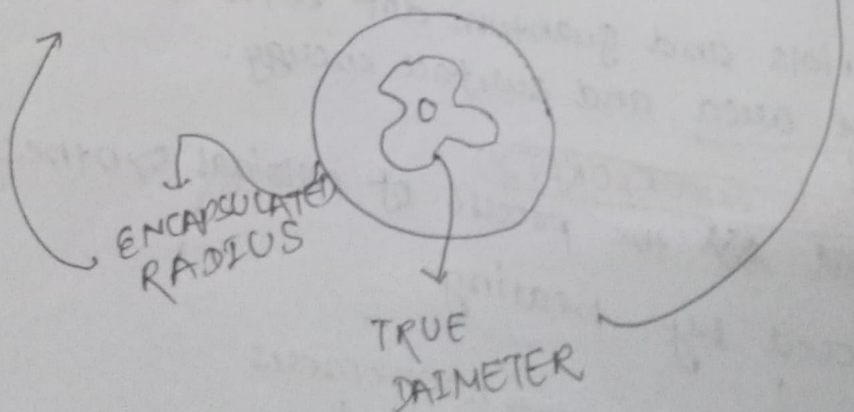
Monodisperse ← → Polydisperse

Poly Dispersity Index < 1.5 is acceptable.

(4) Diameter of Nanomaterials ↓

DLS → Rayleigh scattering
↓
Dynamic light scattering.
↓
Hydrodynamic diameter

HRTEM / FESEM
↓ ↓ ↓ ↓ ↓
High Resolution Transmission Electron Microscopy
OR
Field Emission Scanning Electron Microscopy.



LCO

Lithium cobalt oxide is applied on the surface of nanomaterials to make a hydrophilic surface in DLS to measure hydrodynamic diameter.

(5) credit cards

- Poly Vinyl Chloride (PVC) is used to make credit cards or pipes.
- PVC sheets are thin, so to make credit cards multiple layers are glued to give different functionalities.

high strength low cost availability

high flexibility non-biodegradeable

(7) water contact Angle

WCA > 130° → material is superhydrophobic.
WCA < 30° → " " superhydrophilic.

Parachutes ↓

→ High tensile strength
→ High strength
→ light weight

Polyamide (Nylon)

↓ moisture resistant & temprature resistant.

Spectacles ↓

→ lighter and thinner.
→ provides UV protection.
→ scratch resistant.

(Polycarbonates)

Cookwares ↓

- Polytetrafluoroethylene. PTFE is used in making Teflon and other non-stick cookwares.
  - → waxy, thermally stable, tough, corossion resis and non-flammable.
  - → Resist temprature upto 260° C.
  - → evenuates no smoke when exposed to high temprature.

Automobiles ↓

- Polyolefin (polyalkene) is used.
- makes car lighter.
- much more malleable than metals.
- used to come with more aerodynamic and good-looking cars.

Spandex clothing fibre

⊙ Polyurethane (PU) is used.

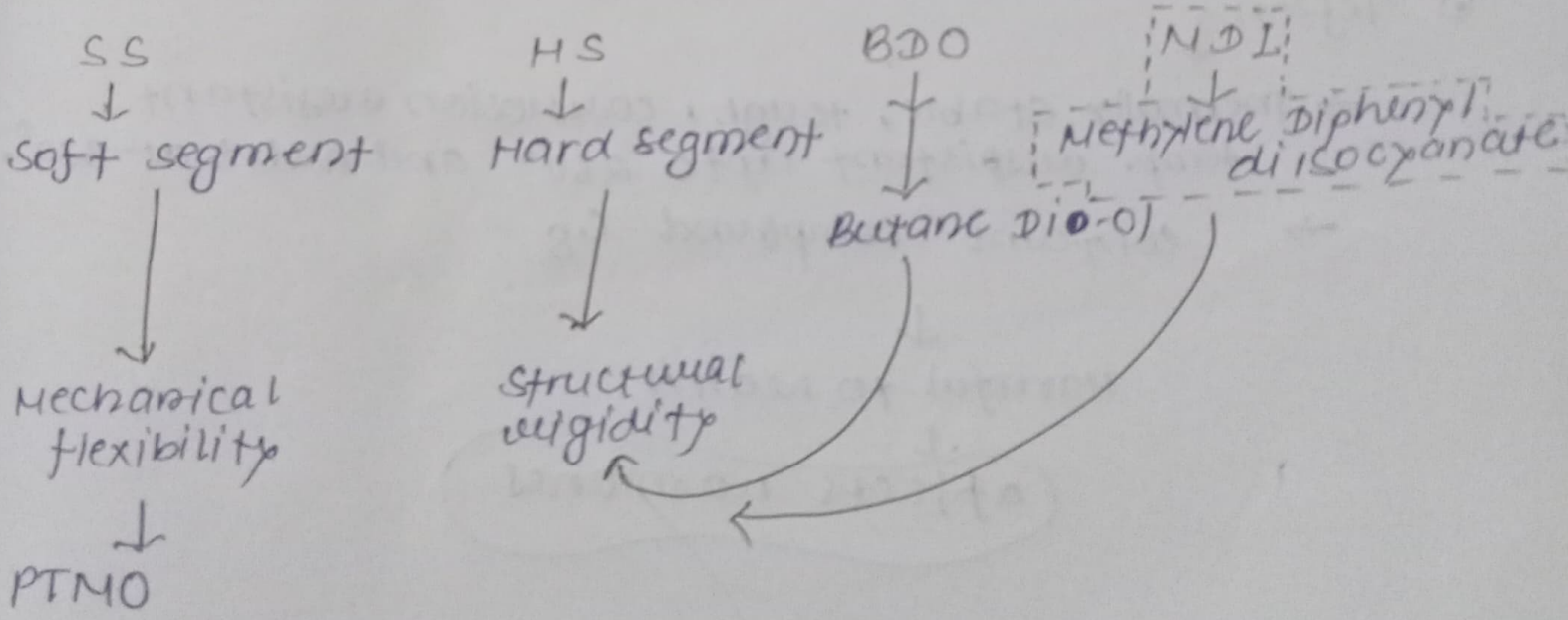
→ quick drying, highly elastic polymers, used to make clothes that stretches.

→ Lycra → clothing items, bathing suits, exercise clothing, leggings, skinny jeans, socks and wet suits.

⊙ elastane requires high levels of energy but lycra don't.

⊙ Elastane also needs a lot of toxic chemicals.

The ingredients of lycra are also synthesized into lab.



⊙ NIPU & BPA

NIPU → Non-isocyanate polyurethane → non-carciogenic.

BPA → Bicphenol-A → low cost but carciogenic.

⊙ UTM → Universal Tensile Machine → Dogbone shape

UTE → ultimate tensile elongation

UTS → ultimate tensile strength.

⊙ Teflon

→ Thermally stable, tough, corrosion resistant, temp. resistant upto 260° and melts at 330°.

→ contains compound C_8 → Harmful to health → affects hormones

⊙ PVC

Poly-vinyl chloride

CARDS & PIPES

low cost
high durability
Elasticity
light weight
Availability
HYDROPHOBIC

- poor heat stability
- toxic fumes upon melting.

⊙ Stimuli responsive Materials

↓

undergo physical, chemical or confirmational changes in response to external stimuli.

(1) Thermo-responsive

LCST

↓

Lower critical solution temprature

↓

Become insolube **ABOVE** a critical temprature.

UCST

↓

Upper critical solution temprature

↓

Precipitates and undergo phase change **BELOW** a critical temprature.

(2) pH-responsive

Protonation ⇄ (pH up / pH down) Deprotonation

(3) Salt-responsive

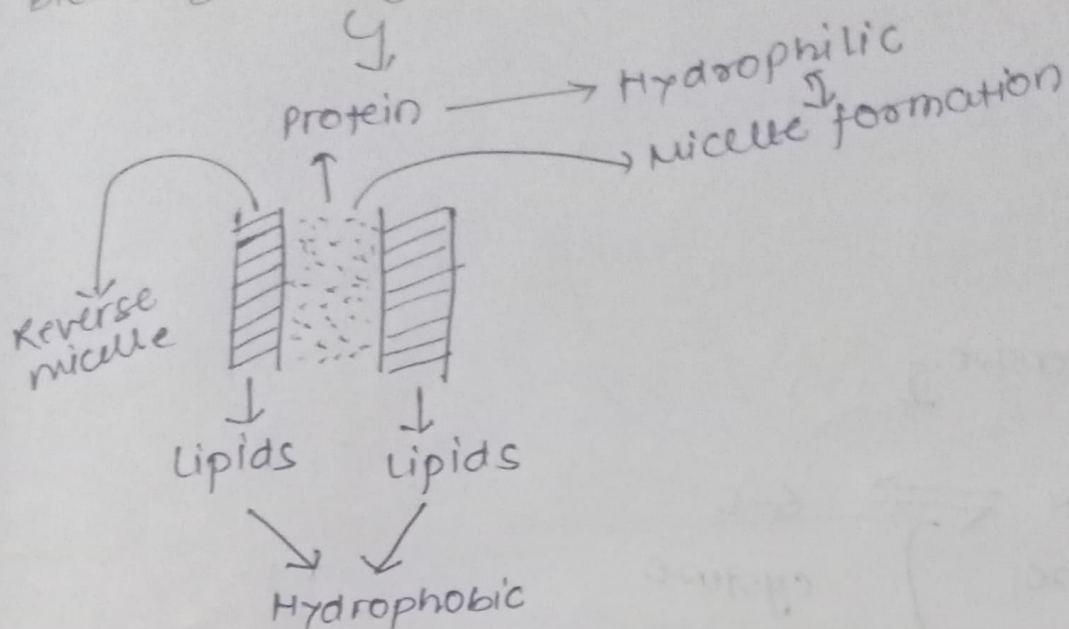
(4) Light-responsive

- UV-sensitive
- visible sensitive

(5) Redox-activity responsive

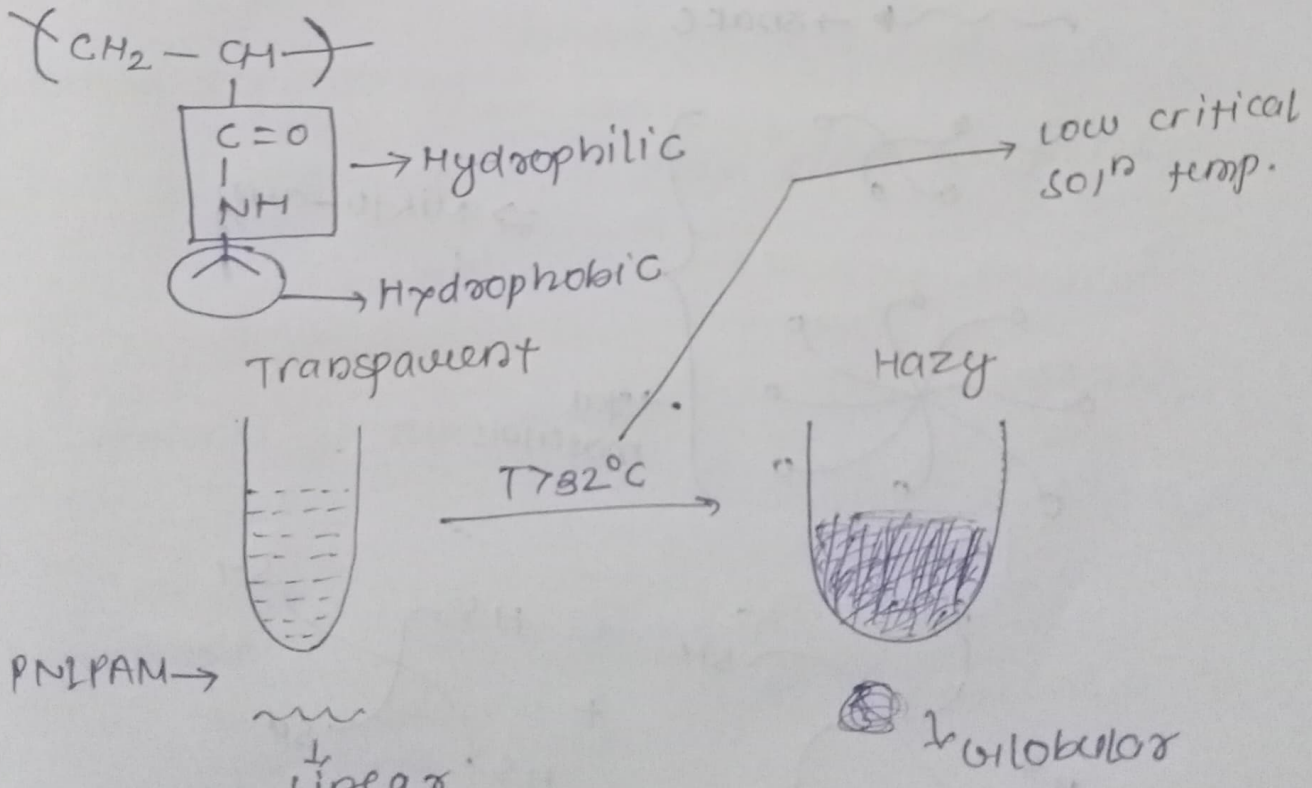
(6) Chemo-responsive

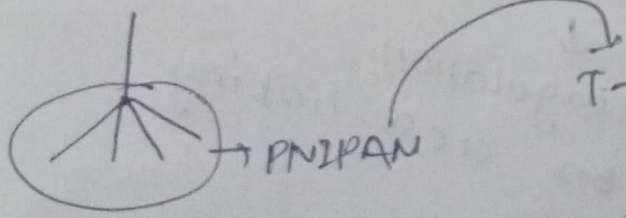
Blood-Brain Barrier



PNIPAM

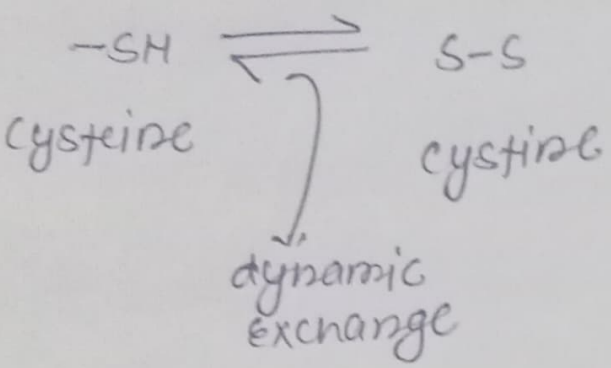
Poly(N-Isopropylacrylamide)

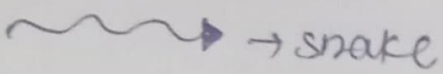


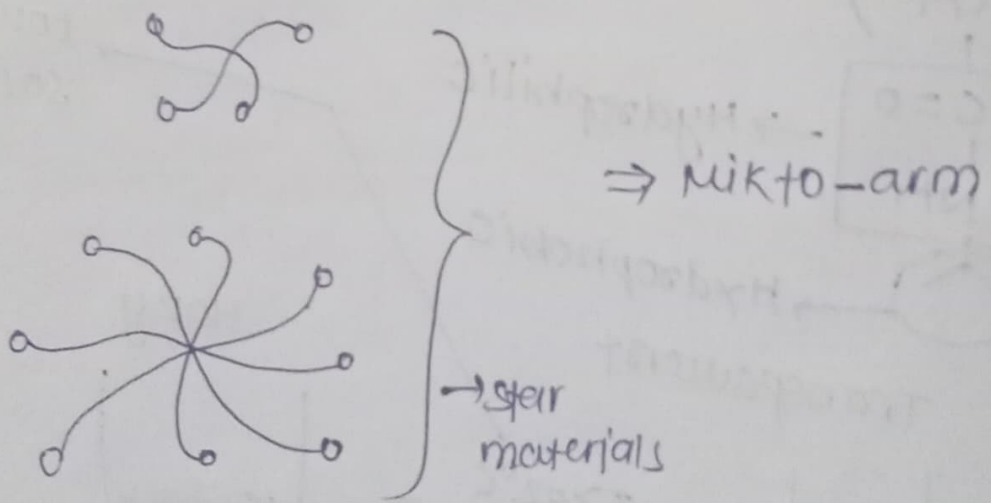


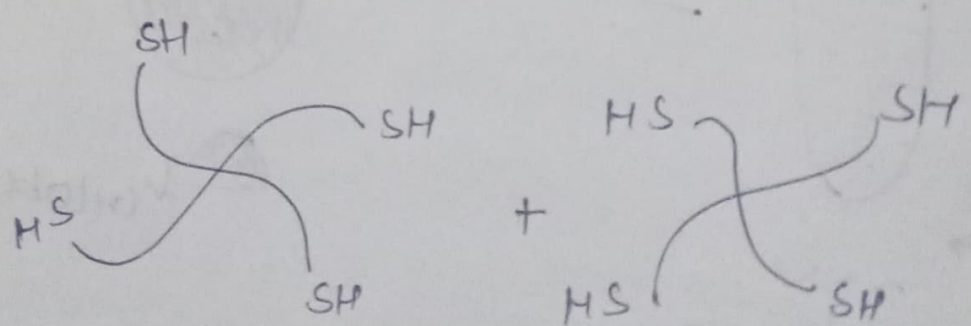
used to fabricate cell sheet surfaces for cell culturing. drug delivery.

Redox-responsive 2

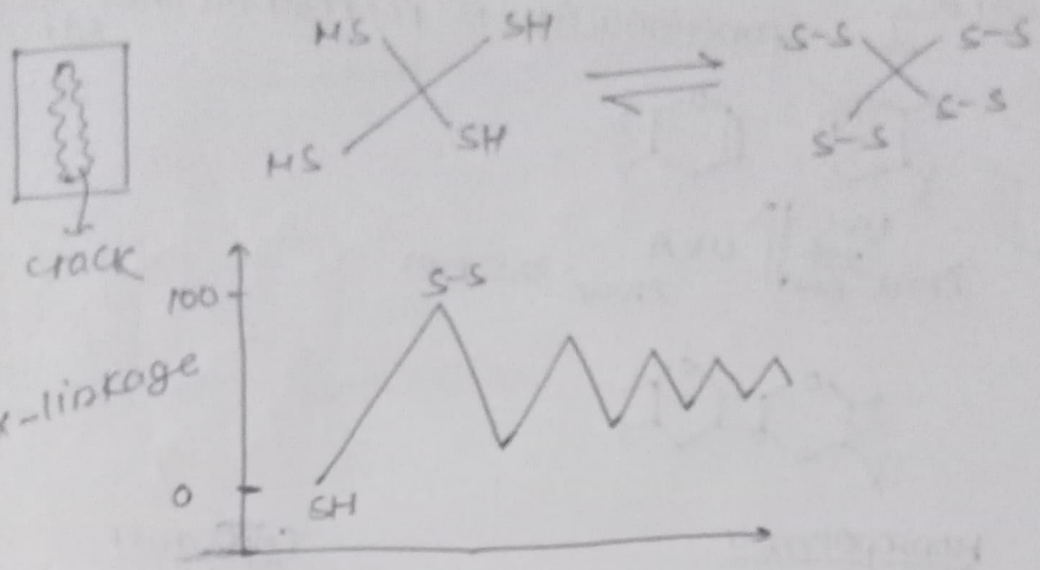






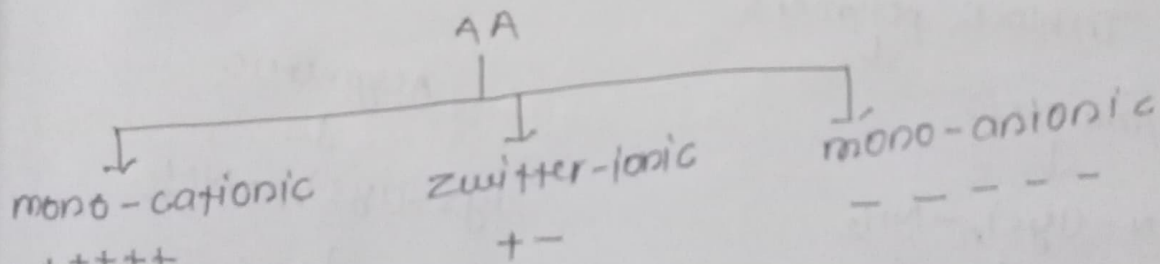


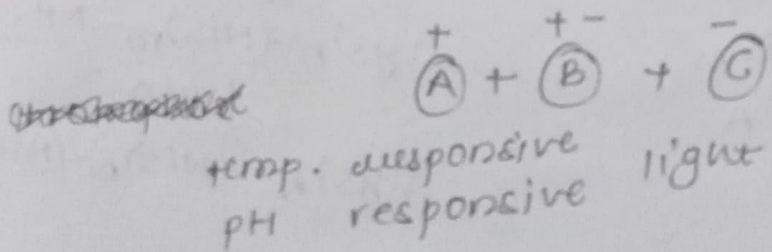
↓
coagulation
or cross-linking



AFM → Atomic force ~~[illegible]~~ Microscopy.

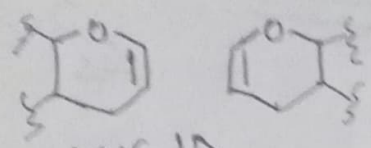
Genome sequencing
↓
sepration of similarly sited proteins



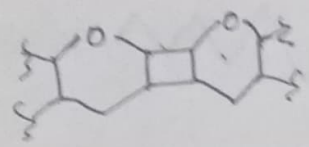


chromophore → materials that absorbs light.

coumarin → functionality is represented (not exact structure)



UVC λ_{max} = 254 nm ⟩⟨ UVA λ_{max} = 365 nm



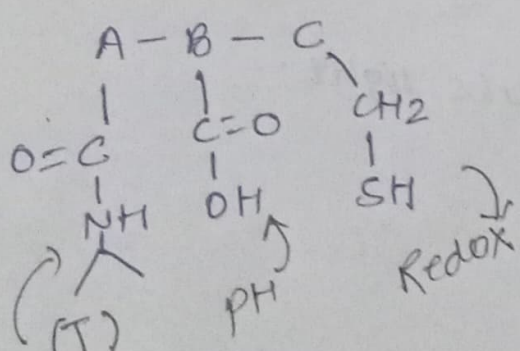
Homopolymer
↓
monofunctional
bifunctional
trifunctional
tetrafunctional

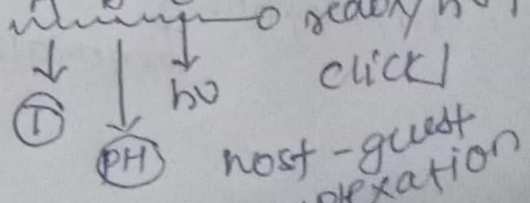
Copolymer
↓
AAAAA

AAABBB → diblock polymer
↓ A-block, ↓ B-block

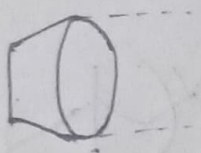
Triblock polymers
↓
Symmetric
↓
$H_2N-(lys)_n-NH_2$
↓ His
$(His)_m-(lys)_n-(His)_m$
A B A

Assymetric
↓
$lys-(lys)_n-NH_2$
↓ His
$(Lys)_n-(His)_m-NH_2$
↓ Ala
$(lys)_n-(His)_m-(Ala)_p$

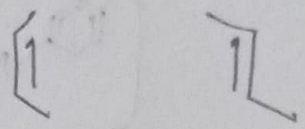




Cyclodextrin → nano-container.

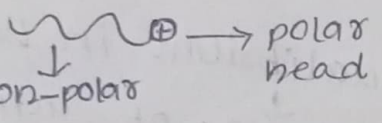


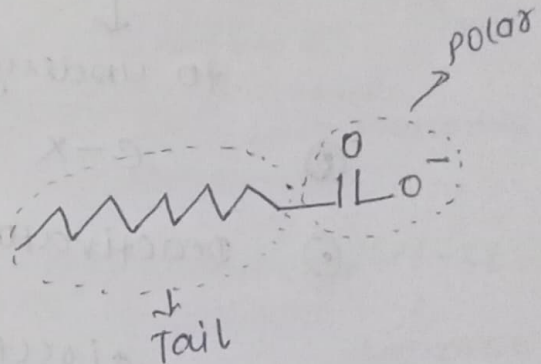
cis / trans



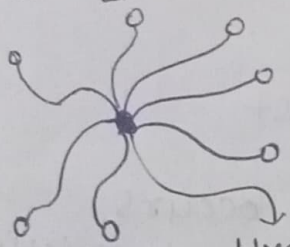
Host-guest complexation →

surfactant →

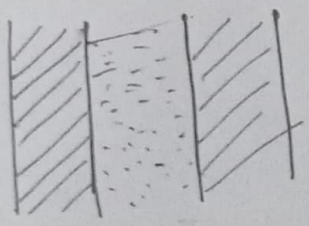




Above CMC →

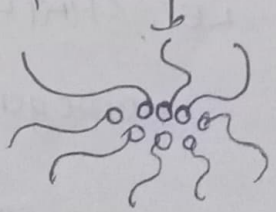


Blood-brain barrier



Drug → encapsulation → chromophore

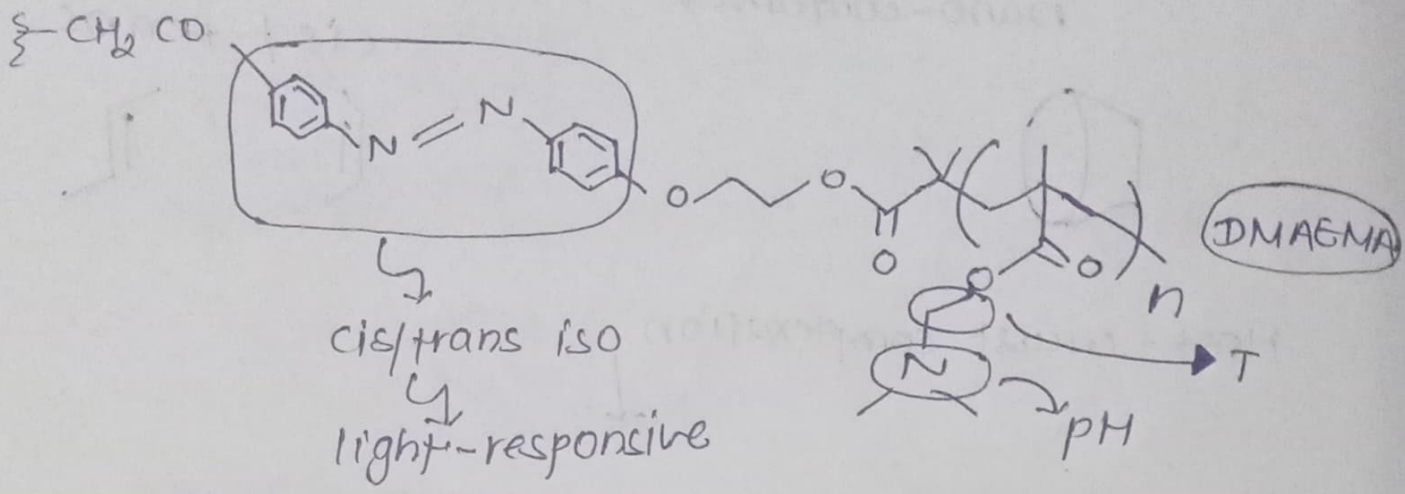
Reverse micelle



↓ Due to solvent's nature

Release → Burst Release

Slow release (sustain release) → amount w.r.t time



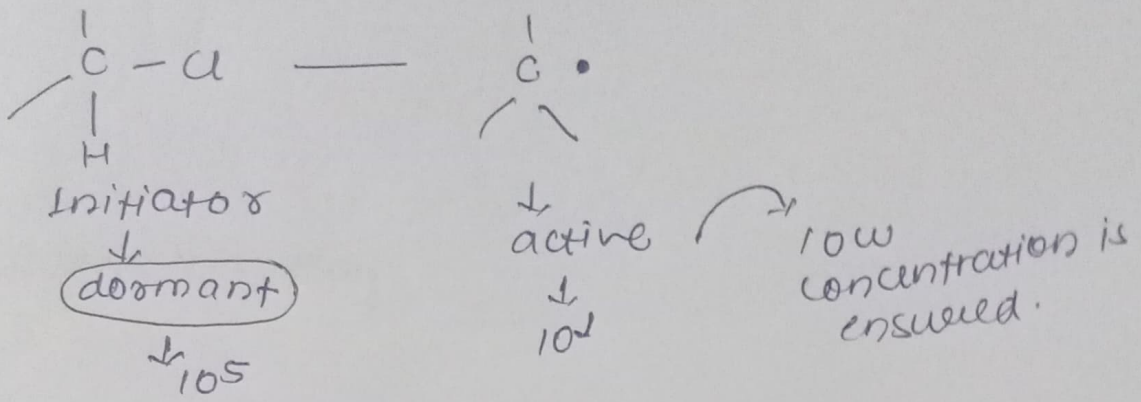
Atom-transfer Radical polymerisation

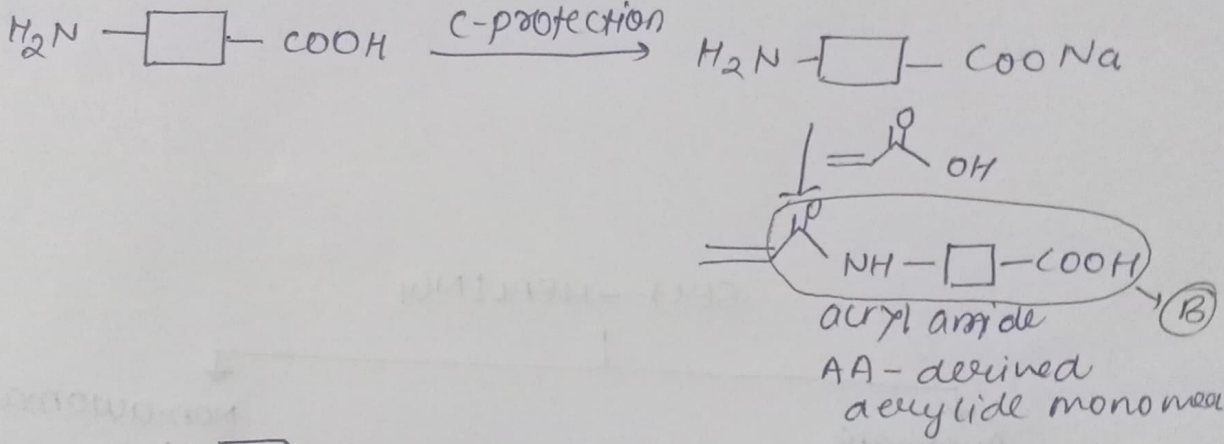
$$P_n\text{-}X + M_m/L_n \underset{K_{od}}{\overset{K_a}{\rightleftharpoons}} P_n^{\bullet} + X\text{-}Mt^{n+1}L_n$$

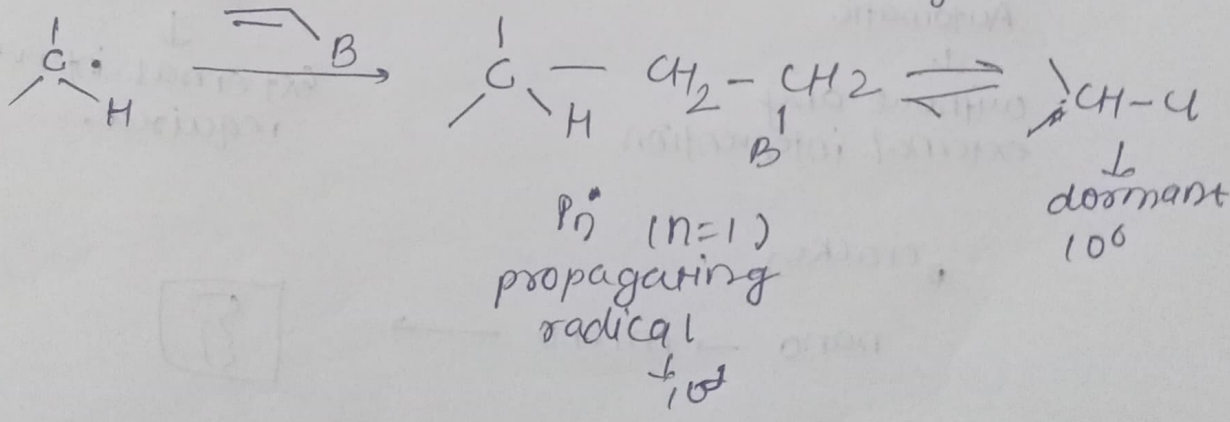
K_p Propagation, $+M$

- Transition metals are used as catalyst.
  - ↓
  - to undergo oxidation and trap radical.
- $C\text{-}X \longrightarrow \dot{C} + \dot{X}$
- Deactivator → shifts equalibrium in backward direction.
  - ↓
  - LE CHATELIER'S PRINCIPLE
  - ↓
  - conc. of active radical is decreased.
- Homogenous catalyst
  - ↓
  - catalyst leaching occurs because reactants and products along with catalyst are in same phase.

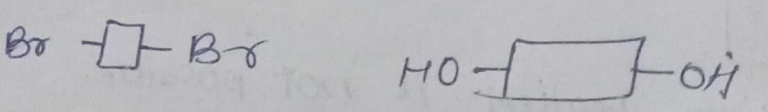
☆ Fast initiation and slow propagation gives control on dispersity.







Preparation of ABA type polymer



Grafting to

Grafting from

SELF-HEALING

- Automatic → without any external intervention
- Non-automatic → External intervention required.

- Cracks
- nano → micro →

Multiple healing is not possible.

Catalyst:- din-Butylindiaurate encapsulated in polyurethane microcapsule.

Fast solidifying of catalyst is not allowed because it makes brittle healing.

Dual capsule-system