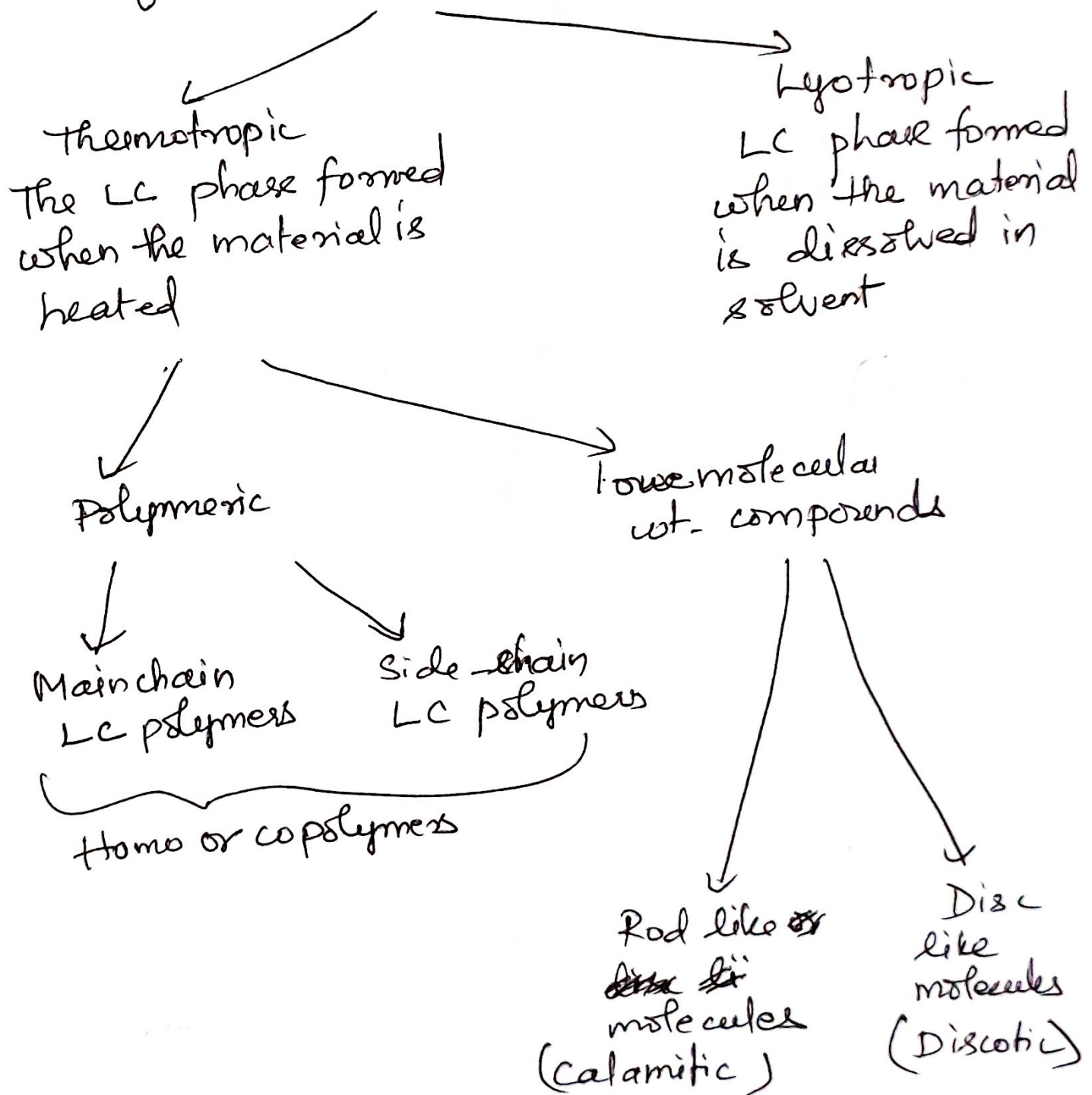


# Liquid crystals

- Intermediate between solids & liquid
- flow like a liquid and take up the shape of the container.
  - Have orderly arrangement of molecules as found in solids and are anisotropic.



## Lyotropic :-

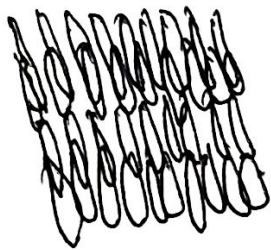
Molecules that are amphiphilic i.e. ~~solvent~~ attracting and solvent repelling ~~end~~ groups present in the same molecule. For eg. fatty acids. When dissolved in a solvent, they tend to align or orient and form micelles. This happens only at a certain concentration



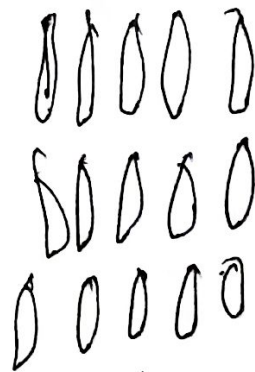
called  
critical  
micelle  
concentration.

ordered structures

## LC materials phases in thermotropic LC materials



solid



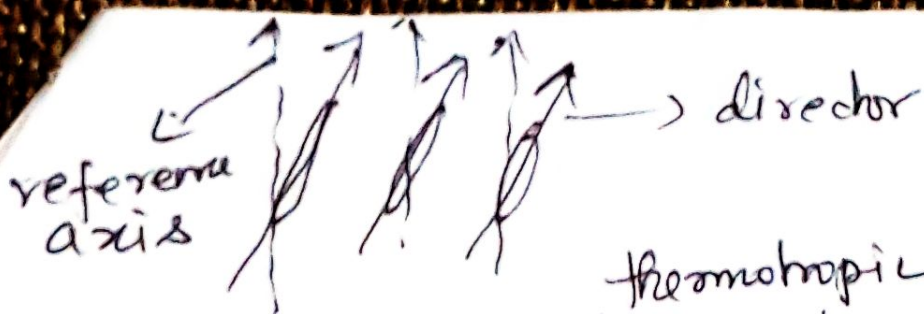
fluid with  
orientation  
(LC phase)



liquid.  
no orientation

The molecules in a liquid crystal tend to orient in a particular direction. The direction of preferred orientation in the liquid crystal is called the director

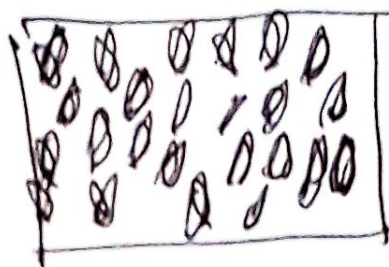




## Different phases of Liquid crystals

### Nematic phase :-

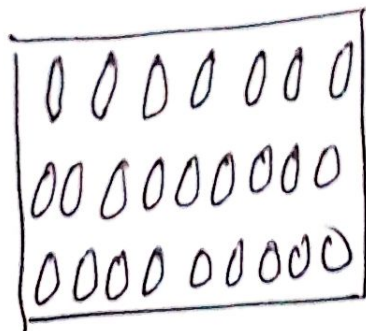
→ No long range ~~trans~~ order. or it is the least ordered mesophase.



i.e, they maintain directional order but are distributed randomly.

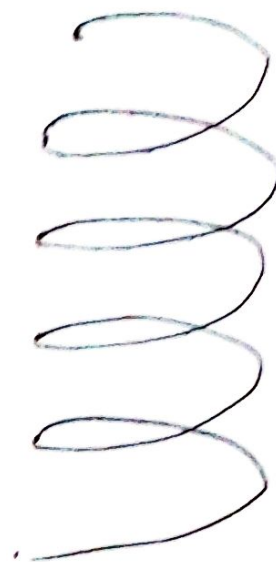
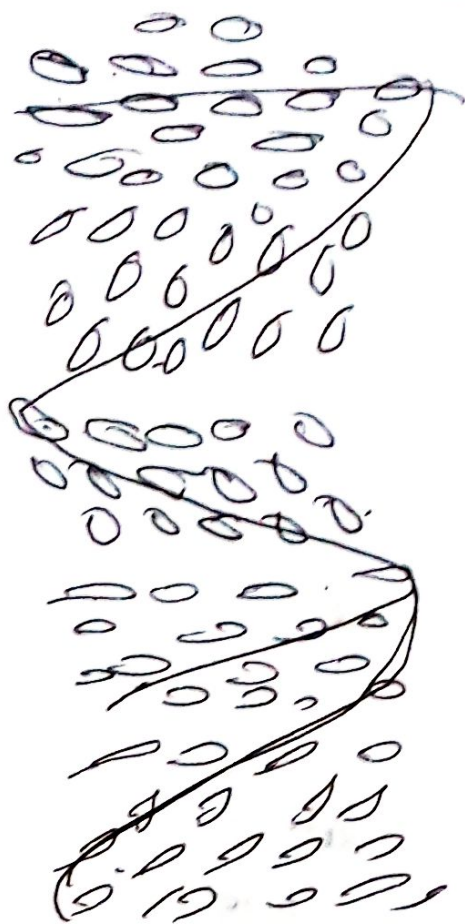
### Smectic phase :-

→ Molecules are arranged in regular layers



### cholesteric phase or chiral nematic phase

Molecules are oriented in a particular direction and are randomly arranged. But as in nematic. But the direction of orientation rotates continuously resulting in helical structures



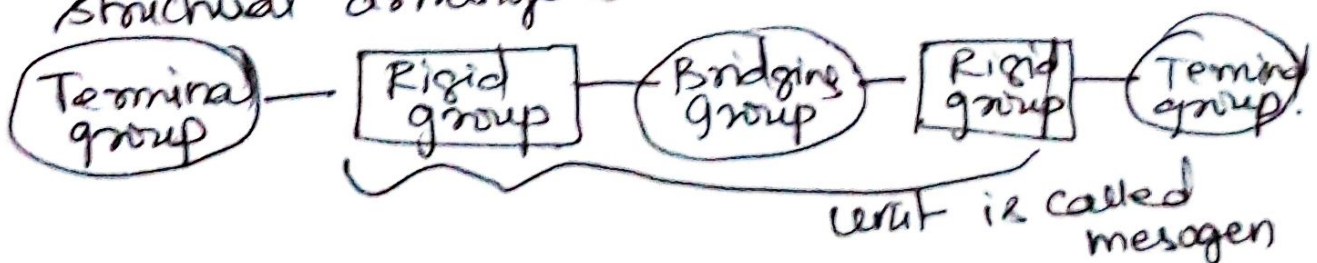
direction  
of orientation

### Structural requirements for LC behaviour:-

Molecules exhibiting LC behaviour are of two types.

- (a) Molecules having a rigid central part with flexible ends in their structure.
- (b) Polymers having backbone chain in which rigid segments are attached by short flexible spacers.

molecules exhibiting LC behaviour are aromatic systems of the following general structural arrangement.

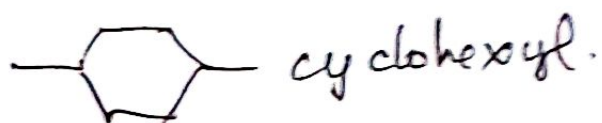




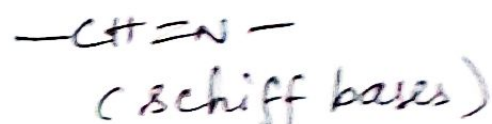
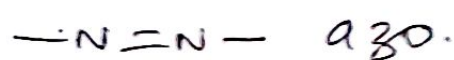
rigid groups are  - p-phenylene



2,6 or 1,4 or 1,5 linkages

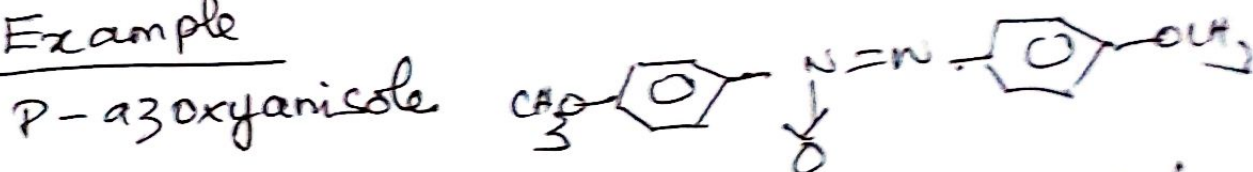


Bridging groups are



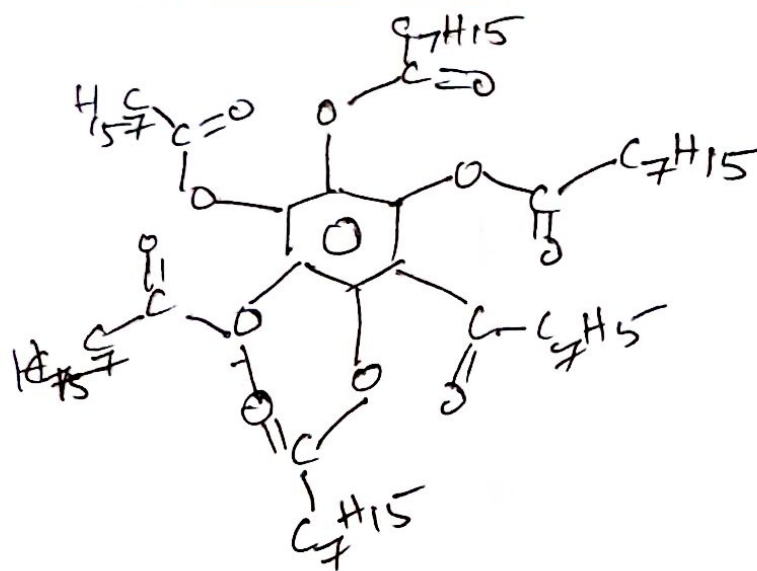
Terminal groups are small groups like  $-\text{OCH}_3$  or short chains.

Example



The above example is a molecule that has rigid rod like structure.

Example of compounds that show disc like or discotic LC phase is benzene-hexa-n-alkanoates

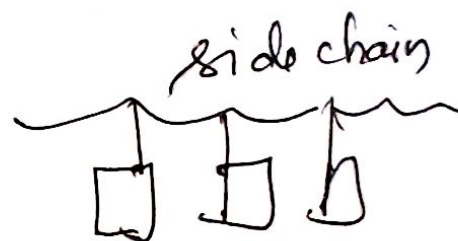
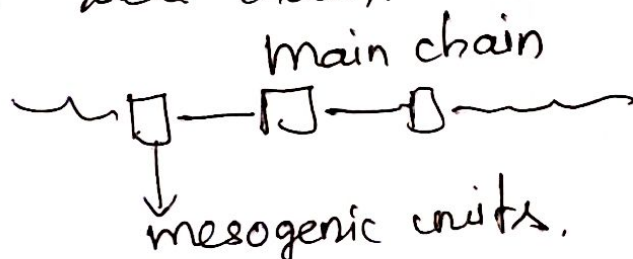


disc like molecule

## Polymeric liquid crystals

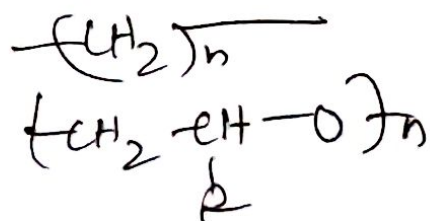
Liquid crystalline polymers (LCP)

In polymers the mesogens (aromatic or cycloaliphatic units ~~but~~ joined by rigid links) form a part of the polymer main chain or is attached to the side chain.



The mesogenic units are linked with spaces which are flexible groups.

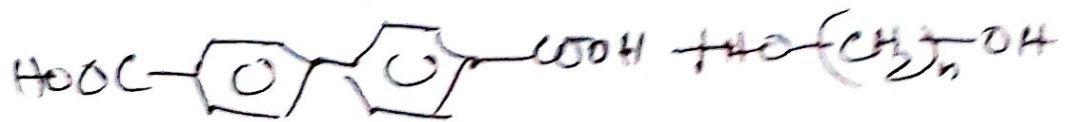
common spacer groups are



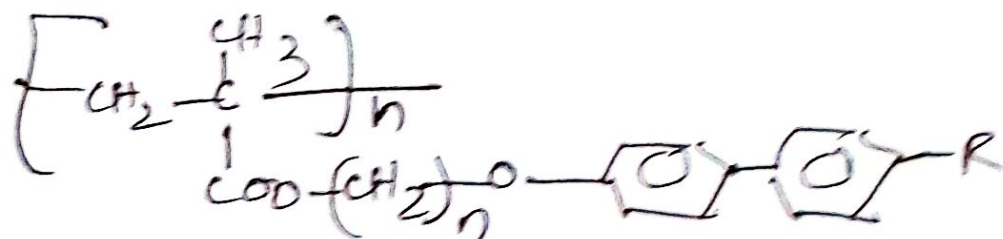
Eg main chain ~~LC~~ LC polymer



obtained from



Side chain LC polymer



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### Advantages of LCP

- High heat resistance
- Flame retardant
- Chemical resistance
- Dimensional stability
- low cost
- ~~red.~~ easy fabrication
- Heat aging resistance
- Adhesion.