Physical Pharmacy

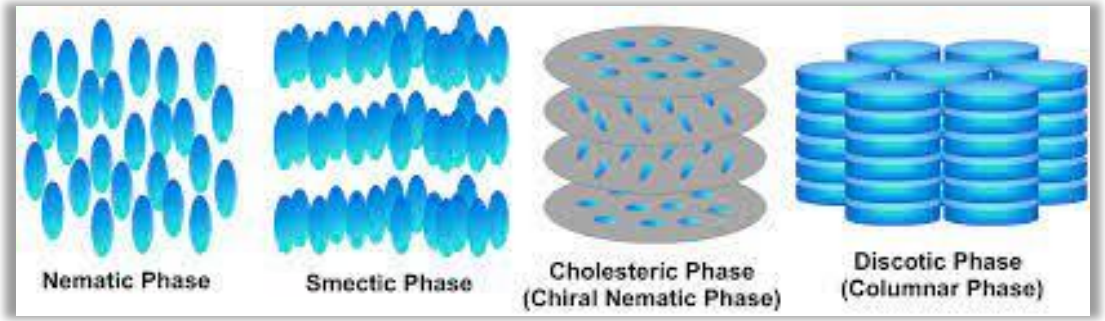
The Liquid Crystalline phase

(LC-phase)or Mesophase

Contents

In this lecture you will learn:

- Definition and introduction to liquid crystals
- Structure of liquid crystals
- Classification of liquid crystals
- Applications of liquid crystals

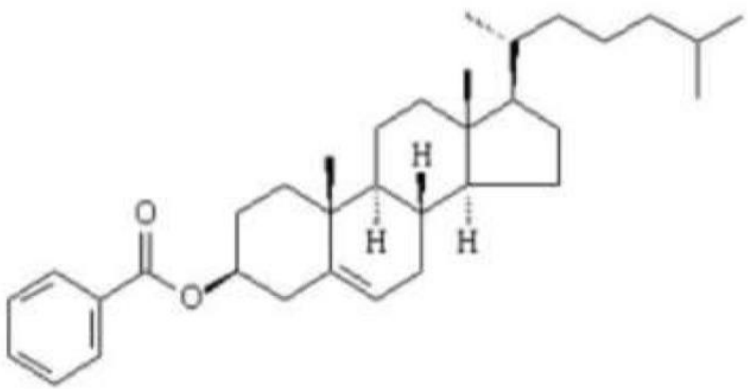


DR CUBE

Discovery of LC

- While studying the function of cholesterol in plants, **Friedrich Reinitzer,** an Austrian botanist, found an unusual melting that was always accompanied by the presence of cloudy liquid state before the clear liquid appears.

Friedrich Reinitzer



cholesteryl benzoate

DR.CUBE

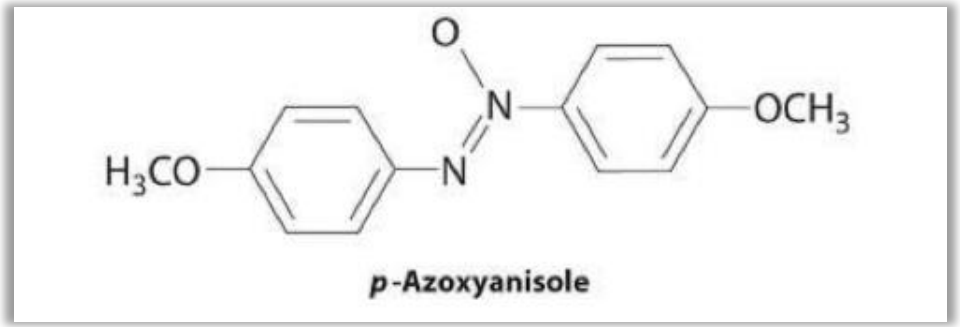
Discovery of LC

Note:

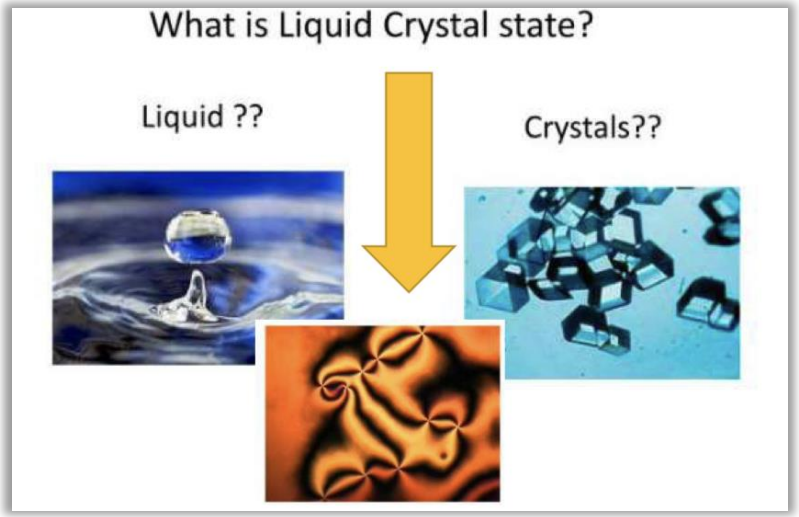
a. Liquid crystal state is seen in some but **not all molecules**

b. Water molecules, for example, melt directly from solid crystalline ice into liquid water (**don't show LC phase**)

c. p-azoxyanisole (PAA) shows LC phase.



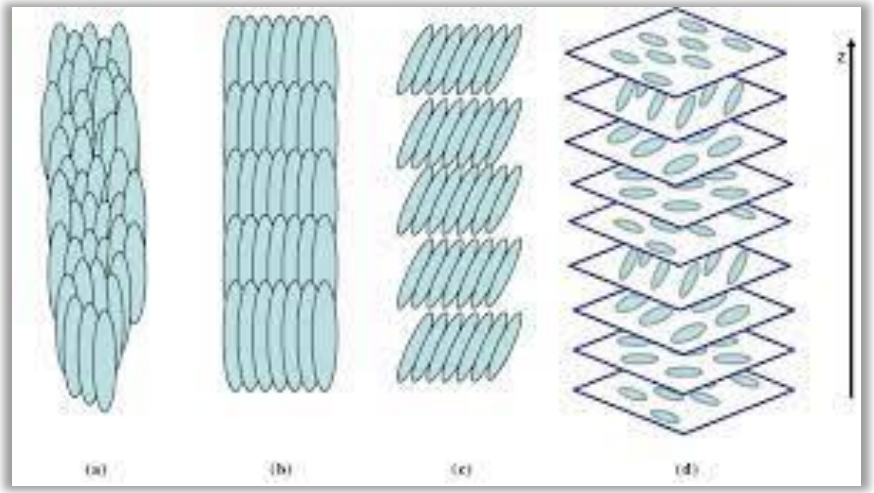
p-Azoxyanisole



DR CUBE

Liquid Crystals (LC)

- Liquid crystal (LC) state is a state of matter whose properties are intermediate between those of conventional liquids and those of solid crystals.
- A more proper name is '**mesomorphic phases**' or '**mesophase**' (mesomorphic: intermediate form).
- It is also known as the "**fourth state of matter**",



DR.CUBE

Liquid Crystals (LC)

Properties of Liquid Crystals

- Because of their intermediate nature, liquid crystals have some of the properties of liquids and some of the properties of solids, as follows:

Comparison with liquids

- **Similar int its ability to flow and are mobile**
- **Different due to presence of some orientational order molecules of LC**

Comparison with crystalline solids

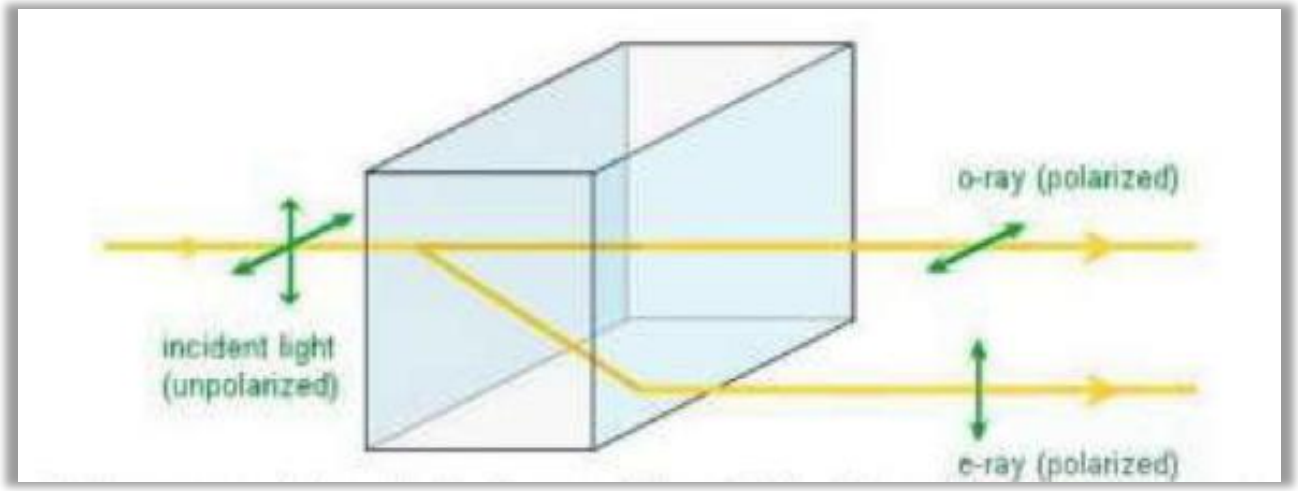
- **Inherited symmetry and orderness of molecules**
- **Possess the property of being birefringent (double refraction)**

DR CUBE

Liquid Crystals (LC)

Properties of Liquid Crystals

- **Note: LC has also properties not found in liquids or solids**



DR.CUBE

Liquid Crystals (LC)

Structure of Liquid Crystals

- The liquid crystal building blocks (molecules that demonstrate mesophases) are called mesogens

- These are organic molecules which have an anisometric shape and combine **flexible and rigid fragments**

- Liquid crystal molecules (mesogens) generally have several common characteristics. Among these are:

a. Long, narrow, rod-like organic molecules (Length > width) with rigid central region and somewhat flexible ends of the molecules.

DR CUBE

Liquid Crystals (LC)

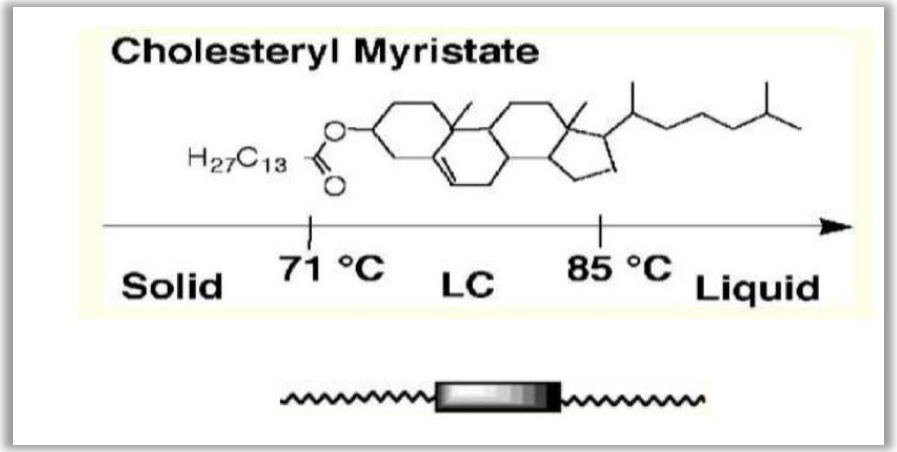
Structure of Liquid Crystals

b. Sufficient molecular interactions

c. Presence of unsaturation and bulky functional group

d. Presence of carboxylic acid group at the end of the side chain.

e. Uneven distribution of electrical charges along their axes (i.e,are strong dipoles and/or easily polarizable substituents).



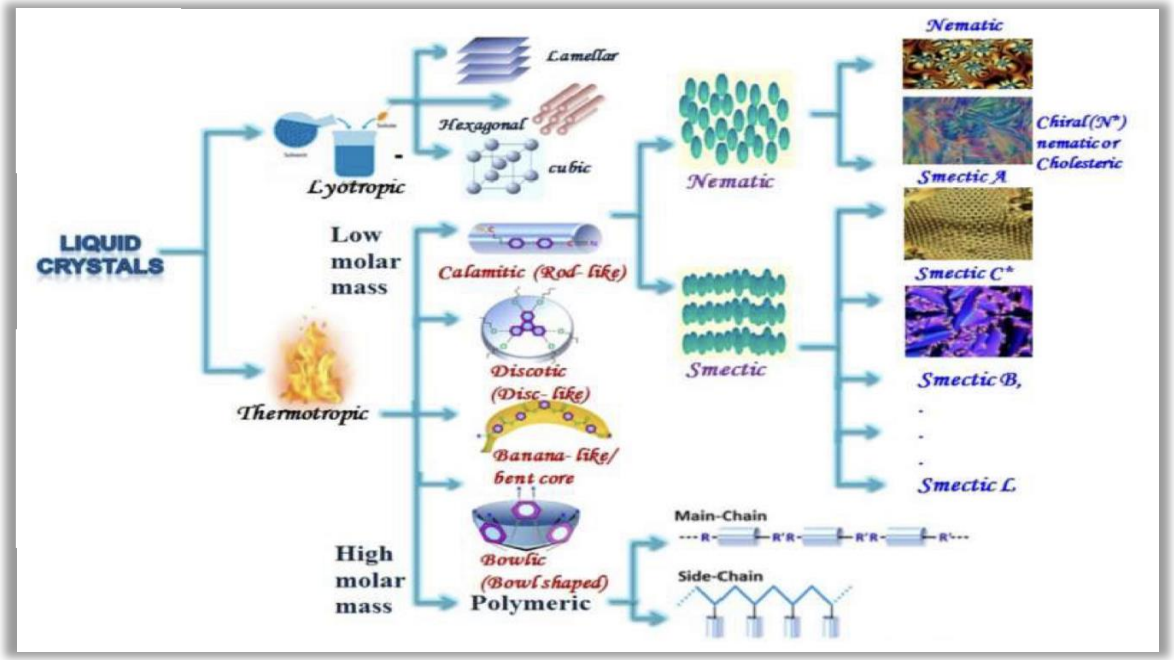
DR CUBE

Liquid Crystals (LC)

Classification of Liquid Crystals

- According to the formation conditions, liquid crystals are categorized into two generic classes, these are:

a. **Lytoropic liquid** crystalline phases
b. **Thermotropic liquid** crystalline phases

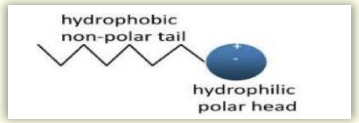


DR CUBE

Liquid Crystals (LC)

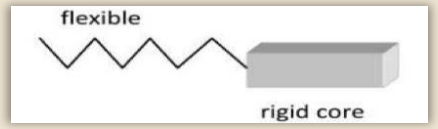
Classification of Liquid Crystals

Lyotropic phases (lyotropics or lyomesophases)



- Lyotropic phases are formed when mixed with aqueous phase (they are mixtures of amphiphilic molecules in a solvent at a given temperatures and relative concentration)
- Phase transitions are temperature and concentration dependent

Thermotropic phases



- Thermotropic liquid crystalline phases are formed by a change of temperature (they are formed on heating the crystalline solid or cooling the isotropic liquid)
- Phase transitions are temperature-dependent

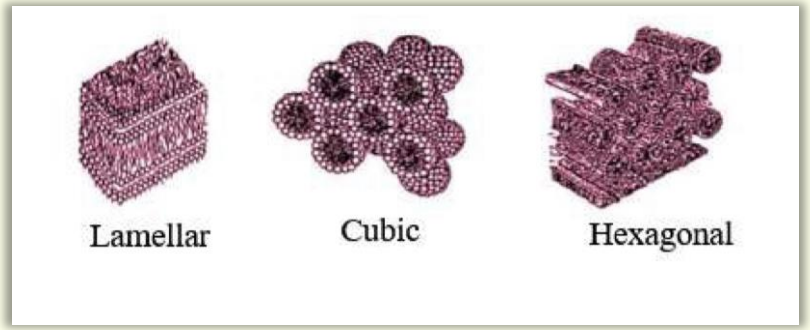
DR CUBE

Liquid Crystals (LC)

Classification of Liquid Crystals

Lyotropic phases (lyotropics or lyomesophases)

- They are important in solubilization and drug delivery systems, and are of importance in colloids, gels, biology and soaps.
- Lyotropic liquid crystals are subcategorized as lamellar, cubic and hexagonal.



Thermotropic phases

- They are used in various applications
- Thermotropic liquid crystals are subcategorized into discotic, calamitic and banana and bowel-shaped LCs

Calamitic LCs can be further subdivided into

DR CUBE

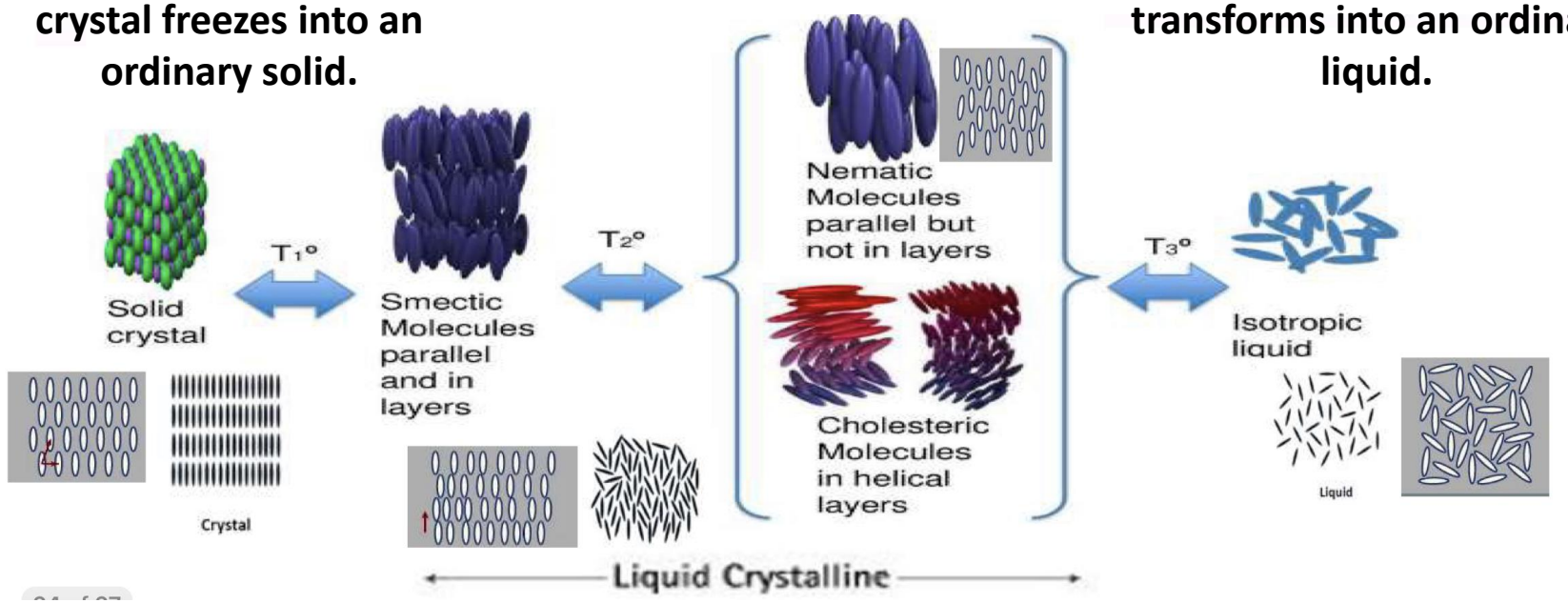
Liquid Crystals (LC)

The liquid crystal phase changes

- Liquid crystals retain their dual liquid and solid nature only over a certain range of temperature and pressures.

- **At low temperatures or high pressures, liquid crystal freezes into an ordinary solid.**

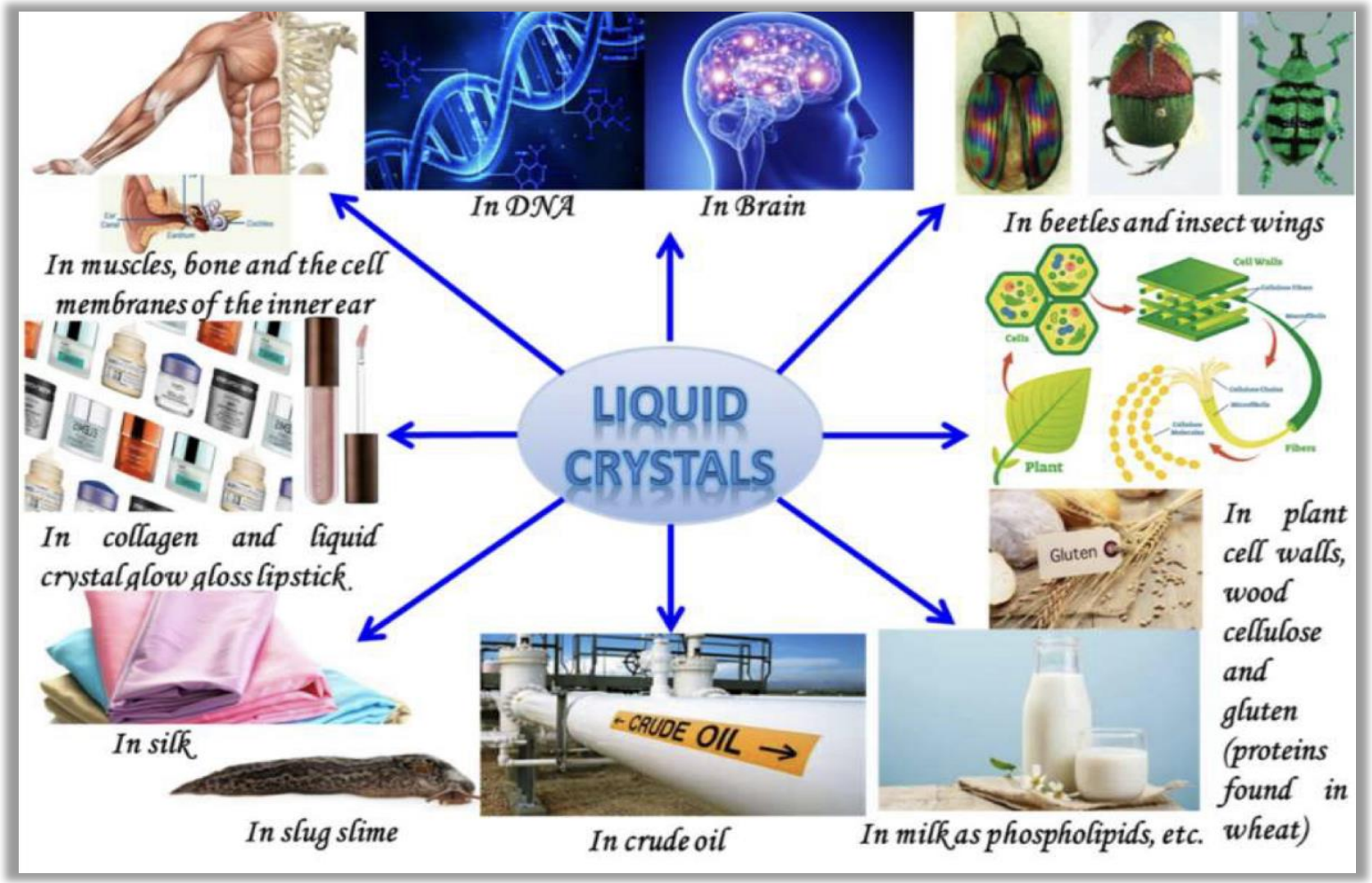
- **At high temperatures or low pressures, liquid crystal transforms into an ordinary liquid.**



DR CUBE

Liquid Crystals (LC)

Significance and Applications of Liquid Crystals



DR CUBE

Liquid Crystals (LC)

Significance and Applications of LC system

- **Many biological materials form liquid crystals:**

a. Myelin, a fatty material extracted from nerve cells, was the first intensively studied liquid crystal.

b. Blood is an ordinary disordered isotropic fluid.

c. The disklike shape of red blood cells, however, favours liquid crystallinity at certain concentrations and temperatures

d. In atherosclerosis, it is the incorporation of cholesterol and lipids in human subendothelialmacrophages that leads to an insoluble liquid crystalline biologic membrane that ultimately results in plaque formation.

DR CUBE

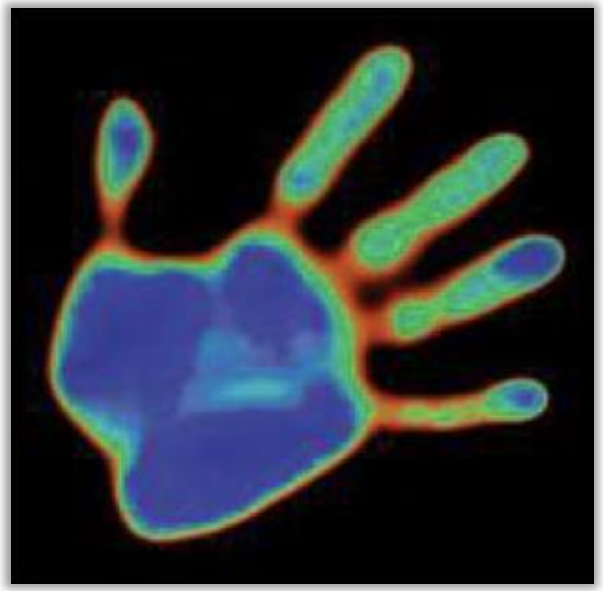
Liquid Crystals (LC)

Significance and Applications of LC system

- **Some liquid crystals show consistent color changes with temperature, and this characteristic has resulted in their being used to:**

a. Detect areas of elevated temperature under the skin that may be due to a disease process (study of malignant and non-malignant tissues in human beings for the treatment of cancer as well)

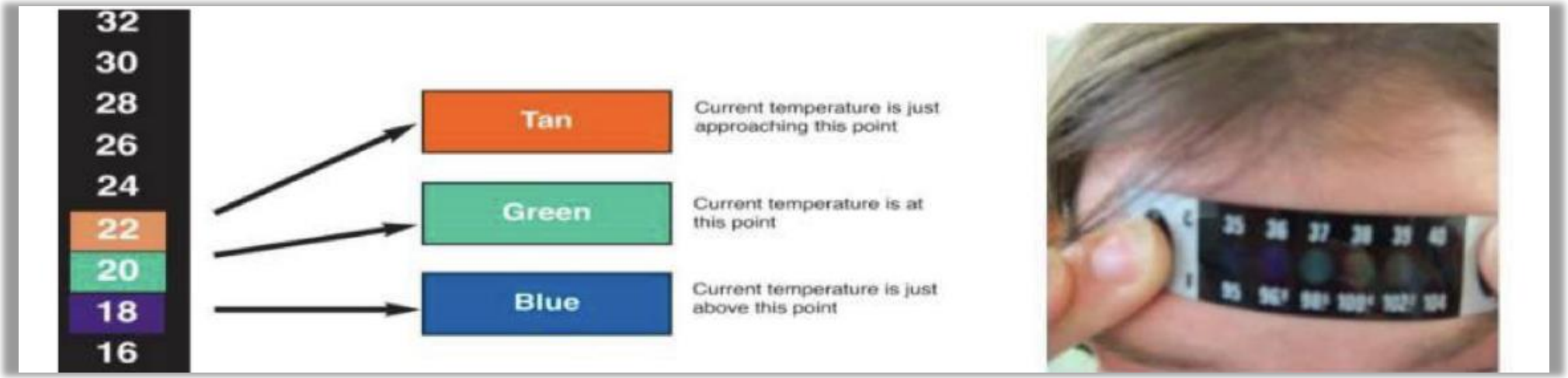
b. Build a liquid crystal thermometer: just by looking at the color or thermometer, we can know the temperature.



DR CUBE

Liquid Crystals (LC)

Significance and Applications of LC system



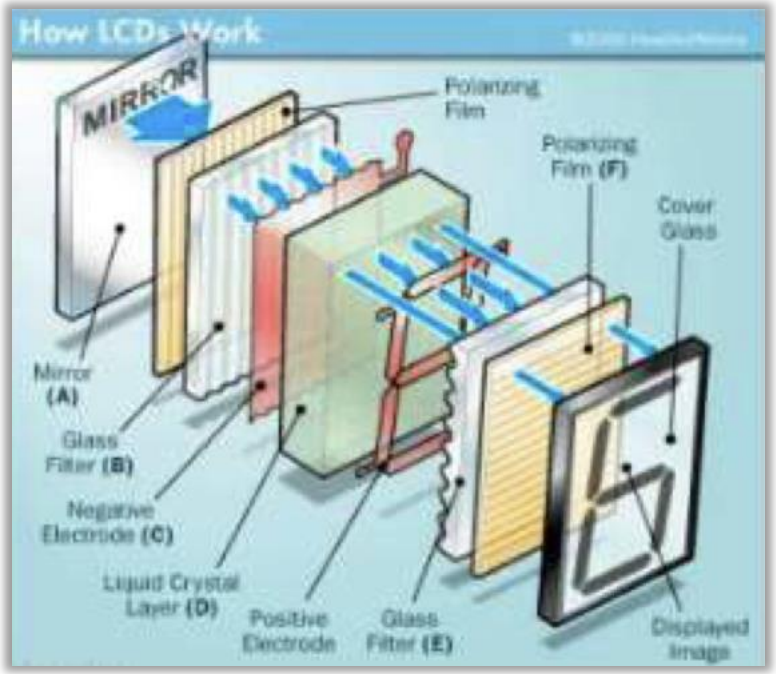
DR.CUBE

Liquid Crystals (LC)

Significance and Applications of LC system

- Hexagonal and cubic mesophases are particularly of high interest in the drug delivery field due to their exceptional potential as drug vehicles.

- Nematic liquid crystals are used in the displays of devices as wristwatches, calculators, portable computers, and flat-screen devices (LCD) and televisions because they are sensitive to changes in temperature and electric field.



DR.CUBE

DR CUBE

Thank You !

https://t.me/Dr_Cube