# Liquid State

Lecture-2

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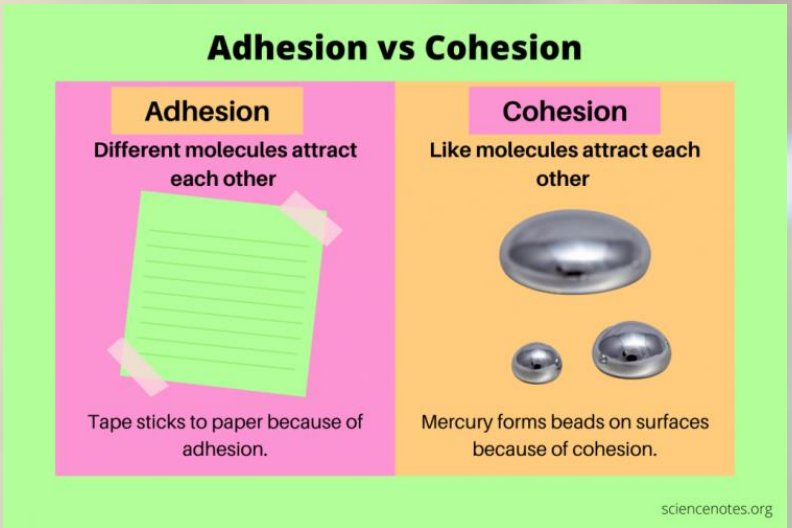
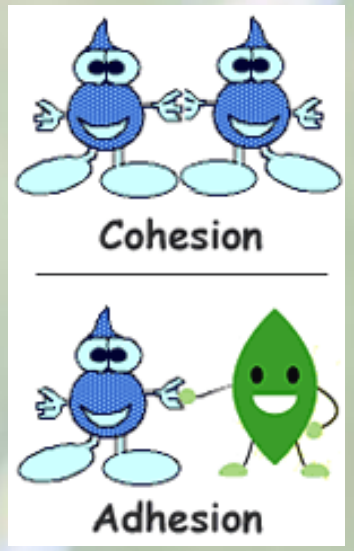
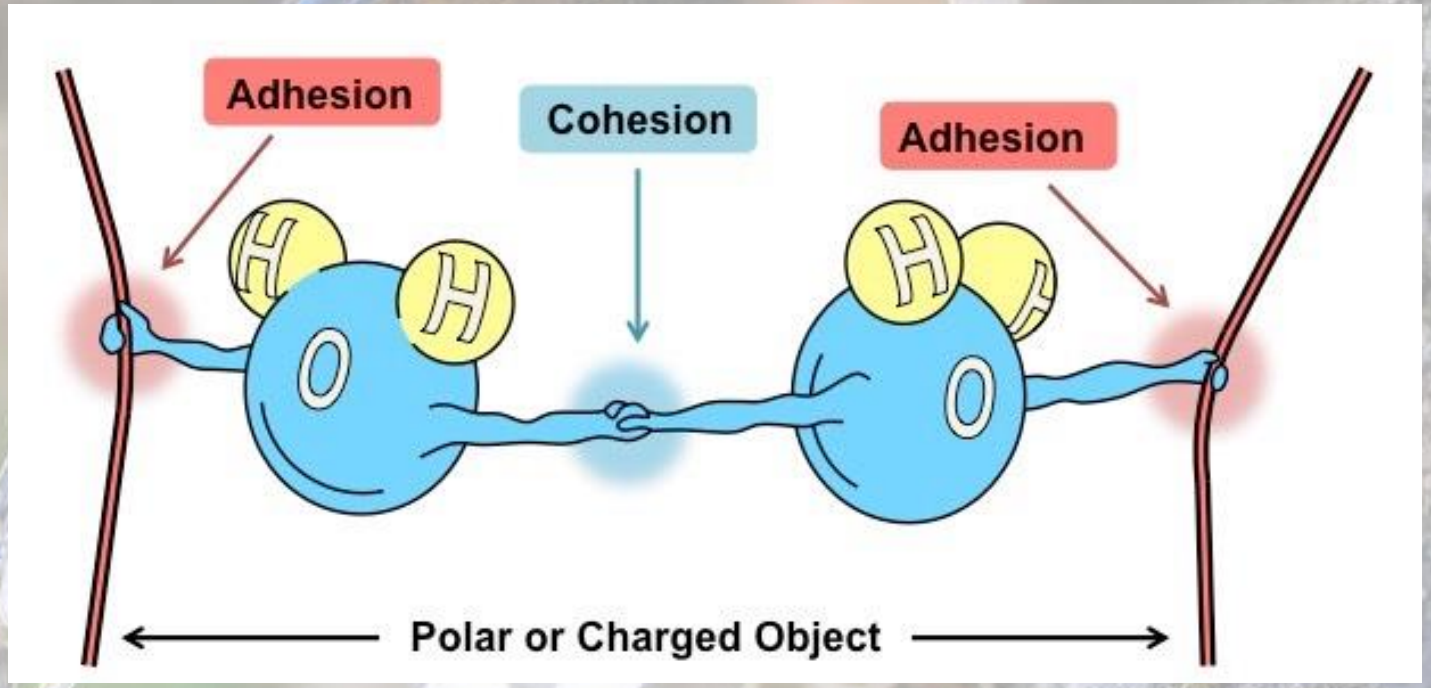
# SURFACE TENSION

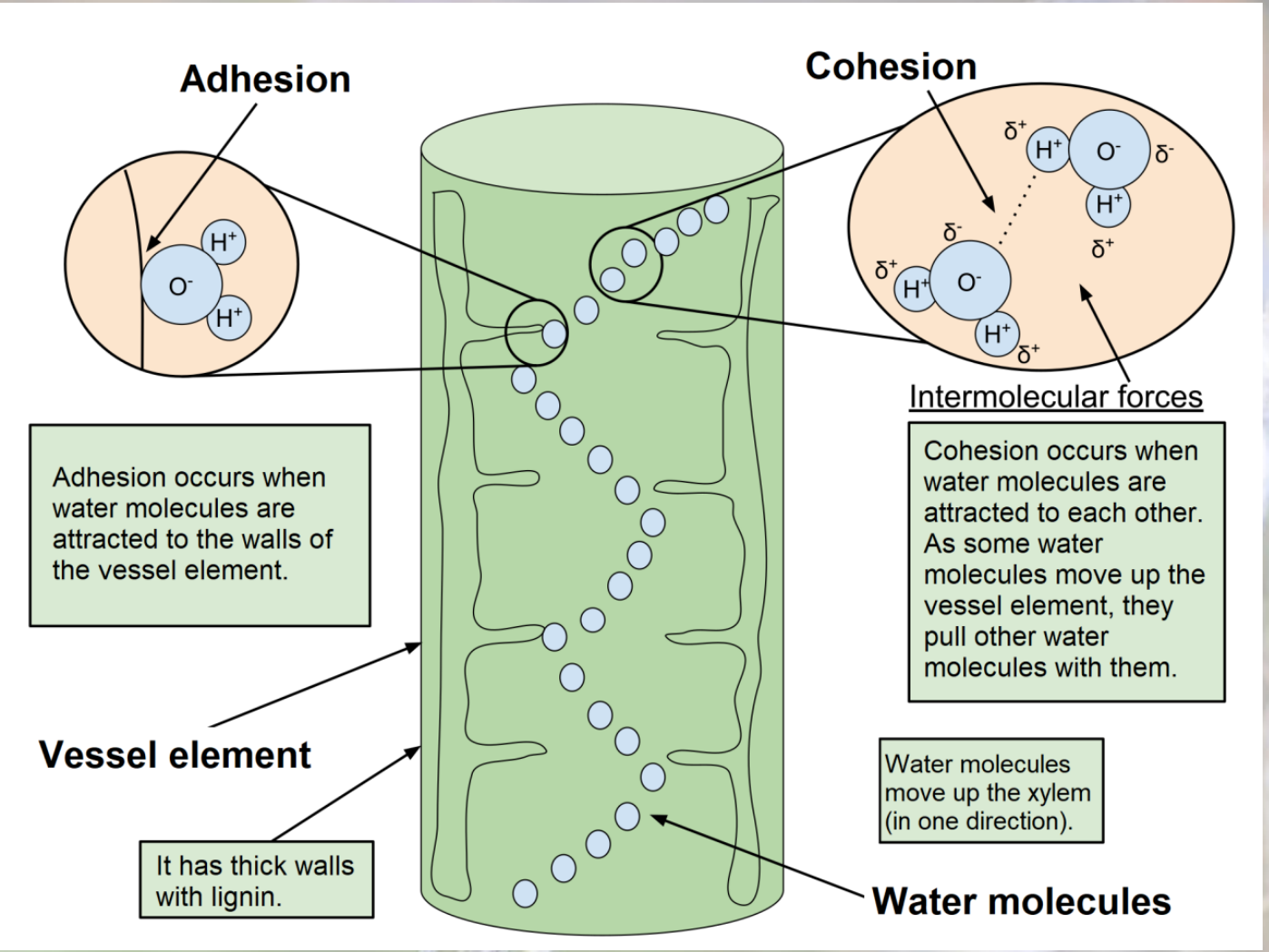
This property of liquids arises from the intermolecular forces of attraction. A molecule in the interior of a liquid is attracted equally in all directions by the molecules around it. A molecule in the surface of a liquid is attracted only sideways and toward the interior. The forces on the sides being counterbalanced the surface molecule is pulled only inward the liquid. Thus there is a tendency on the part of the surface molecules to go into the bulk of the liquid. The liquid surface is, therefore, under tension and tends to contract to the smallest possible area in order to have the minimum number of molecules at the surface. It is for this reason that in air, drops of a liquid assume spherical shapes because for a given volume a sphere has the minimum surface area.

# Adhesion & Cohesion



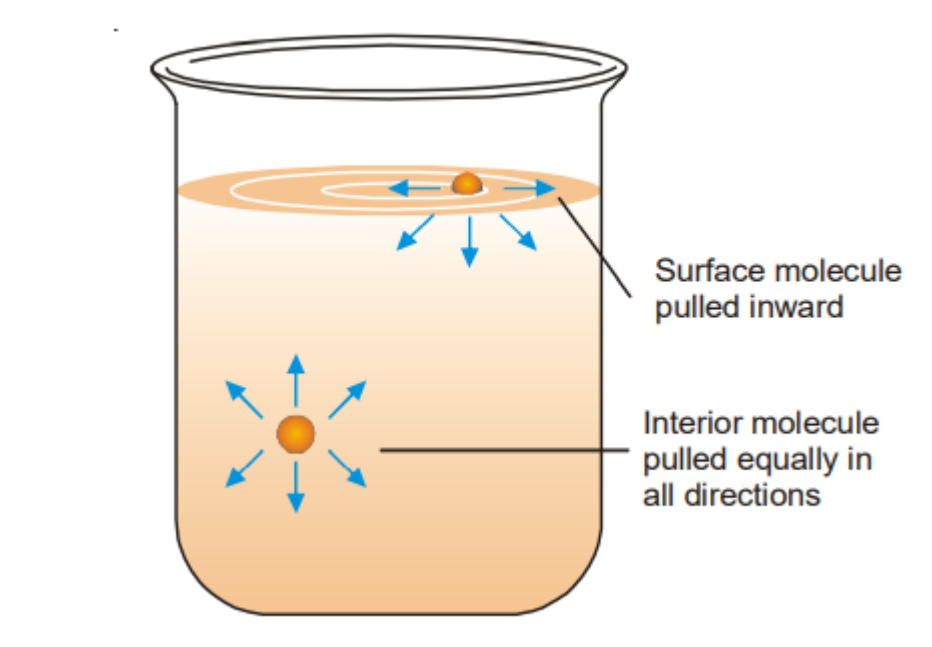



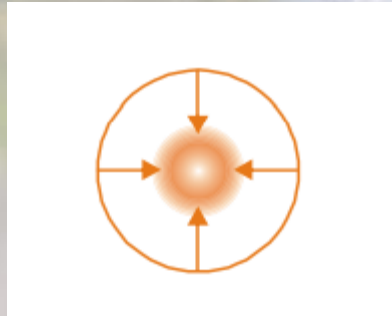

Adhesion
Cohesion
Adhesion occurs when water molecules are attracted to the walls of the vessel element.
Intermolecular forces
Cohesion occurs when water molecules are attracted to each other. As some water molecules move up the vessel element, they pull other water molecules with them.
Vessel element
It has thick walls with lignin.
Water molecules move up the xylem (in one direction).
Water molecules

The surface tension (γ) is defined as : the force in dynes acting along the surface of a liquid at right angle to any line 1 cm in length.

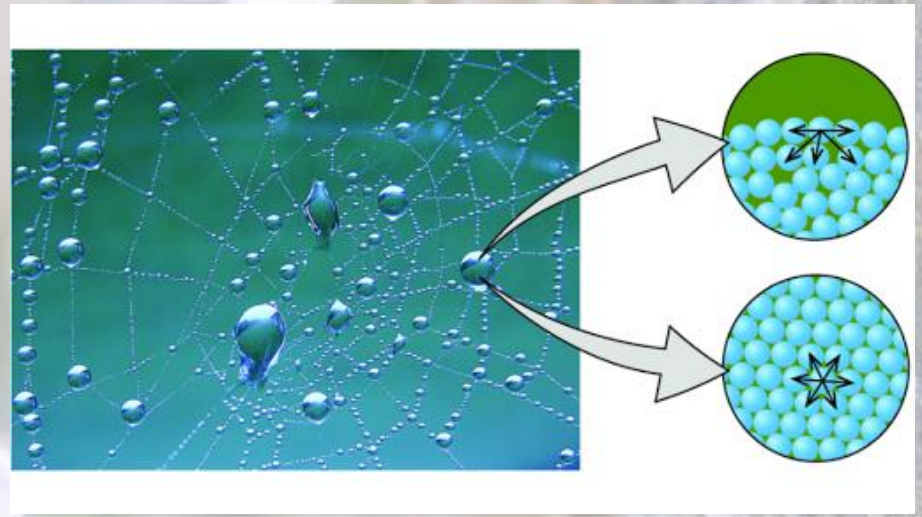
"The property of the surface of a liquid that allows it to resist an external force, due to the cohesive nature of its molecules.

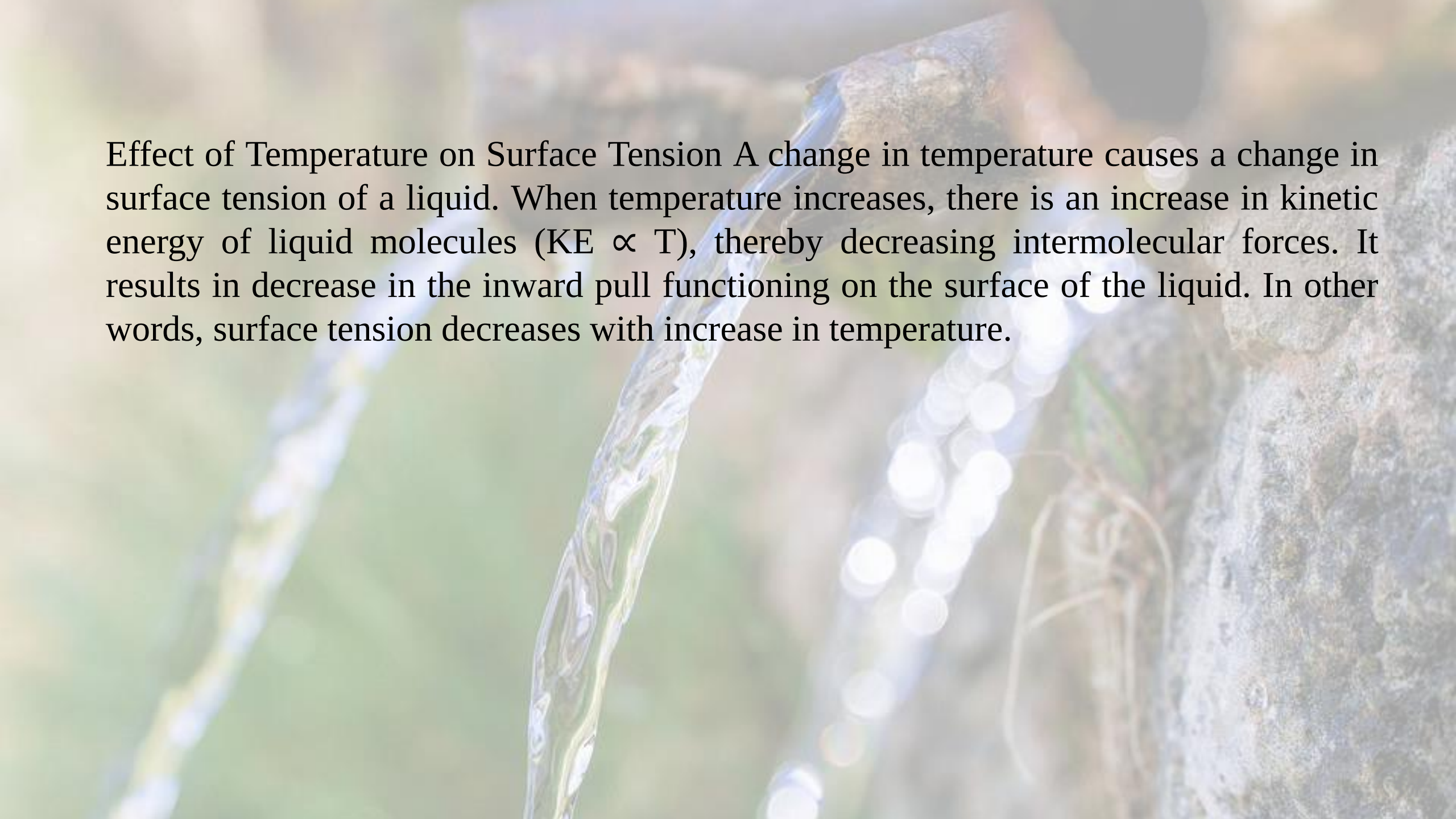



Surface tension is caused by the net inward pull on the surface molecules.



The inward forces on the surface molecules minimize the surface area and form a drop.





Effect of Temperature on Surface Tension A change in temperature causes a change in surface tension of a liquid. When temperature increases, there is an increase in kinetic energy of liquid molecules (KE $\propto$ T), thereby decreasing intermolecular forces. It results in decrease in the inward pull functioning on the surface of the liquid. In other words, surface tension decreases with increase in temperature.

# SURFACE TENSION

Surface tension helps dew drops stick to the grass and prevents them from spreading.

Surface tension prevents this flower from sinking.

Surface tension prevents a paper clip from sinking.

Surface tension helps insects to walk on water.

Surface tension is an effect within the surface layer of a liquid that causes the layer to behave as an elastic sheet. It is the effect that allows insects (such as the water strider) to walk on water, and causes capillary action. Surface tension is caused by the attraction between the molecules of the liquid, due to various intermolecular forces. In the bulk of the liquid each molecule is pulled equally in all directions by neighbouring liquid molecules, resulting in a net force of zero. At the surface of the liquid, the molecules are pulled inwards by other molecules deeper inside the liquid, but there are no liquid molecules on the outside to balance these forces. All of the molecules at the surface are therefore subject to an inward force of molecular attraction which can be balanced only by the resistance of the liquid to compression. Thus the liquid squeezes itself together until it has the lowest surface area possible

# VISCOSITY

A liquid may be considered to be consisting of molecular layers arranged one over the other. When a shearing force is applied to a liquid, it flows. However, the forces of friction between the layers offer resistance to this flow. Viscosity of a liquid is a measure of its frictional resistance. Let us examine a liquid flowing on a glass surface (Fig. 11.22). The molecular layer in contact with the stationary surface has zero velocity. The successive layers above it move with increasingly higher velocities in the direction of the flow

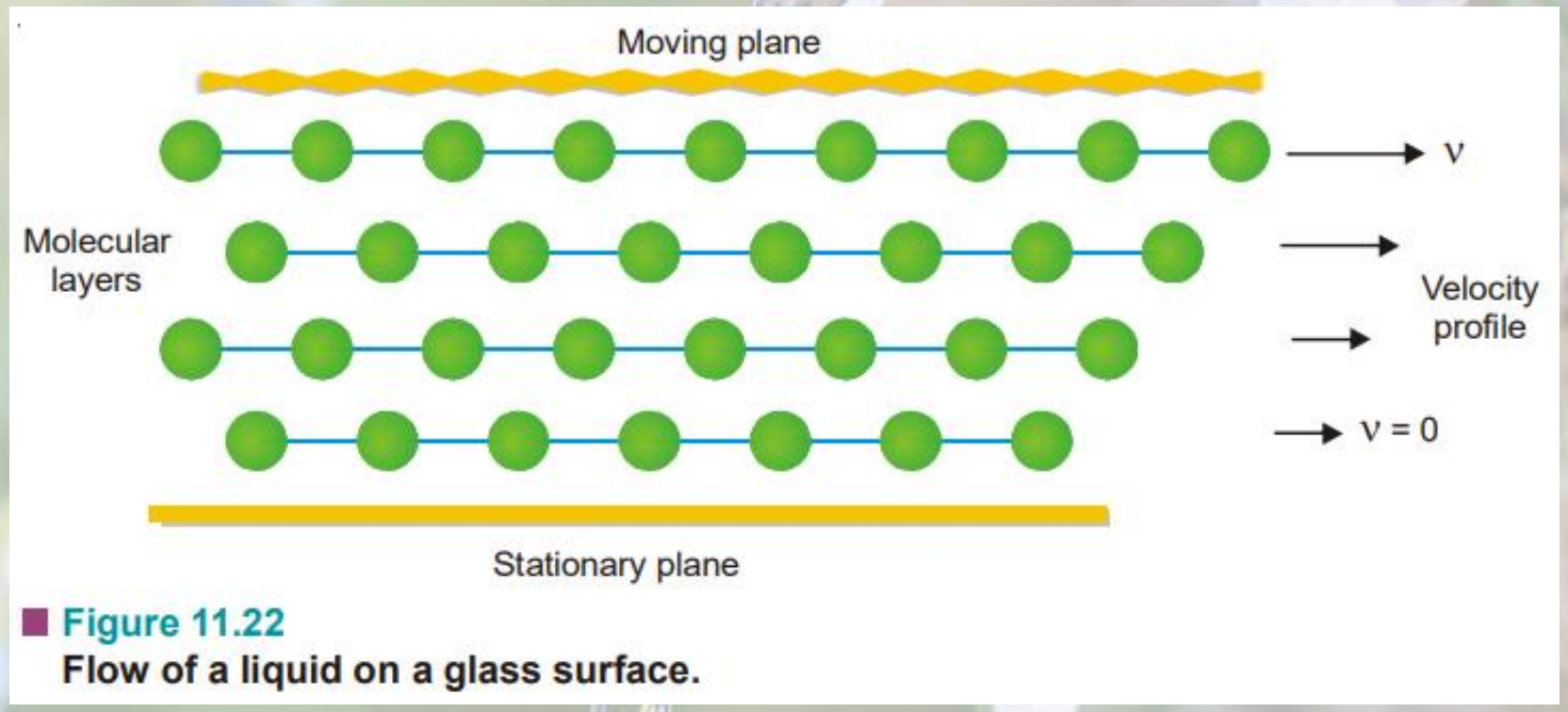



**Figure 11.22**
**Flow of a liquid on a glass surface.**

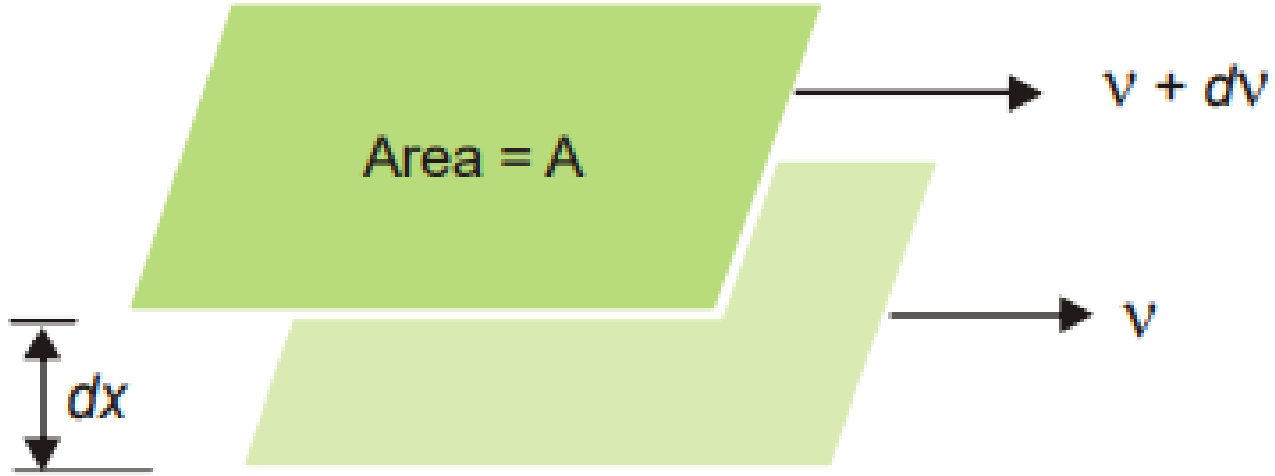



**Figure 11.23**

**Two parallel layers moving in a liquid.**

# OPTICAL ACTIVITY

A beam of ordinary light consists of electromagnetic waves oscillating in many planes. When passed through a polarizer (e.g., a Polaroid lens), only waves oscillating in a single plane pass through. The emerging beam of light having oscillations in a single plane is said to be planepolarized.

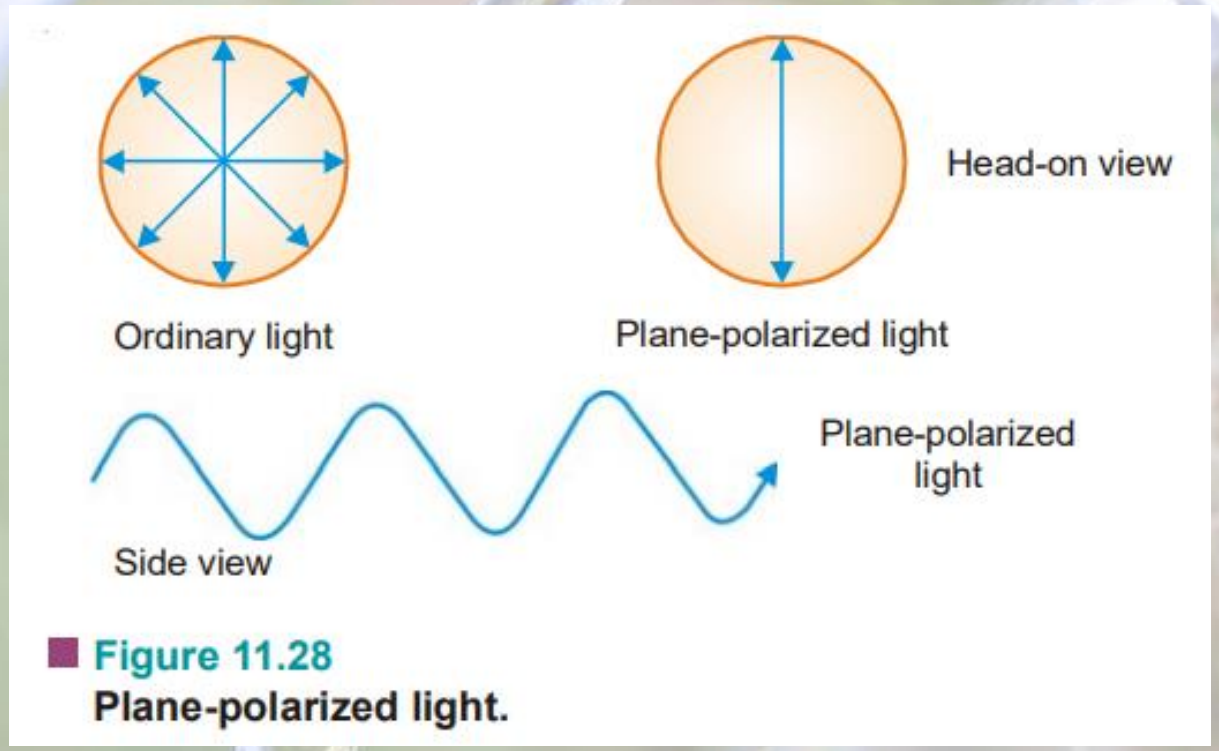



**Figure 11.28**
**Plane-polarized light.**

When plane-polarized light is passed through certain organic compounds, the plane of polarized light is rotated. A compound that can rotate the plane of polarized light is called optically active. This property of a compound is called optical activity. A compound which rotates the plane-polarized light to the left (anticlockwise), is said to be levorotatory. A compound that rotates the plane-polarized light to the right (clockwise), is said to be dextrorotatory. By convention, rotation to the left is given a minus sign (–) and rotation to the right is given a plus sign (+). For example, (–)-lactic acid is levorotatory and (+)-lactic acid is dextrorotatory

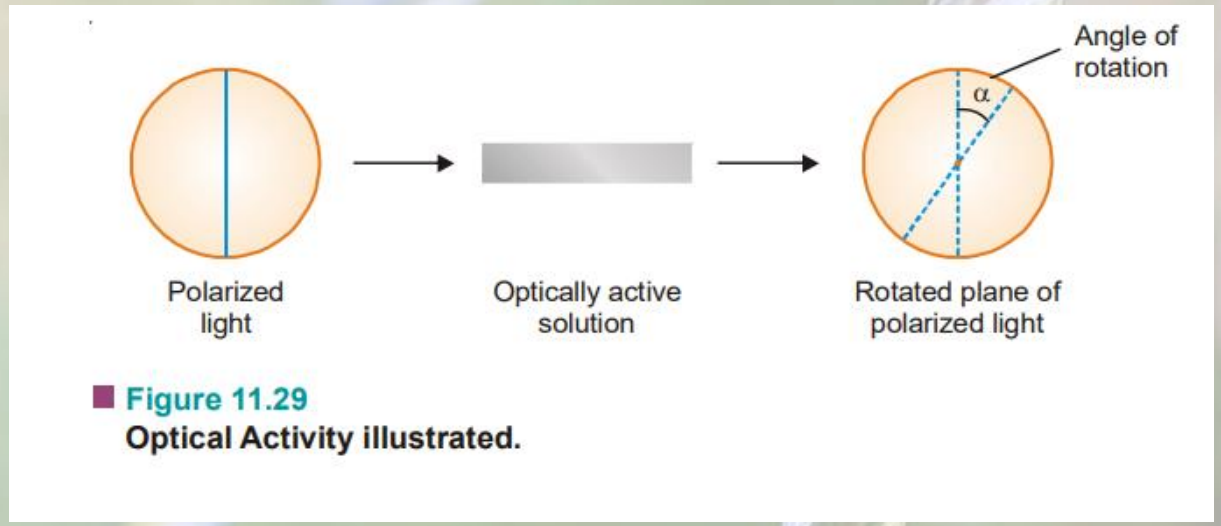



Figure 11.29
**Optical Activity illustrated.**