BIOLOGY
Topic Summary

# LT10 - FACTORS AFFECTING PERMEABILITY & STRUCTURE OF MEMBRANES

The permeability of a membrane is essential to the survival of cells. A membrane too permeable will allow in molecules that shouldn't enter the cell (e.g. polar and charged molecules) and a membrane too rigid will prevent the rapid diffusion of essential molecules from entering the cell, such as oxygen.

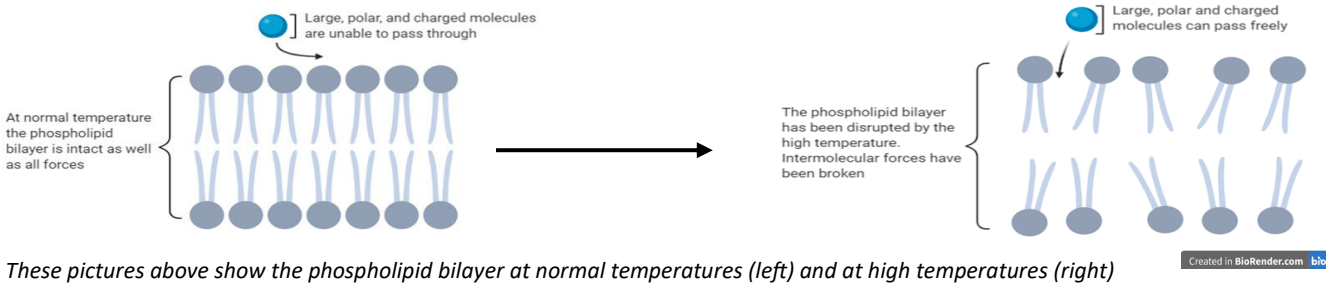
## High Temperature

High temperature affects the permeability and the structure of cell membranes. When temperature is increased, the phospholipid molecules will vibrate more (move faster). Due to this the intermolecular forces between the phospholipid molecules will break as they are overcome by the high energy. These forces keep the molecules together and help form the main structure of the phospholipid bilayer.

Once these forces break, the phospholipids are 'free', meaning the phospholipid bilayer is no longer intact and the membrane loses its structural integrity. Now molecules (polar, charged molecules etc.) can pass through freely, which normally wouldn't happen. The permeability of the membrane increases.

High temperatures also have an effect on the proteins embedded within the membrane, such as carrier proteins and channel proteins. These proteins will lose their shape and structure (they will denature).

Channel proteins and carrier proteins usually transport molecules in and out of the cell. However due to denaturing they may not be able to do this as they no longer function. This prevents essential molecules from being transported in and out of the cell.




*These pictures above show the phospholipid bilayer at normal temperatures (left) and at high temperatures (right)*

## Low Temperature

At low temperatures the fluidity of the cell membrane decreases. This is because at lower temperatures, phospholipids cluster together (come closer) as they do not have as much energy. Due to being clustered together, intermolecular interactions are increased and are stronger. This makes it harder for essential molecules, such as oxygen, to rapidly diffuse through the membrane.

In freezing cold temperatures water inside cells may freeze and cause ice crystals to form. These ice crystals may pierce through the cell and kill it as the membrane is unable to regulate its contents

## Solvents

The phospholipid tail is hydrophobic. This means it will repel most solutes that are hydrophilic and polar. However solutes that are non-polar and hydrophobic are able to dissolve between phospholipids. These solutes are usually called 'lipid soluble solvents'.

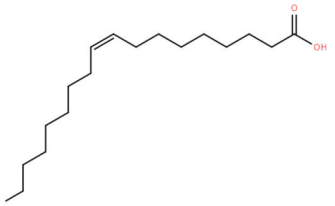
High levels of these solutes dissolved between phospholipids can cause  forces between them to weaken/ break causing these phospholipids to have more spaces between them. This allows for bigger molecules to pass through therefore increasing the permeability of the membrane.

## Saturated & Unsaturated Fatty Acids

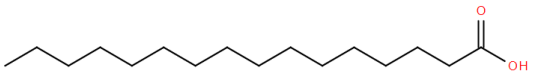
Fatty acids in phospholipids can be either saturated or unsaturated. Saturated phospholipid tails are usually straight whereas unsaturated phospholipid tails are slightly crooked (bent).

Saturated tails are arranged closely together which has more attractions between the tails due to being straight. They can cluster together more closely. The distance is smaller between phospholipid tails which decreases fluidity and allows less molecules to pass through the membrane.

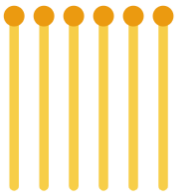
Unsaturated tails, due to having a slight bend, have more distance between tails and therefore less interactions between molecules. This increases membrane fluidity which allows molecules to pass through.



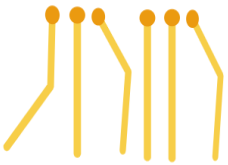

*Unsaturated fatty acid as it contains a double bond, from Lipid Maps*




*Saturated fatty acid as it only contains single bonds. Picture from Lipid Maps - https://www.lipidmaps.org/data/LMSDRecord.php?LMID=LMFA01010001*




Saturated phospholipids arrangement in phospholipid bilayer




Unsaturated phospholipid arrangement in the phospholipid bilayer

## Cholesterol

The main role of cholesterol is to regulate the fluidity of the cell membrane. This is dependent on the temperature. At high temperatures phospholipids are further apart (see above). Cholesterol causes these molecules to come closer together increasing interactions between the two. So at high temperatures, cholesterol decreases fluidity

At low temperatures phospholipids are clustered together. However cholesterol between them decreases the strength of these interactions between them when this happens. Therefore at low temperatures, cholesterol increases fluidity