



MEDICAL CHEMISTRY BIOCHEMISTRY

University Of Fallujah
College Of Medicine

Lecture : **Lipid**

Stage : 1st Stage

Lecturer : **Dr. Waleed Khalid Ahmed**

Department: **Chemistry and Biochemistry department**

Date: **8/ 4/ 2026**

Learning Objective :

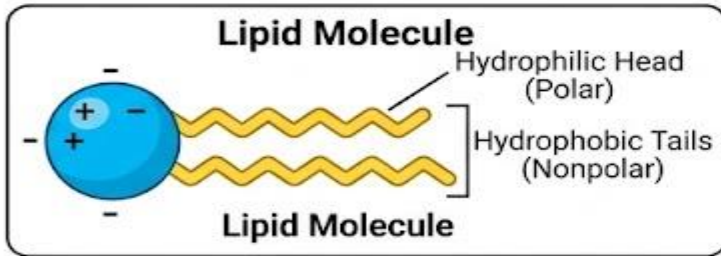
- *Understand the Fundamental Definition of Lipids .*
- *Identify Biological Functions of Lipids .*
- *Distinguish between the three main classes of lipids .*

LIPID

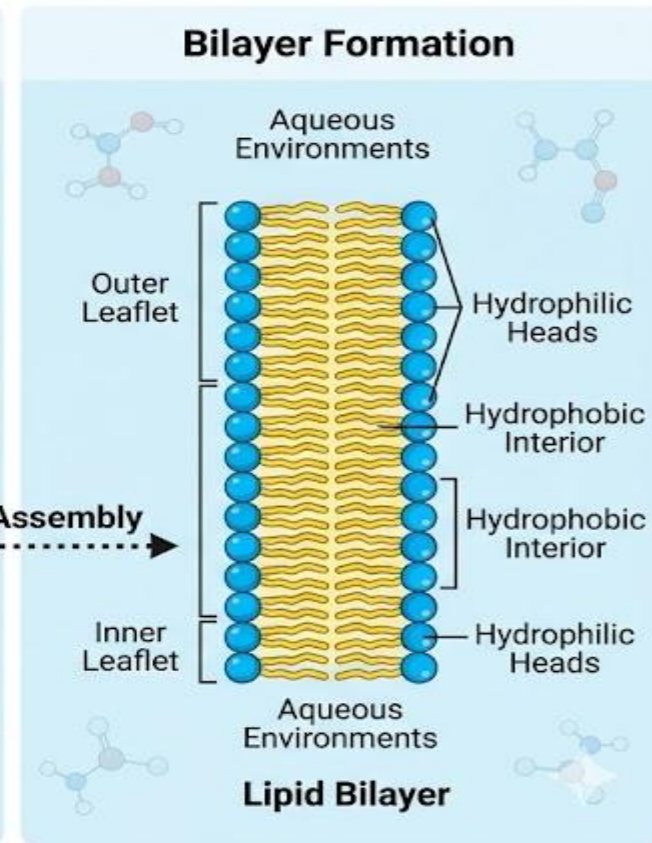
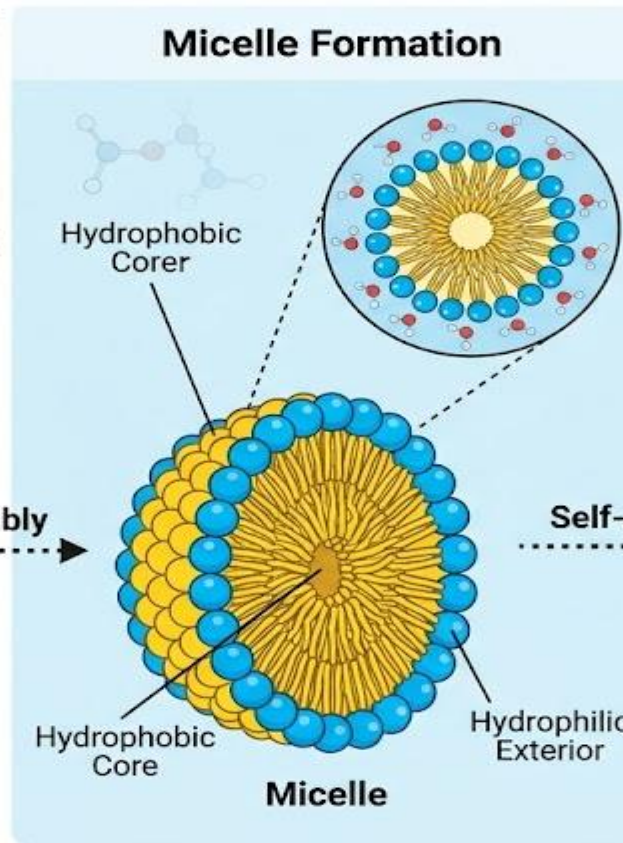
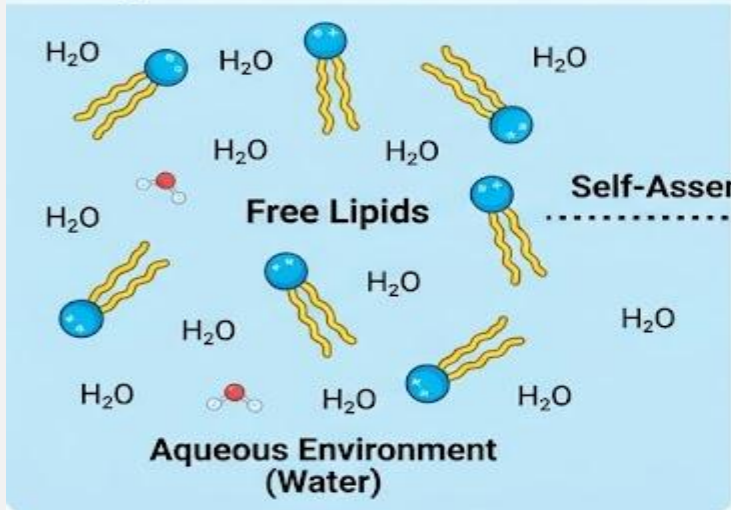
- What is Lipids ?
- **Definition:** Lipids are a heterogeneous group of organic compounds insoluble in water but soluble in nonpolar solvents.
- **The Amphiphilic Concept:** Many lipids possess a dual nature (a polar "head" and a nonpolar "tail").

LIPID

Self-Assembly of Lipids in Aqueous Environment: Micelles and Bilayers



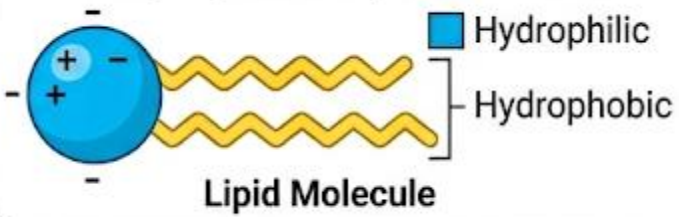
Step 1: Introduction into Water



BIOLOGICAL FUNCTIONS

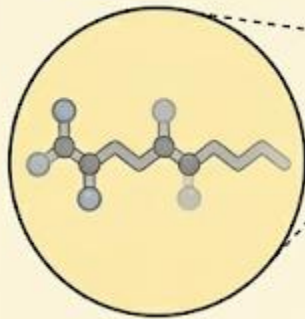
Biological Functions of Lipids

Amphipathic Lipid Molecule

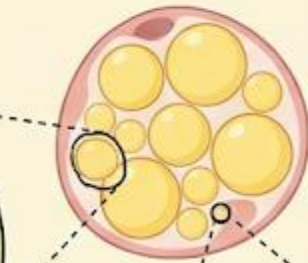


Energy Storage

Highly Reduced Carbon Chain

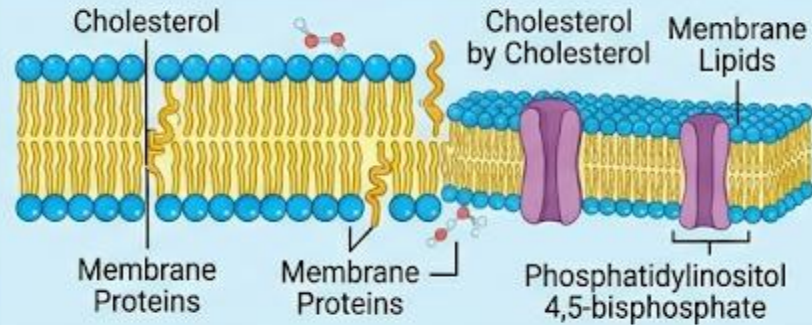


9 kcal/g
(High-Density Energy)



Triglyceride
Major Energy Reservoir

Structural: The Primary Matrix of All Biological Membranes

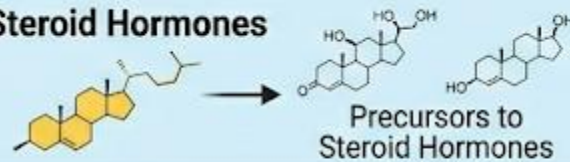


Matrix of Biological Membranes

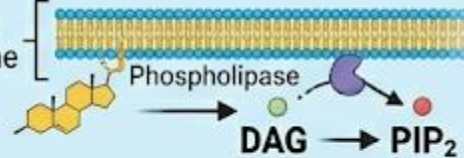
- Lipids organize to form membranes: barrier, fluidity control by cholesterol
- Cholesterol so their lipids to forming membranes

Bio-Signaling

Steroid Hormones



Plasma Membrane



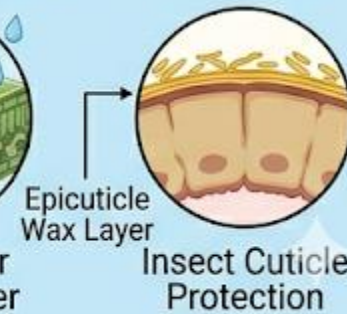
Intracellular Second Messengers

Protection

Water-Resistant Coating for Plants



Insect Cuticle Protection



FATTY ACIDS

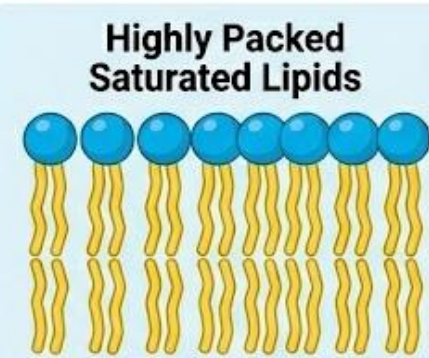
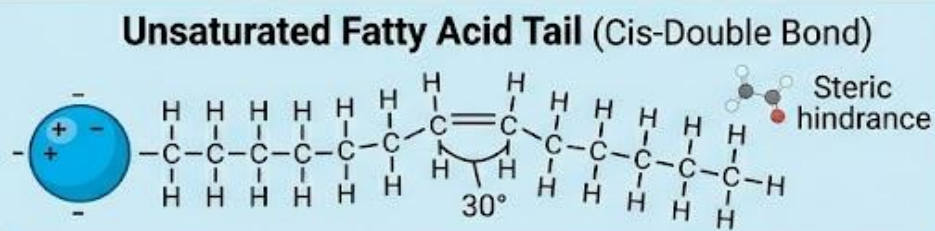
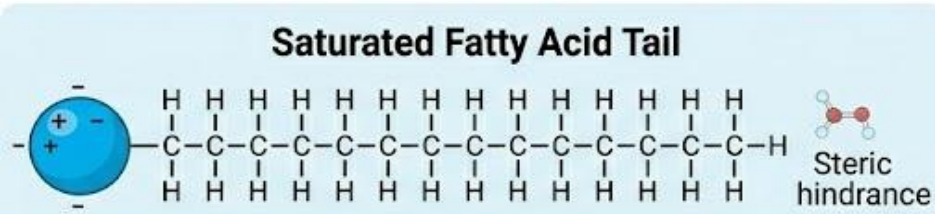
■ **The Structural Monomers :**

- **Chemical Formula:** ($R-COOH$) (Hydrocarbon chain + Carboxyl group).
- **Classification by Saturation:**
- **Saturated:** No double bonds; maximum hydrogen atoms; straight chains.
- **Unsaturated:** Presence of ($C=C$) double bonds; "kinks" in the chain.

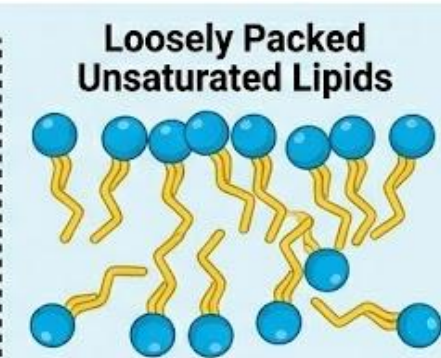


FATTY ACIDS - THE STRUCTURAL MONOMERS

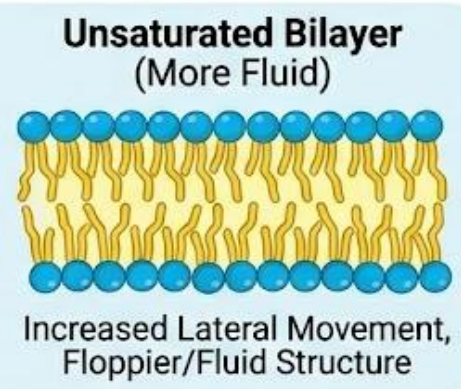
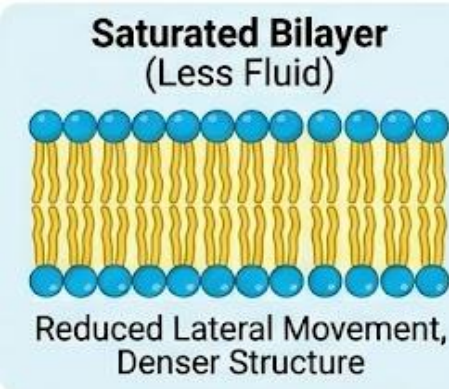
Structural Packing of Saturated vs. Unsaturated Lipids: A Side-by-Side Comparison



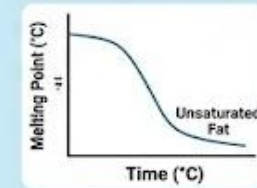
Saturated Lipids:
Maximize VDW interactions,
solid/semi-solid at Room Temp.



Unsaturated Lipids:
Kinks create steric hindrance,
prevent dense packing, liquid.



High Melting Point
due to Dense Packing



Low Melting Point due
to Kinks and Loose Packing

TYPES OF FATTY ACIDS



arachidic



stearic



palmitic



erucic



oleic



arachidonic



linoleic



linolenic

GEOMETRIC ISOMERISM (CIS VS. TRANS)

- **Cis vs. Trans:**

- **Cis-Isomer:** Hydrogen atoms on the same side. This creates a structural bend, increasing membrane fluidity.
- **Trans-Isomer:** Hydrogen atoms on opposite sides. The chain remains linear, leading to higher melting points (similar to saturated fats).

GEOMETRIC ISOMERISM (CIS VS. TRANS)

■ Cis vs. Trans:

Schematic: 2D Skeletal Formula and Detailed Bond Angle Comparison of Saturated and Unsaturated Fatty Acids

Saturated Fatty Acid

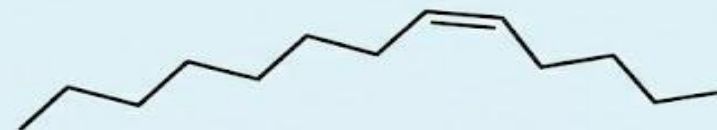


2D Skeletal Formula

Linear Geometry

*No double bonds, all single C-C bonds allow free rotation.

Unsaturated Fatty Acid (Cis-Isomer)

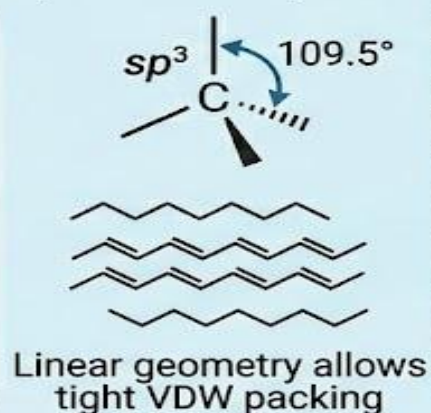
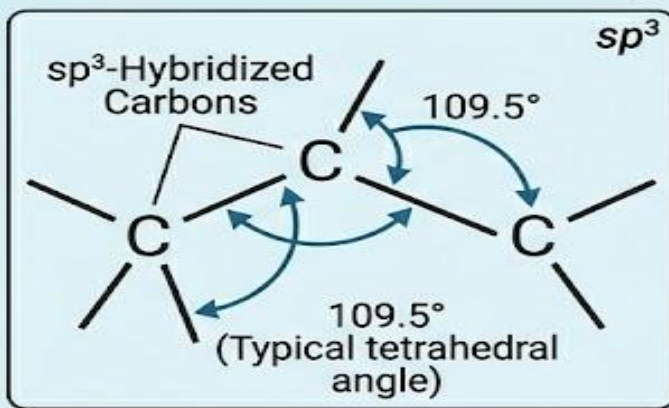


2D Skeletal Formula
(Cis-Kinked)

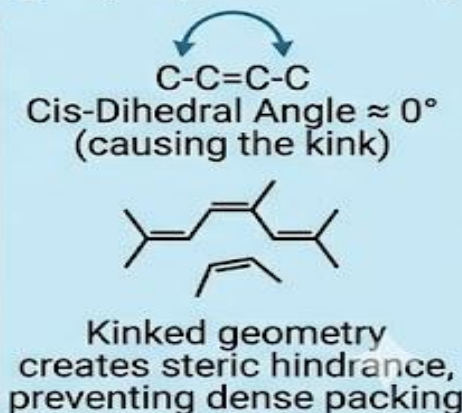
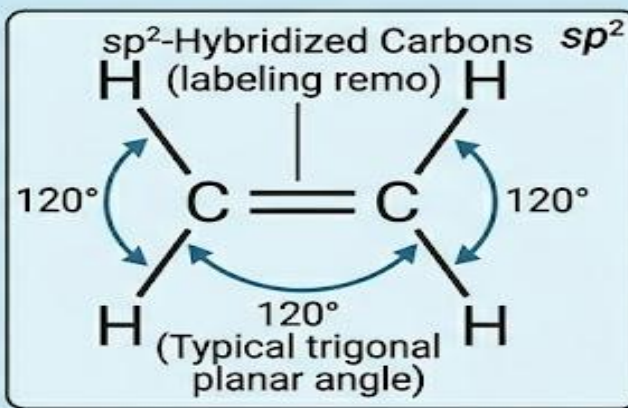
Kinked Geometry

*Presence of a cis-double bond introduces a fixed rigid kink.

Saturated C-C Bond Angle (Tetrahedral)



Unsaturated Cis-C=C Bond Angle (Trigonal Planar)



CLASSIFICATION OF LIPIDS

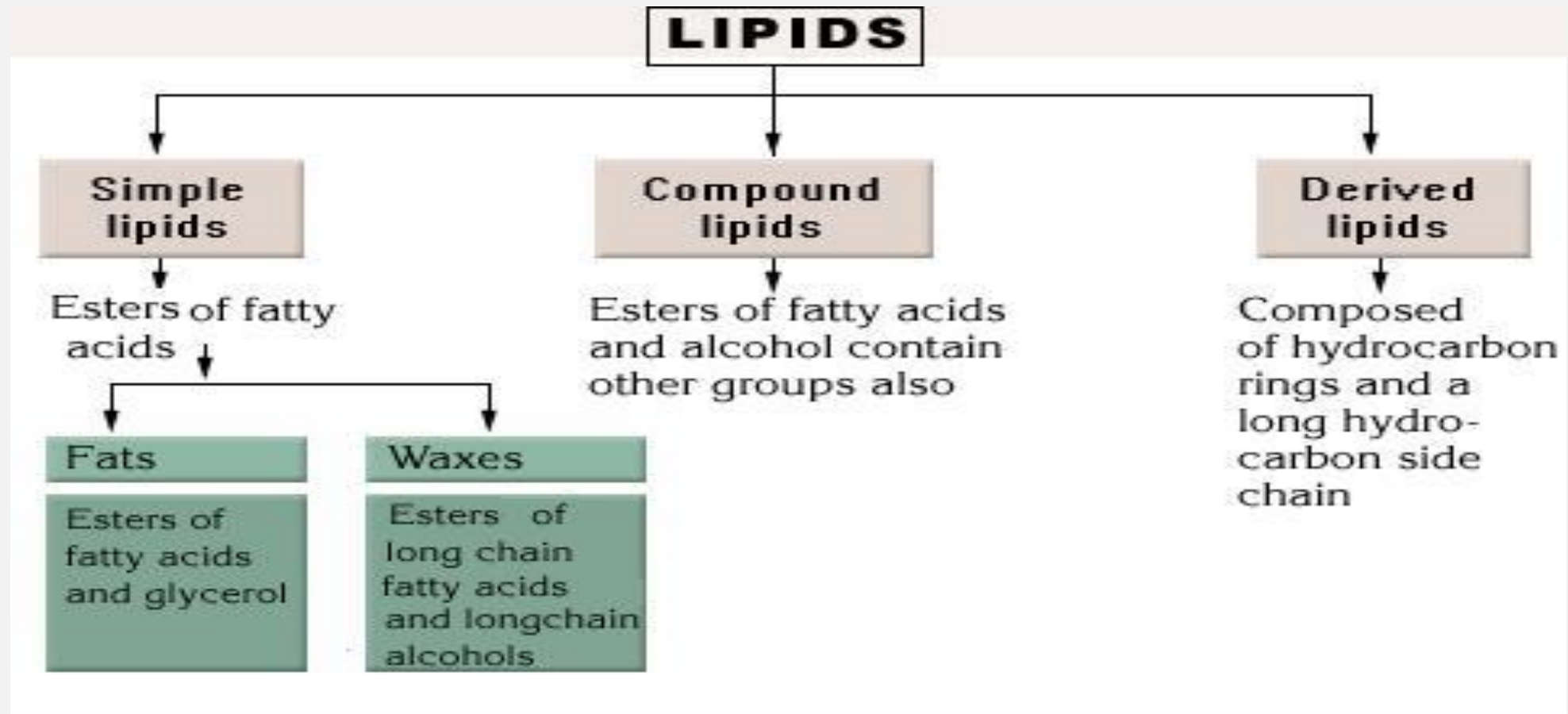
■ **Classification of Lipid :**

- **Simple Lipids:** Esters of fatty acids + Alcohols (Fats, Oils, Waxes).
- **Compound Lipids:** Esters + Additional groups (Phospholipids, Glycolipids).
- **Derived Lipids:** Products of hydrolysis (Steroids, Terpenes, Fat-soluble vitamins).



CLASSIFICATION OF LIPIDS

Classification of Lipid :

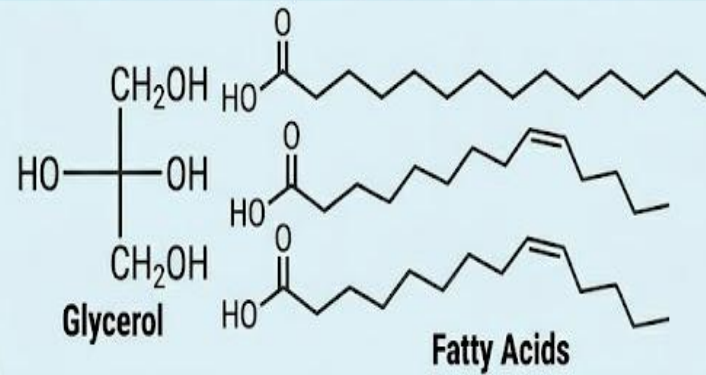


CLASSIFICATION OF LIPID

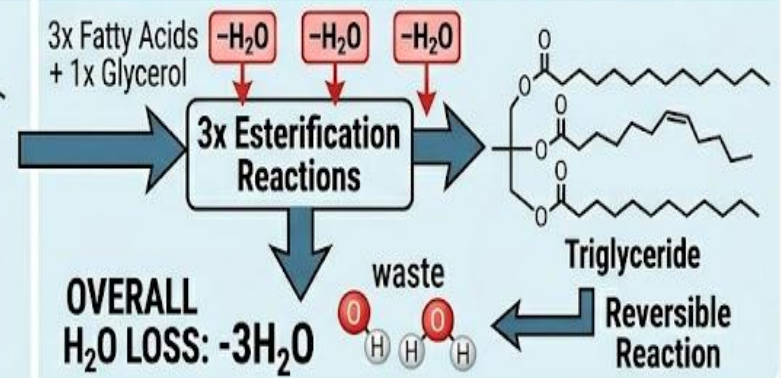
- **Simple Lipids :**
- Triacylglycerols (TAGs):
- **Synthesis:** The esterification of one Glycerol molecule with three Fatty Acids.
- **Function:** Principal energy reservoir in adipocytes.

SCHEMATIC: TRIGLYCERIDE SYNTHESIS VIA ESTERIFICATION AND H₂O LOSS, WITH DETAILED ESTER BOND GEOMETRY

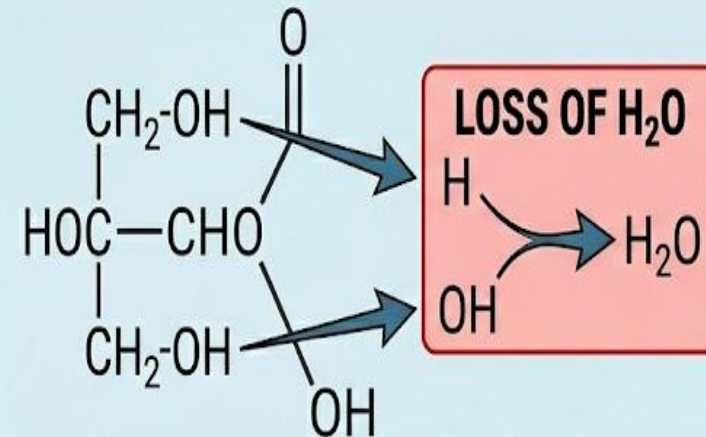
REACTANTS: GLYCEROL AND THREE FATTY ACIDS



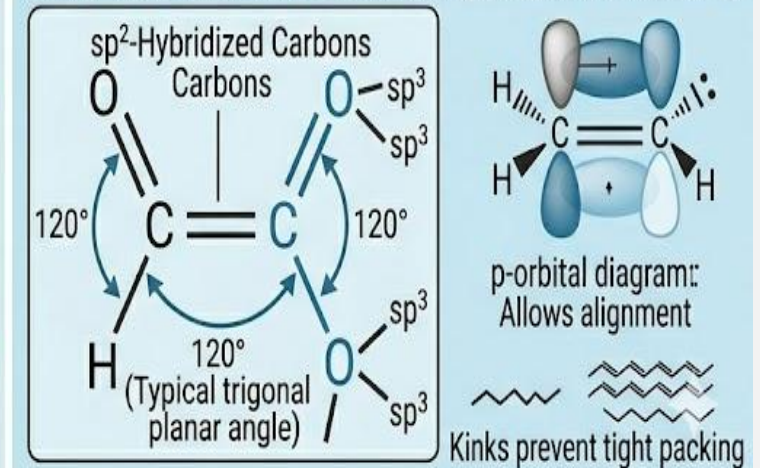
REACTION SCHEME: (DEHYDRATION SYNTHESIS)



ESTER BOND FORMATION MECHANISM (Dehydration Step)



DETAILED ESTER BOND GEOMETRY (TRIGONAL PLANAR C)



CLASSIFICATION OF LIPID

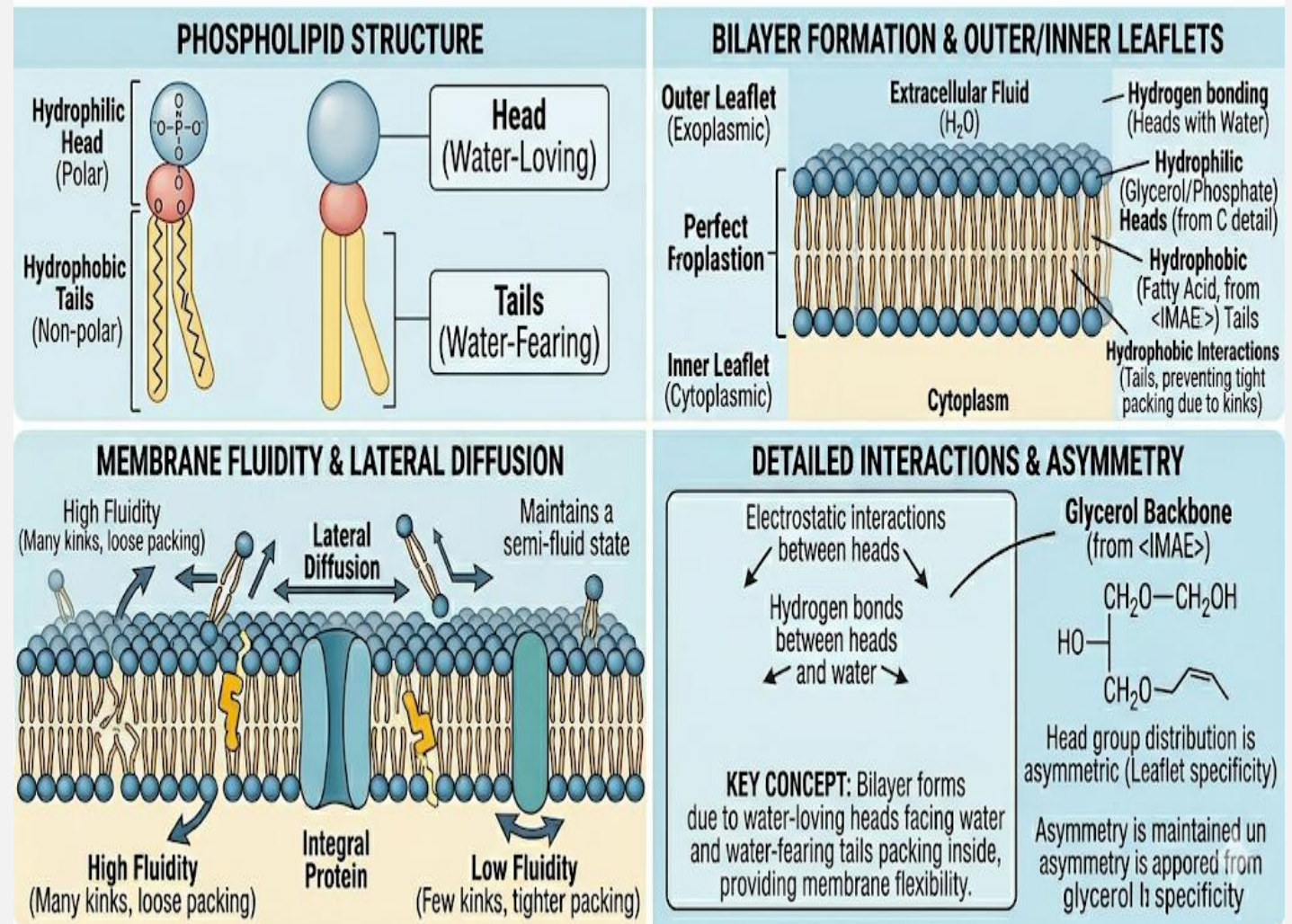
- **Compound Lipids :**

- Phospholipid :

- Structure: Glycerol backbone + 2 Fatty Acids + Phosphate group + Amino alcohol (e.g., Choline).

- Biological Role: Formation of the semi-permeable cell membrane.

SCHMATIC: FLUID MOSAIC MODEL CROSS-SECTION, FOCUSING ON PHOSPHOLIPID ORIENTATION AND INTERACTIONS

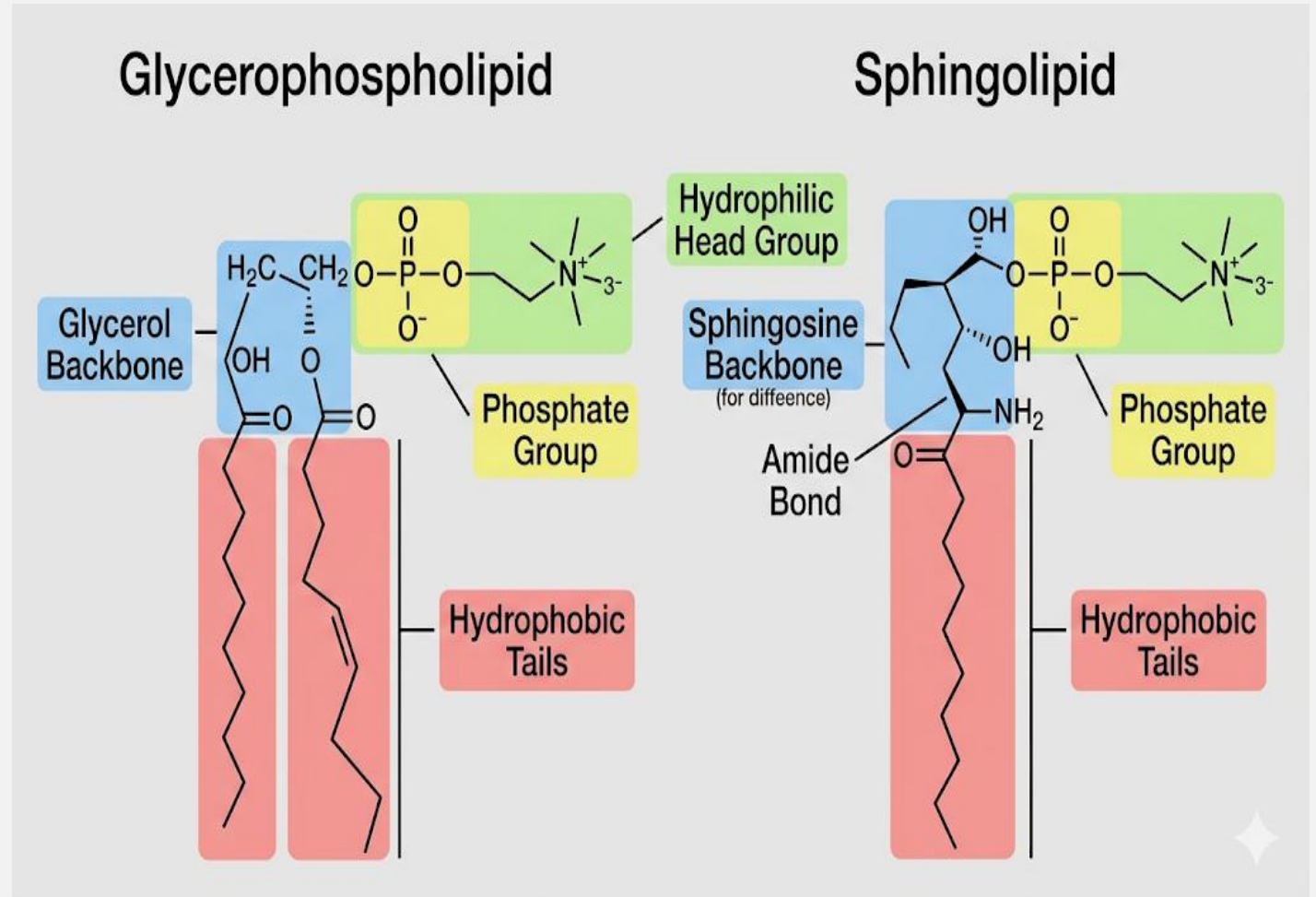


COMPOUND LIPIDS

- Complex Sphingolipids & Glycolipids :

-**Sphingolipids:** Based on a Sphingosine backbone rather than glycerol. Critical for neural tissue (Myelin sheath).

-**Glycolipids:** Lipids with attached carbohydrates; essential for cell recognition and signaling.

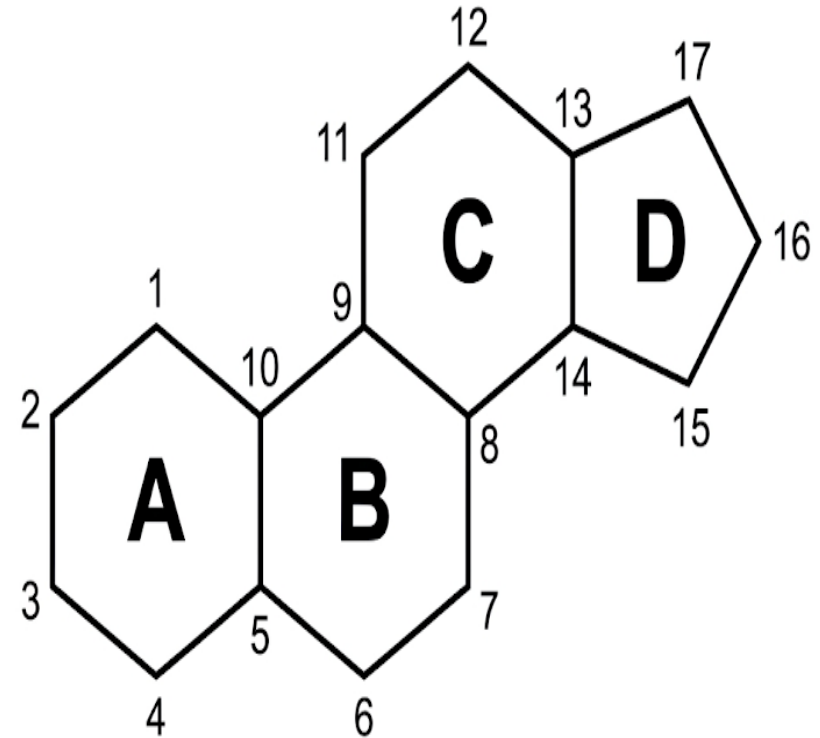


CLASSIFICATION OF LIPID

■ **Derived Lipids:**

- **Steroid:**
- **Structure:** A characteristic four-ring carbon structure (Sterane core).
- **Key Molecules:**
- **Cholesterol:** Maintains membrane integrity.
- **Hormones:** Testosterone, Estrogen, Cortisol.

Tetracyclic Ring Structure of Steroids (A, B, C, D Labeling)





**THANK YOU
FOR YOUR
ATTENTION**