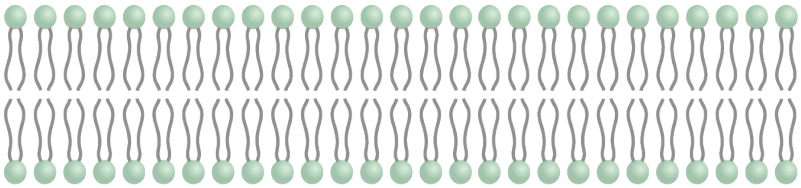
Life Sciences 1a

An Integrated Introduction
to the Life Sciences



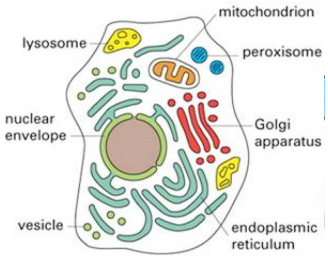
Membranes

- Prof. Erin O'Shea

October 5 & 7, 2010

The flask vs. The cell

The flask



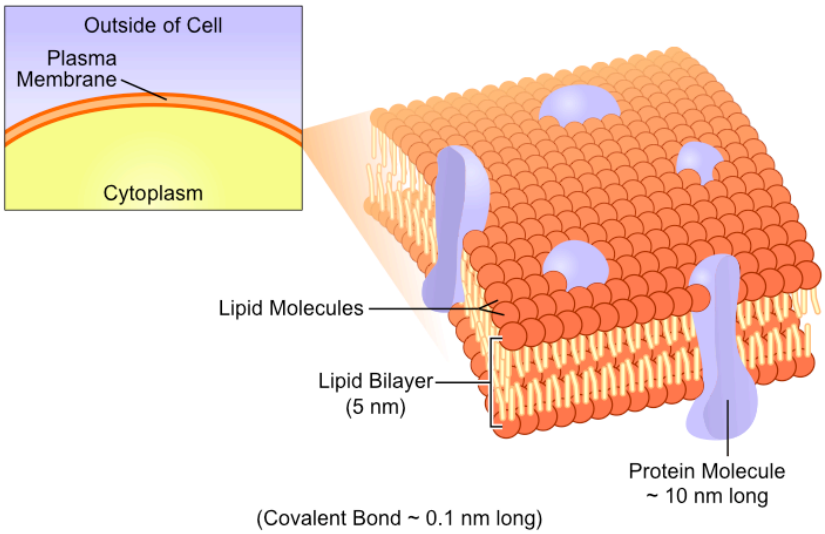
The cell

What does it mean to be alive?

Properties of Membranes, Membrane Proteins and Membrane Transport

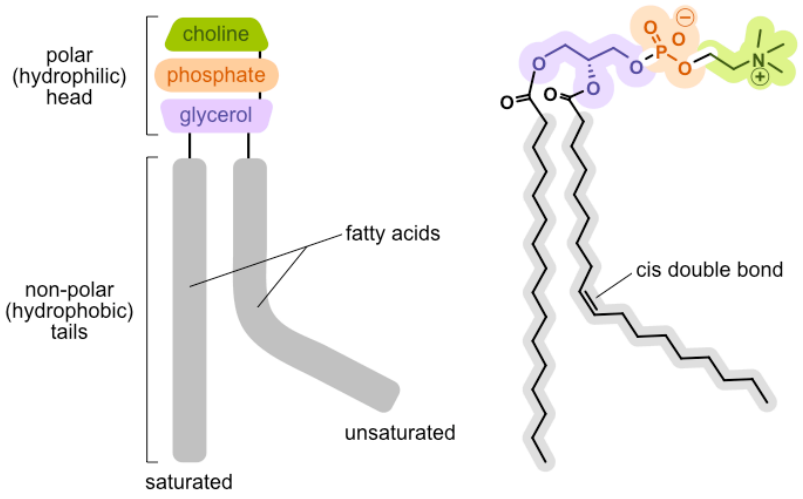
1. Membrane structure and properties
   a. Phospholipids
   b. Lipid properties and behavior in aqueous solution
   c. Membrane fluidity
   d. How we know: FRAP and green fluorescent protein
   g. Influence of fatty acid structure on fluidity
   h. Influence of cholesterol on membrane properties
2. Membrane proteins
   a. Association of proteins with membranes
   b. Transmembrane helices
3. Lipid Rafts
4. Membrane transport
   a. Membrane permeability
   b. Transport proteins
   c. Ion distribution inside and outside cells
   d. Electrochemical gradient
   e. Active transport
   f. Ion channels
5. Membrane potential

Cell Membranes

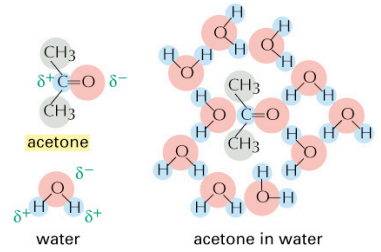


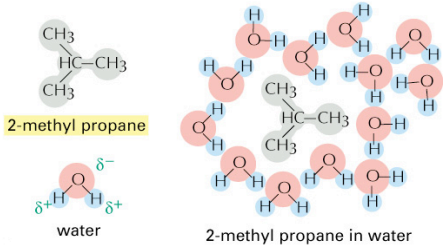
(Covalent Bond ~ 0.1 nm long)

Phospholipids: Phosphatidylcholine

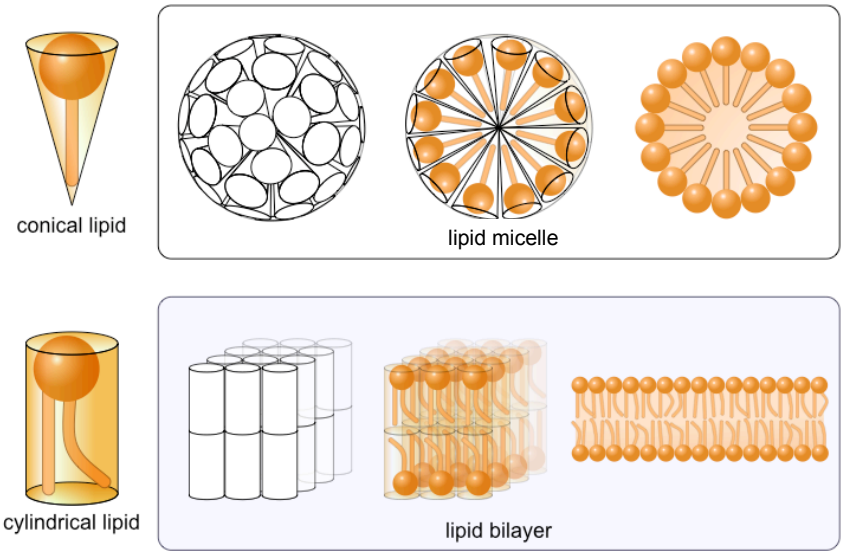


Hydrophobic Effect

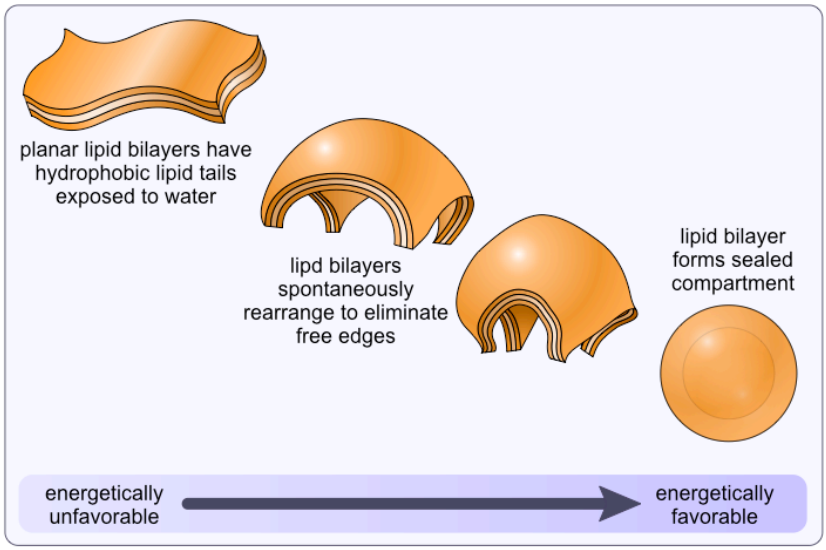




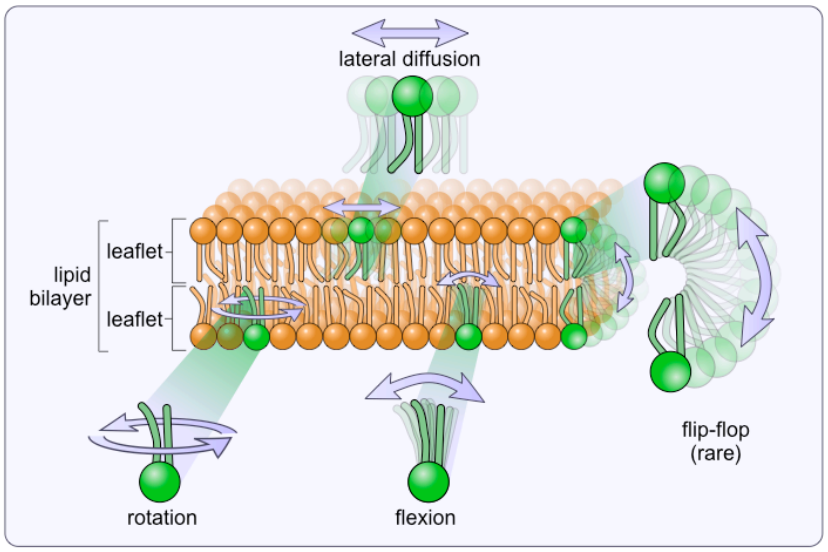
Packing of Lipids in Aqueous Solutions



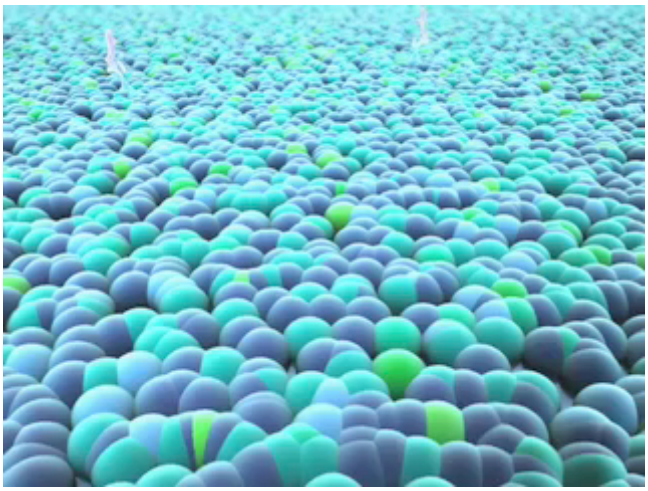
Spontaneous Closure to Form a Sealed Compartment

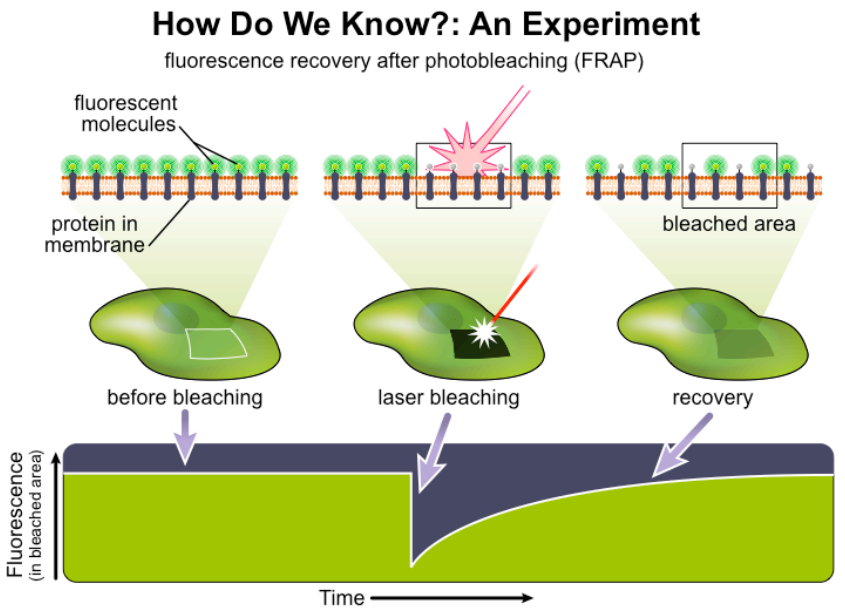


Phospholipid Mobility

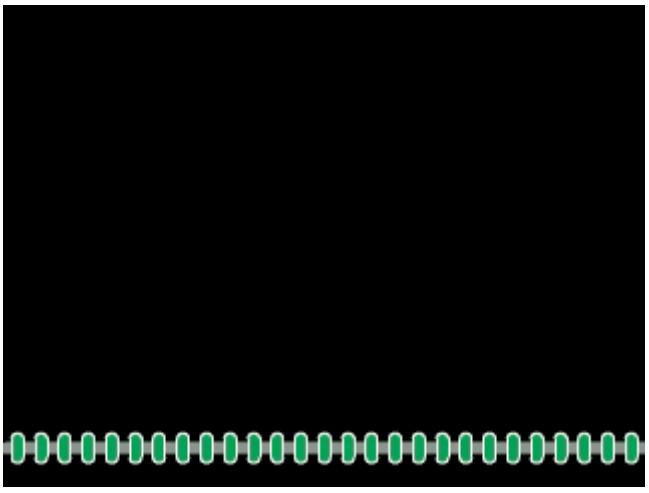


Animation: Membranes are Dynamic!

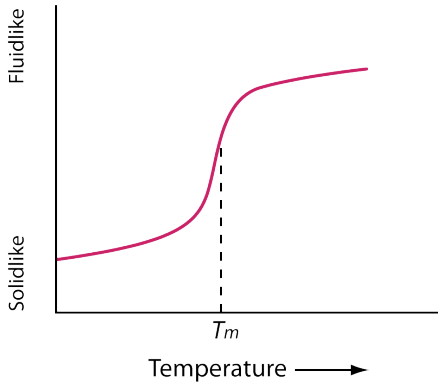




FRAP With Fluorescently-Labeled Membrane Protein

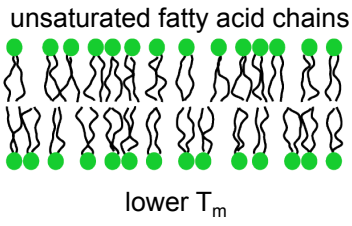


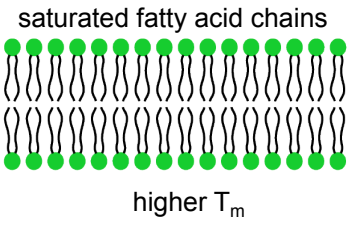
Measures of Membrane Fluidity: Melting Temperature



- T_m (melting temperature) is a phase transition, a change from a more rigid solid-like state to a fluid-like state

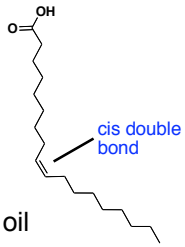
Membrane Composition Influences Membrane Fluidity: Fatty Acid Structure





lower T_m

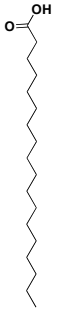
higher T_m



olive oil

oleic acid

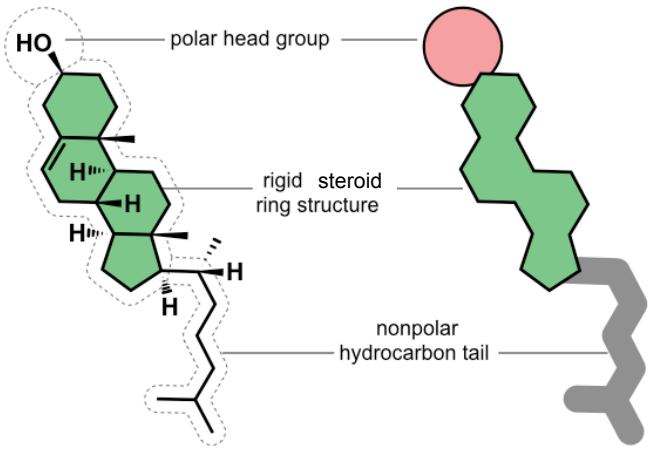
17 carbons



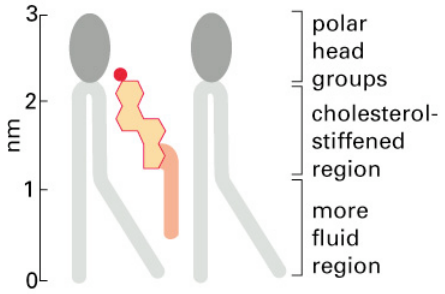
candle wax

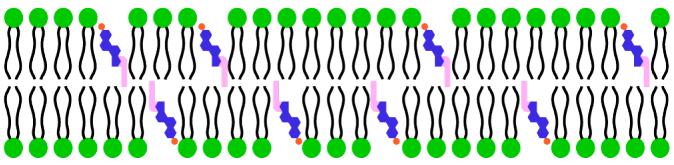
stearic acid

Membrane Composition Influences Membrane Fluidity: Cholesterol Content

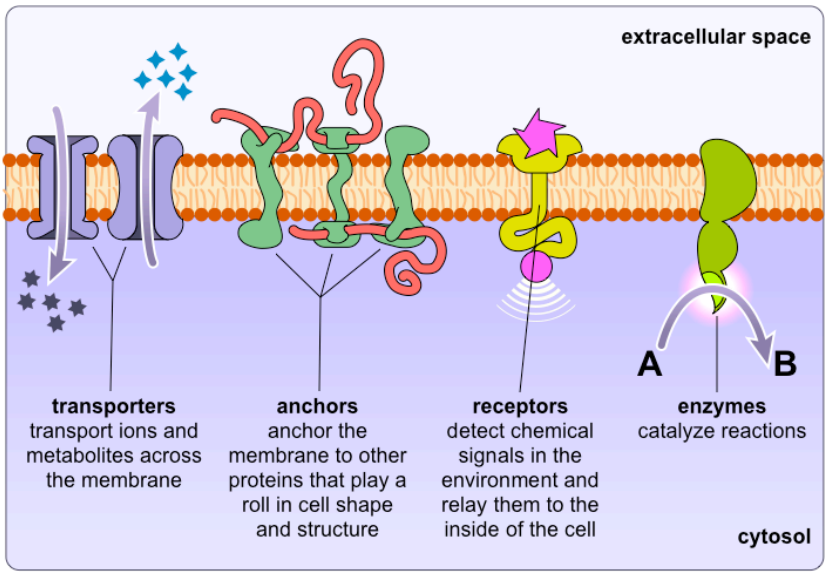


Cholesterol Influences Membrane Fluidity

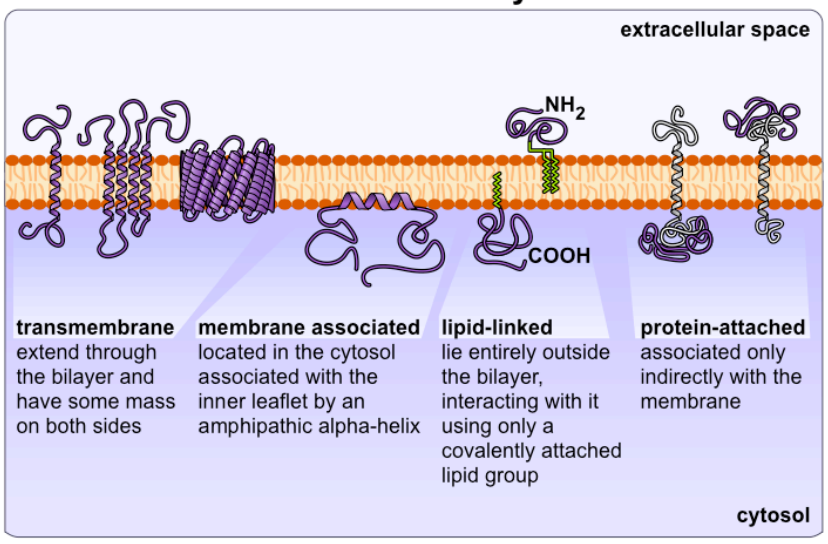




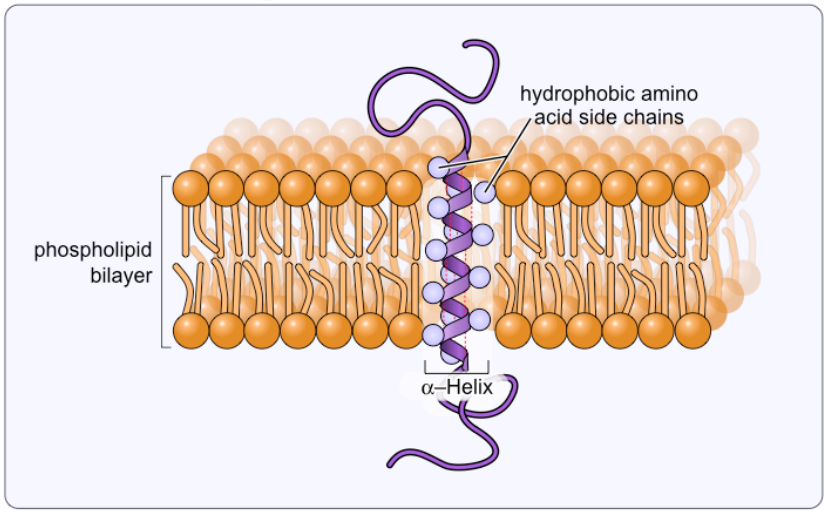
Membrane Proteins



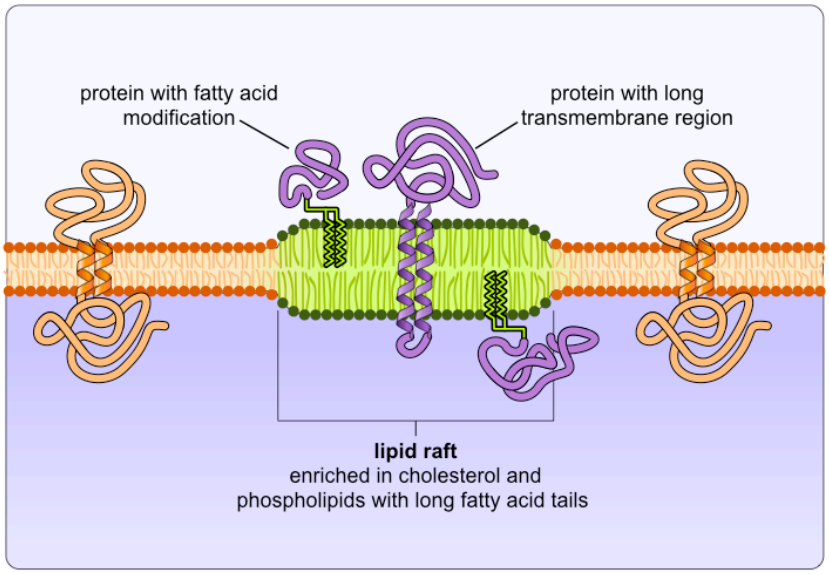
Proteins Associate with Membranes in Different Ways



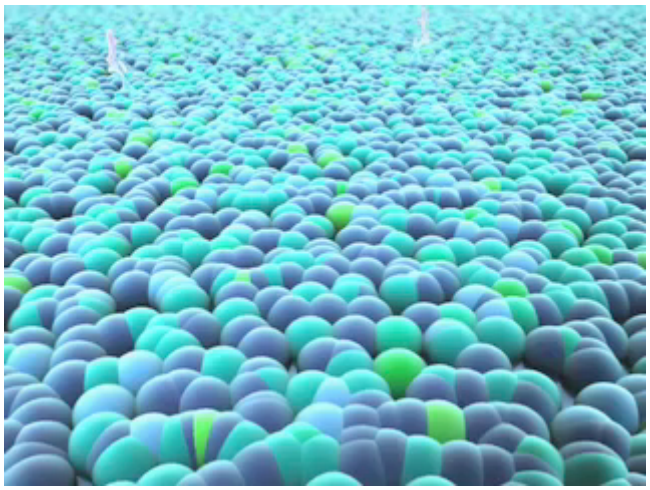
Many Membrane Proteins Cross the Bilayer Using One or More α–Helices



Lipid Rafts in the Plasma Membrane



Animation: Lipid Rafts



Summary of Main Points

- Cell membranes are bilayers composed of amphipathic phospholipids containing charged head groups and hydrophobic tails
- The hydrophobic effect drives the packing of lipids into structures which minimize exposed hydrophobic groups
- Membranes are fluid because phospholipids and proteins can move in the plane of the bilayer; fatty acid structure and cholesterol content influence fluidity
- Proteins of different functions associate in different ways with membranes; regions of proteins that are contained within the bilayer are hydrophobic
- Lipid rafts are enriched in cholesterol and certain lipids, and play important roles in signaling and protein sorting