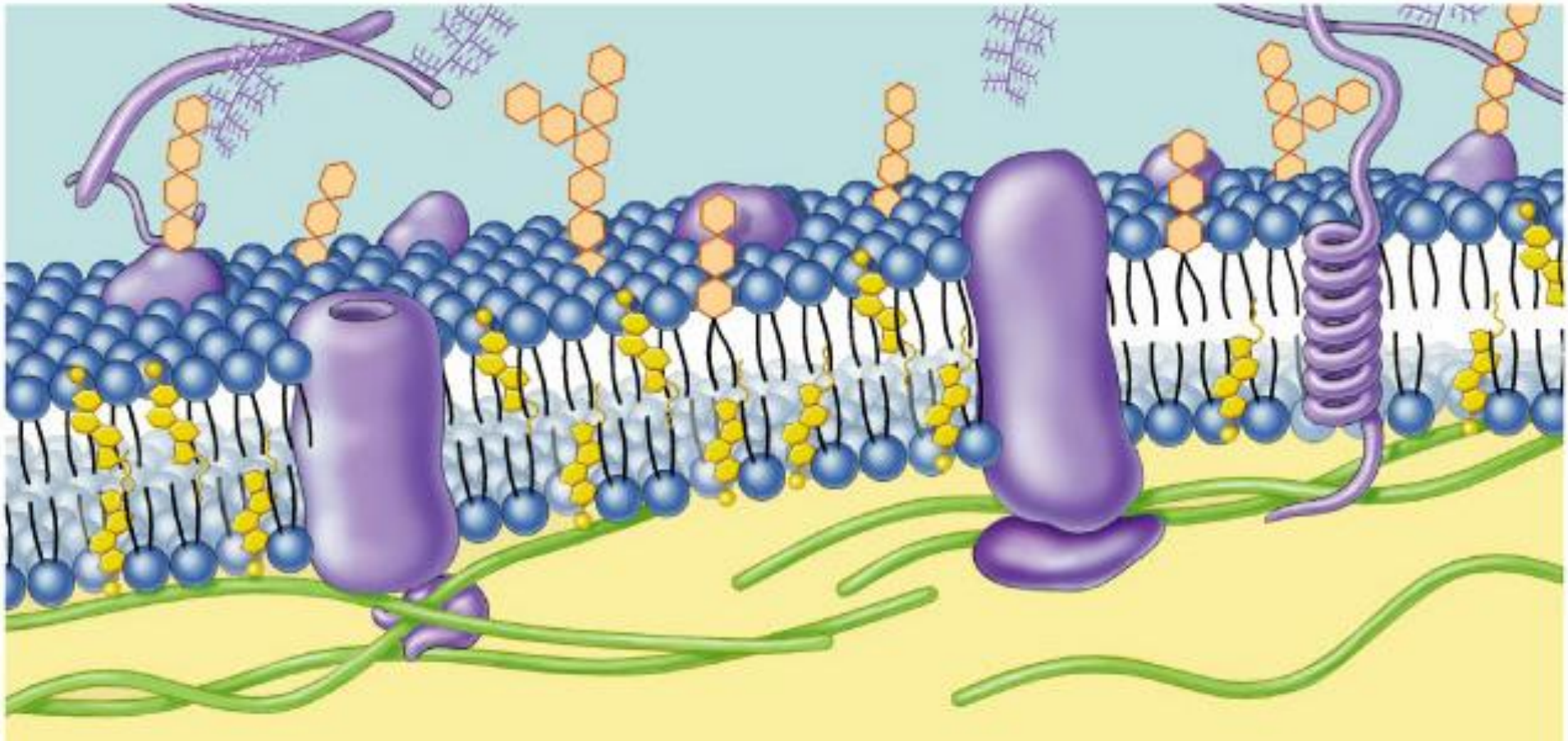
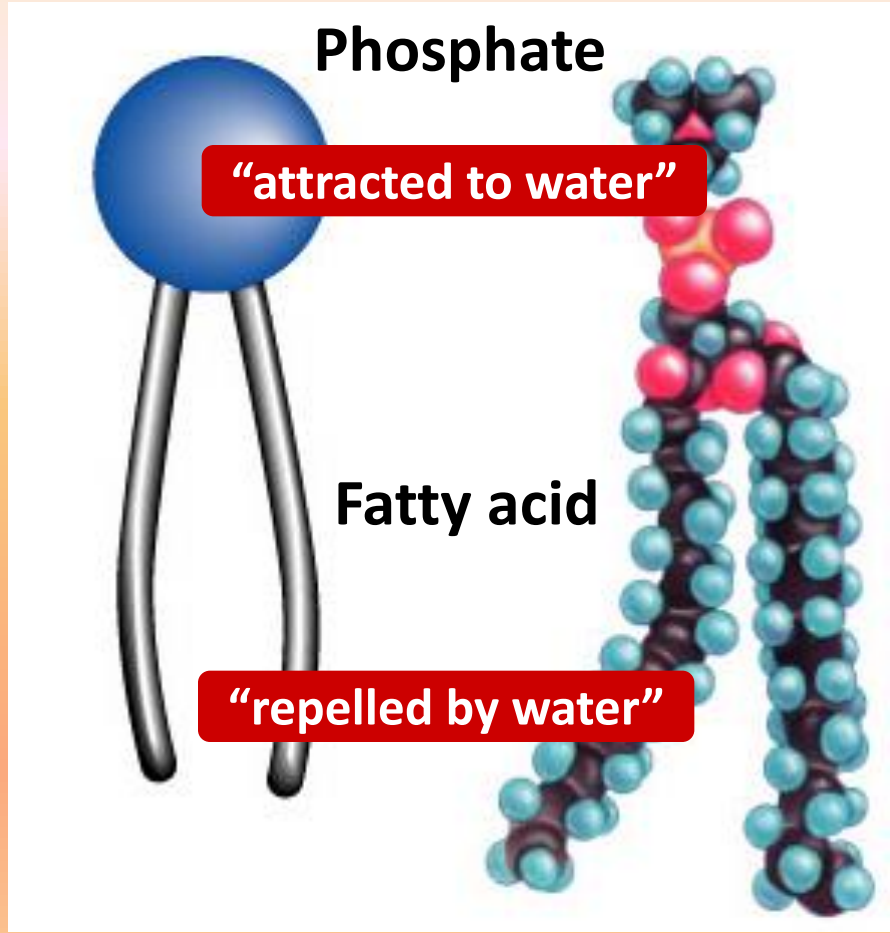
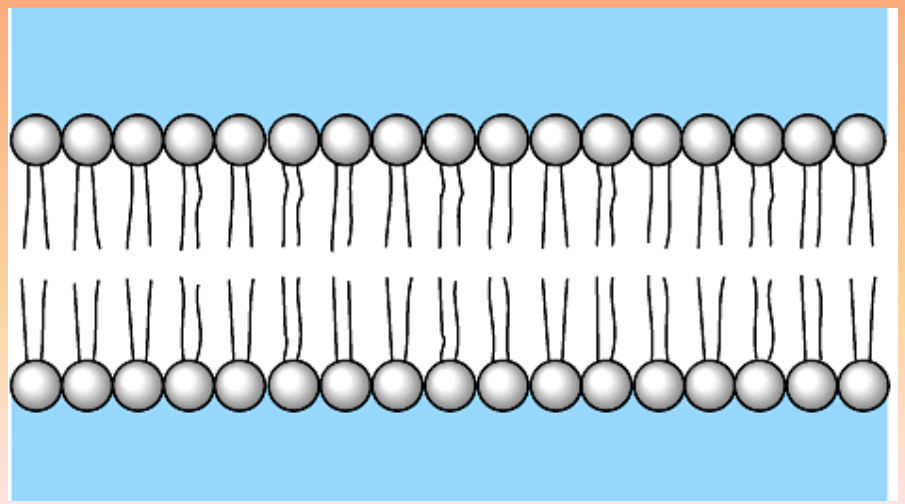
1.3 – Membrane Structure

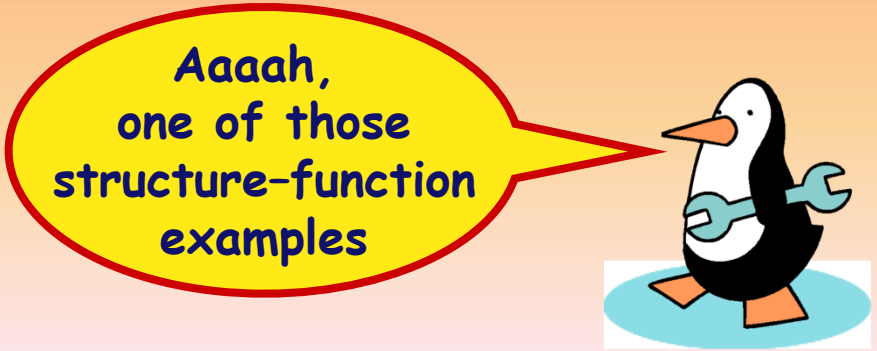


Phospholipids

- Phosphate head
  - hydrophilic
- Fatty acid tails
  - hydrophobic
- Arranged as a bilayer

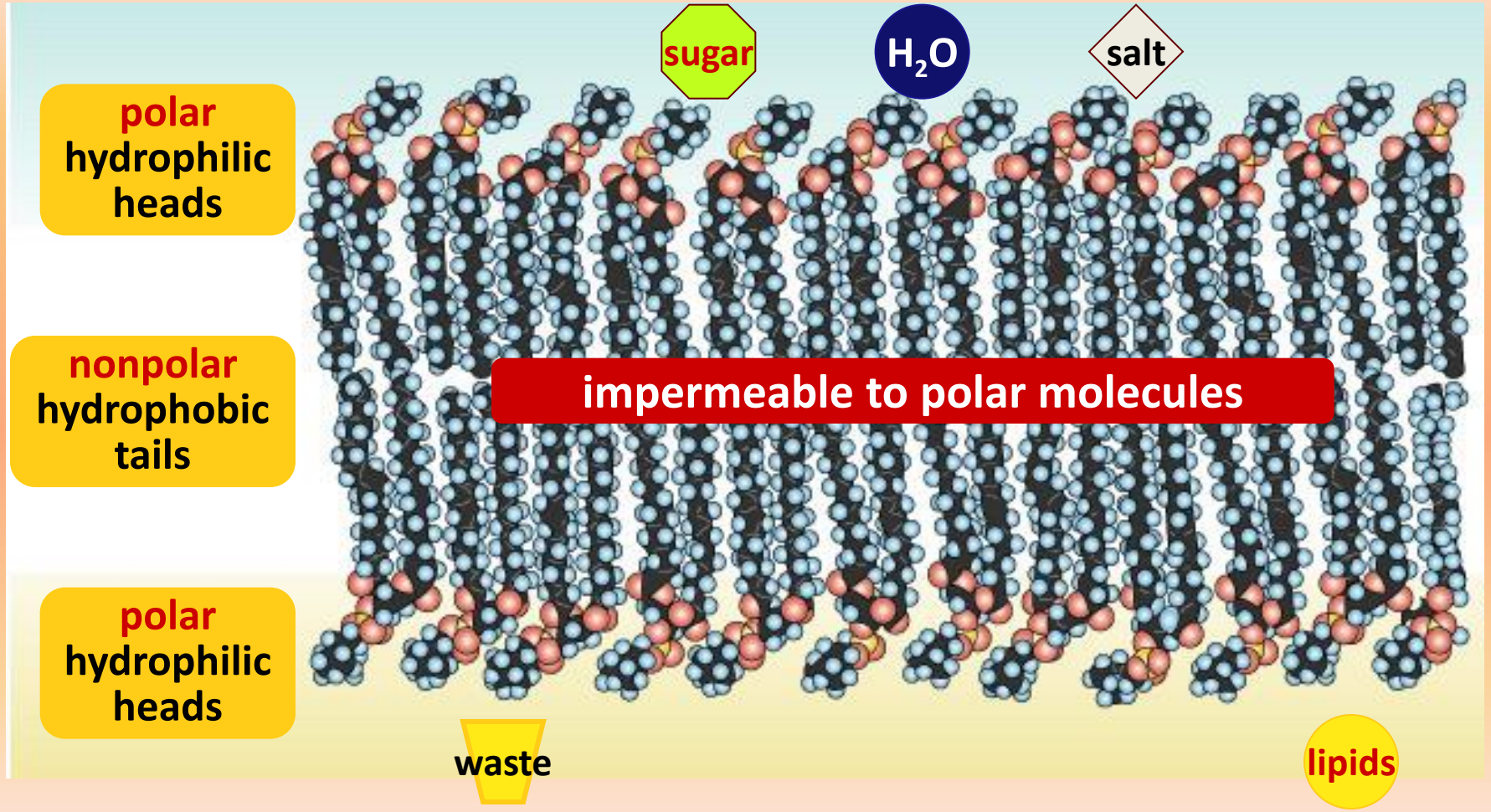






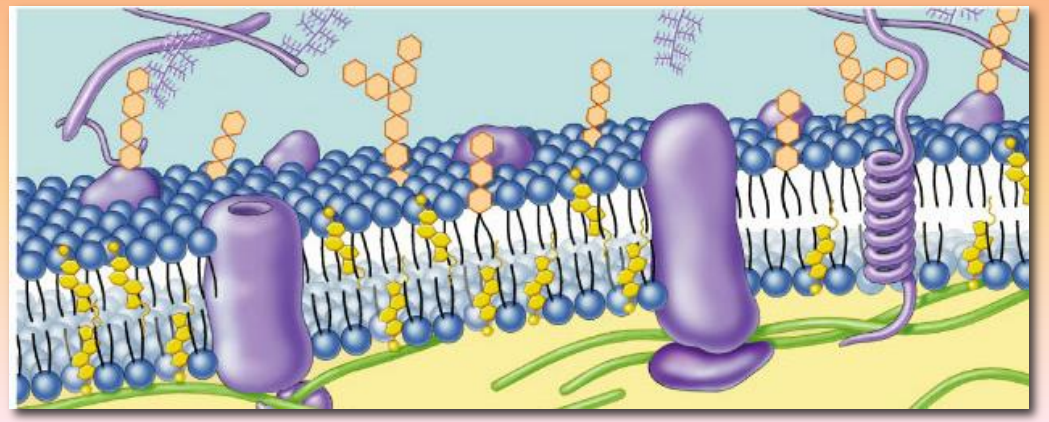
Arranged as a Phospholipid bilayer

- Serves as a cellular barrier / border



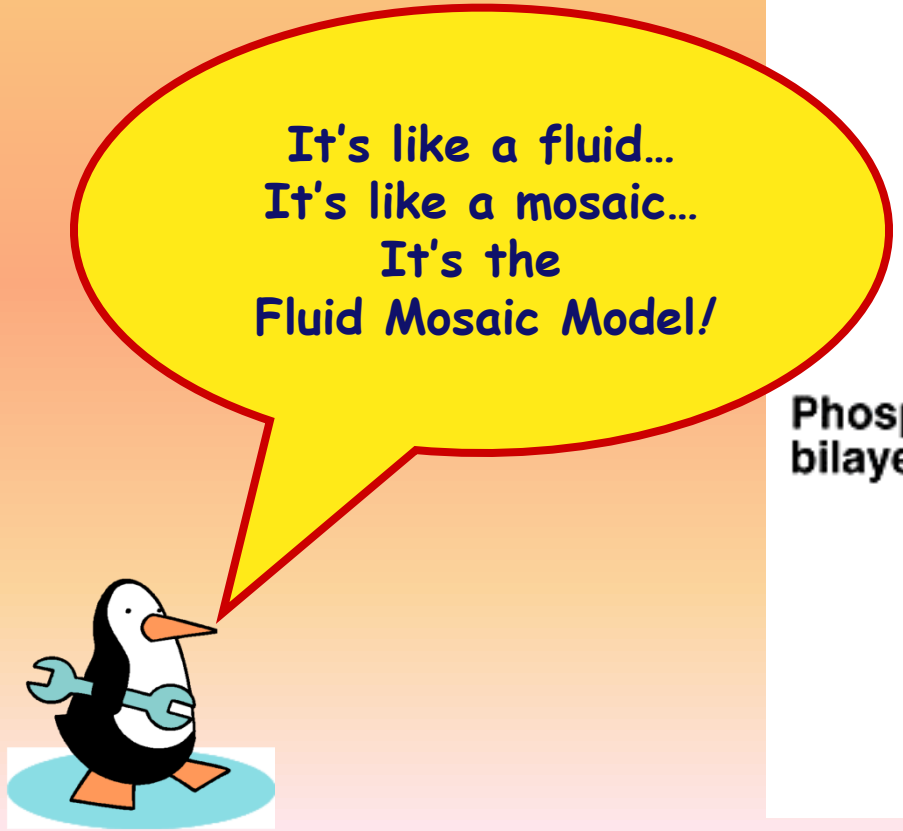
Cell membrane defines cell

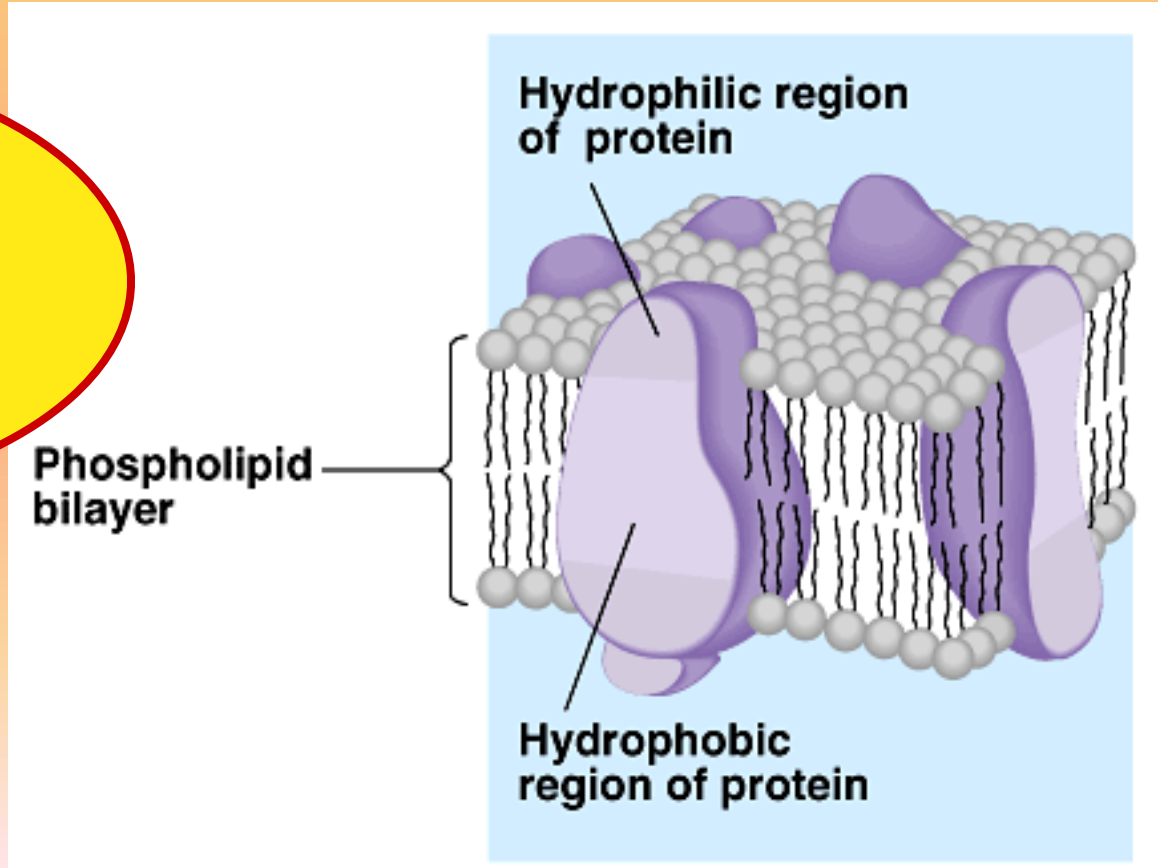
- Cell membrane separates cell from aqueous environment
  - Thin = 8nm thick
- Controls transport in & out of the cell
  - Some substances cross more easily than others
    - hydrophobic (nonpolar) vs. hydrophilic (polar)
    - Small vs. big.



Cell membrane must be more than lipids…

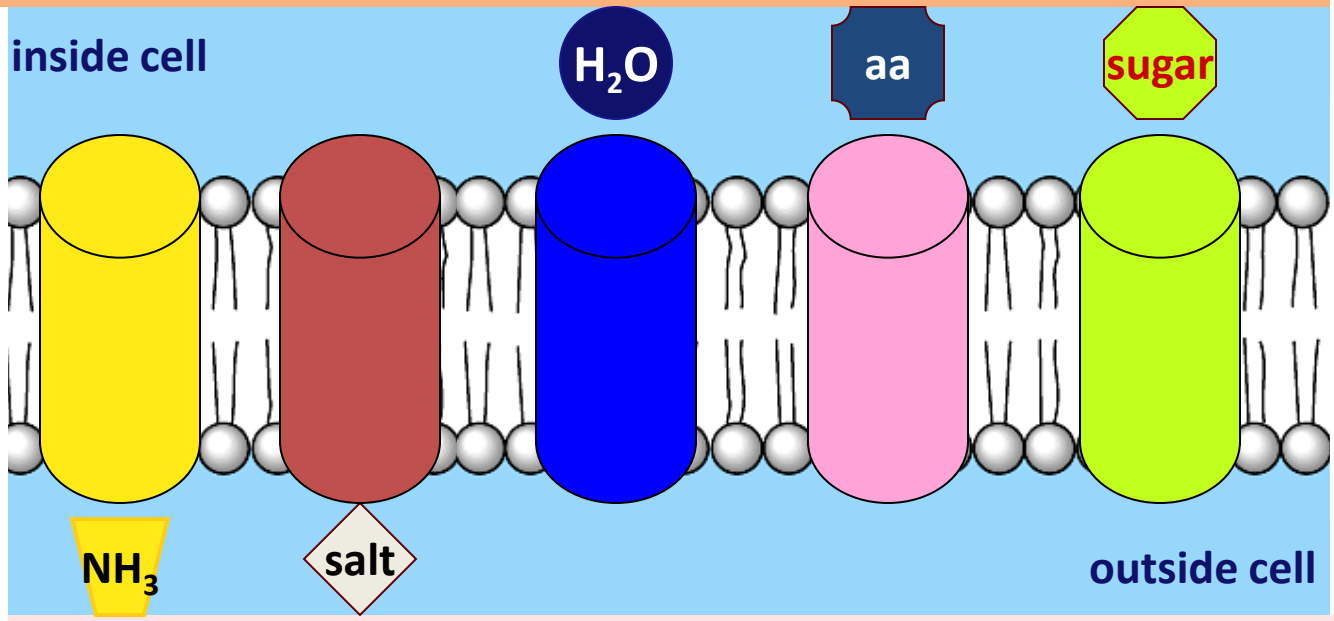
- In 1972, S.J. Singer & G. Nicolson proposed that membrane proteins are inserted into the phospholipid bilayer

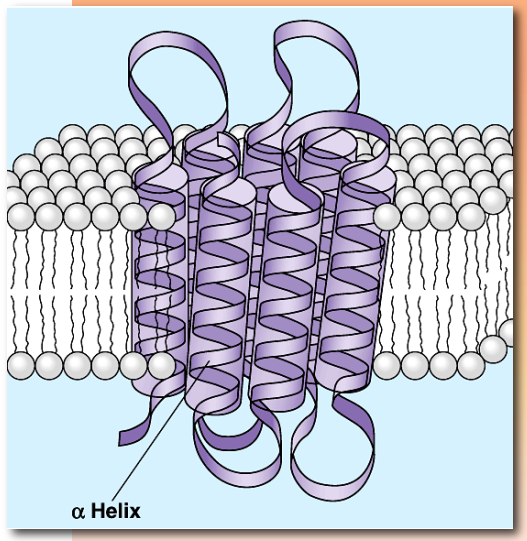




Permeability to polar molecules?

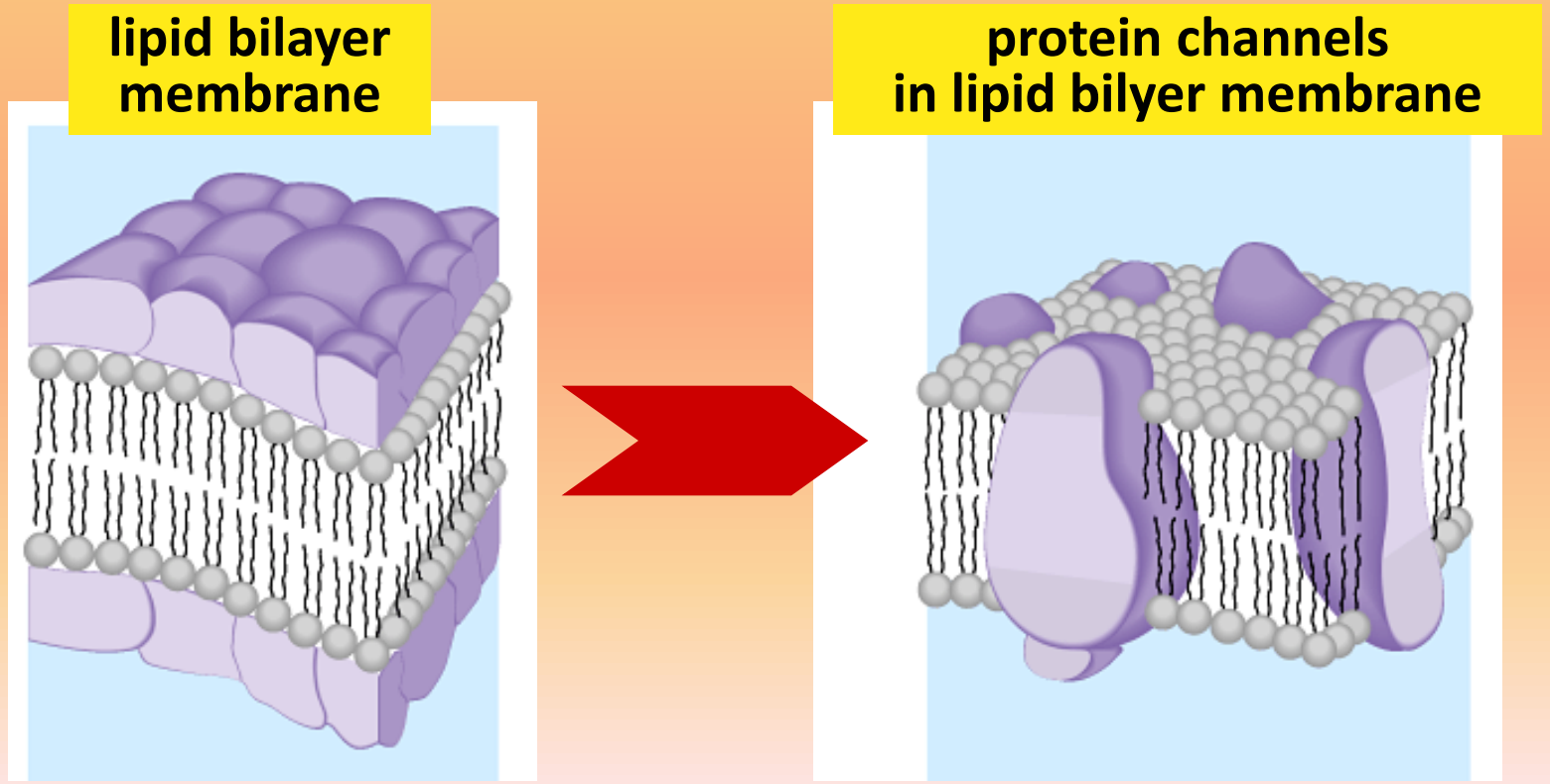
- Membrane becomes semi-permeable via protein channels
  - specific channels allow specific material across cell membrane



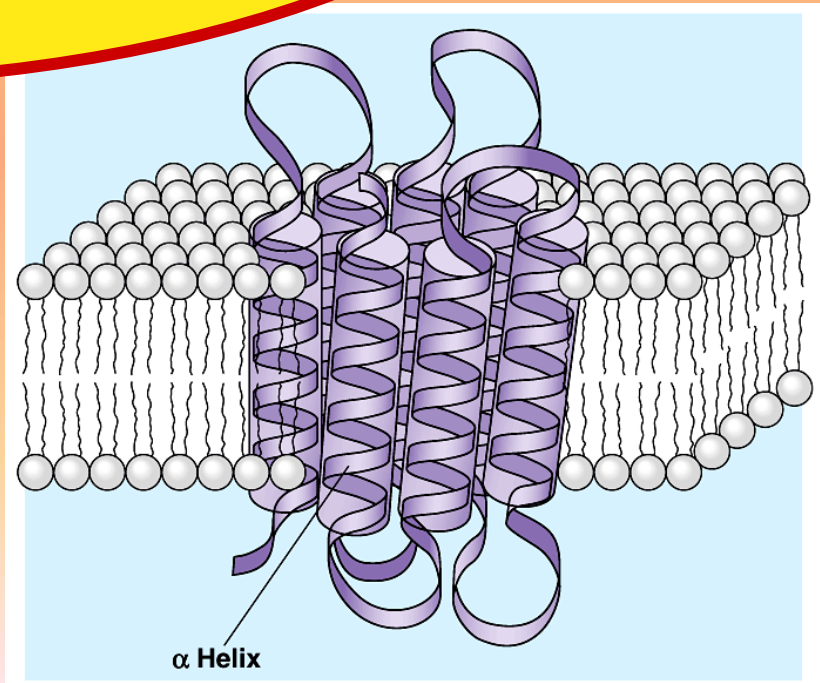


Cell membrane is more than lipids…

- Transmembrane proteins embedded in phospholipid bilayer
  - –create semi-permeable channels

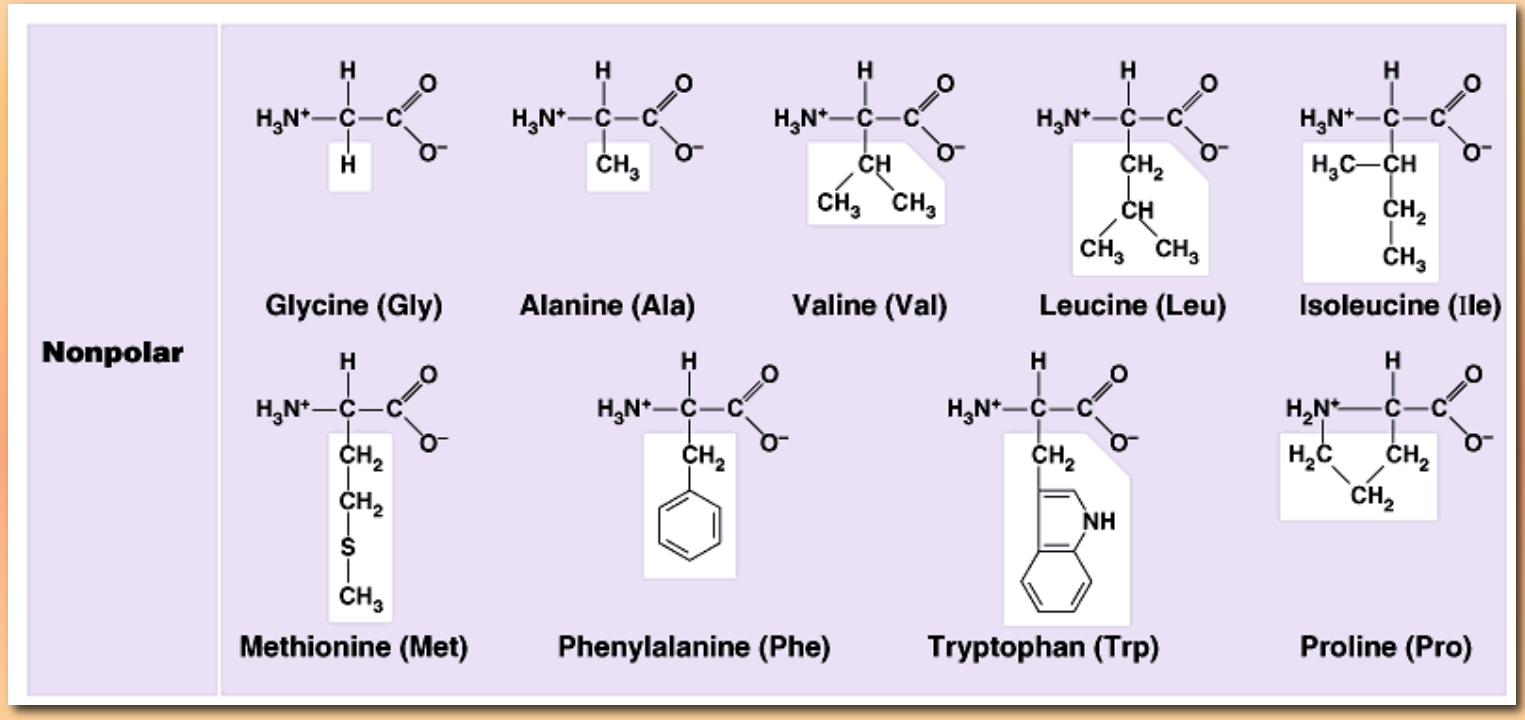


Why are
proteins the perfect
molecule to build structures
in the cell membrane?



Classes of amino acids

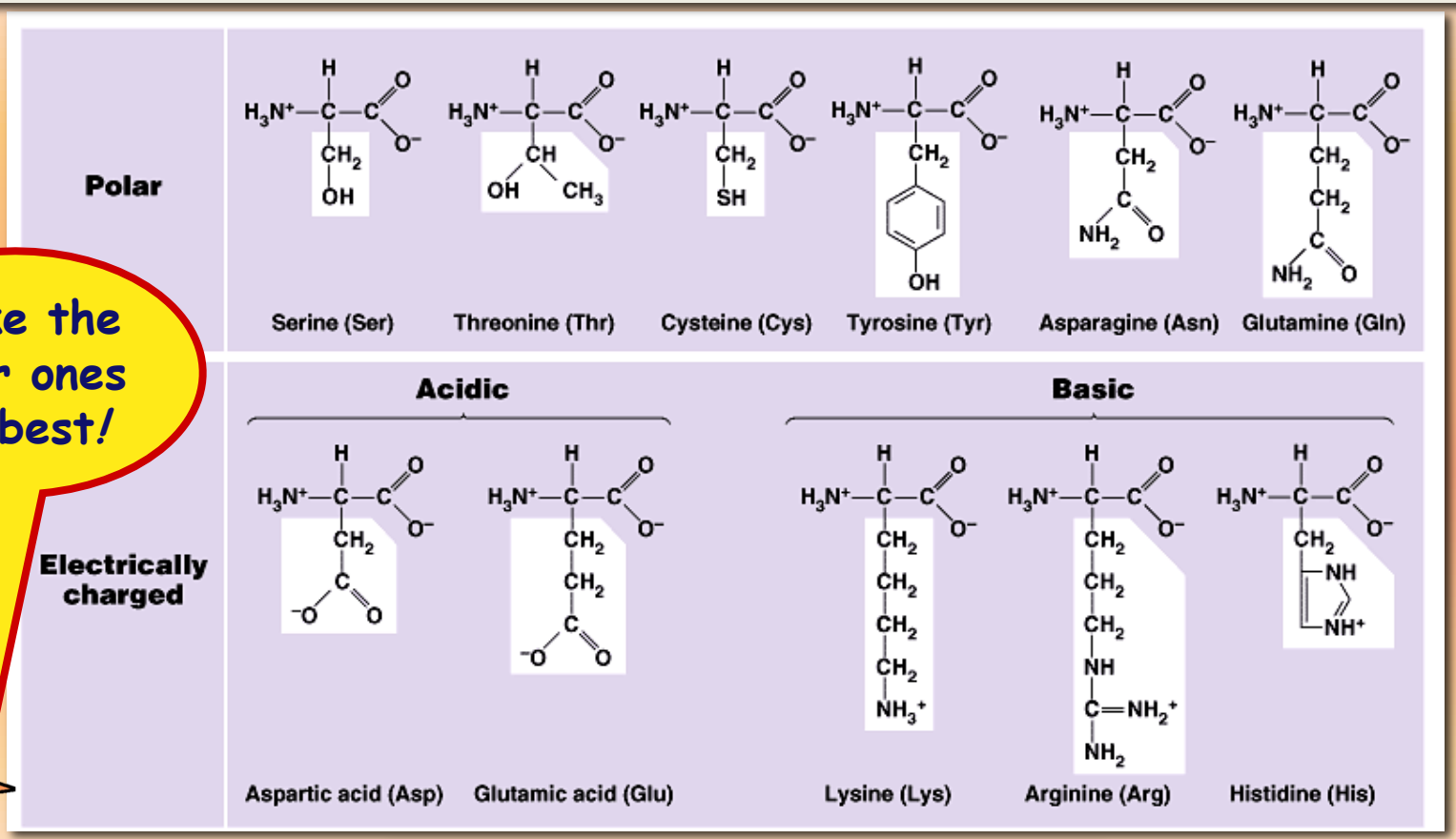
What do these amino acids have in common?

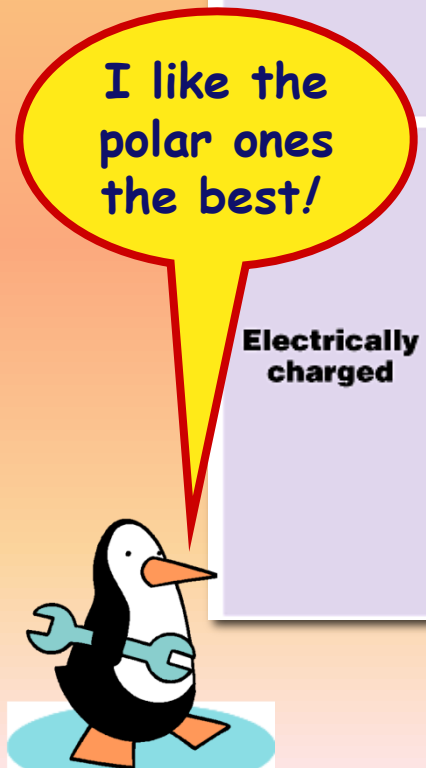


nonpolar & hydrophobic

Classes of amino acids

What do these amino acids have in common?

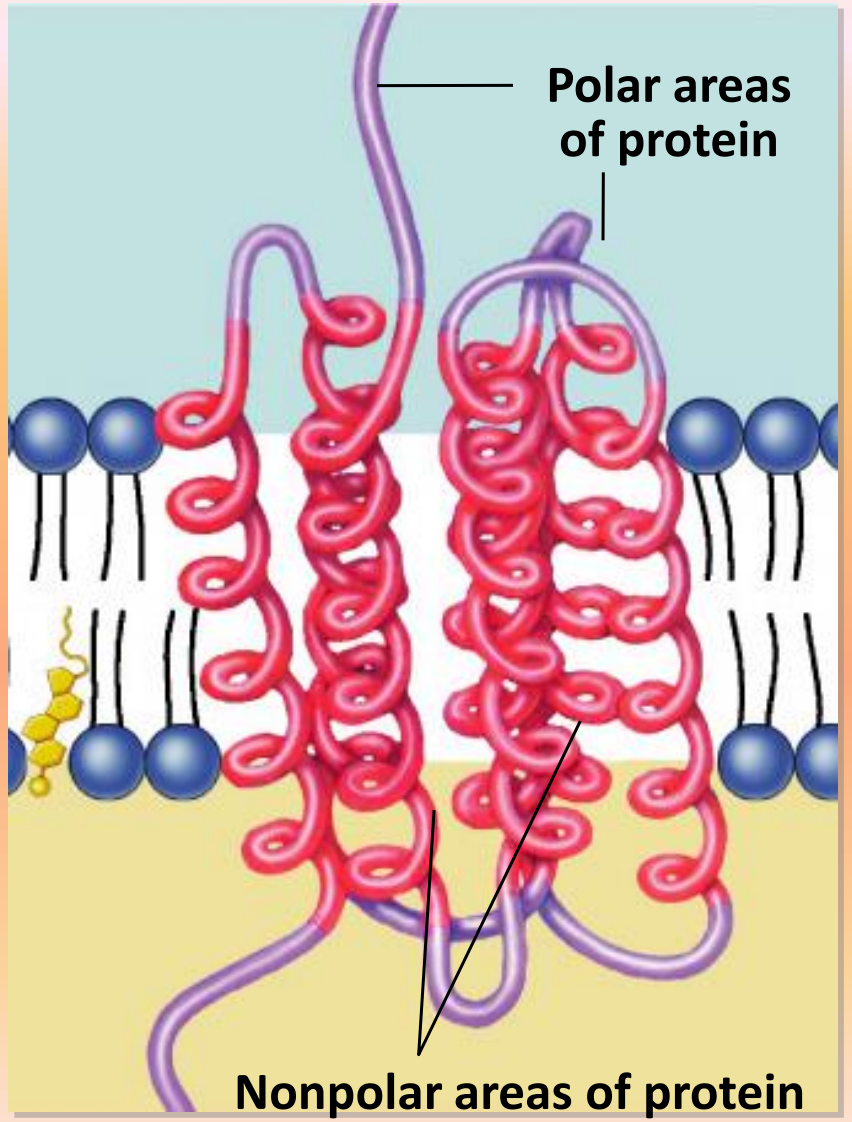




polar & hydrophilic

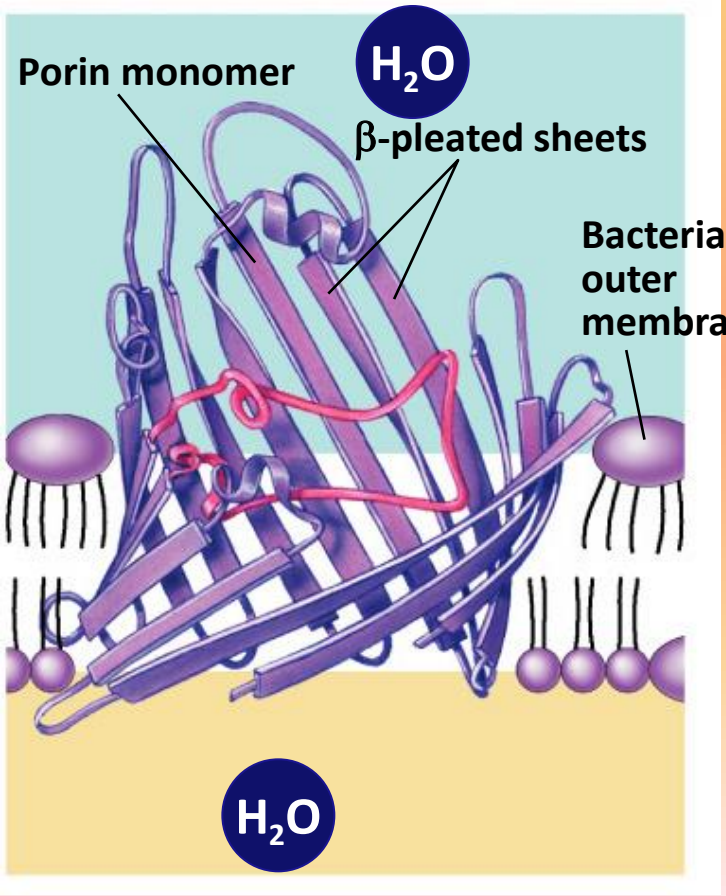
Protein domains anchor molecule

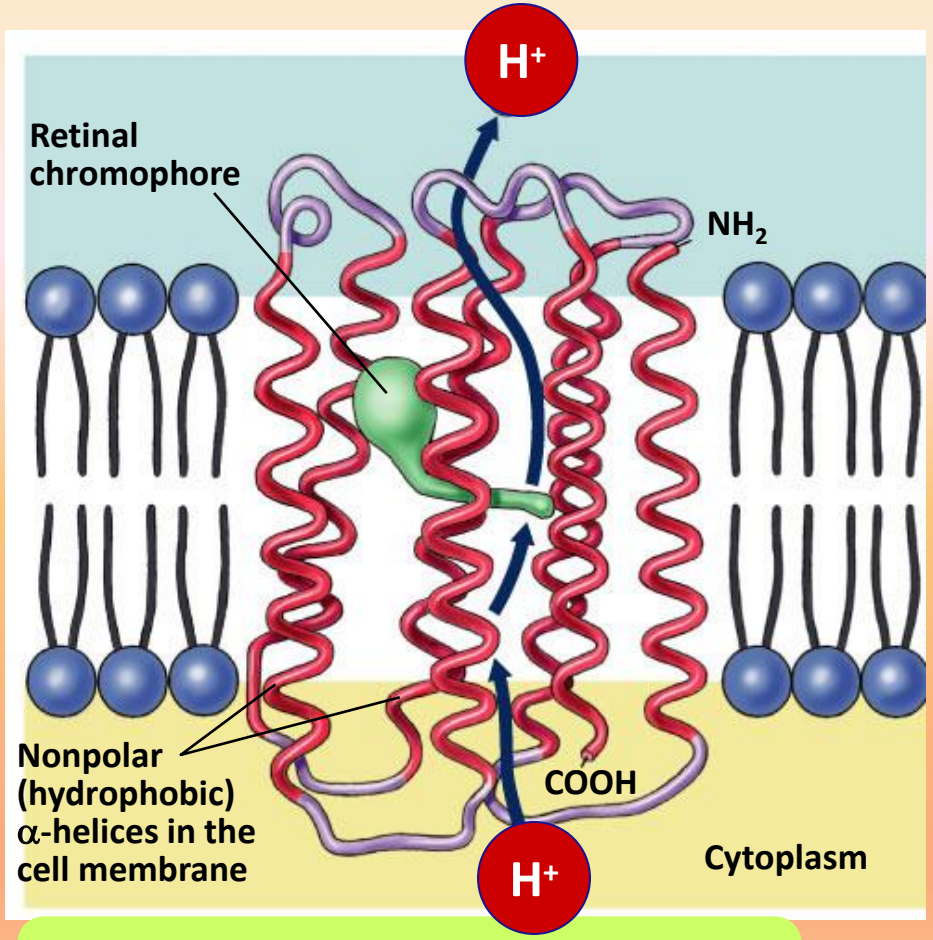
- Within membrane
  - nonpolar amino acids
    - hydrophobic
    - anchors protein into membrane
- On outer surfaces of membrane in fluid
  - polar amino acids
    - hydrophilic
    - extend into extracellular fluid & into cytosol



Examples

aquaporin =
water channel in bacteria

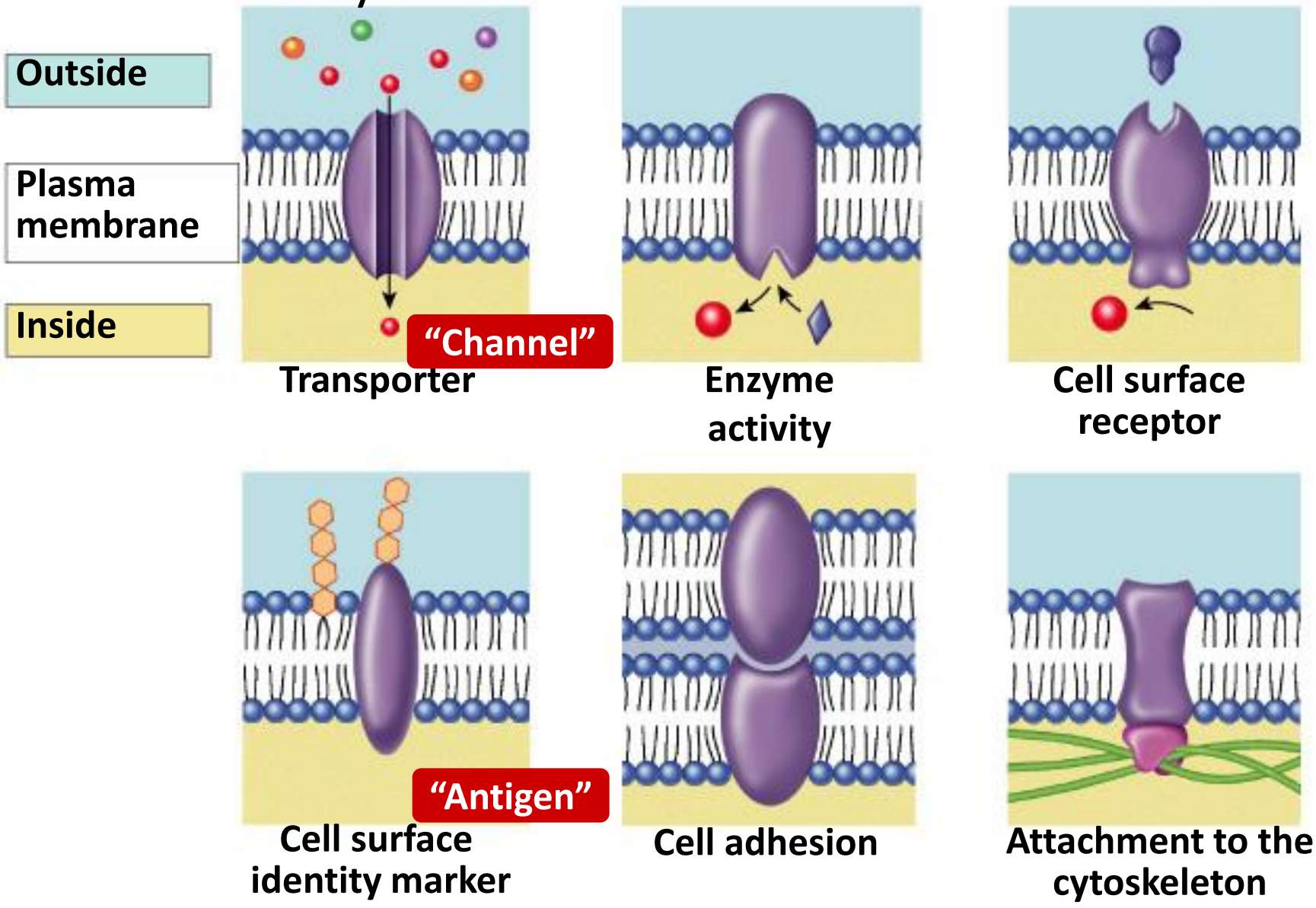




proton pump channel
in photosynthetic bacteria

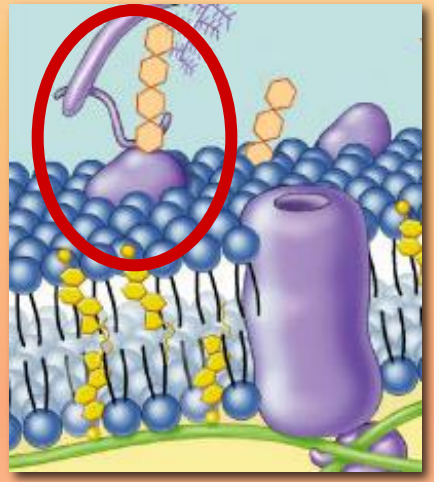
function through
conformational change =
protein changes shape

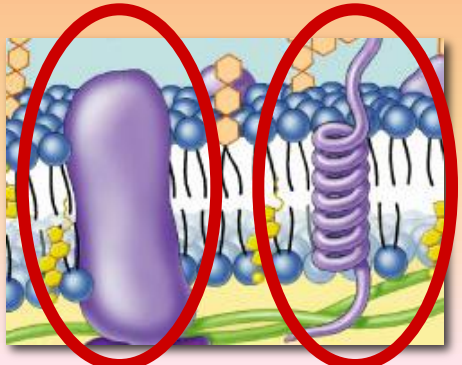
Many Functions of Membrane Proteins



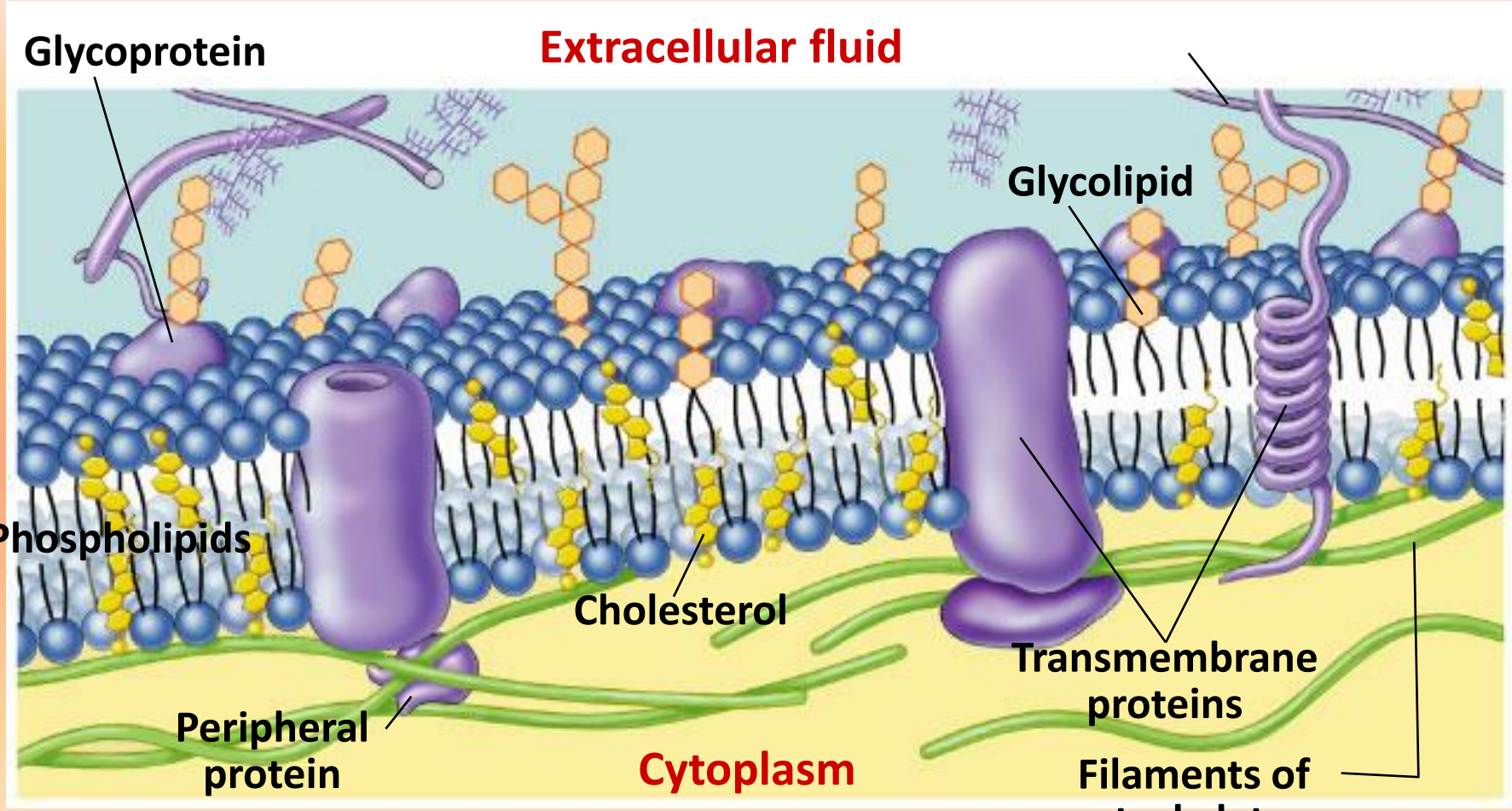
Membrane Proteins

- Proteins determine membrane's specific functions
  - Every membrane in a cell has a unique collection of proteins
- Classes of membrane proteins:
  - peripheral proteins
    - loosely bound to surface of membrane
    - ex: cell surface identity marker (antigens)
  - integral proteins
    - penetrate lipid bilayer, across whole membrane
    - "transmembrane" protein
    - ex: transport proteins
      - channels, permeases (pumps)



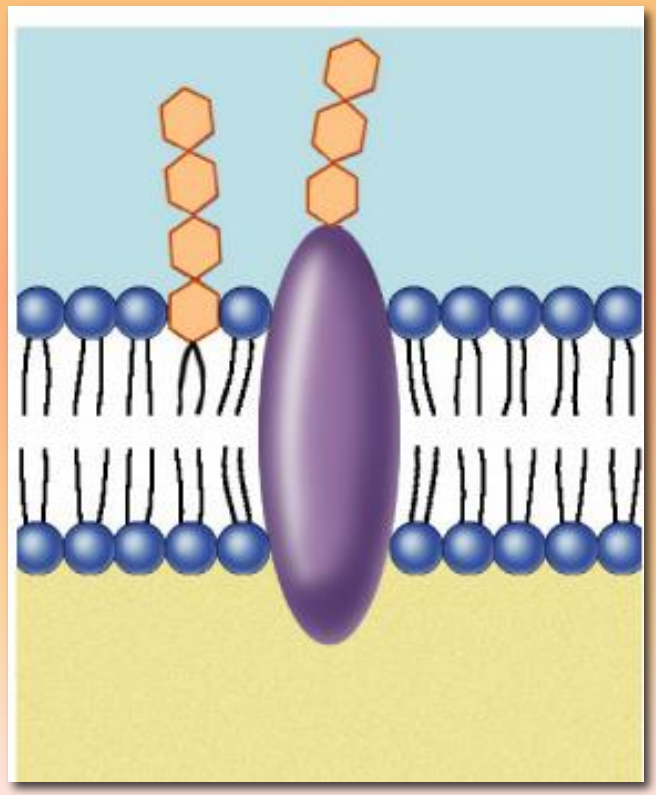


Membrane is a collage of proteins & other molecules embedded in the fluid matrix of the lipid bilayer



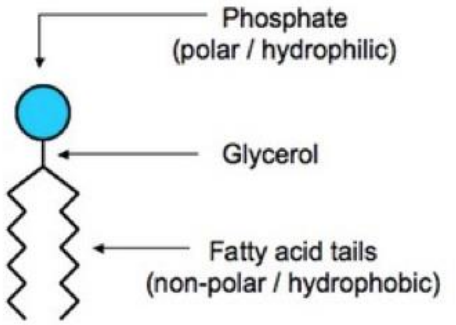
Membrane carbohydrates

- Play a key role in cell-cell recognition
  - ability of a cell to distinguish one cell from another
    - antigens
  - important in organ & tissue development
  - basis for rejection of foreign cells by immune system



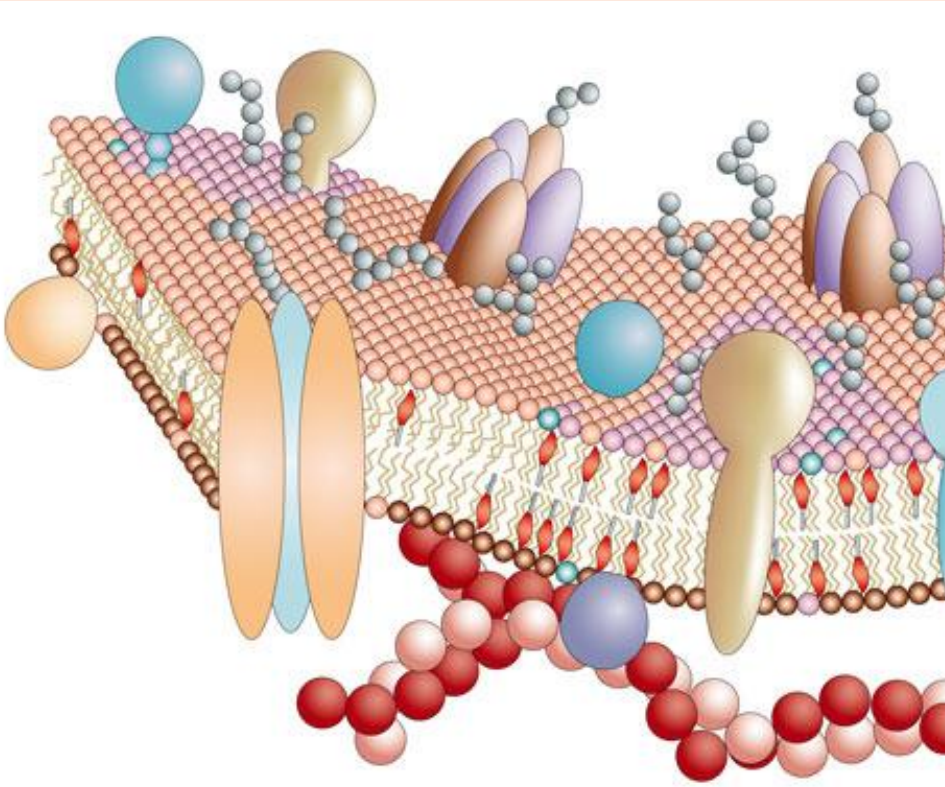
1.3.A1 Cholesterol in mammalian membranes reduces membrane fluidity and permeability to some solutes.

Membrane fluidity



The hydrophobic hydrocarbon tails usually behave as a liquid. Hydrophilic phosphate heads act more like a solid.

Though it is difficult to determine whether the membrane is truly either a solid or liquid it can definitely be said to be fluid.

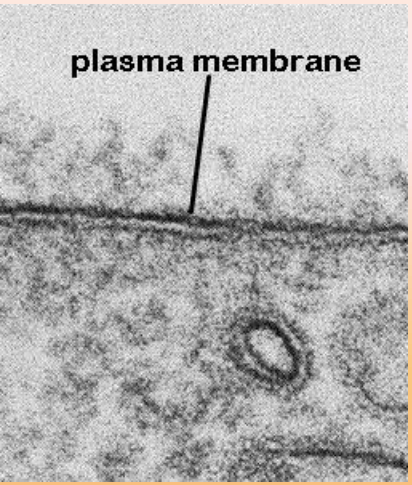


It is important to regulate the degree of fluidity:

- Membranes need to be fluid enough that the cell can move
- Membranes need to be fluid enough that the required substances can move across the membrane
- If too fluid however the membrane could not effectively restrict the movement of substances across itself

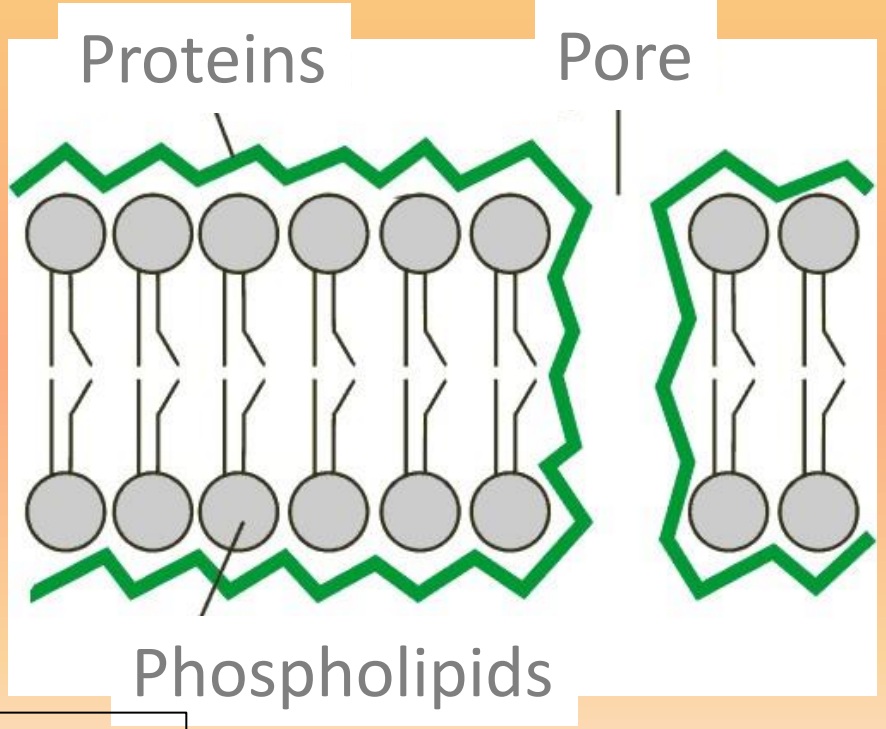
http://www.nature.com/scitable/content/ne0000/ne0000/ne0000/ne0000/14668965/U2.cp5.3_membrane_f2.jpg

1.3.S2 Analysis of evidence from electron microscopy that led to the proposal of the Davson-Danielli model.



The evidence: In high magnification electron micrographs membranes appeared as two dark parallel lines with a lighter coloured region in between.
Proteins appear dark in electron micrographs and phospholipids appear light - possibly indicating proteins layers either side of a phospholipid core.

Davson-Danielli Model



The model:

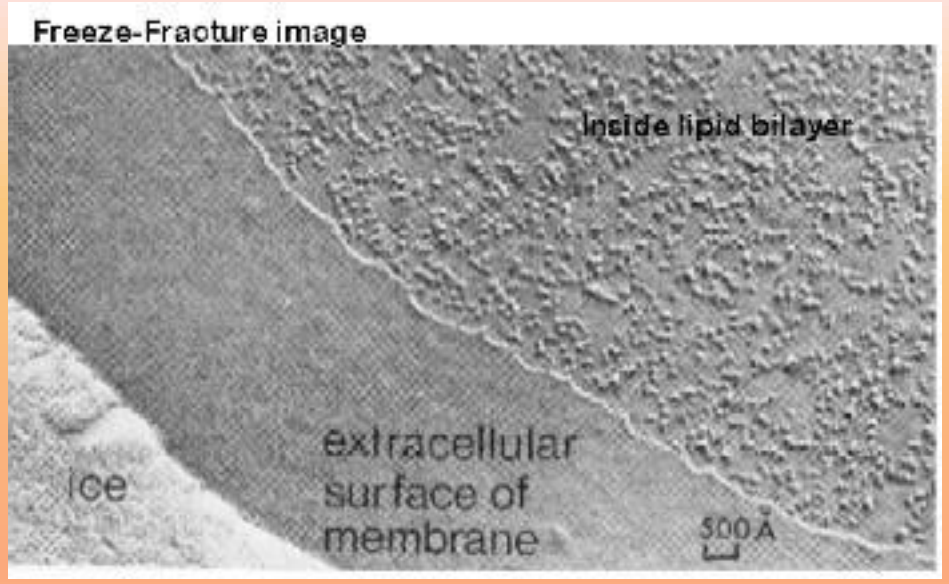
- A protein-lipid sandwich
- Lipid bilayer composed of phospholipids (hydrophobic tails inside, hydrophilic heads outside)
- Proteins coat outer surface
- Proteins do not permeate the lipid bilayer

This explains: Despite being very thin membranes are an effective barrier to the movement of certain substances.

http://www.cytochemistry.net/cell-biology/EMview.jpg

http://upload.wikimedia.org/wikipedia/commons/6/69/Davson_danielli_miguelferig.jpg

Falsification of the Davson-Danielli model – freeze fracturing



This technique involves rapid freezing of cells and then fracturing them.

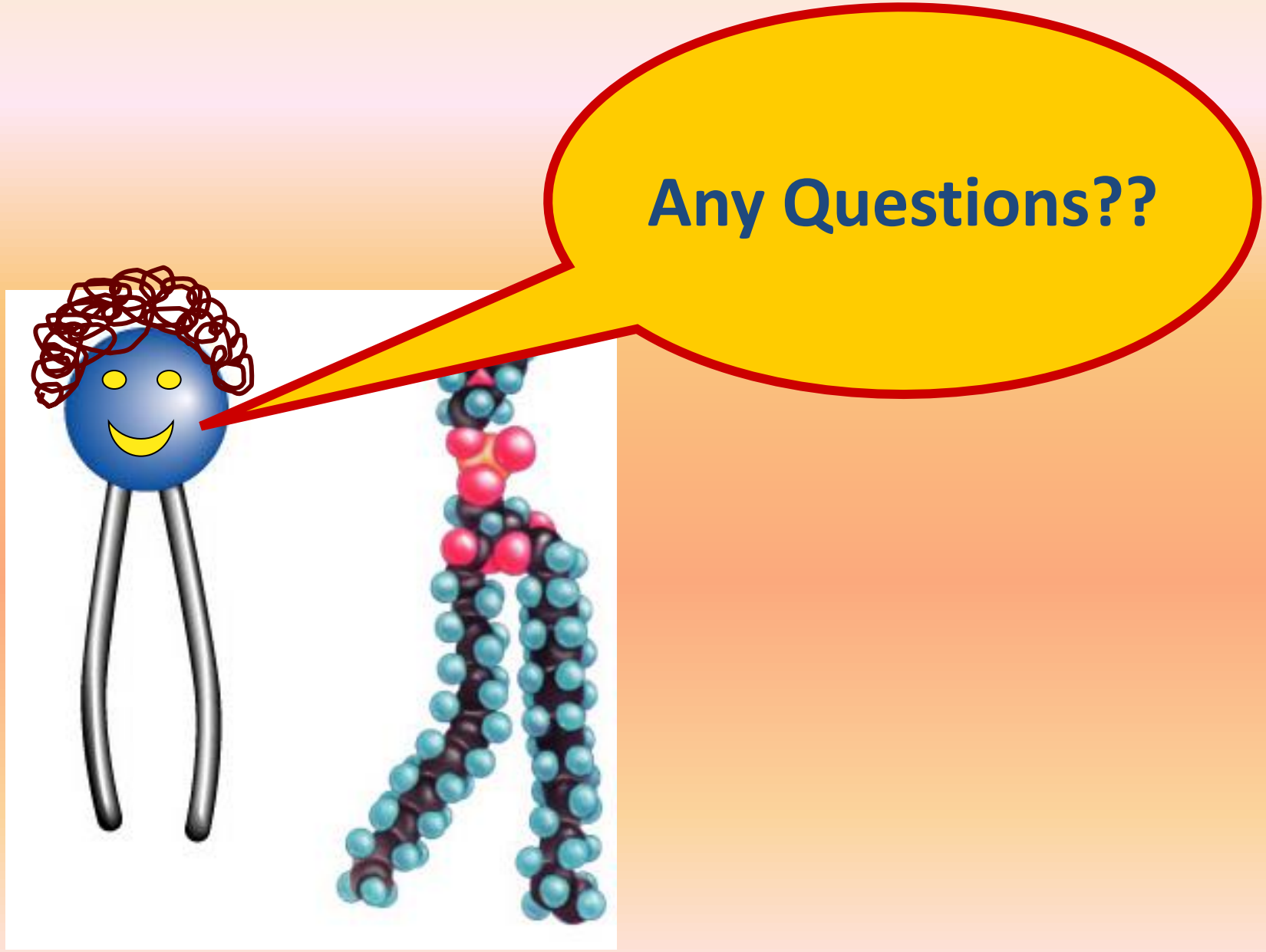
Interpreting the image:

- The fracture occurs along lines of weakness, including the centre of membranes.
- The fracture reveals an irregular rough surface inside the phospholipid bilayer
- The globular structures were interpreted as trans-membrane proteins.

Conclusion:

This is contrary to the Davson-Danielli model which only involves proteins coating the surface of the membrane. A new model is needed to explain the presence of as trans-membrane proteins.

http://www.cytochemistry.net/cell-biology/ffimage.jpg


Any Questions??

Review Questions

1. Which of the following is not a component of cell membranes?
   A. Nucleotides
   B. Carbohydrates
   C. Proteins
   D. Cholesterol
   E. Phospholipids

2. The fluid mosaic model of the cell membrane states that
   A. Proteins are embedded in the phospholipid bi-layer.
   B. Hydrophobic regions of proteins are on the external surface of the membrane, exposed to water
   C. Membranes are composed only of lipids and phosphates
   D. The hydrophilic tails of phospholipids are adjacent to each other
   E. Proteins exist in the membrane sandwiched between phospholipid layers.