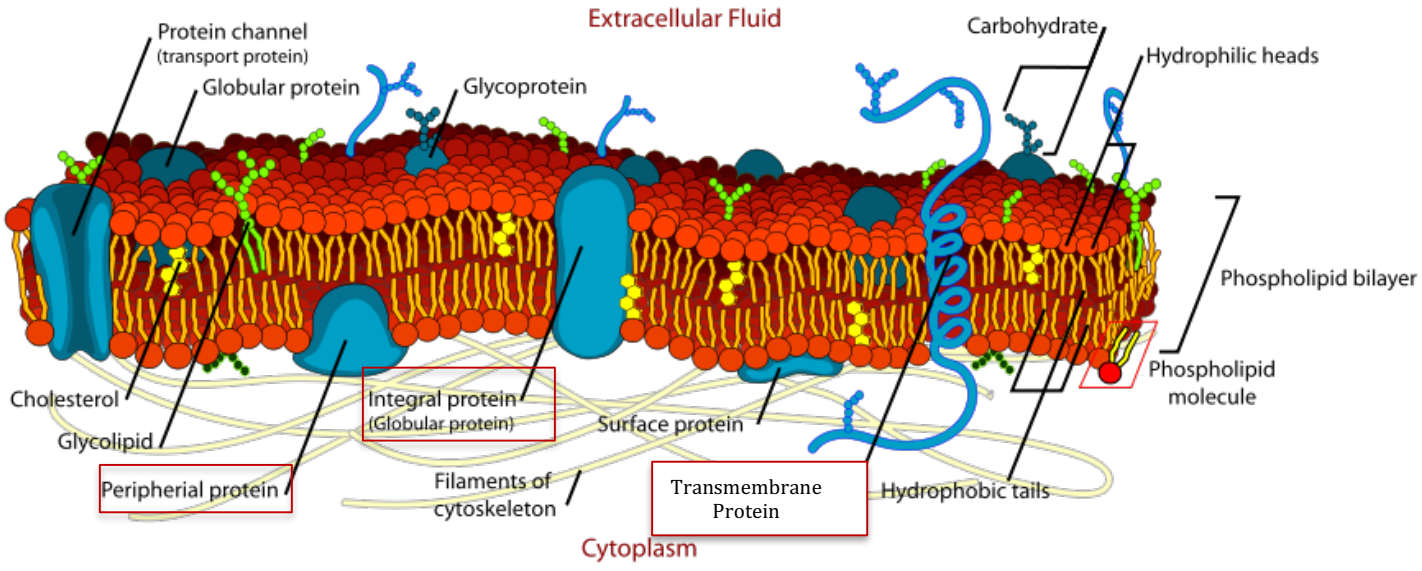
CONCEPT: MEMBRANE PROTEINS

Types of Membrane Proteins

- There are many types of membrane proteins
  - □ **Transmembrane proteins** extend through the _____ bilayer
  - □ **Integral membrane proteins** are attached directly to the bilayer
    - *Monotopic proteins* are found on only one side of the bilayer
  - □ **Peripheral membrane proteins** are bound to membranes through _____ interactions with other proteins
    - Can be entire in the cytosol, or entirely on the extracellular surface
  - □ **Lipid-anchored proteins** are covalently bound to lipid molecules within the membrane
    - Fatty acid anchored: synthesized in cytosol and covalently attached to a saturated fatty acid
    - Isoprenylated proteins: synthesized in cytosol before being modified and inserted into the membrane
    - **GPI anchored membrane proteins**: synthesized in ER as transmembrane protein that becomes cleaved
      - It is replaced by a *glycosylphosphatidylinositol (GPI)* anchor which attaches to membranes

EXAMPLE: Types of membrane lipids in the plasma membrane



Alpha Helices and Beta Barrel Structures

● Transmembrane proteins form two main structures as they _____ the membrane

□ An **alpha helix** is the most common structure formed by transmembrane proteins

- Allows hydrophobic side chains to be exposed on helix which mask the hydrophilic backbone

- Important because the inside of a membrane bilayer is hydrophobic

□ A **beta barrel** can form by repeating beta sheets

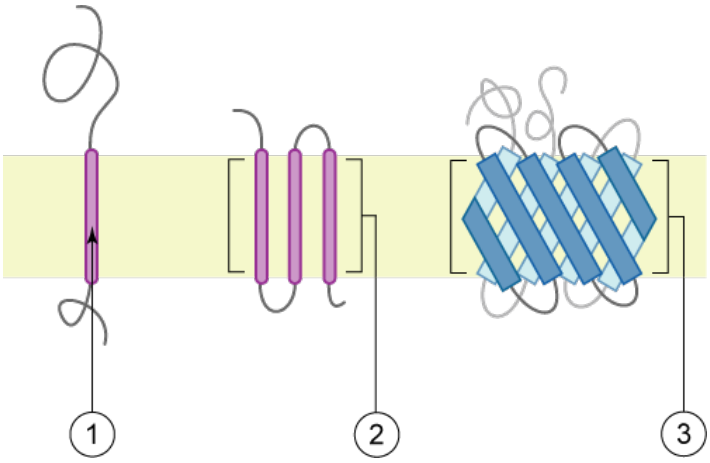
- Typically forms larger channels which allows for large molecules to travel through the membrane

□ Transmembrane proteins can form as *single pass* or *multipass* proteins

- **Single pass** proteins are one alpha helix that extend through the membrane

- **Multipass** proteins can cross the membrane multiple times

EXAMPLE: Examples of a single (1) and multipass (2) alpha helix and beta barrel (3)



Organization of membrane proteins

● Like membrane lipids, membrane proteins are not equally distributed on each side of the bilayer

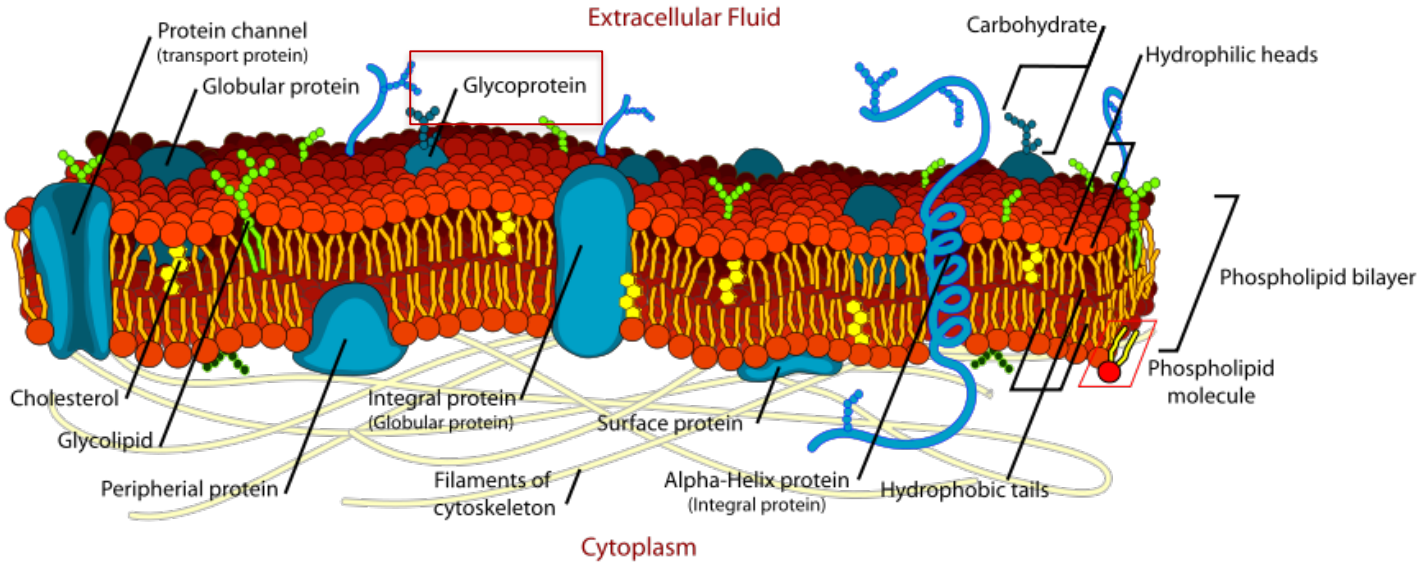
□ Only transmembrane proteins are present and function on each _____ of the membrane

- But, usually each side has a different function

□ **Glycosylation** is the addition of carbohydrates to proteins can be different on each side of the bilayer

- Extracellular face: protects cells, prevent unwanted cell to cell contact, and blurs barrier between the ECM

EXAMPLE: Image demonstrates asymmetry of proteins on each side of the membrane



● Like membrane lipids, membrane proteins can move and are divided into domains

□ Membrane proteins can _____ in the membrane

- *Lateral diffusion*: They can move laterally within one membrane layer

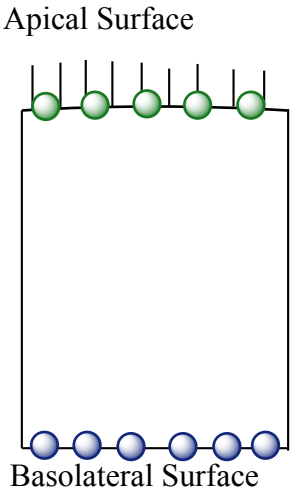
- *Rotational diffusion:* They can rotate around an axis

- *Traverse diffusion*: They canoot flip across to the other membrane layer

□ Specific domains exist on cells and have different protein compositions and different protein functions

- Epithelial cells contain *apical* (absorb nutrients) and *basolateral* (transfer nutrients to blood) domains

EXAMPLE: Different proteins are found on the apical and basolateral surfaces of an epithelial cell



● Membrane proteins form complex structures that help _____ the cell

□ The **glycocalyx** is formed by glycoproteins and gylcolipids and coats the outside of the plasma membrane

- Contains **proteogylcans** (proteins linked to polysaccharides) & glycoproteins (linked to oligosaccharides)

□ The cell *cortex* sits on the inner surface of the plasma membrane and interacts with the cell's cytoskeleton

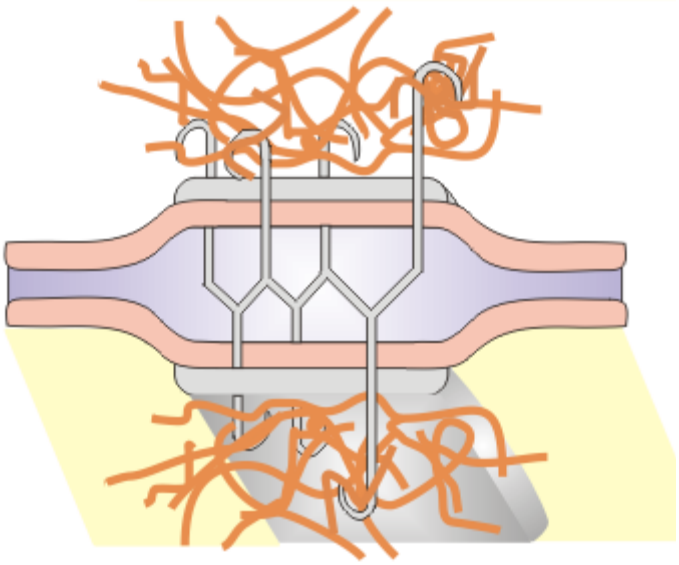
- The **cortex** is a network of cytoskeleton and membrane proteins that are anchored together

- Provides the cell with support and limits membrane protein movement

□ Membrane proteins can also support membrane bending and _____

- Insertion of hydrophobic protein domains at specific locations controls intensity of bending

EXAMPLE: Large protein structures found on the internal and extracellular surface



Laboratory Techniques to Study Membranes and Proteins

● There are many useful techniques used to _____ membranes in cells

□ **Detergents** are small amphipathic molecules with a hydrophobic tail that aggregate to form *micelles* in water

- When mixed with membranes the hydrophobic portions interact and disrupt to isolate proteins

□ **X ray crystallography** is used to get the structure of proteins, but isn't very effective with membrane proteins

- Detergents make it difficult to use this technique – therefore few membrane protein structures are known

□ **Freeze fracturing** is used to reveal the inner surface of the cell and the cell's cortex

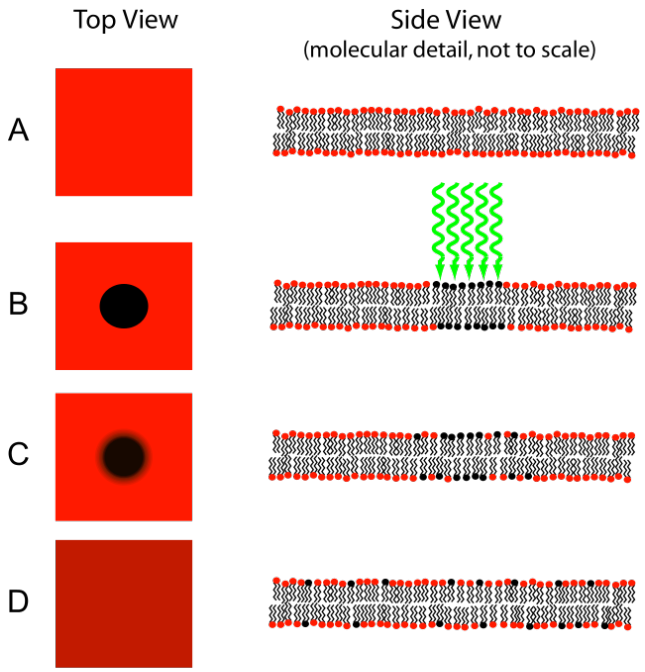
- Freeze's membranes fast and pierced with diamond knife to split hydrophobic areas (least resistance)

□ **FRAP** (Fluorescence recovery after photobleaching) is used to study membrane fluidity

- Labels lipids or proteins with fluorescent molecule, then bleaches a small region to remove fluorescence

- Watch for recovery of fluorescence which can only occur if molecules are moving into the bleached area

EXAMPLE: Diagram of FRAP



PRACTICE

1. Which of the following is not a type of membrane protein?
    a. Integral membrane proteins
    b. Peripheral membrane proteins
    c. Proteogylcan membrane proteins
    d. Lipid anchored membrane proteins

2. Which of the following membrane proteins does NOT attach to the membrane by binding to lipids?
    a. Integral membrane proteins
    b. Peripheral membrane proteins
    c. GPI-anchored membraned proteins
    d. Lipid-anchored membrane proteins

3. Which of the following secondary structures is most commonly found in membrane proteins?
    a. Coiled coil
    b. Beta sheet
    c. Alpha helix

4. True or False: Like lipids, membrane proteins have the same ability to act like a fluid and move around in the membrane.
    a. True
    b. False

5. What is the name of the collection of membrane bound and transmembrane proteins that are interconnected on the cytoplasmic surface of the plasma membrane?
    a. Proteoglycans
    b. Glycocalyx
    c. Cell Cortex
    d. Actin groupings

6. Which of the following techniques is best used when studying membrane fluidity?
    a. X-ray crystallography
    b. Detergents
    c. Freeze fracturing
    d. FRAP