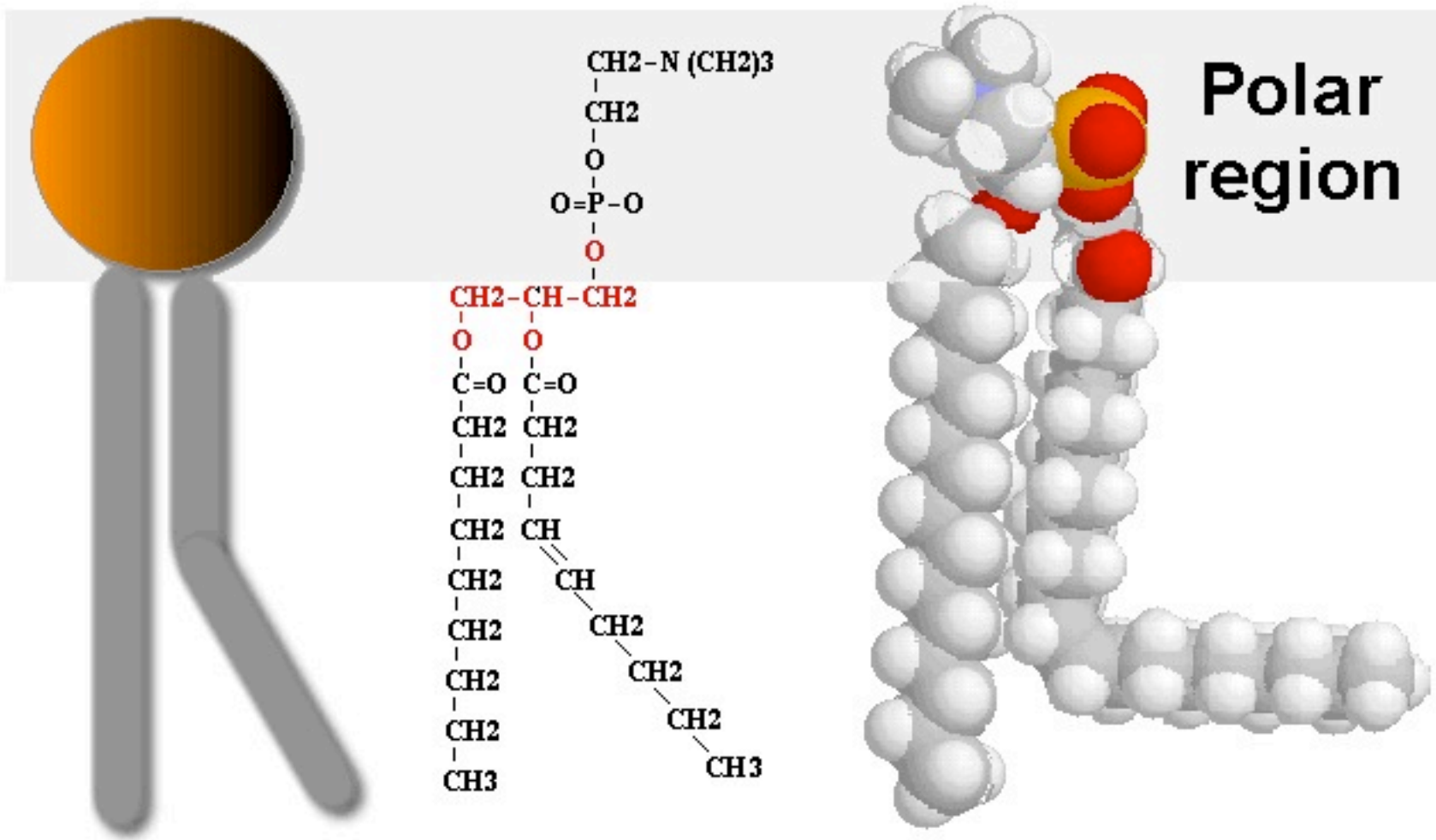
Membrane Proteins

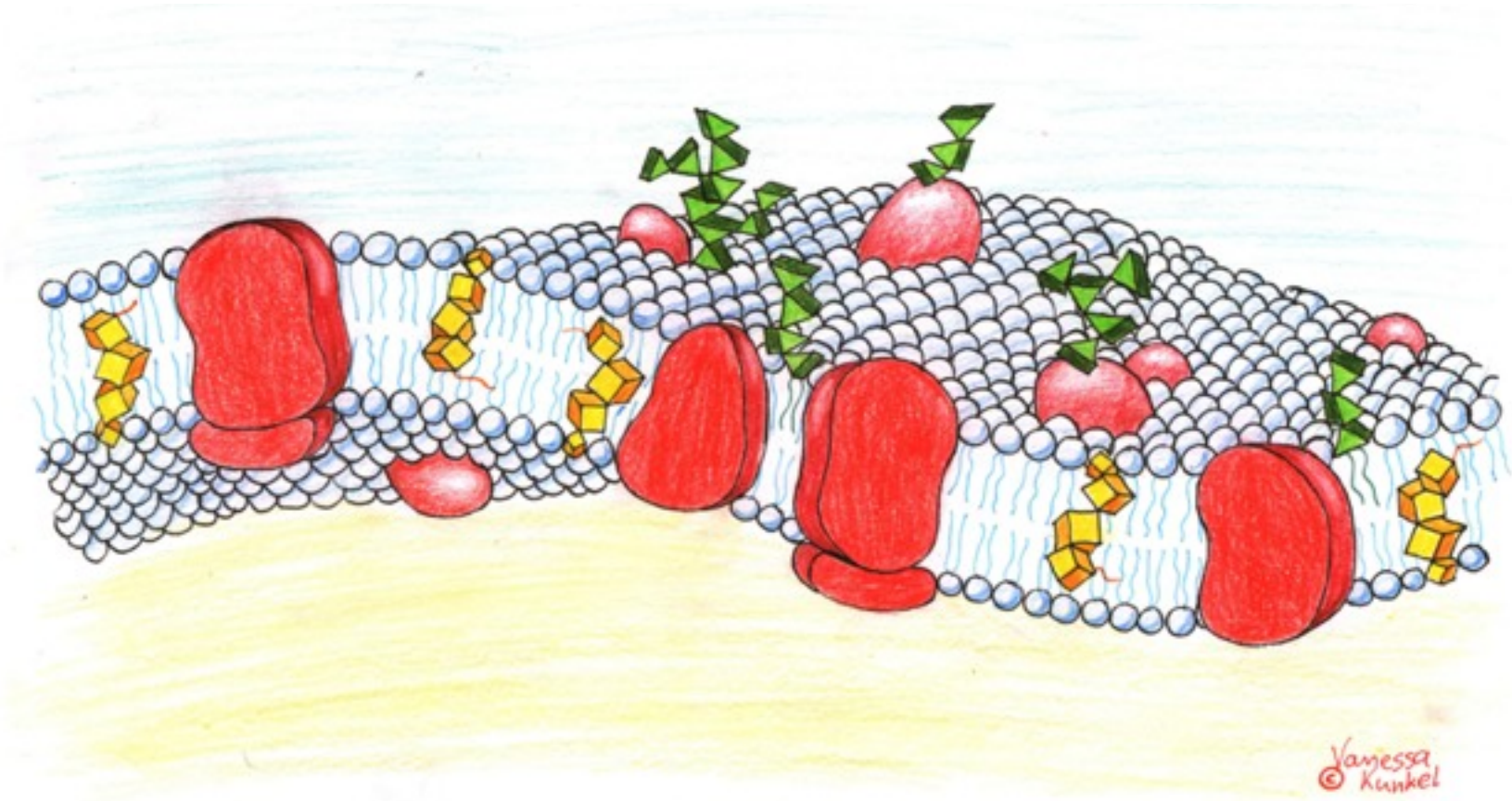
Membranes

- Cellular membranes physically establish a cell and internal membranes separate the enclose cellular components
- Fluid mosaic model - freedom of proteins to move freely about the membrane in two dimensions.
  - model requires the membrane to be homogeneous
- Membrane contain a complex lateral organization
  - Single molecule studies demonstrated that lipids and membrane proteins are temporarily confined to defined regions

Phospholipids

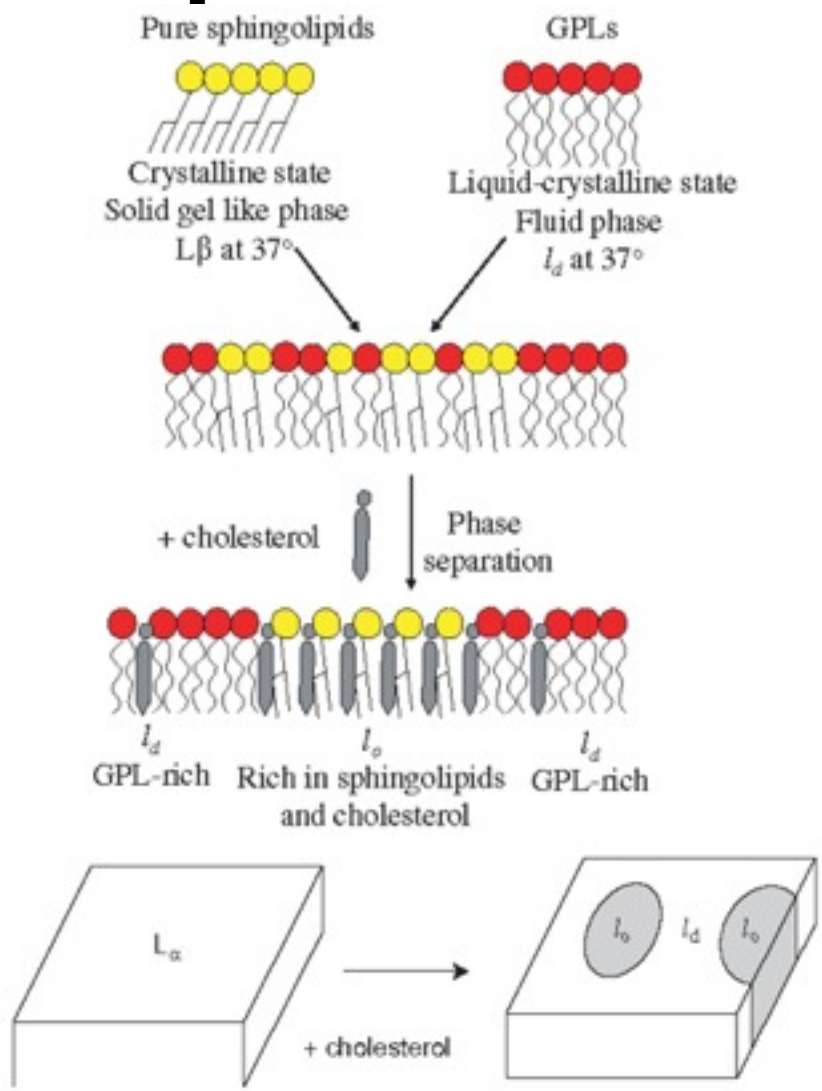


Fluid Mosaic Model



Proteins have a degree of motional freedom in a lipid sea.

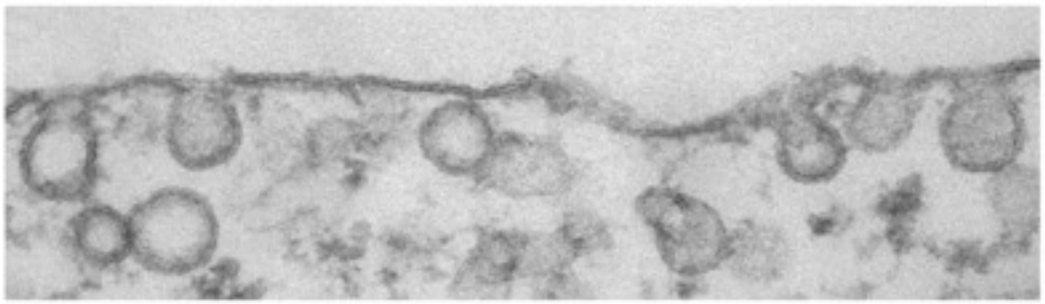
Lipid Rafts

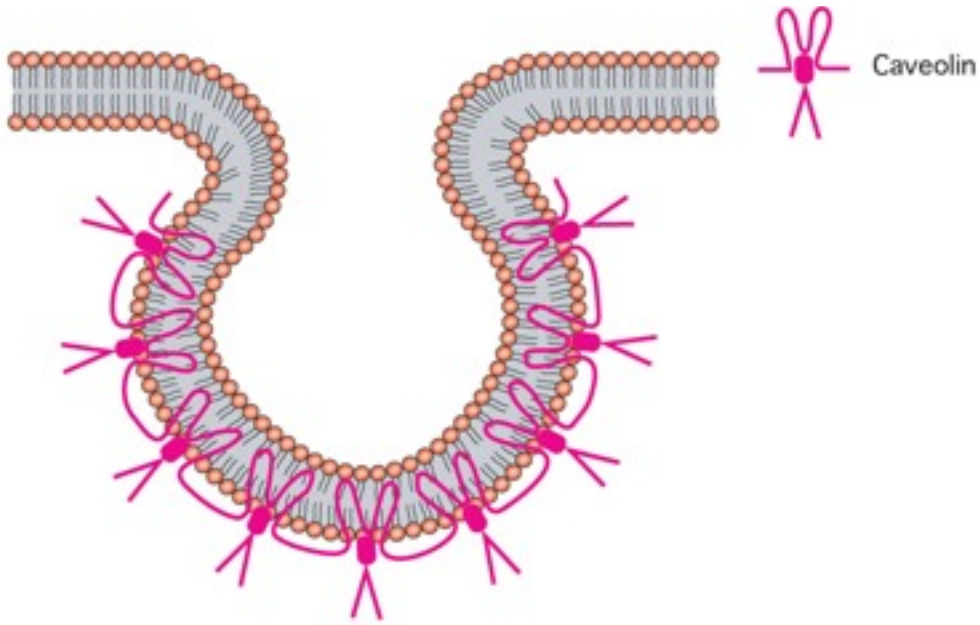


glycerophosolipid (GLP)

- Lipid rafts were first identified as triton X-100 (detergent) resistant membranes
- Lipid rafts contain high levels of cholesterol and sphingolipids as well as saturated phosoholipids
- The presence of lipids and cholesterol promotes the ordering of lipid hydrocarbon carbon

Caveola





- Caveola are located at the plasma membrane
- Constitutes a lipid raft subtype
- Principal protein component is caveolin, a scaffolding protein that binds cholesterol and interacts with signaling proteins

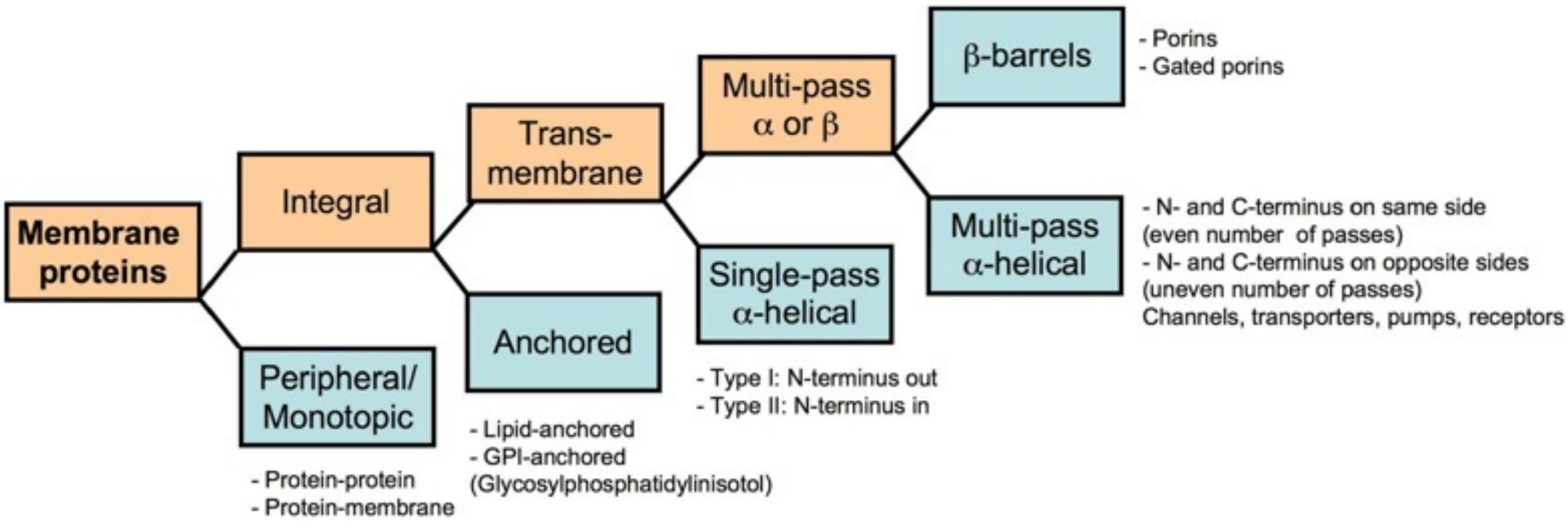
Membrane Proteins

- Can have a range of activities similar to soluble/ cytoplasmic proteins
- unique function - transporters and channels
- membranes create a physical barrier to free movement of items

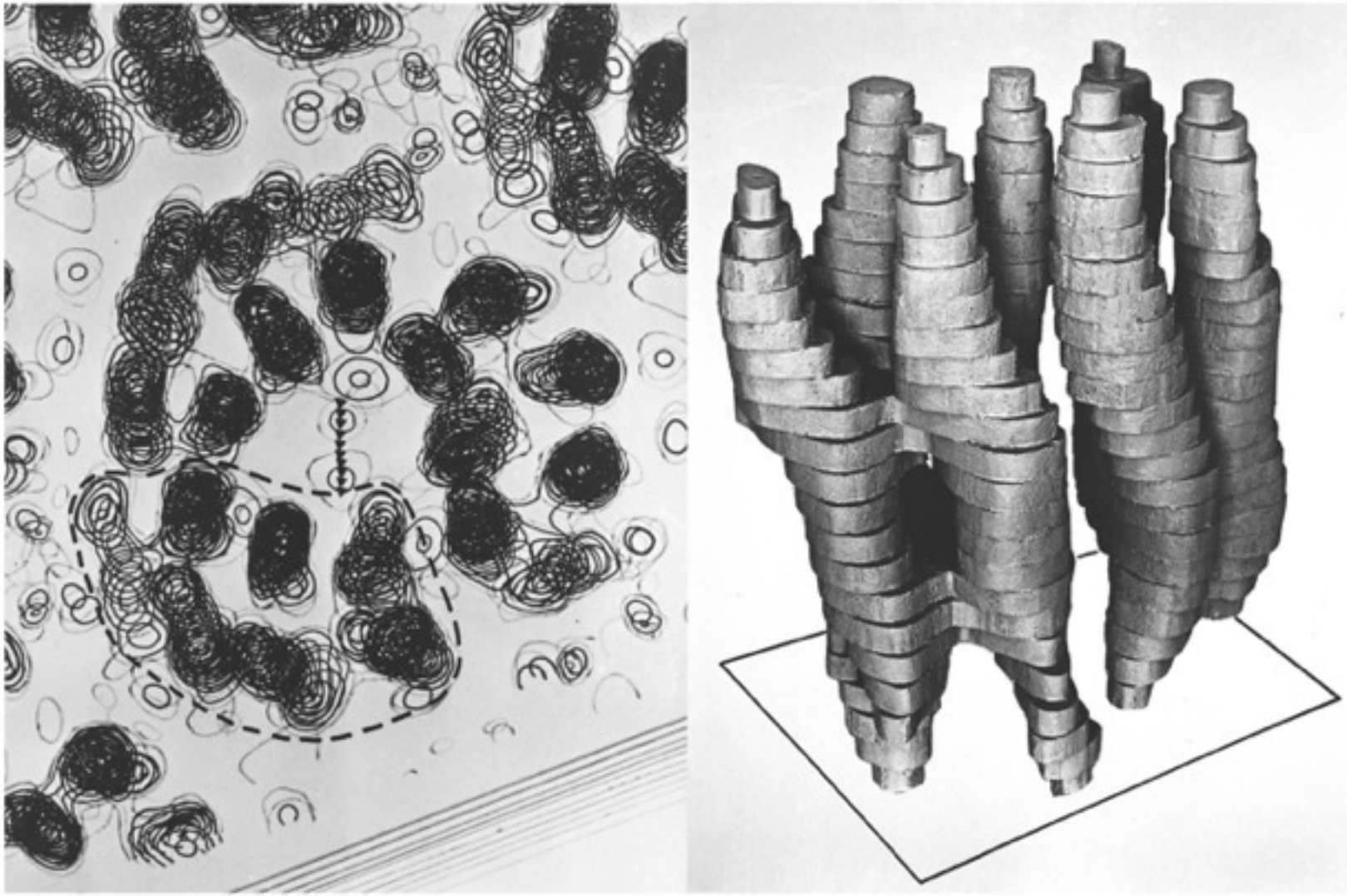
Transporters

- transporters perform active transport against a concentration gradient (from lower to higher concentrations)
- maintains osmotic or electrochemical gradients.
- primary transporters use an external energy - ATP hydrolysis, light or redox reactions
- Secondary transporters use an already established gradient, usually Na^+ or H^+
- Channels - passive transporters from higher to lower concentrations, coupled to a gating mechanism

Categories of Membrane

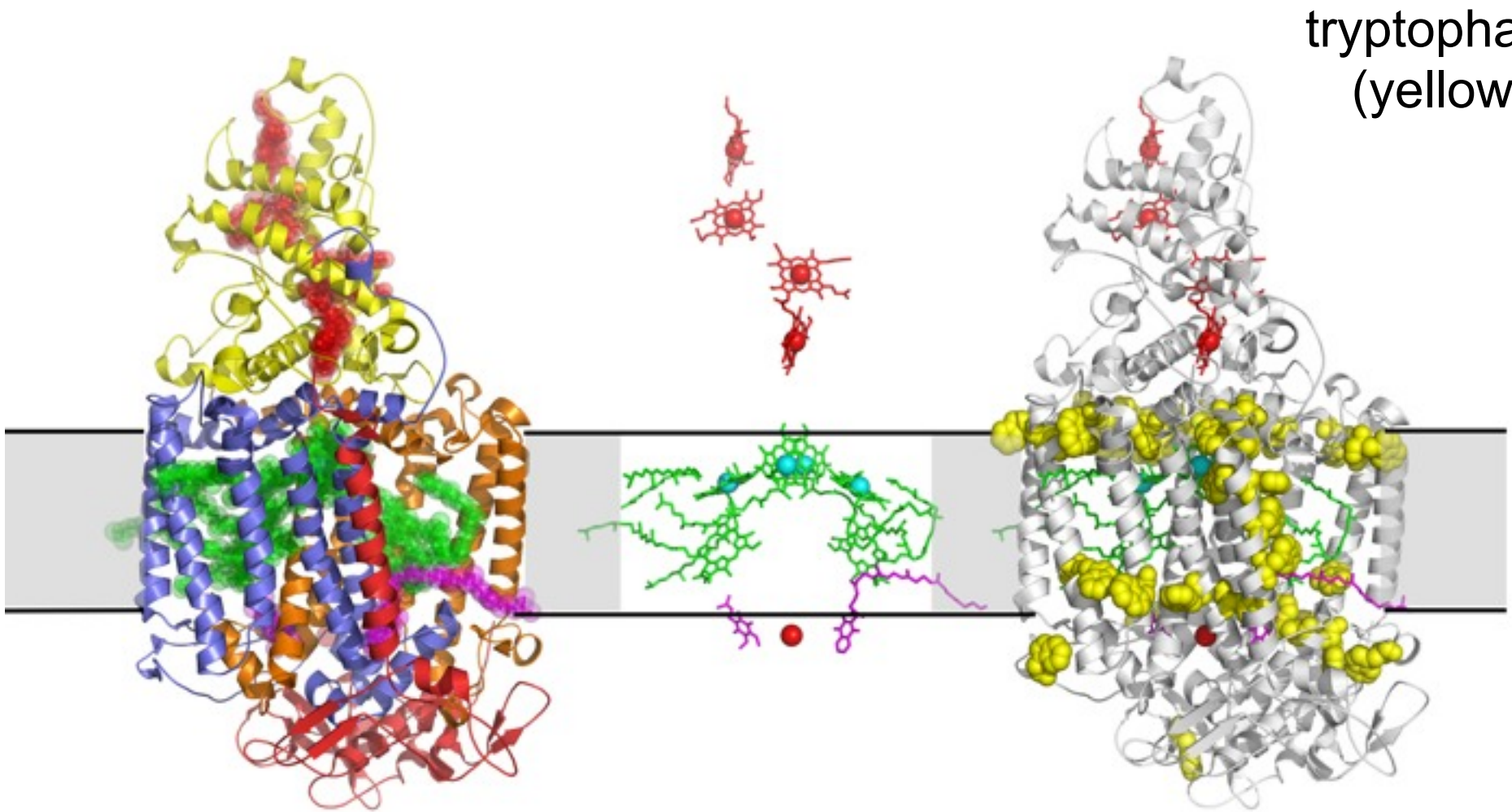


First Membrane Protein Structure



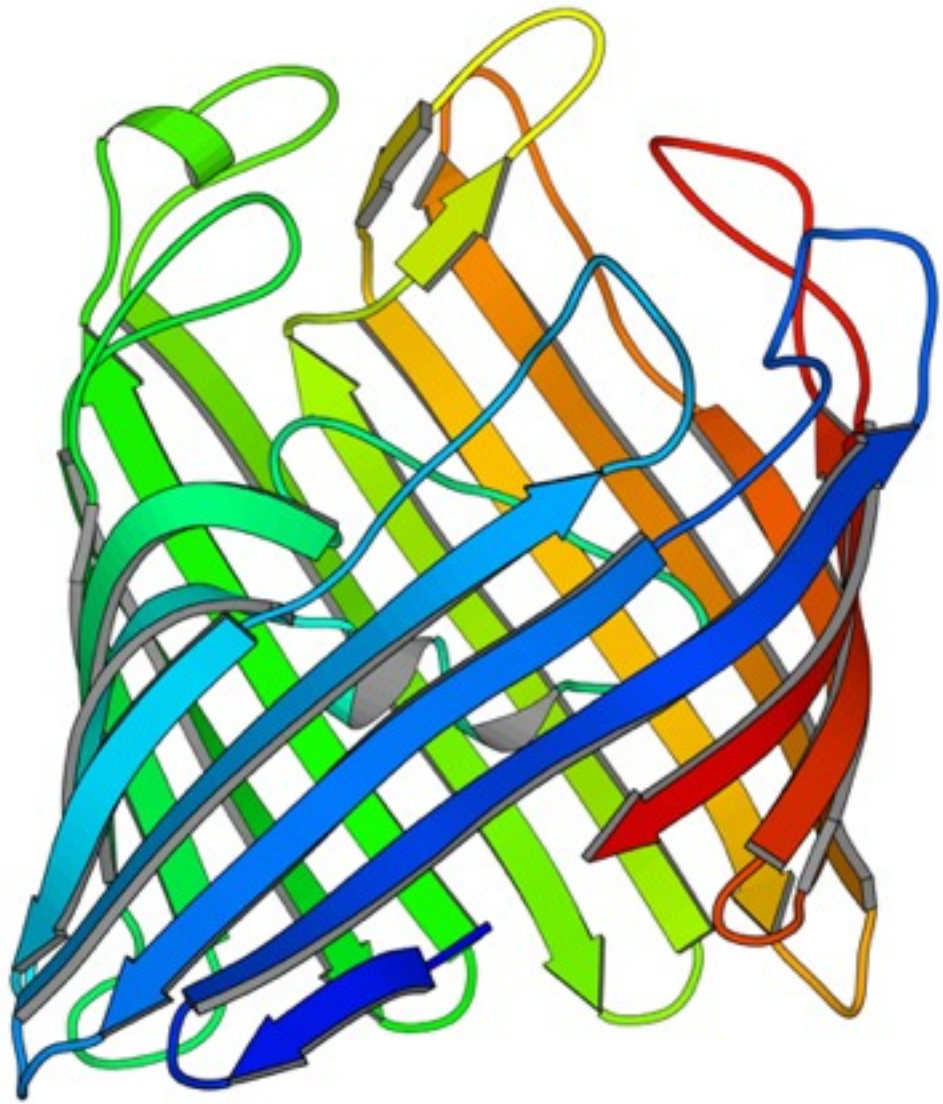
- Electron microscopy structure of bacteriorhodopsin (7Å resolution) 1975
- Rods are about 35-40Å long
- thickness of the rods suggested the existence of alpha helices

Photosynthetic Reaction Center

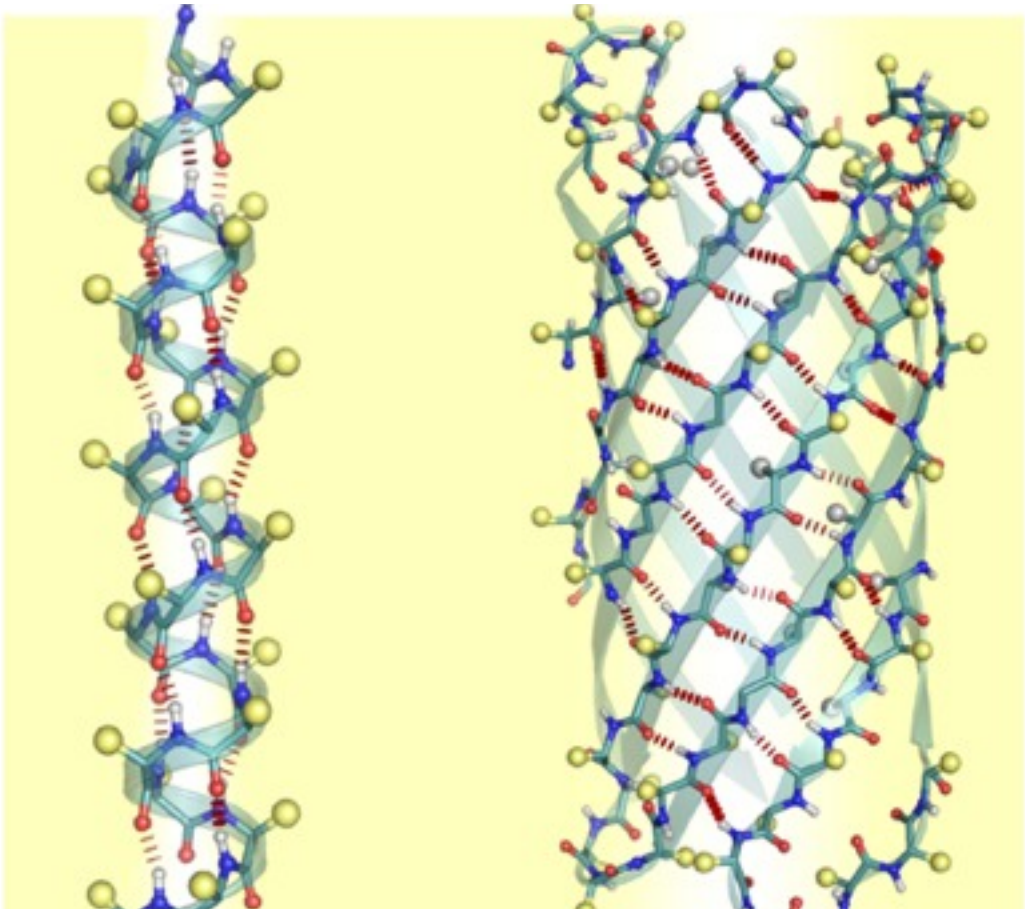


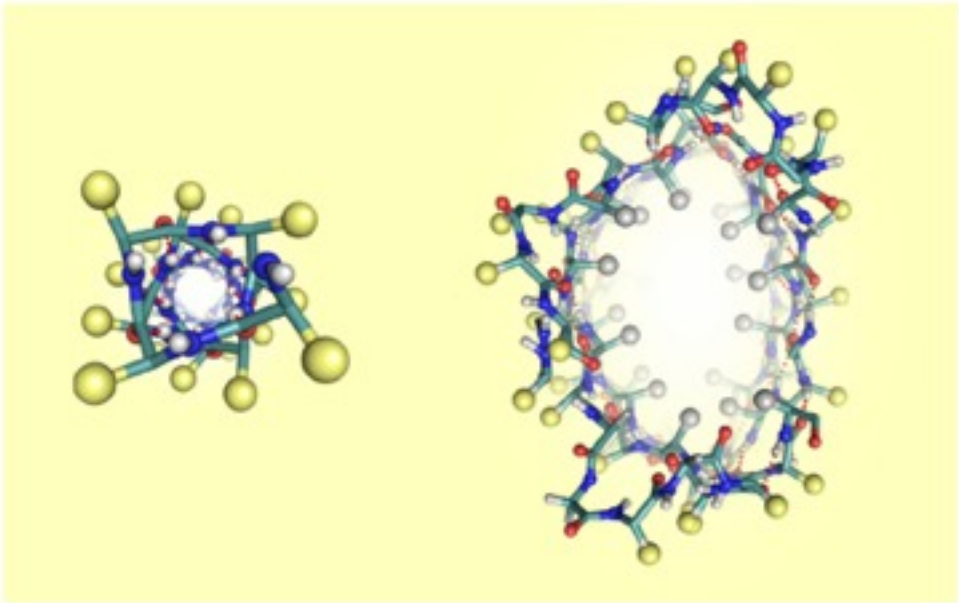
Complex of proteins and co-factors assembled together to execute the primary energy conversion reactions in photosynthesis

Structure of Omp F



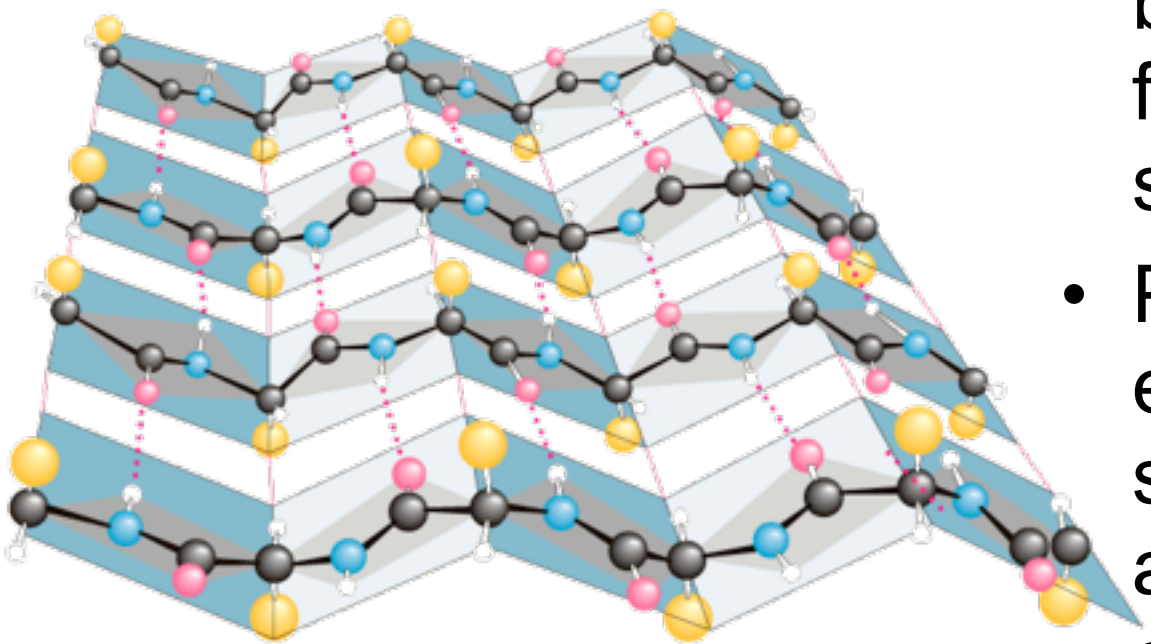
Membrane Spanning





•approximately 21 residues of alpha helix to span the membrane (1.5Å pitch per residue)

β Sheet

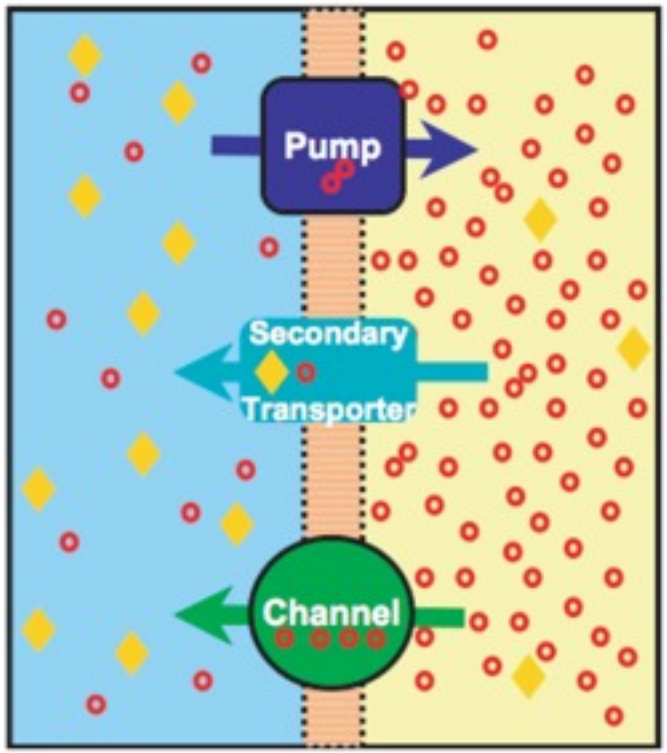


- Stabilized by H-bonds between N-H & C=O from adjacent stretches of strands
- Peptide chains are fully extended pleated shape because adjacent peptides groups can’t be coplanar.

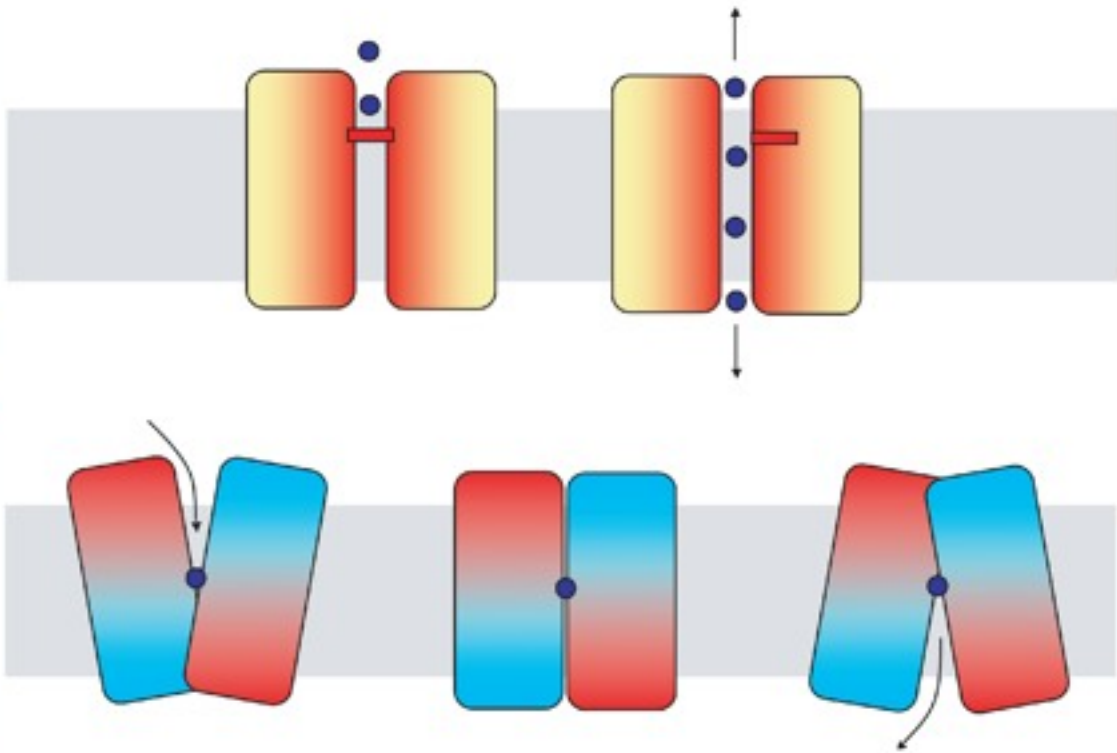
Single-Pass Alpha-Helical Membrane Proteins

- Proteins with a single spanning alpha helix
- Place the amino and carboxyl termini of protein on opposite sides of the membrane
- Type 1 - have their N- terminus outside of the cytoplasm
- Type 2 - N-terminus in cytoplasm
- Frequently these proteins multimerize - how??

Transport Mechanisms

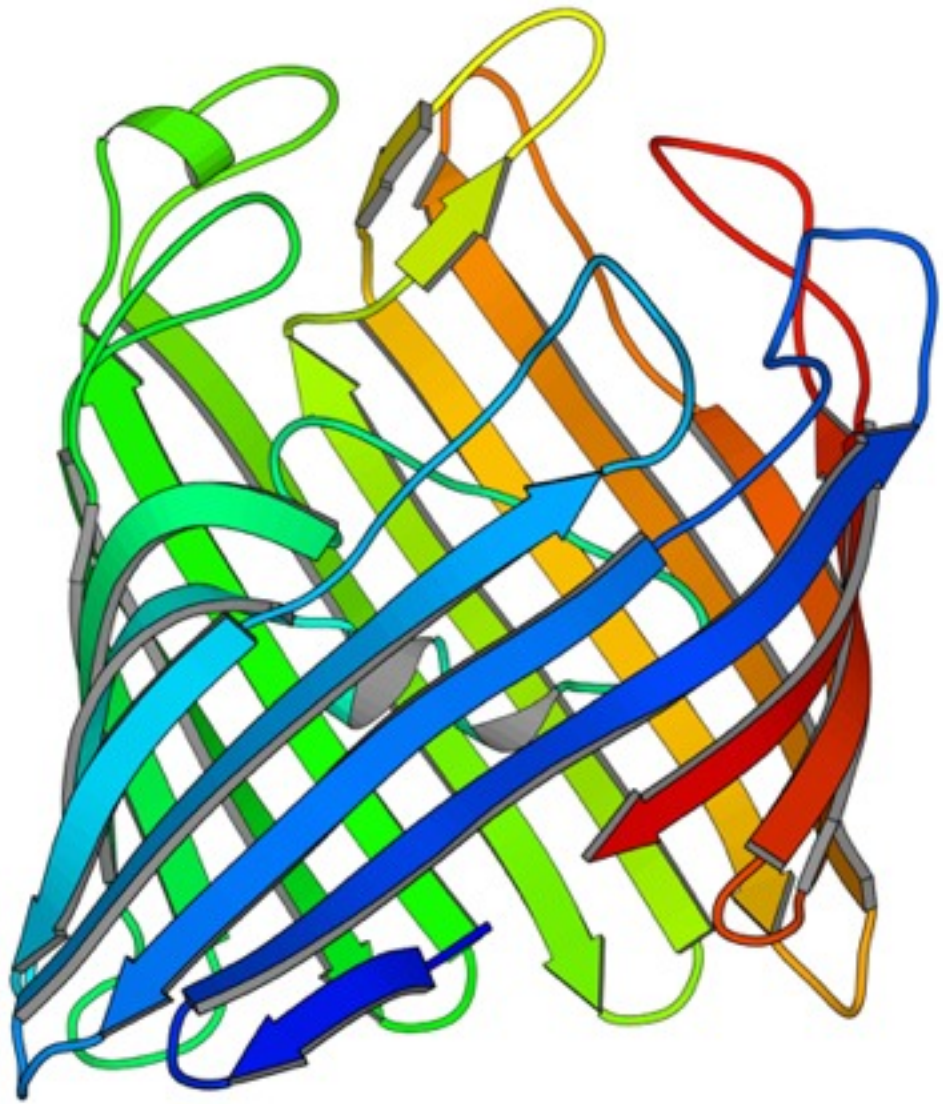


Gating Mechanisms



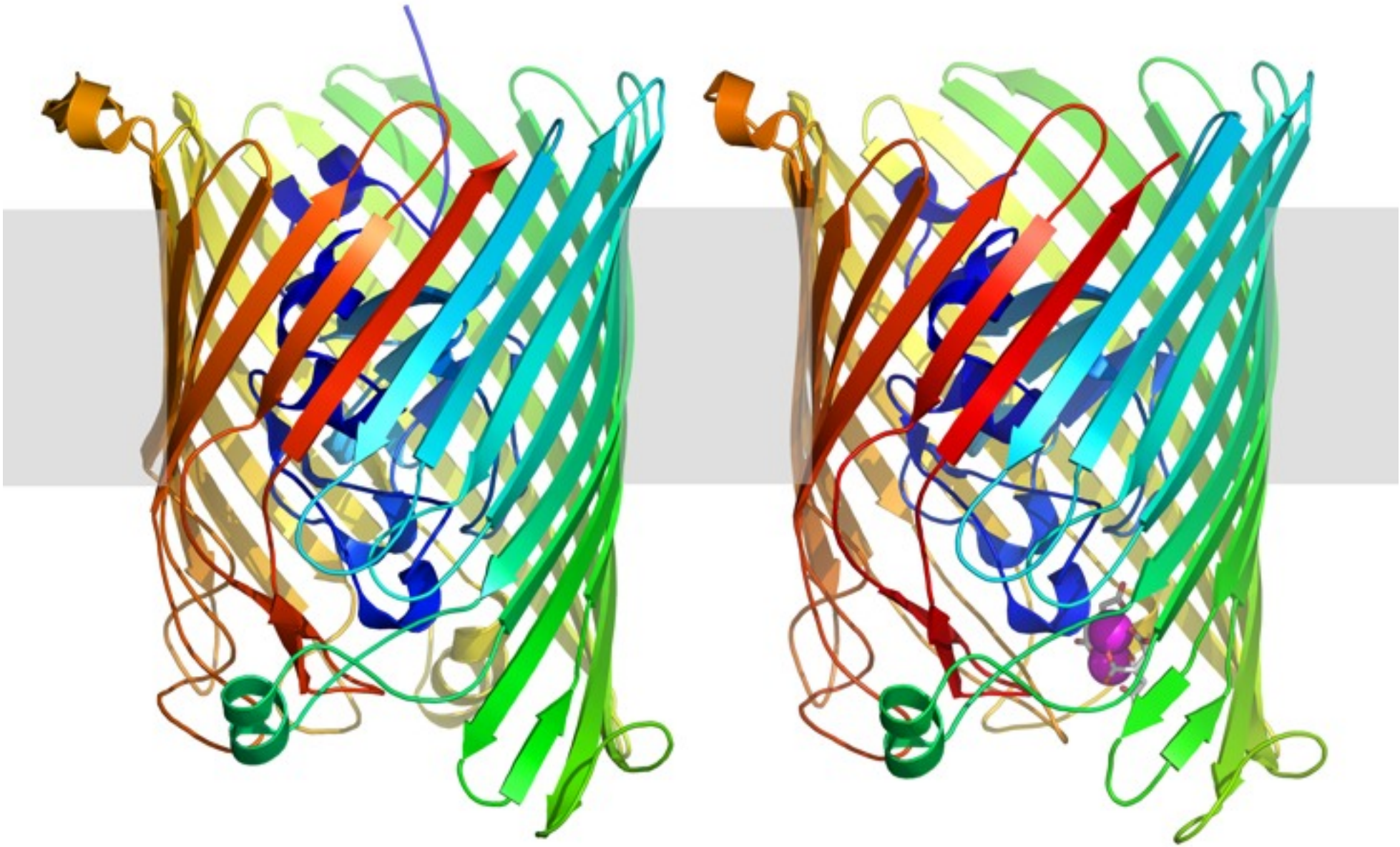
- Active transporters do not allow a channel to form
- Usually have a large conformational changes associated with transport
- Transporters are slower than channels

Structure of Omp F

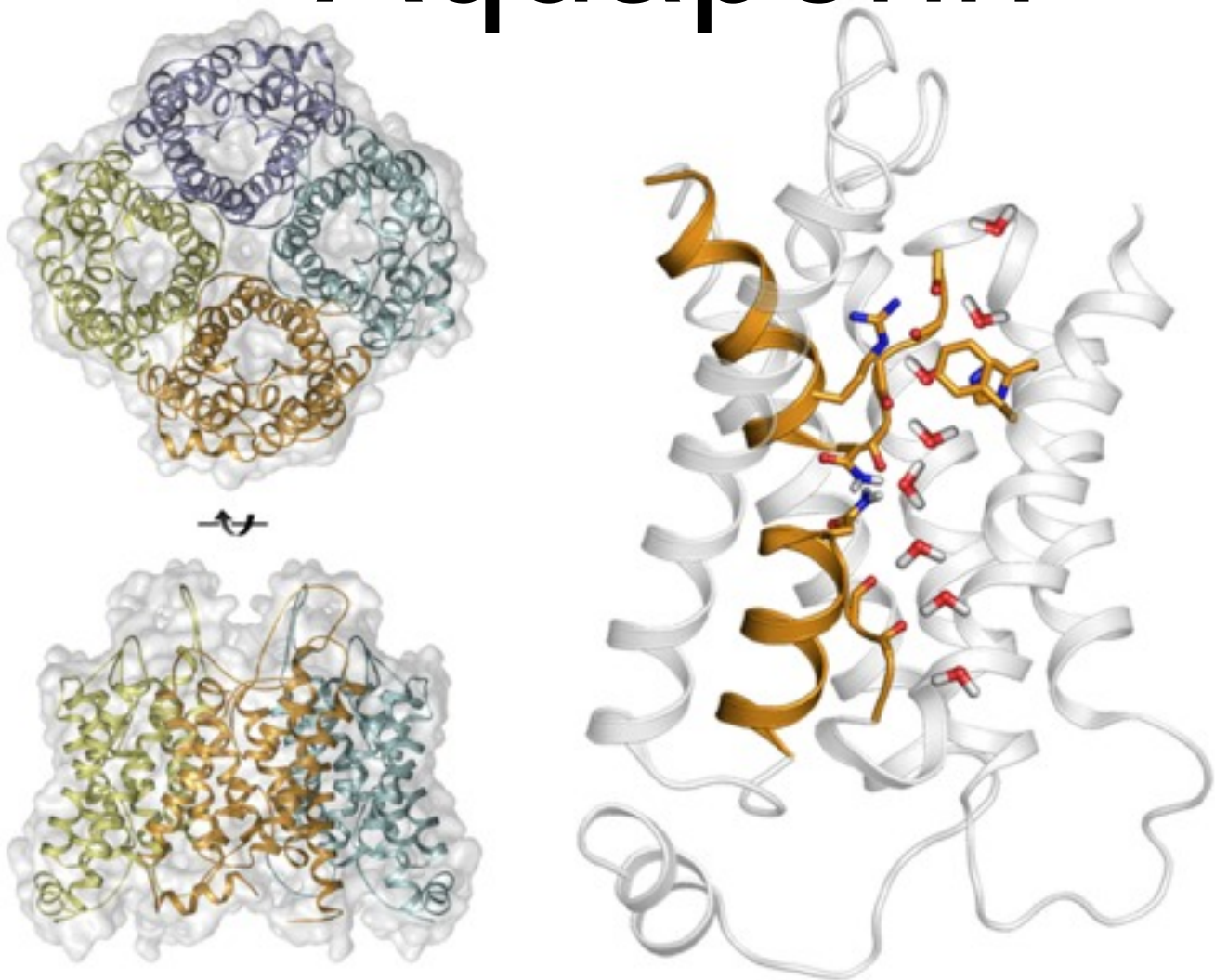


•OmpF is an integral membrane protein located in the outer membrane of the bacteria,
•OmpF porin is a non-specific transport channel that allows for the passive diffusion of small, polar molecules (600-700 Da in size) through the cell's outer membrane.
•Molecules include water, ions, glucose, and other nutrients as well as waste products

FecA Iron-Citrate Transporter

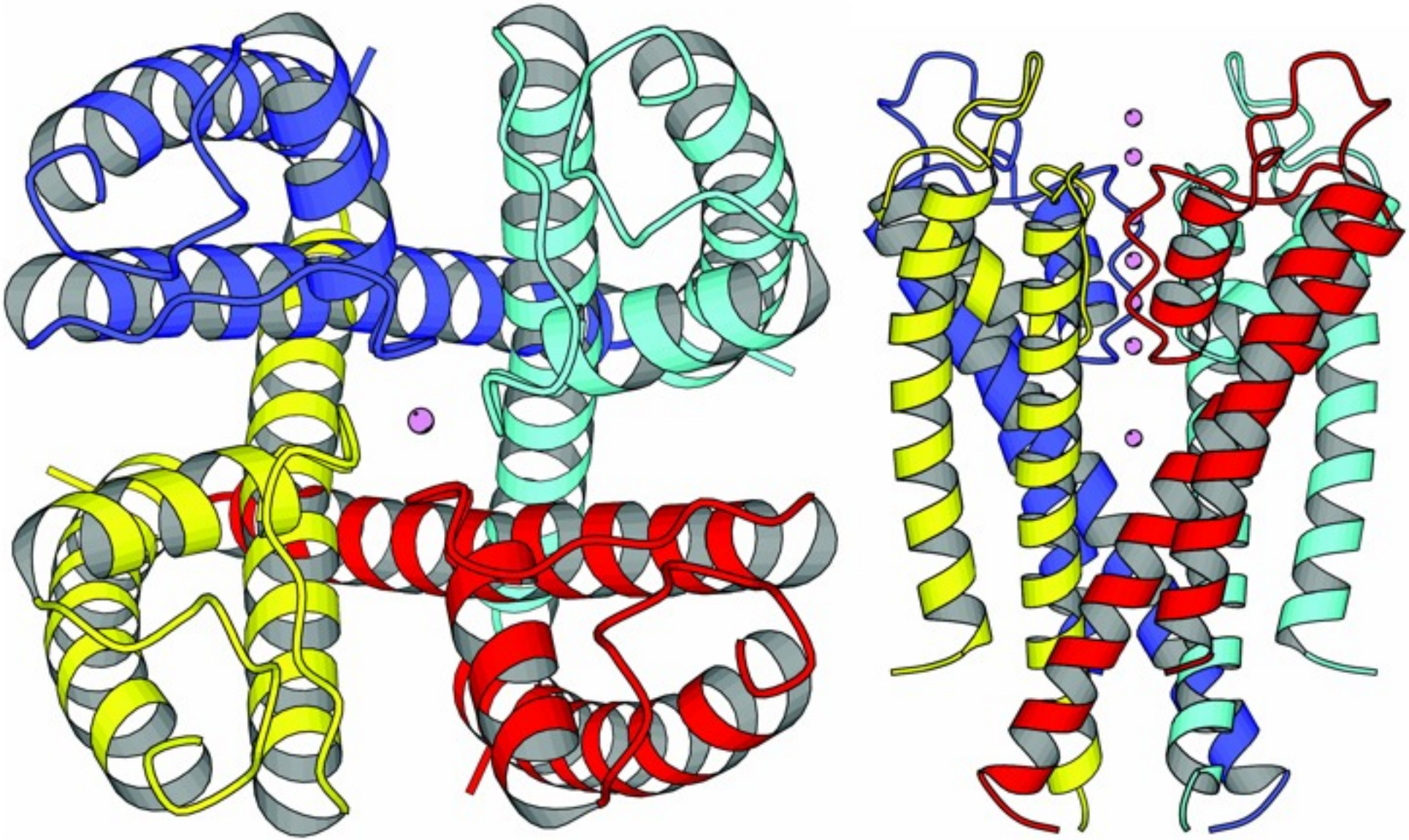


Aquaporin



- Water can diffuse through membranes, however this is not sufficient for many cells
- Aquaporins are tetramers
- Channel has an hourglass shape. Middle of channel is only 2.8Å wide.
- Water goes through in single file

Potassium Channel



Selectivity Filter in K Channels