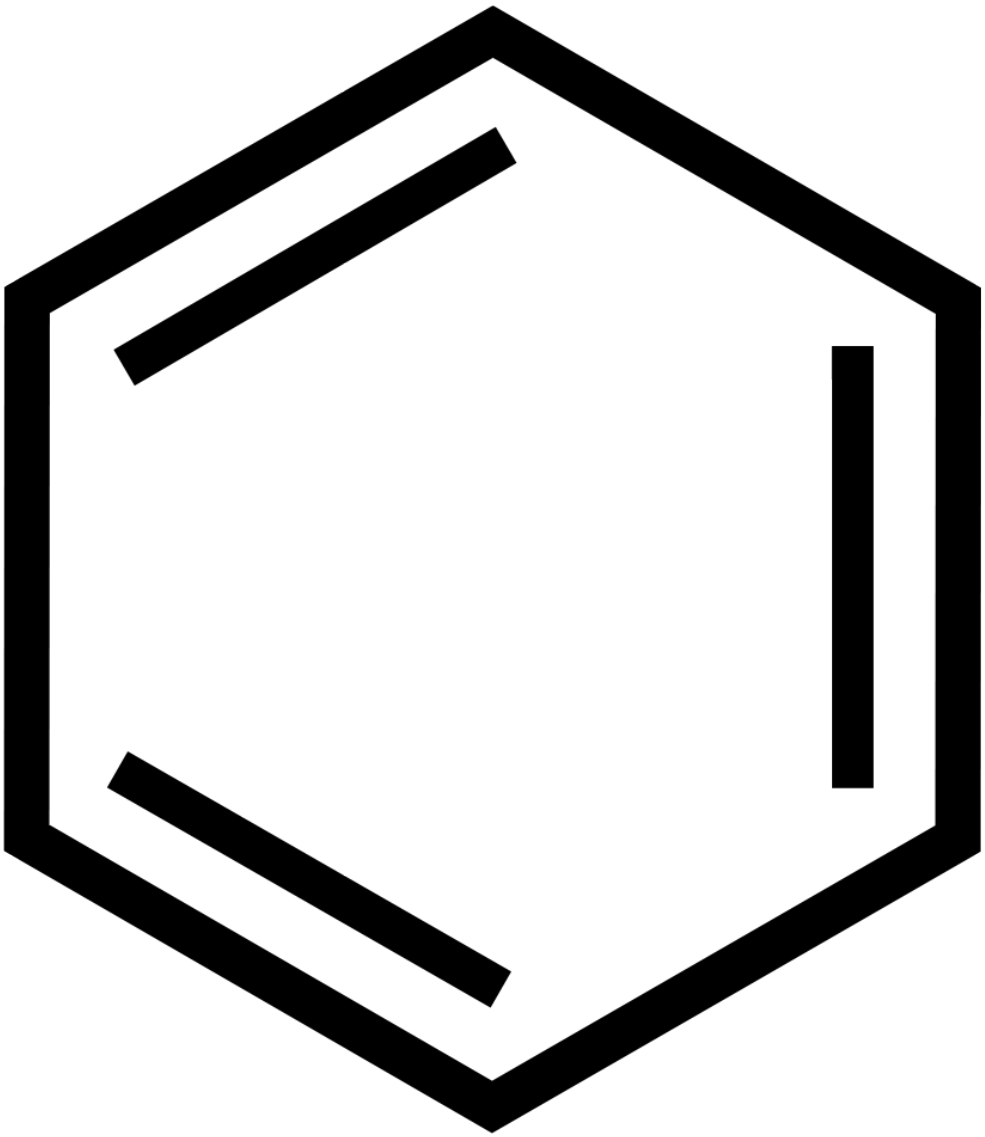
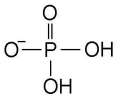
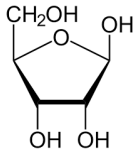
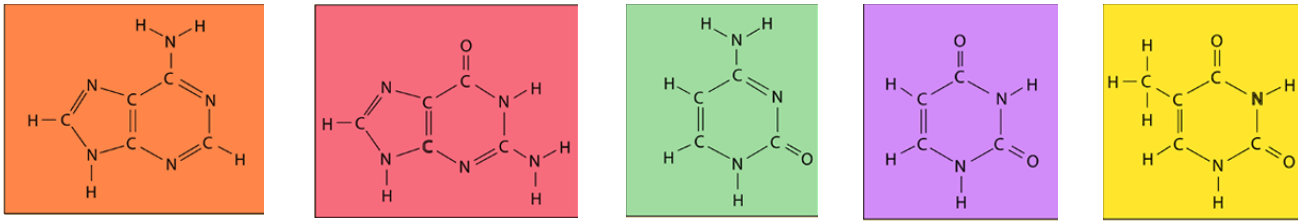


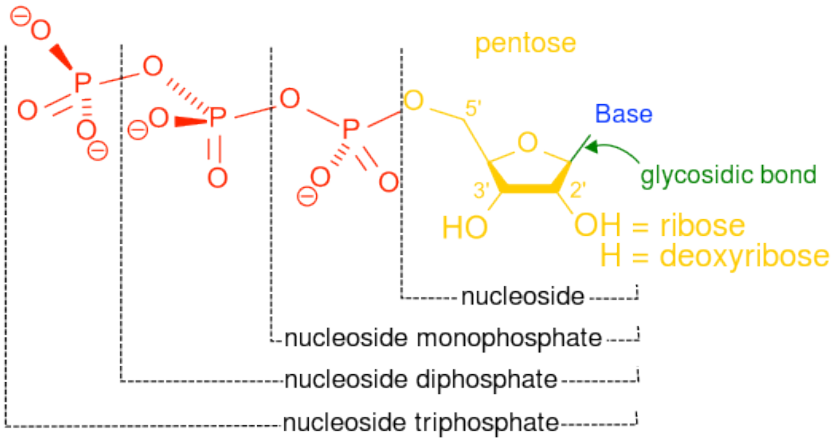
CLUTCH

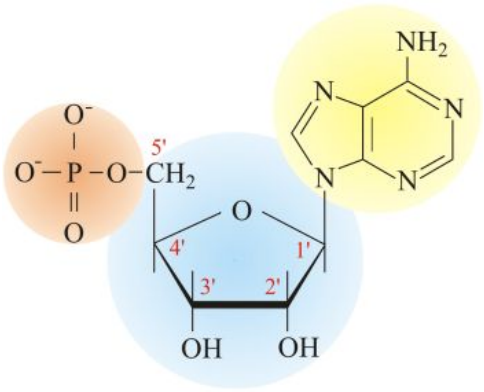
www.clutchprep.com

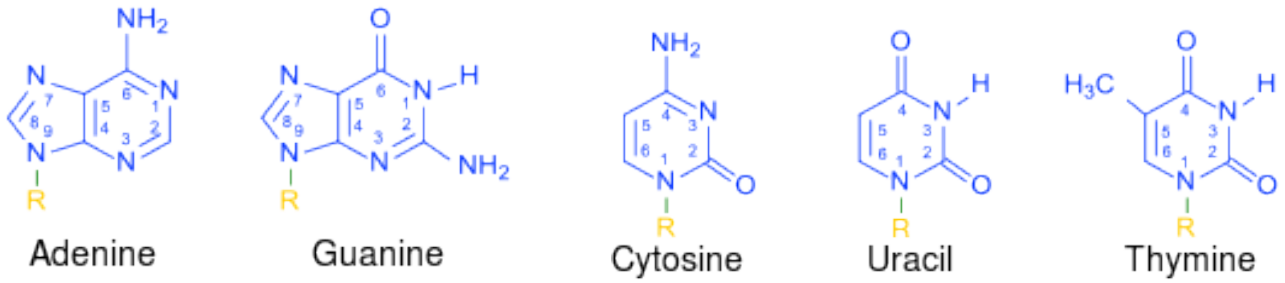
CONCEPT: NUCLEIC ACIDS

- Nucleic acids are made of three components:
  - ☐ 
  - ☐ 
  - ☐ 

- Nucleic acids are polymers of _____
  - ☐ Nucleosides lack a phosphate groups, nucleotides have one
  - ☐ Nucleotide triphosphates are used to synthesize nucleic acids because they provide the energy for the reaction
  - ☐ Nucleotides use a unique carbon numbering system

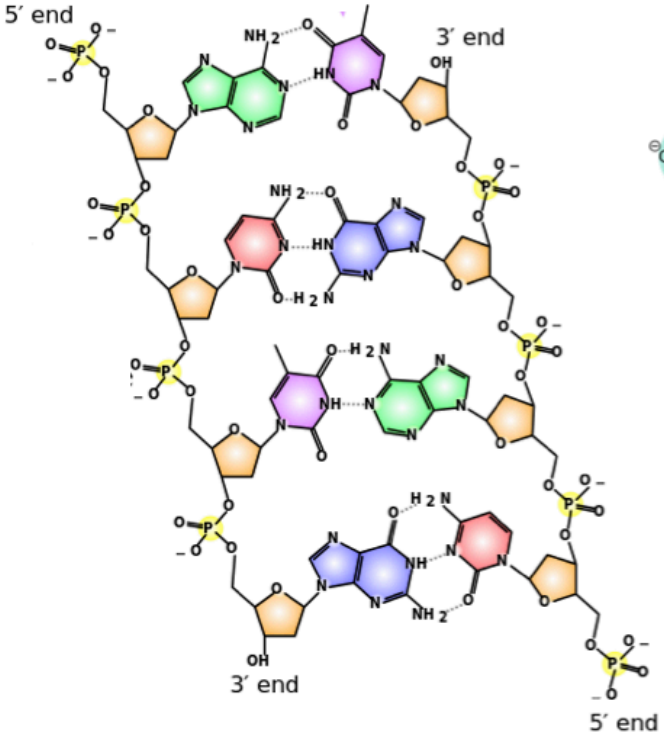


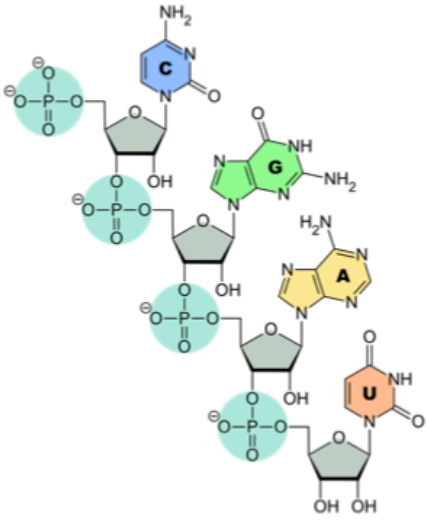




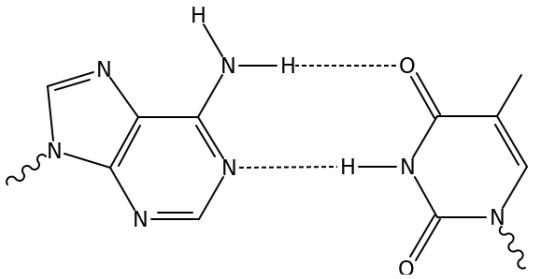
CONCEPT: NUCLEIC ACIDS

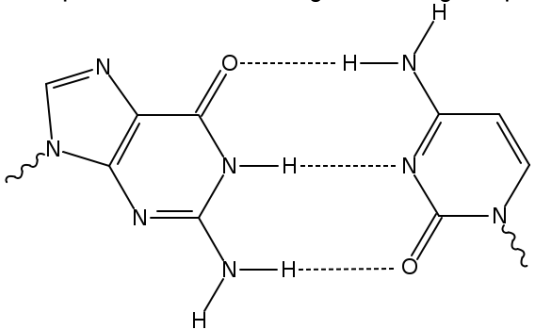
- Nucleotides are connected by _____ bonds.
- The individual strands of DNA are _____ to each other.
- RNA is less stable than DNA at high pH because of it's 2' hydroxyl group
- Nucleotides, and nucleic acids, have a maximum light absorption at 260 nm (proteins at 280 nm)





- The two strands of DNA are complementary due to the specificity of base pairing.
  - □ Strands of DNA with a higher GC composition are harder to separate, and have a higher melting temperature



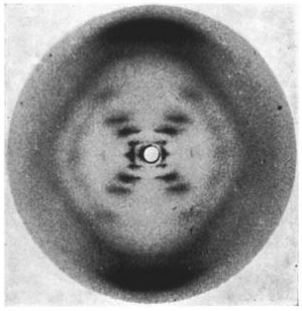


PRACTICE: What percentage of DNA is made of purines? Pyrimadines?

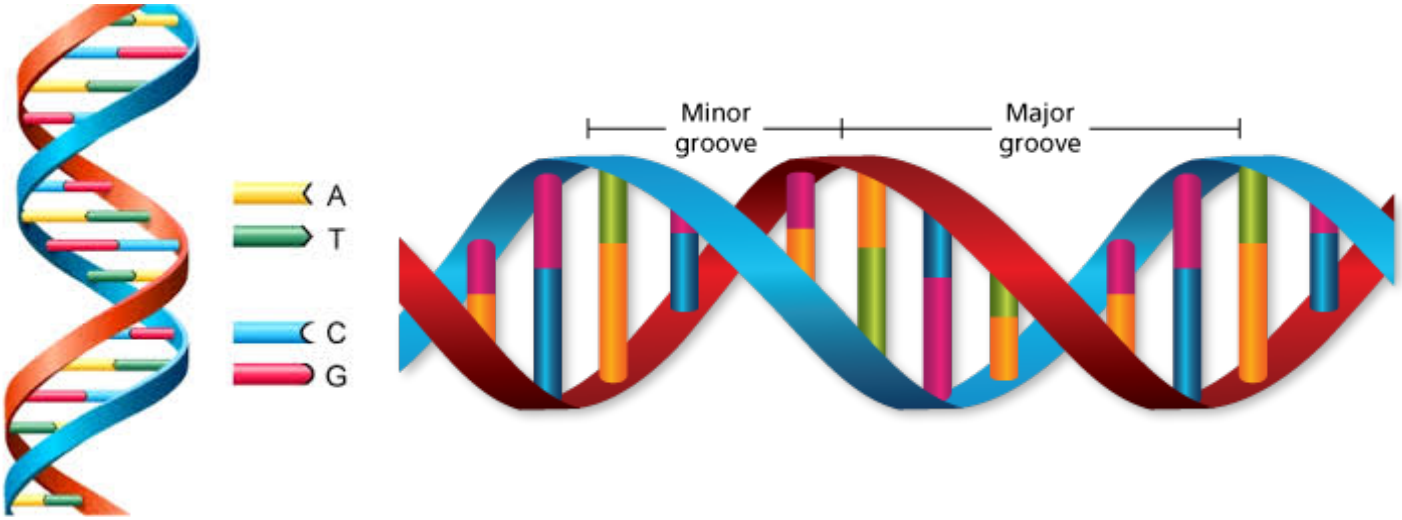
PRACTICE: If a piece of double-stranded DNA is made of 35% A and 15% C, what percent of its composition is T and G?

CONCEPT: NUCLEIC ACIDS

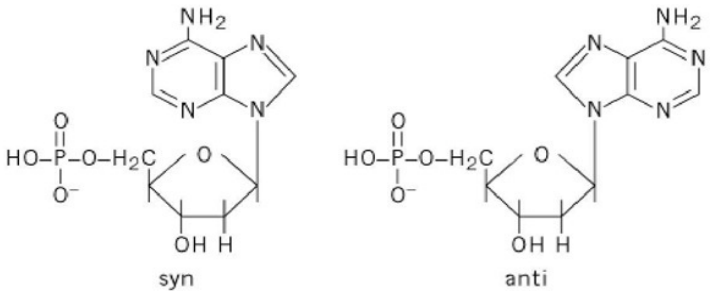
- Chargaff's rules – a series a rules about the composition of DNA, used by Watson and Crick to determine DNA structure
  - □ In a double stranded molecule of DNA, %A=%T and %G=%C, likewise %A+%G=%T+%C
- Watson and Crick also used the X-ray crystallography image from Rosalind Franklin
  - □ This image showed the structure to be simple, and have substituents 3.4 Å apart



- The structure of DNA is called a _____.
  - □ It contains a major and minor groove, allowing degrees of access to the nucelobases
  - □ Proteins bind DNA via H-bonds with their R groups, and generally use either the major groove

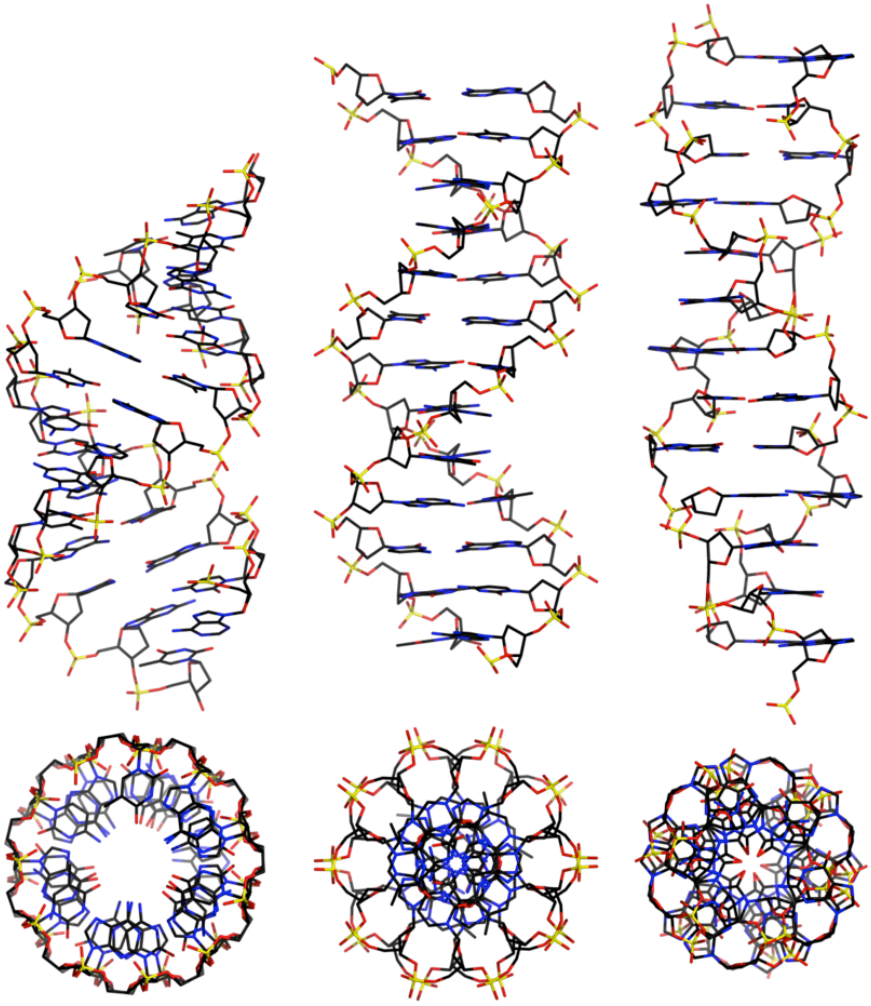


- The structural bonds of DNA are all single bonds, so the molecule is quite flexible
  - □ Nucleotides can have two conformations, but most DNA is in the anti conformation



CONCEPT: NUCLEIC ACIDS

- The double helix of nucleic acids can appear in three forms: A, B, and Z form
    - □ A and B forms are both right-handed helices, but A is more squished that B
        - Double stranded RNA takes the A form
        - Most DNA is found in the B form
    - □ Z form is a left-handed helix
        - Z form is found near regulatory sequences
    - □ There is a hole through the A form, but B and Z are filled in
- B-Z junctions – areas where the helix switched between the B and Z forms
    - □ The nucleotides flip out from the strands, switching helix direction
        - This shape makes regulatory sequences easy for the cell to identify

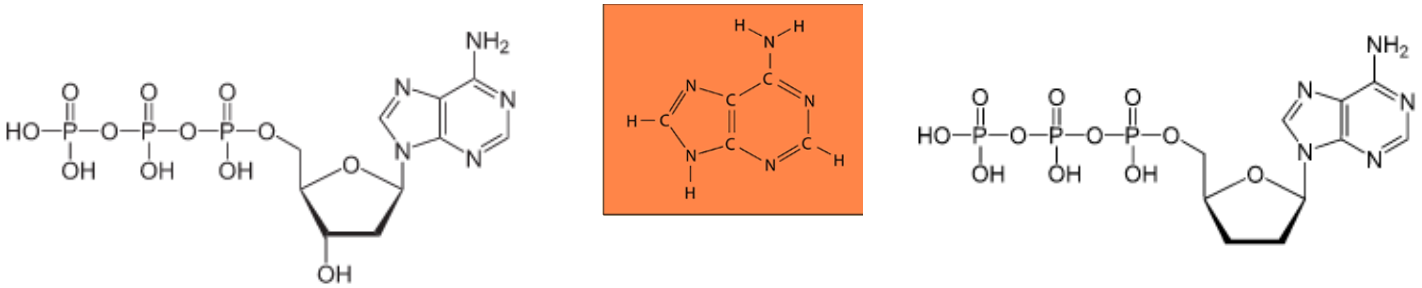


- Single strands of DNA are held together as double-stranded DNA(dsDNA) by H-bonds and hydrophobic stacking forces

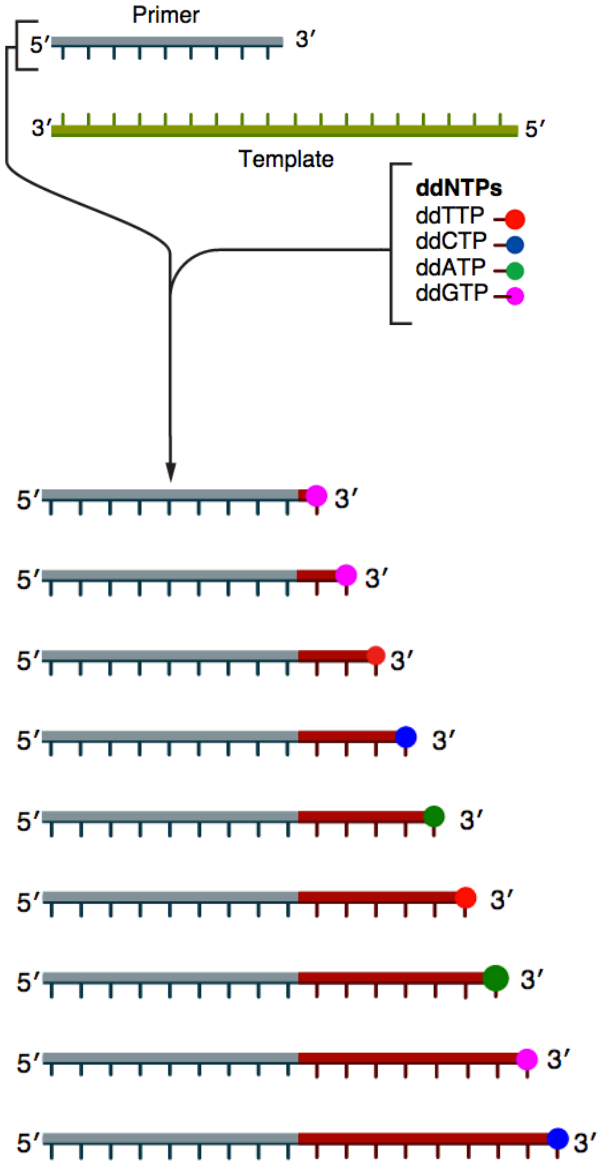
□ The stacking forces result from the fact that the relatively hydrophobic bases are stacked within the B form helix

CONCEPT: DNA SEQUENCING

- DNA polymerase requires a RNA primer, template, and deoxynucleotide triphosphates to synthesize DNA
  - □ $Primer_n$ + dNTP => $Primer_{n+1}$ + PP + H^+
- Dideoxy DNA sequencing – an early sequencing method that relied of the use of dideoxynucleotide triphosphates

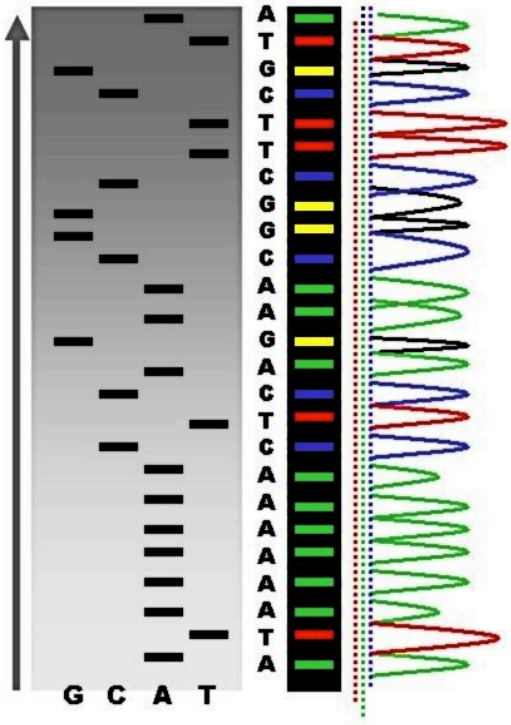


- ddNTPs terminate elongation of the strand because there is no available 3' –OH group to continue the polymerization.

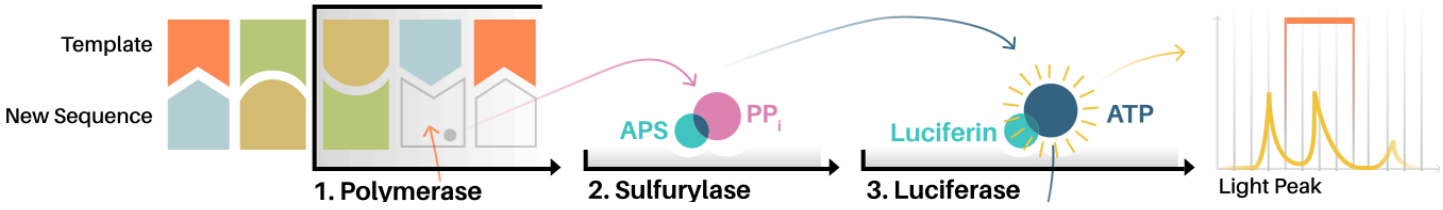


CONCEPT: DNA SEQUENCING

- Sanger sequencing – dideoxy sequencing using radiolabelled ddNTP's
  - □ mM conc. of dNTP's and uM conc. of ddNTP's
    - Only use one type of ddNTP (A, T, C, or G) per synthesis
  - □ Use gel electrophoresis to separate the segments of varying length
- Radiolabelled ddNTP's eventually replaced with fluorescent ones
  - □ Capillary gel electrophoresis column used with fluorescent detector to separate strands and determine sequence



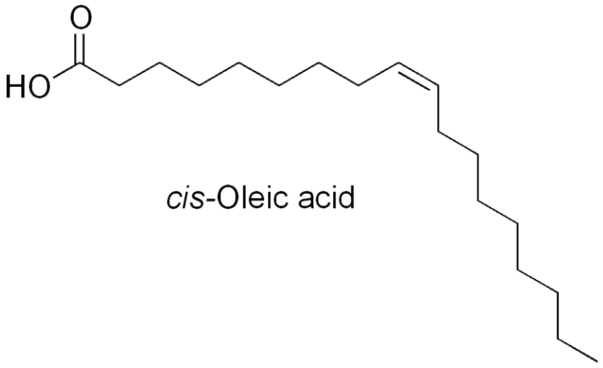
- Pyrosequencing (454) – uses the pyrophosphate that is released by DNA polymerase to determine sequence
  - □ Beads in well with sequence of interest, along with enzymes sulfurylase and luciferase
  - □ Try each base in sequence, only a match will result in the release of pyrophosphate
  - □ Detect light flashes due to sulfurylase converting pyrophosphate to ATP, which activates luciferase



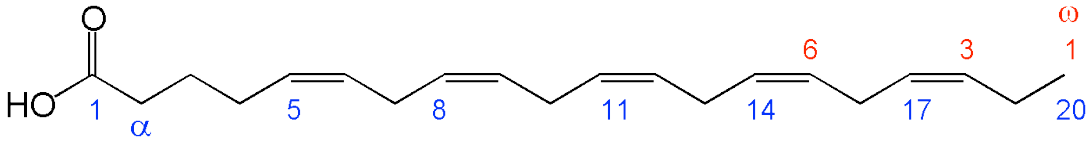
- Ion torrent sequencing – uses the H^+ that is released by DNA polymerase to determine sequence
  - □ Similar concept to pyrosequencing, but monitoring pH changes instead of light emission

CONCEPT: LIPIDS

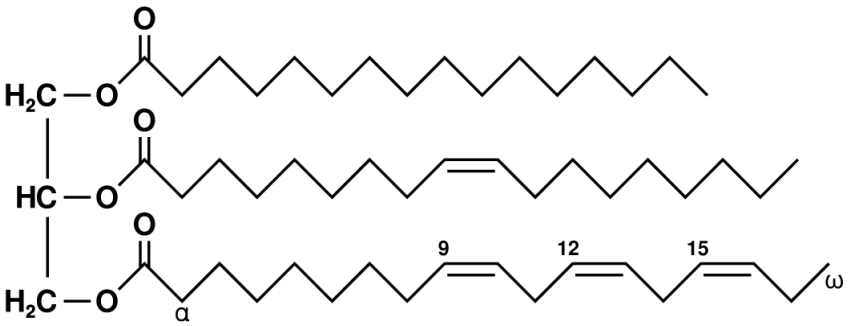
- Fatty acids have a unique naming convention
  - □ # of carbons : # of double bonds ($\Delta^{\#}$ of carbons participating in double bonds)
  - □ Omega 3 and 6 fatty acids must be acquired through diet because humans can't synthesize them



cis-Oleic acid

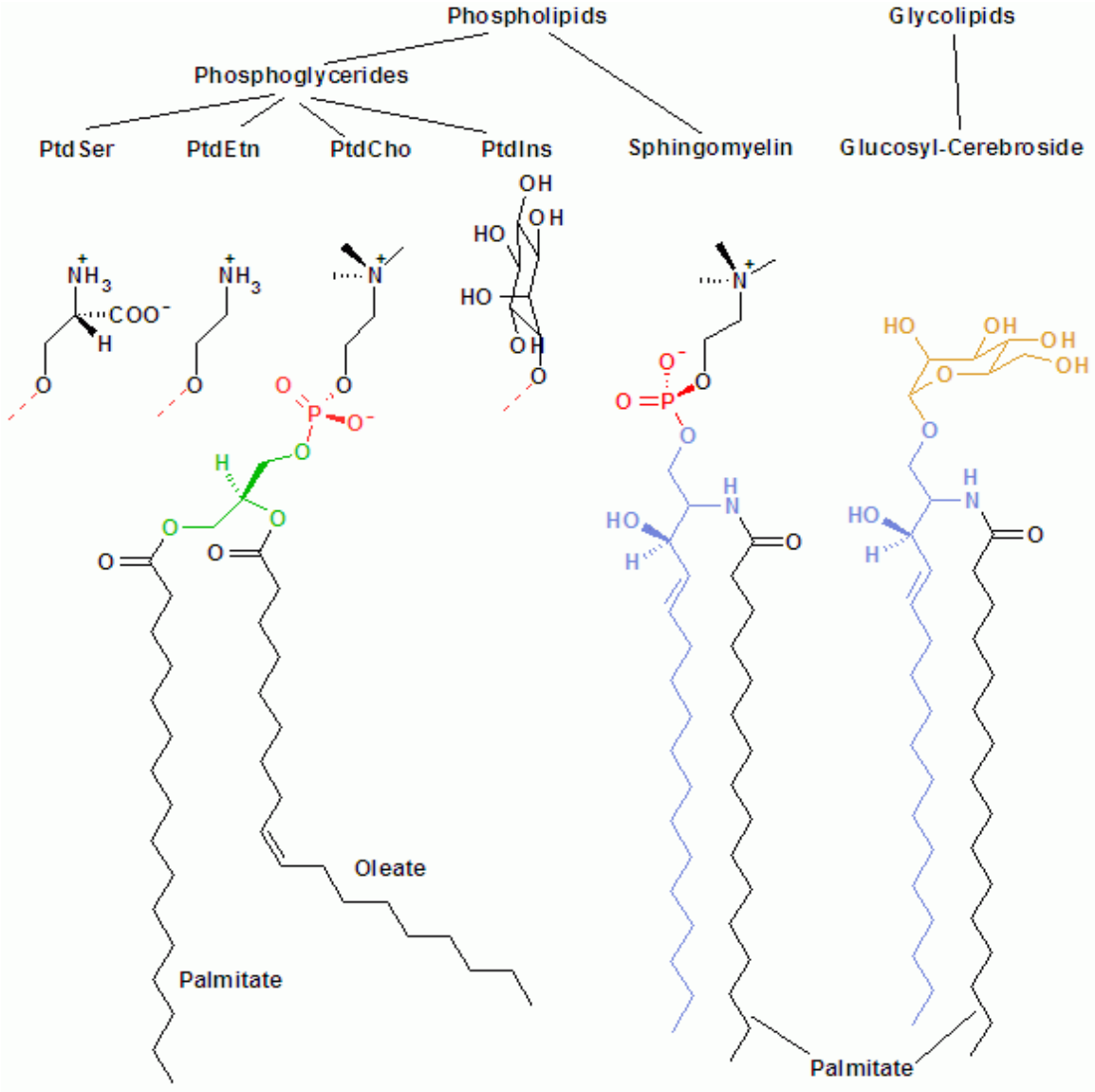


- Naturally occurring unsaturated fatty acids are always cis
  - □ Melting point increases as chain length increases
    - The longer the chain, the less soluble the fatty acid
  - □ Unsaturation greatly reduces melting point of the fatty acids
    - Trans fats have higher melting points because, despite unsaturation, their trans double bonds are linear
- Triacylglycerols – storage lipids made from glycerol and 3 fatty acids attached via ester bonds
  - □ If one unsaturated chain, always on carbon 2



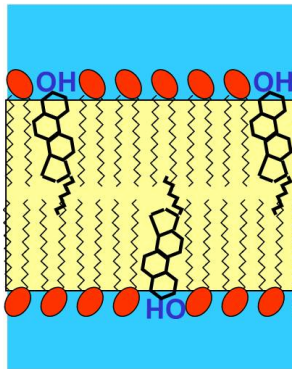
CONCEPT: LIPIDS

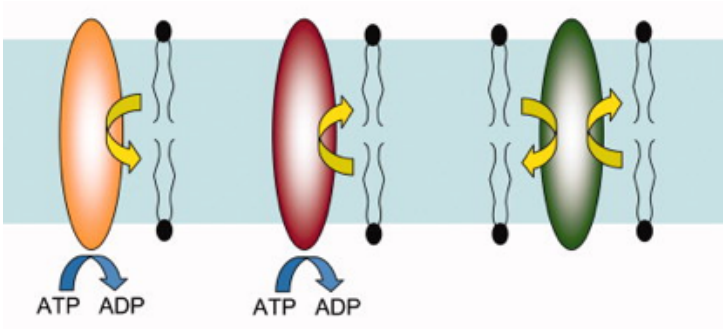
- Glycerophospholipids are the major membrane lipids (mostly phosphatidylethanolamine and phosphatidylcholine)
    - □ Many prokaryotes can't synthesize phosphatidylcholine, and use a different lipid
- Sphigolipids include ceramides, sphingomyelin, and glycolipids
    - □ Ceramides with attached sugars make the various blood antigens



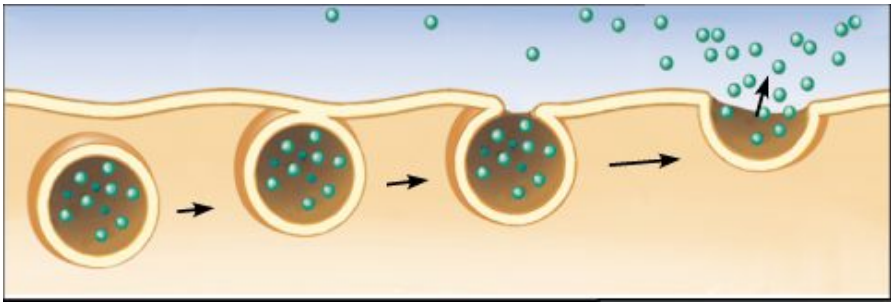
CONCEPT: MEMBRANE STRUCTURE

- The membrane is largely made up of proteins, phospholipids, and sterols
- Plasma membrane has a large amount of cholesterol, but internal membranes tend to have more phosphatidylcholine
- The membrane is a fluid, there are no covalent bonds between the membrane components
    - □ Phospholipids tend to move laterally, but it's rare for them to flip-flop
    - □ Flippase, floppase, and scramblease move phospholipids between the inner and outer monolayers
    - □ Membranes can have a crystal like state when cold





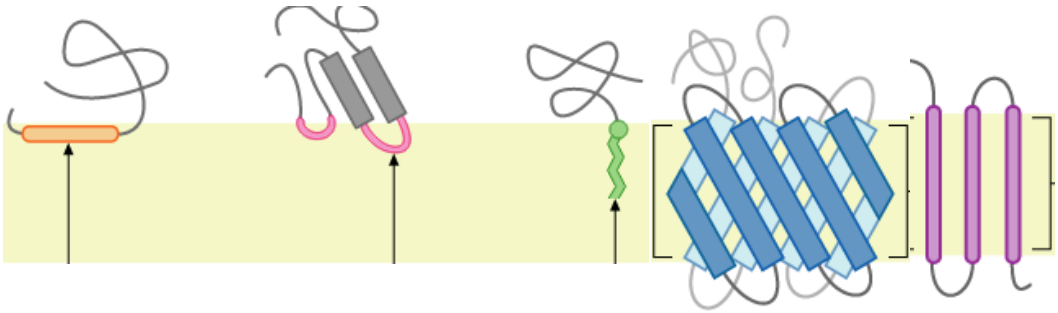
- There is an asymmetric distribution of phospholipids in the membrane
    - □ Phosphatidylethanolamine, phosphotidylserine, and phophotidylinositol tend to be found on the inner monolayer
    - □ Phosphatidylcholine and sphingomyelin tend to be on the outer monolayer
    - □ The distribution of phospholipids is different in internal membranes



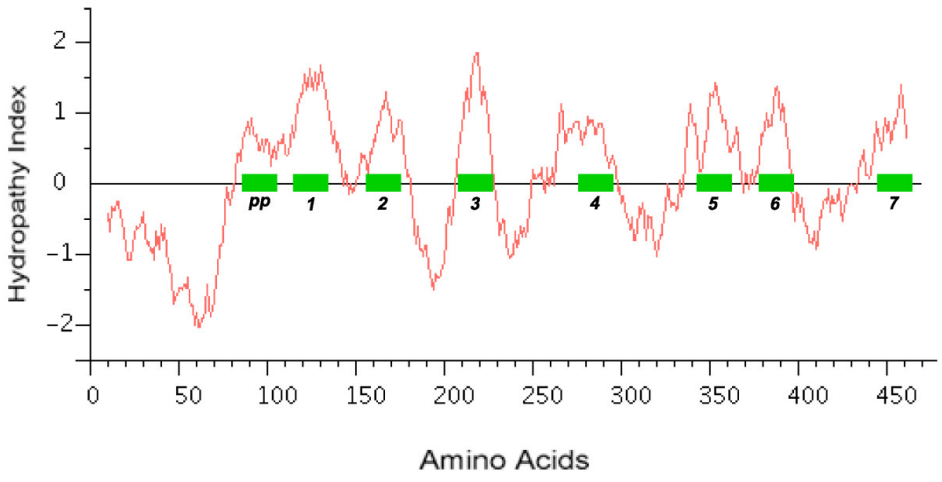
- Composition of membrane lipids is related to the temperature of organism environment
    - □ More saturated fatty acids at higher temps
    - □ More Unsaturated fatty acids and cooler temps
    - □ Temperature affects the lateral diffusion of membrane phospholipids
- Rafts – areas of high sphingolipid and cholesterol concentration

CONCEPT: MEMBRANE STRUCTURE

- Proteins make up a large portion of the membrane, there are six classifications
    - □ Receptors act in signaling pathways
    - □ Channels, gates, and pumps transport molecules and ions
    - □ Enzymes to mostly catalyze lipid biosynthesis and ATP synthesis
- Exterior amino acids tend to be polar, and may have attached carbohydrates
- Interior amino acids tend to be nonpolar, if they're polar they stick together
- Alpha helix has polar and non polar side



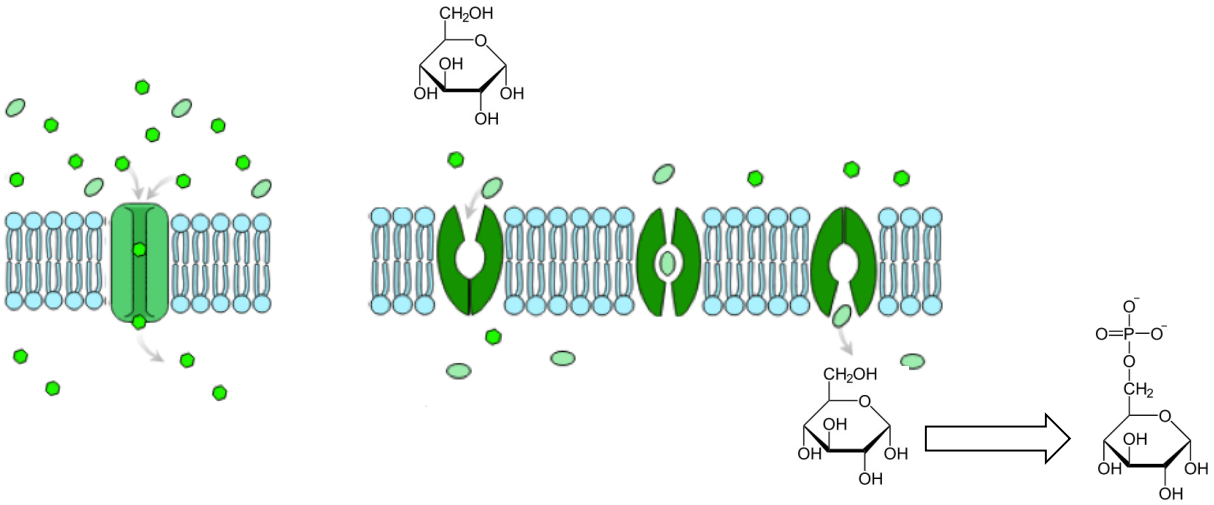
- Phospholipids can become associated with the interior and exterior surfaces of proteins
- Hydropathy index shows how hydrophilic/phobic areas of the protein are



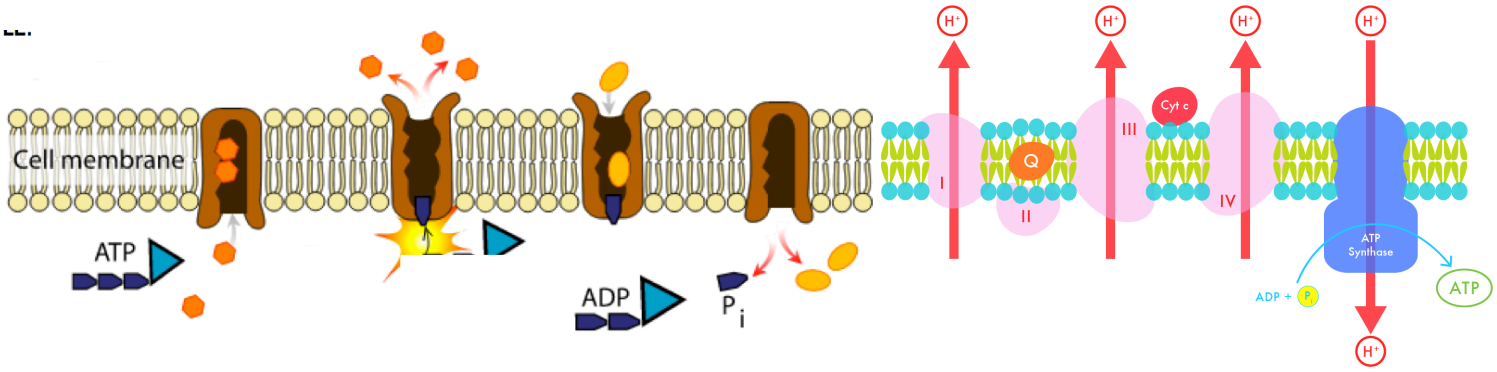
- W and Y tend to be right at the edge of the membrane in trans membrane proteins
- Peripheral proteins are always attached to a fatty acid embedded in the membrane

CONCEPT: MEMBRANE TRANSPORT

- Simple diffusion only occurs with nonpolar compounds because they must enter the nonpolar within the membrane
- Facilitated diffusion uses channels and carriers that have specificity for a particular solute
    - □ Solutes only move down concentration gradient
    - □ Some glucose transporters use facilitated diffusion, and can actually transport in both directions
        - Insulin increases number of glucose transporters



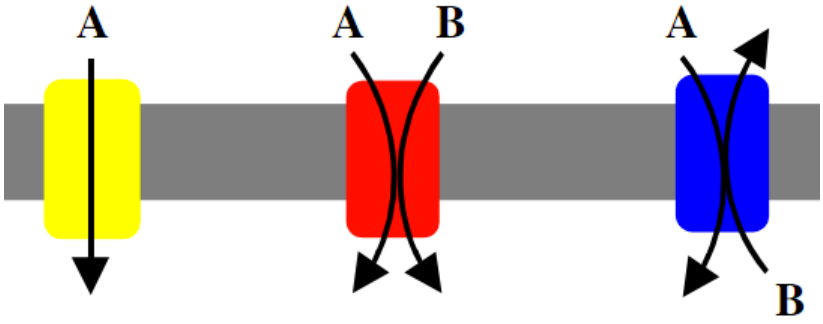
- Primary active transport uses ATP to move solutes against their concentration gradients
- Pumps play a huge role in maintaining electrochemical gradients across the membrane
    - □ The Na^+/K^+ pump uses ATP to move ions across the membrane
    - □ Proton pumps play a crucial role in ATP synthesis in the mitochondria



CONCEPT: MEMBRANE TRANSPORT

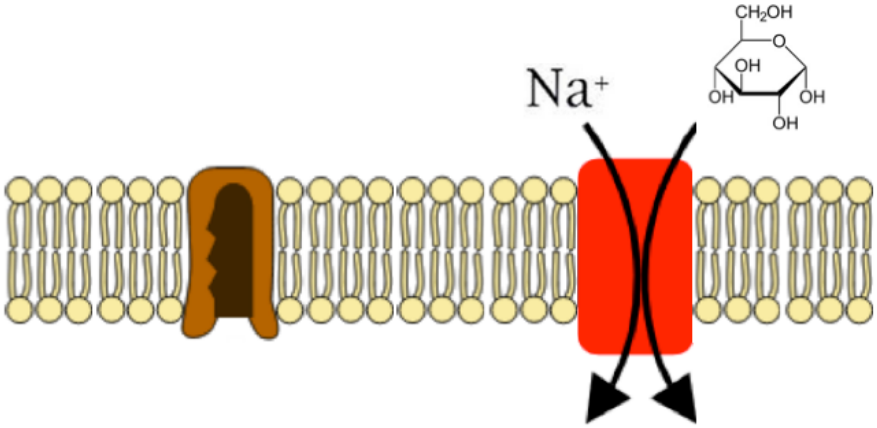
● Secondary active transport uses the potential energy of one substance's electrochemical gradient to transport another substance against its electrochemical gradient.

- □ Uniporters move one solute in one direction, and use only the electrical gradient
- □ Symporters move two solutes in the same direction
- □ Antiporters move two solutes in opposite directions

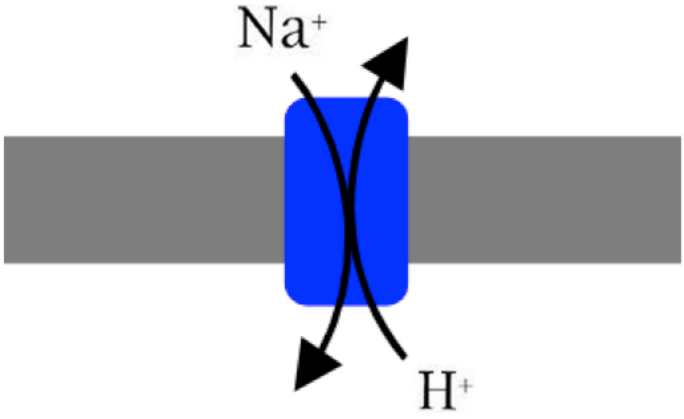


● Cotransport moves two substances together

- □ Cotransport molecule is usually sodium or proton
- □ The glucose/Na+ transporter takes advantage of the Na+ concentration gradient to transport glucose into the cell.

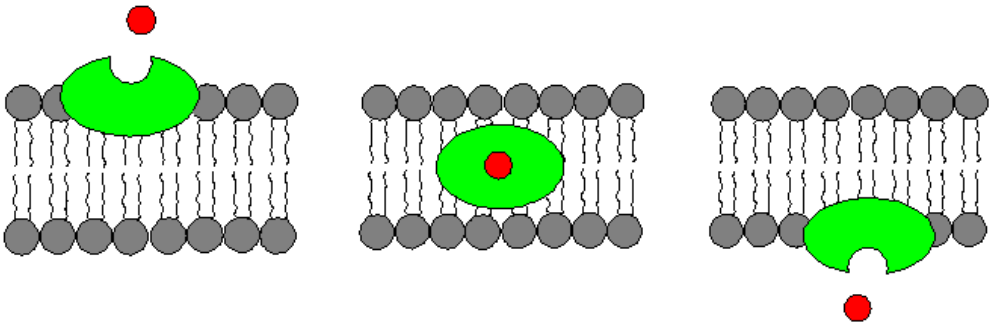


- □ Na^+/H^+ transporter takes advantage of the Na+ concentration gradient to transport H+ out of the cell.

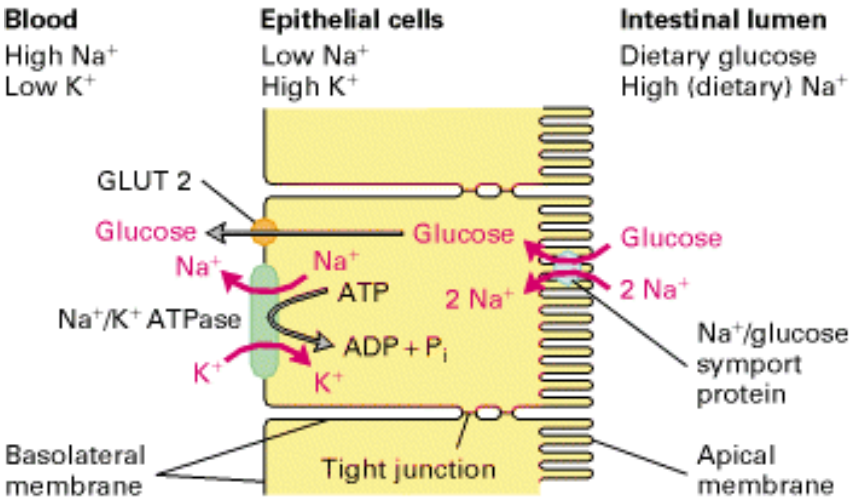


CONCEPT: MEMBRANE TRANSPORT

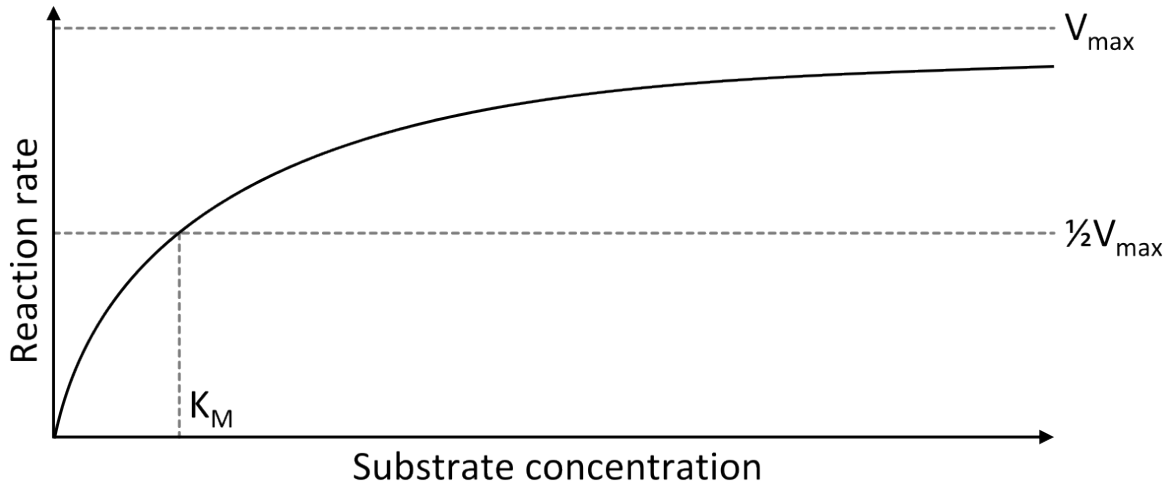
- Ionophores can transport ions through the membrane, most are toxins



- Transport of nutrients in the intestine shows how sophisticated these systems can get



- Transport kinetics are the same Michaelis-Menten enzyme kinetics
  - □ K_t is equivalent to K_m, and represents the concentration at which entry is at ½ the maximum
  - □ k_t is equivalent to k_{cat}, and represents the time it takes for one molecule to be transported



CONCEPT: NUCLEIC ACIDS

1. Purines have ____ ring(s), (each) containing ____ nitrogen(s); whereas pyrimidines have ____ ring(s), (each) containing ____ nitrogen(s).

a. 1; 1; 1; 1
b. 1; 2; 1; 2
c. 2; 1; 1; 2
d. 2; 2; 2; 1
e. 2; 2; 1; 2

2. The phosphodiester bonds that link adjacent nucleotides in RNA and DNA:

a. link A with T and G with C
b. are susceptible to alkaline hydrolysis
c. are uncharged at neutral pH
d. form between the planar rings of the nucleotides bases
e. link by a phosphate between the 3' hydroxyl of one nucleotide to the 5' hydroxyl of the adjacent nucleotide

3. Alkaline hydrolysis of RNA does not produce:

a. 2'-AMP
b. 2'-3'- cGMP
c. 2'-CMP
d. 3'-5'-cAMP
e. 3'-UMP

4. The DNA oligonucleotide pATCGCA has:

a. seven phosphates
b. a 3' hydroxyl
c. a phosphate on its 3' end
d. an A on its 3' end
e. violated Chargaff's rules

5. Nucleic acid bases:

a. absorb UV light at 280 nm
b. are all about the same size
c. are all hydrophilic
d. are roughly planar
e. all can base pair with each other

6. Chargaff's rules state that in typical DNA:

a. A = C
b. A = G
c. A = U
d. A + T = G + C
e. A + G = T + C

7. The Watson-Crick model of DNA double helix does not include:

a. two strands that run antiparallel with each other
b. base pairing occurs on the inside of the double helix
c. the double helix is right-handed
d. two equally sized grooves run up the sides of the helix
e. two strands that have complementary sequences

8. Which of the following is a palindromic sequence:

a. AGGTCC / TCCAGG
b. CCTTCC / GGAAGG
c. GATTCC / CTAAGG
d. GGATCC / CCTAGG
e. GTATCC / CATAGG

9. Diagram, **showing all atoms** (not skeletal structures) dCTP, a substrate for DNA polymerase.

10. The compound that consists of ribose linked by an N-glycosidic bond to N-9 of adenine is:

a. a deoxyribonucleoside
b. a purine nucleotide
c. a pyrimidine nucleotide.
d. adenosine monophosphate
e. adenosine

11. The double helix of DNA in the B-form is stabilized by:

a. covalent bonds between the 3’ end of one strand and the 5’ end of the other
b. hydrogen bonding between the phosphate groups of two side-by-side strands
c. hydrogen bonds between the riboses of each strand
d. nonspecific base-stacking interaction between two adjacent bases in the same strand
e. ribose interactions with the planar base pairs.

12. Double stranded regions of RNA typically take on a(n):

a. A-form left-handed helix
b. A-form right-handed helix
c. B-form left-handed helix
d. B-form right-handed helix
e. Z-form left-handed helix

13. If one strand of a DNA molecule has the base sequence 5'-ATTGCAT-3', its complementary strand will have the sequence

a. TAACGTA
b. ATGCAAT
c. GCCATGC
d. CGGTACG
e. ATAGGCC

14. When DNA is heated (~95^{o}C), which change does not occur?

a. UV light absorption increases
b. The glycoside bonds break
c. The helix un-winds
d. The H-bonds between bases break
e. The viscosity of the solution decreases

15. In DNA sequencing by the classical Sanger method,

a. radioactive dideoxy-ATP in included in the four reaction mixtures before addition of DNA polymerase
b. specific enzymes are used to cut the product into small pieces separated by electrophoresis
c. dideoxynucleotides are present at high levels to get the complementary strand form
d. the role of dideoxy-CTP is to only occasionally terminate formation of the complementary strand
e. the template strand is radioactive so that it can cleave the product into small pieces

CONCEPT: LIPIDS

16. Which of the following is true about sterols?

a. all sterols share a fused ring structure
b. sterols are found only in the membranes of living cells
c. sterols are soluble in water and less so in organic solvents
d. cholesterol is the main sterol in fungi
e. the principle sterol in humans is ergosterol

17. The fluidity of the membrane is generally increased by:

a. a decrease in temperature
b. an increase in fatty acyl chain length
c. binding of water to the fatty acyl side chains
d. an increase in the number of double bonds in fatty acids
e. an increase in the percentage of phophatidylethanolamine

18. Sphingosine is not a component of:

a. cardiolipin
b. ceramide
c. cerebrosides
d. gangliosides
e. sphingomyelin

19. Fatty acids are a component of:

a. carotenes
b. cerebrosides
c. sterols
d. vitamin D
e. vitamin K

20. Which of the following statements concerning fatty acids is correct?

a. A fatty acid is the precursor of prostaglandins
b. Phosphatidic acid is a common fatty acid
c. Fatty acids all contain one or more double bonds
d. Fatty acids are constituent of sterols
e. Fatty acids are strongly hydrophilic

21. Diagram phosphatidylcholine containing palmitoleic acid (16:1 Δ^9) and dodecanoic acid (12:0)

CONCEPT: MEMBRANE STRUCTURE

22. The phospholipase that is likely to remove an unsaturated fatty acid from a phospholipid is:

a. phospholipase A1.
b. phospholipase A2.
c. phospholipase C.
d. phospholipase D.

23. The shortest helix segment that could span a biological membrane has about _____ amino acids.

a. 5
b. 20
c. 50
d. 100
e. 200

24. An integral membrane protein can be extracted with:

a. a buffer of alkaline or acid pH
b. a chelating agent that removes divalent cations
c. a solution containing detergent
d. a solution of high ionic strength
e. hot water

25. Which of the following are *not* enzymes involved in moving phospholipids form one leaflet to another?

a. Flippases that move phosphatidylethanolamine and phosphatidylserine
b. Floppases that move phospholipids from the cytosolic leaflet to the extracellular leaflet
c. Fip-flopases that allow phospholipids to move back and forth between the inner and outer leaflets
d. Scramblases that allow phospholipids to move down their concentration gradient
e. Phosphatidylinositol transfer proteins that play a role in lipid signaling.

26. The plasma membrane of animal cells contains 45% by weight of phospholipid and 55% of protein. What is the mole ratio of lipid to protein assuming the average molecular weight of phospholipid is 750 daltons and the average molecular weight of membrane proteins is 60,000 daltons?

27. Which of the following answers is not true?

a. Phospholipase A1 hydrolyzes the fatty acid from the 1-position on the glycerol backbone
b. Phospholipase B1 hydrolyzes the fatty acid from the 2-position on the glycerol backbone
c. Phospholipase C hydrolyzes the complete phospho-head group from the glycerol backbone
d. Phospholipase D hydrolyzes just the head group from the phospho-glycerol backbone

28. The inner (plasma) membrane of E. coli is about 25% lipid and 75% protein by weight. How many molecules of membrane lipid are there for each molecule of protein? (Assume that the average protein is Mr 80,000 and the average lipid is 750.)

a. 3
b. 35
c. 220
d. 10, 000
e. 50, 000

29. A hydropathy plot is used to:

a. determine the water-solubility of a protein.
b. deduce the quaternary structure of a membrane protein.
c. determine the water content of a native protein.
d. extrapolate for the true molecular weight of a membrane protein.
e. predict whether a given protein sequence contains membrane spanning segments.

30. The fluidity of a lipid bilayer will be increased by:

a. decreasing the number of unsaturated fatty acids
b. decreasing the temperature
c. increasing the length of the alkyl chains
d. increasing the temperature
e. substituting 18:0 (stearic acid) in place of 18:2 (linoleic acid)

31. Peripheral membranes proteins:

a. are generally noncovalently bound to membrane lipids
b. are usually denatured when released from membranes
c. can be released from membranes only by treatment with detergent(s)
d. may have functional units on both sides of the membrane
e. penetrate deeply into the lipid bilayer

CONCEPT: MEMBRANE TRANSPORT

32. For the process of solute transport, the constant K_t is:

a. analogous to K_a for ionization of a weak acid
b. analogous to K_M for an enzyme-catalyzed reaction
c. analogous to V_{max} for an enzyme reaction
d. the maximum rate of glucose transport
e. proportional to the number of molecules of glucose transporter per cell

33. In one catalytic cycle, the Na^+/K^+ ATPase transporter transports:

a. 2 Na+ out, 3 K+ in, and converts 1 ATP to ADP + Pi
b. 3 Na+ out, 2 K+ in, and converts 1 ATP to ADP + Pi
c. 3 Na+ in, 2 K+ out, and converts 1 ATP to ADP + Pi
d. 1 Na+ out, 1 K+ in, and converts 1 ATP to ADP + Pi
e. 2 Na+ out, 3 K+ in, and converts 1 ADP + Pi to ATP

34. The movement of water across membranes is facilitated by proteins called:

a. annexins
b. hydropermeases
c. selectins
d. aquaporins
e. transportins

35. Glucose transport from the small intestine lumen into blood, uses in order, a _____ transporter and a _____ transporter.

a. facilitated diffusion; ATPase
b. Na^+ glucose symport; facilitated diffusion
c. ATPase; ATPase
d. ABC transporter; facilitated diffusion
e. H^+ glucose symport; Na^+ symport

36. A process not involved in the fusion of two membranes or two regions of the same membrane is:

a. endocytosis
b. entry of enveloped viruses to cells
c. entry of glucose into cells
d. exocytosis
e. reproductive budding in yeasts

37. Facilitated diffusion through a biological membrane is:

a. driven by a difference in solute concentrations
b. driven by ATP
c. endothermic
d. generally irreversible
e. not specific with regard to substrate

38. The specificity of the potassium channel for K^+ over Na^+ is mainly the result of the:

a. differential interaction of the selectivity filter of the protein
b. hydrophobicity of the channel
c. phospholipid composition of the channel
d. presence of carbohydrates in the channel
e. presence of cholesterol in the channel

39. The following data was obtained for the transport glucose into rat hepatocytes. Determine the K_T and V_{max}.

[glucose] mM	(μ moles/sec) / mg cell protein
0.05	0.0286
0.1	0.0425
0.2	0.057
1	0.077

40. The type of membrane transport that uses ion gradients as the energy source is:

a. facilitated diffusion
b. passive transport
c. primary active transport
d. secondary active transport
e. simple diffusion

41. In examining arginine transport in certain bacterial membranes, it was found that lysine could inhibit arginine uptake (transport) by 50%, and conversely arginine could inhibit lysine uptake (transport) by 50%. This means these bacteria have at least ___ transporters for these molecules.

a. 1
b. 2
c. 3
d. 4
e. zero, these get in through osmosis