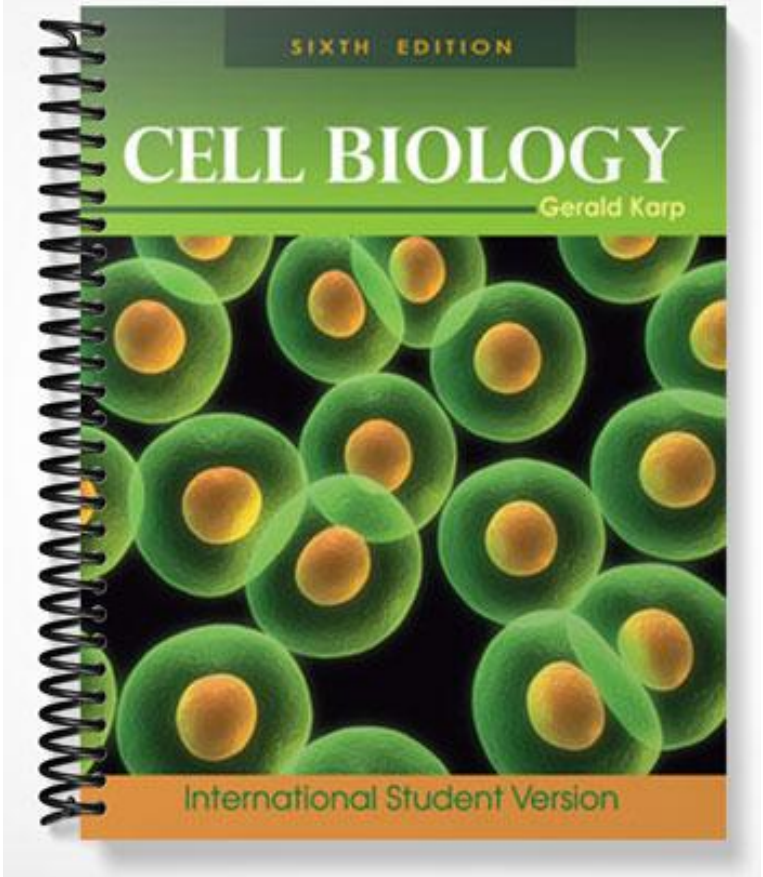
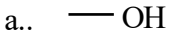
TEST BANK


SIXTH EDITION
CELL BIOLOGY
Gerald Karp
International Student Version

1. TB 2.001 Which of the groups below is capable of only hydrophobic interactions?

a..



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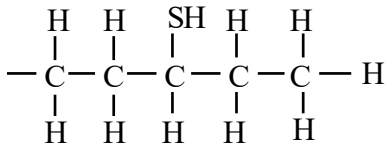

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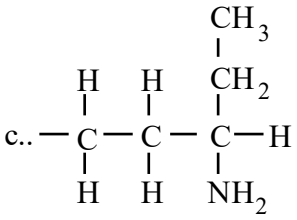

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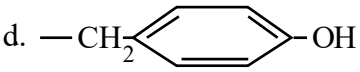

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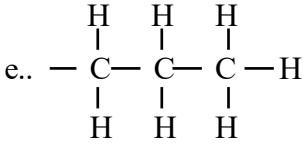
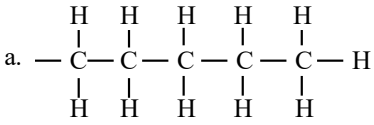


A) A
B) B
C) C
D) D
E) E

Ans: E
Difficulty: Medium
2.2

2. TB 2.002 Which of the following groups is capable of only hydrophilic interactions?

a.



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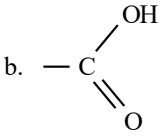

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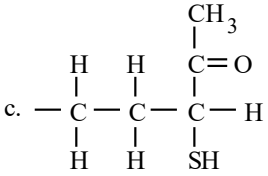

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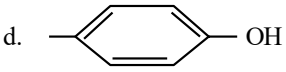

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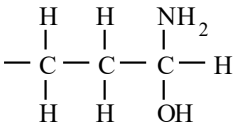


A) A
B) B
C) C
D) D
E) E

Ans: B
Difficulty: Medium
2.2

3. TB 2.003 Which of the following tripeptides would be most likely to be soluble in an organic (hydrophobic) solvent like benzene?
   A) N - phenylalanine - alanine - glycine – C
   B) N - leucine - alanine - lysine - C
   C) N - proline - phenylalanine - leucine - C
   D) N - arginine - lysine - proline - C
   E) N - glutamate - aspartate - glycine – C

   Ans: C
   Difficulty: Difficult
   2.5

4. TB 2.004 What kind of bond results from an unequal sharing of electrons?
   A) ionic bond
   B) polar covalent bond
   C) H bond
   D) nonpolar covalent bond

   Ans: B
   Difficulty: Easy
   2.1

5. TB 2.005 Under which circumstances would electrons be most likely to be shared equally?
   A) when they are equidistant from nuclei
   B) when they are equidistant from each other
   C) when atoms of the same element are sharing them
   D) when the atoms sharing them are different

   Ans: C
   Difficulty: Easy
   2.1

6. TB 2.006 The most electronegative atoms typically present in biological molecules are ____ and ____.
   A) O, C
   B) O, P
   C) O, N
   D) C, N
   E) C, Na

   Ans: C
   Difficulty: Easy
   2.1

7. TB 2.007 The most stable atoms and thus those that are typically nonreactive are the atoms that have _____.
   A) equal numbers of electrons and protons
   B) equal numbers of electrons and neutrons
   C) full inner shells
   D) full outer shells
   E) all covalent bonds

   Ans: D
   Difficulty: Easy
   2.1

8. TB 2.008 Why are free ionic bonds of little importance and relatively unlikely to form in living organisms?
   1) Cells are composed mostly of water, which interferes with ionic bonds between free ions.
   2) Cells are largely hydrophobic.
   3) They are crystals.
   A) 1
   B) 2
   C) 3
   D) 1 and 2
   E) 2 and 3

   Ans: A
   Difficulty: Easy
   2.2

9. TB 2.009 In a living organism, where are ionic bonds most likely to be found?
   A) in the cytoplasm
   B) between DNA strands
   C) deep in a protein's core where water is excluded
   D) on the surface of a protein
   E) on the surface of a lipid

   Ans: C
   Difficulty: Medium
   2.2

10. TB 2.010 Which interaction is most important in enhancing the solubility of macromolecules in water?
    A) hydrophobic interactions
    B) nonpolar covalent bonds
    C) H bonds
    D) van der Waals forces
    E) Both hydrophobic interactions and nonpolar covalent bonds

    Ans: C
    Difficulty: Medium
    2.2

11. TB 2.011 Where are hydrophobic interactions most likely to occur?
    A) on the surface of a water-soluble protein
    B) the core of a water-soluble protein
    C) in contact with water molecules
    D) between two charged molecules
    E) between two ions

    Ans: B
    Difficulty: Easy
    2.2

12. TB 2.012 What kind of noncovalent interaction is typified by interactions between two molecules that are so close together that they can experience weak attractive forces bonding them together?
    A) H bonds
    B) ionic bonds
    C) hydrophobic interactions
    D) polar covalent bonds
    E) van der Waals forces

    Ans: E
    Difficulty: Medium
    2.2

13. TB 2.013 A molecule that is capable of releasing or donating a hydrogen ion is termed a(n) _____.
    A) base
    B) hydrion
    C) acid
    D) anachronism
    E) pain

    Ans: C
    Difficulty: Easy
    2.3

14. TB 2.014 A release of hydrogen ions to a solution would most likely _____.
    A) raise pH
    B) lower pH
    C) buffer pH
    D) change salinity
    E) keep pH steady

    Ans: B
    Difficulty: Easy
    2.3

15. TB 2.015 Why is silicon not suitable for making covalent bonds stable and strong enough to form the basis of living organisms, even though it is just below carbon on the periodic table?
    A) Silicon is too large for its nucleus to attract the valence electrons of neighboring atoms enough to hold molecules together sufficiently.
    B) Silicon is too small for its nucleus to attract the valence electrons of neighboring atoms enough to hold molecules together sufficiently.
    C) Silicon is too large for its nucleus to attract the protons of neighboring atoms enough to hold molecules together.
    D) Silicon is too small for its nucleus to attract the protons of neighboring atoms enough to hold molecules together.

    Ans: A
    Difficulty: Difficult
    2.1

16. TB 2.016 The low-molecular-weight building blocks of polymers are called _____.
    A) minipolymers
    B) monoblocks
    C) monomers
    D) portions
    E) octamers

    Ans: C
    Difficulty: Easy
    2.4

17. TB 2.017 What bond is responsible for the branch points in glycogen and amylopectin?
    A) α(1—>4) glycosidic linkages
    B) β(1—>4) glycosidic linkages
    C) α(1—>6) glycosidic linkages
    D) β(1—>6) glycosidic linkages
    E) 3'-5' phosphodiester linkages

    Ans: C
    Difficulty: Medium
    2.5

18. TB 2.018 Which polysaccharide bond cannot be broken by mammalian enzymes that normally digest polysaccharides?
    A) α(1—>4) glycosidic linkages
    B) β(1—>4) glycosidic linkages
    C) α(1—>6) glycosidic linkages
    D) β(1—>6) glycosidic linkages
    E) phosphate ester linkages

    Ans: B
    Difficulty: Difficult
    2.5

19. TB 2.019 Why do sugars tend to be highly water soluble?
    A) because they have only a few hydroxyl groups
    B) because of their large numbers of hydroxyl groups
    C) because of their large numbers of sulfhydryl groups
    D) because of their large numbers of methyl groups
    E) because of their small molecular weights

    Ans: B
    Difficulty: Medium
    2.5

20. TB 2.020 Which of the following is <u>not</u> a macromolecule formed by polymerization?
    A) proteins
    B) lipids
    C) polynucleotides
    D) polysaccharides
    E) DNA

    Ans: B
    Difficulty: Difficult
    2.5

21. TB 2.021 What is the maximum number of 100 amino acid long polypeptides that could be made?
    A) 100^{20}
    B) 2,000
    C) 20^{100}
    D) 20^{101}
    E) 20

    Ans: C
    Difficulty: Difficult
    2.5

22. TB 2.022 How do amino acids like hydroxylysine and thyroxine, which are not among the 20 amino acids that are inserted into proteins, get into proteins?
    A) They are inserted directly.
    B) They are the result of the alteration of R groups of the 20 amino acids after their incorporation into the polypeptide.
    C) They are the result of the alteration of R groups of the 20 amino acids before their incorporation into the polypeptide.
    D) There are more than the 20 amino acids that are said to be inserted into proteins.
    E) Their atoms are altered by insertion into the polypeptide.

    Ans: B
    Difficulty: Medium
    2.5

23. TB 2.023 Which amino acid is most likely to be found in the core of a protein?
    A) methionine
    B) asparagine
    C) serine
    D) threonine
    E) glutamic acid

    Ans: A
    Difficulty: Medium
    2.5

24. TB 2.024 What type of protein secondary structure is characterized as being highly extensible because of its coiled structure?
    A) β-pleated sheet
    B) double helix
    C) α-helix
    D) supercoiling

    Ans: C
    Difficulty: Medium
    2.5

25. TB 2.025 The β-pleated sheet is characterized by orientation of _____ the molecular axis.
    A) H bonds parallel to
    B) H bonds perpendicular to
    C) ionic bonds parallel to
    D) ionic bonds perpendicular to
    E) peptide bonds perpendicular to

    Ans: B
    Difficulty: Easy
    2.5

26. TB 2.026 Proteins are often composed of two or more distinct modules that fold up independently of one another. They often represent parts of a protein that function in a semi-independent manner. These modules are called _____.
    A) protein motifs
    B) functionals
    C) domains
    D) dominoes

    Ans: C
    Difficulty: Easy
    2.5

27. TB 2.027 What level of structure in proteins is held together by intermolecular R group interactions?
    A) primary structure
    B) secondary structure
    C) tertiary structure
    D) quaternary structure

    Ans: D
    Difficulty: Medium
    2.5

28. TB 2.028 Which of the following is a nucleotide?
    A) phosphate + ribose
    B) adenine + deoxyribose
    C) sugar + nitrogenous base
    D) adenine + ribose + phosphate

    Ans: D
    Difficulty: Medium
    2.5

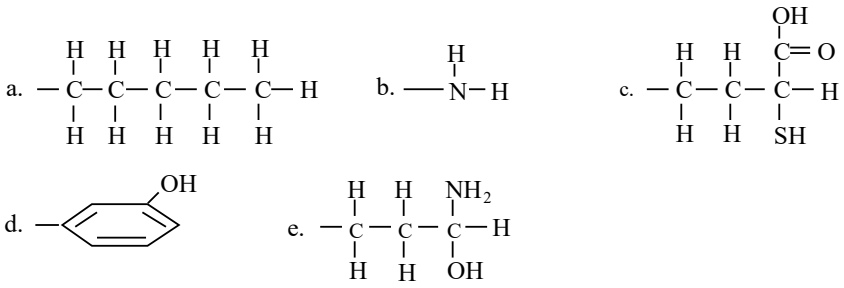
29. TB 2.029 Tertiary structure in DNA is also known as _____.
    A) primary structure
    B) supercoiling
    C) double helix
    D) α-helix

    Ans: B
    Difficulty: Easy
    2.5

30. TB 2.030 What is now thought to have been the genetic material in the first living organisms on Earth?
    A) RNA
    B) DNA
    C) protein
    D) polypeptides

    Ans: A
    Difficulty: Easy
    2.5

31. Critical Thinking Question 2.001
Which of the groups below is capable of only hydrophobic interactions? Explain your answer. Which is capable of only hydrophilic interactions? Explain your answer.



Ans: A is capable of only hydrophobic interactions. It contains no ionizable or hydrophilic groups. B is capable of only hydrophilic interactions, since it has no component with a long carbon chain or a carbon-containing ring and no nonpolar covalent linkages. It is also capable of ionization.

Difficulty: Medium
2.2

32. Critical Thinking Question 2.002
You treat a partially purified preparation of protein with a reagent that breaks bonds between sulfur atoms. Which level(s) of protein structure are likely to be affected the most?
Ans: Both the tertiary and quaternary levels of structure would be affected since those levels are the only ones in which disulfide bonds are prominent.

Difficulty: Medium
2.5

33. Critical Thinking Question 2.003
Not all proteins are able to renature. Some proteins when exposed to heat or some other denaturing treatment are irreversibly denatured. What is an example of such a protein?
Ans: Egg white protein and yolk are examples of proteins that are irreversibly denatured by heat.

Difficulty: Easy
2.5

34. Critical Thinking Question 2.004
You are working with an enzyme altase that you denature in the presence of urea. If altase were denatured no further by the addition of mercaptoethanol, what would that suggest to you about the enzyme?
Ans: The enzyme probably contained no disulfide linkages since mercaptoethanol breaks such linkages.

Difficulty: Medium
2.5

35. Critical Thinking Question 2.005
Would all proteins be likely to require exposure to mercaptoethanol in order to accomplish full denaturation? If not, what trait would a protein that did not require mercaptoethanol possess?
Ans: Not all proteins would require mercaptoethanol to accomplish full denaturation. If a protein has no disulfide linkages, it probably would not require mercaptoethanol for full denaturation.

Difficulty: Medium
2.5

36. Critical Thinking Question 2.006
An enzyme is placed in a solution containing urea. Assuming that this protein contains no disulfide linkages, is it reasonable to suspect that it will be totally denatured by the treatment? How could you know that the enzyme has, in fact, been denatured? Why does the urea denature the tertiary structure of the enzyme?
Ans: Placement in a urea solution should totally denature the enzyme, especially since there are no disulfide linkages. If there are extensive hydrophobic interactions between enzyme R groups, total denaturation may be difficult to accomplish. If the enzyme activity disappears, there is a good chance the enzyme has been denatured. Urea breaks up the tertiary structure by interfering with hydrophilic interactions, like H bonds.

Difficulty: Difficult
2.5

37. Critical Thinking Question 2.007
Which of the following tripeptides would be most likely to be soluble in an organic (hydrophobic) solvent like benzene: N - phenylalanine - alanine - glutamine - C, N - leucine - alanine - lysine - C, N - proline - phenylalanine - leucine - C, N - arginine - lysine - proline - C, N - glutamate - aspartate - glycine - C? Explain your answer.
Ans: N - proline - phenylalanine - leucine - C would be most soluble in a hydrophobic solvent. All three amino acids are classed as nonpolar amino acids and could be soluble in benzene. In the other tripeptides, at least one of the amino acids does not belong to the nonpolar class.

Difficulty: Medium
2.5

38. Critical Thinking Question 2.008
What level of structure in DNA would be disrupted by a reagent that breaks apart hydrogen bonds?
Ans: Secondary structure would be disrupted, because it is held together by hydrogen bonds. Hydrogen bonds are also involved in tertiary and quaternary structure. Thus, such a reagent would also disrupt these levels of structure in areas where H bonds are involved.

Difficulty: Difficult
2.5

39. Critical Thinking Question 2.009
DNA is isolated from two different species. Both DNA samples are found to be the same size. One of the DNA samples has a G+C/A+T ratio of 2.0 and the other 2.5. Which DNA sample has a higher G+C content? Which sample contains the smallest number of H bonds between strands? Which DNA sample would be easiest to denature?
Ans: The second sample has the higher G+C content, since the G+C/A+T ratio for that sample is the largest. The first sample contains a larger amount of A+T. Since A-T base pairs make only 2 H bonds, while G-C base pairs make three, the sample with the most A-T base pairs would have the fewest H bonds. The first sample would be the easiest to denature, since it is held together with the smallest number of H bonds.

Difficulty: Medium
2.5

40. Critical Thinking Question 2.010
Mammals lack the enzyme that hydrolyzes cellulose. Yet many mammals are herbivores and they eat grass and other plant material for nutrition. How can this be, given that they cannot digest the food they are eating?
Ans: While these animals lack the enzyme that digests cellulose, bacteria that reside within their digestive tracts possess it. There is a symbiotic relationship between the two organisms. The herbivores seek out and eat the grass; the bacteria in their digestive tract digest it. What the bacteria don't use, the herbivore does.

Difficulty: Easy
2.5

41. Critical Thinking Question 2.011
You are a crew member on the starship Enterprise. Your responsibilities include investigation of biological life forms. You take out your tricorder after landing on the planet Yamihere and find a number of organisms, all of which contain DNA that follows the nitrogenous base pairing rules you are familiar with on Earth. For one species, the following relationships hold for the organism's DNA.

moles of adenine = 8 $\quad \frac{A + T}{G + C} = 2$

How many moles of guanine are present?
How many moles of thymine are present?
How many moles of uracil are present?

You isolate DNA from another organism living on the surface of Yamihere and find that it contains all the bases normally found in DNA, but does not obey the pairing rules. Can you explain these strange results?
Ans: 4 moles of guanine, 8 moles of thymine and 0 moles of uracil (There is no uracil in DNA.) are present. One possible explanation is that the DNA is single-stranded.

Difficulty: Difficult
2.5

42. Critical Thinking Question 2.012
What are some possible explanations for the branched structure of glycogen?
Ans: First, branching allows more efficient storage of energy. More glucose monomers can be stored in a smaller space. Second, branching creates more free ends on the structure. This would allow glycogen to be disassembled more rapidly when free glucose is needed and would also allow quicker assembly when glycogen is being constructed.

Difficulty: Medium
2.5

43. Critical Thinking Question 2.013
Scientists have sequenced proteins by using specific proteases to "clip" a purified protein preparation between two specific amino acids, thus forming a number of moderately sized fragments; they have used acid hydrolysis to produce smaller fragments. Each fragment can then be sequenced by breaking the moderate fragments into dipeptides that are easily sequenced. The fragments below are obtained after the initial enzymatic cleavages. Can you deduce the sequence of the original polypeptide? (HINT: the original cleavages at specific locations differ depending on which proteolytic enzyme was used to create each fragment; this causes an overlap in the fragments' sequences.) The final polypeptide should have 18 amino acid residues.

N - ala - ala - gluN - aspN - met - C
N - iso - pro - aspA - try - thr - C
N - met - cys - leu - lys - phe - arg - aspA - C
N - aspN - met - cys - leu - lys - C
N - aspA - try - thr - phe - tyr - ala - ala - C

Ans: N- iso - pro - aspA - try - thr - phe - tyr - ala - ala - gluN - aspN - met - cys - leu - lys - phe - arg - aspA - C

Difficulty: Difficult
2.5

44. Critical Thinking Question 2.014
Many so-called temperature-sensitive mutations have been discovered in a wide variety of organisms. These are proteins that are non-functional at higher temperatures, while, at lower temperatures (often just a few degrees lower), they function normally. For example, the coloration patterns in Siamese Cats arise from a temperature-sensitive mutation. An enzyme required for the synthesis of dark pigment is unable to function in areas close to the body where normal physiological temperatures prevail. However, at the tips of the ears, paws, the tip of the tail and other extremities where the temperature is slightly lower, the enzyme works correctly and dark pigment is produced. What is happening at the molecular level that explains this?

Ans: In warmer areas of the organism, the temperature is just high enough to denature the enzyme in question. Since it is denatured, it will not work properly and dark pigment will not be produced in those areas.

Difficulty: Easy
2.5

45. Critical Thinking Question 2.015
You are studying a protein. It binds to elongating polypeptide chains as they emerge from an exit channel within the ribosome's large subunit. It appears to prevent partially formed or nascent polypeptides from binding to other proteins in the cytosol, which might cause them either to aggregate or misfold. What kind of proteins is this likely to be? Another protein you are studying picks up larger proteins from Hsp70 family proteins. It is a cylindrical protein complex that contains chambers in which newly synthesized polypeptides can fold without interference from other cellular macromolecules. What is this protein called?
Ans: A chaperone of the Hsp70 family. It is called a chaperonin. One chaperonin, TRiC, is thought to assist in the folding of up to 15% of the polypeptides synthesized in mammalian cells.

Difficulty: Difficult
2.5

46. Critical Thinking Question 2.016
It is thought that most human diseases leave telltale patterns among the thousands of proteins present in the blood or other bodily fluids. It was hoped that analysis of the proteins present in the blood would help in the diagnosis of human disease; however, thus far, searches for these proteins in blood or bodily fluids have been largely unsuccessful and their use in diagnostics largely unreliable. What are these telltale patterns of proteins called?
Ans: Biomarkers

Difficulty: Easy
2.5

47. Critical Thinking Question 2.017
Some proteins have multiple binding partners. In some cases, they have several different binding interfaces and they are thus capable of binding a number of different binding partners at the same time. On the other hand, other such proteins have a single binding interface, which is capable of binding several different partners, but only one at a time. They can play central roles in such processes as cell division and gene expression. What are such proteins called?
Ans: Hub proteins

Difficulty: Easy
2.5

48. Critical Thinking Question 2.018
What does the compound, 2-phenylaminopyrimidine, inhibit? It was determined that 2-phenylaminopyrimidine would not have made a very effective drug. Why? What is the basis of Gleevec's effectiveness as a drug in the treatment of chronic myelogenous leukemia (CML)? Why do some patients taking Gleevec experience a recurrence of their cancer even though they initially went into remission?
Ans: It inhibits tyrosine kinases. It was a weak enzyme inhibitor, which meant that it would have had to be used in very large quantities. Tyrosine kinases are often involved in the transformation of normal cells into cancer cells. The development of CML is driven almost single-handedly by the presence of an overactive tyrosine kinase called ABL. Gleevec binds tightly to the inactive form of the ABL tyrosine kinase and prevents the enzyme from being activated, which is a necessary step if the cell is to become cancerous. Thus, the drug can put CML patients into remission. The ABL kinase becomes resistant to the drug, thus abrogating its effectiveness as a treatment for CML.

Difficulty: Medium
2.5

49. Human Perspective Question 2.001
What kinds of conditions can cause free radicals?
Ans: Free radicals may form when a covalent bond is broken such that each atom that had participated in the bond retained one of the two shared electrons that comprised the bond. They may also form when an atom or molecule accepts a single electron transferred during an oxidation - reduction reaction. Water, for example, can be converted into free radicals when exposed to solar radiation.

Difficulty: Medium
Human Perspectives: Free Radicals as a Cause of Aging

50. Human Perspective Question 2.002
Why are free radicals capable of altering molecules, such as proteins, nucleic acids and lipids?
Ans: They are extremely reactive, which makes them well suited for chemically altering these molecules. The formation of hydroxyl radicals is probably a major reason that sunlight is so damaging to the skin.

Difficulty: Easy
Human Perspectives: Free Radicals as a Cause of Aging

51. Human Perspective Question 2.003
What enzyme is responsible for the destruction of a type of free radical formed when molecular oxygen picks up an extra electron?
Ans: Superoxide dismutase

Difficulty: Easy
Human Perspectives: Free Radicals as a Cause of Aging

52. Human Perspective Question 2.004
Why is hydrogen peroxide often used as a disinfectant and bleaching agent? How do cells generally rid themselves of hydrogen peroxide?
Ans: Hydrogen peroxide is a potentially reactive oxidizing agent. If it is not rapidly destroyed, hydrogen peroxide can break down to form hydroxyl radicals that attack the cell's macromolecules. Hydrogen peroxide is normally destroyed in the cell by the enzymes catalase or glutathione peroxidase.

Difficulty: Medium
Human Perspectives: Free Radicals as a Cause of Aging

53. Human Perspective Question 2.005
What is some specific evidence that demonstrates the importance of superoxide dismutase in getting rid of superoxide free radicals?
Ans: Mutant bacteria and yeast cells that lack SOD activity are unable to grow in the presence of oxygen. Furthermore, mice that lack the mitochondrial version of the enzyme (SOD2) are not able to survive more than a week or so after birth. Conversely, mice that have been genetically engineered so that their mitochondria contain elevated levels of the H_2O_2–destroying enzyme catalase live 20% longer than untreated controls.

Difficulty: Difficult
Human Perspectives: Free Radicals as a Cause of Aging

54. Human Perspective Question 2.006
Why might an organism that had functional SOD but mutant catalase and/or glutathione peroxidase be at a disadvantage?
Ans: SOD converts two superoxide free radicals and two hydrogen ions into hydrogen peroxide and oxygen. Hydrogen peroxide is also a highly destructive substance and without catalase and glutathione peroxidase, the organism would be less able to get rid of it.

Difficulty: Difficult
Human Perspectives: Free Radicals as a Cause of Aging

55. Human Perspective Question 2.007

a) It has been hypothesized that aging results from tissue damage caused by free radicals. What are free radicals?

b) In 1969, the enzyme superoxide dismutase (SOD) was discovered. The sole function of this enzyme is the destruction of the superoxide free radical. A connection between free radicals and aging has not been firmly established, but a few predictions assuming their involvement in aging have been made. Below are graphs depicting hypothetical data collected testing some of these hypotheses. Interpret the results of each graph. What do they tell you about the effect of free radicals on aging and the role of enzymes that neutralize free radicals? Consider each graph separately. Do not try to combine the results to form a coherent model.

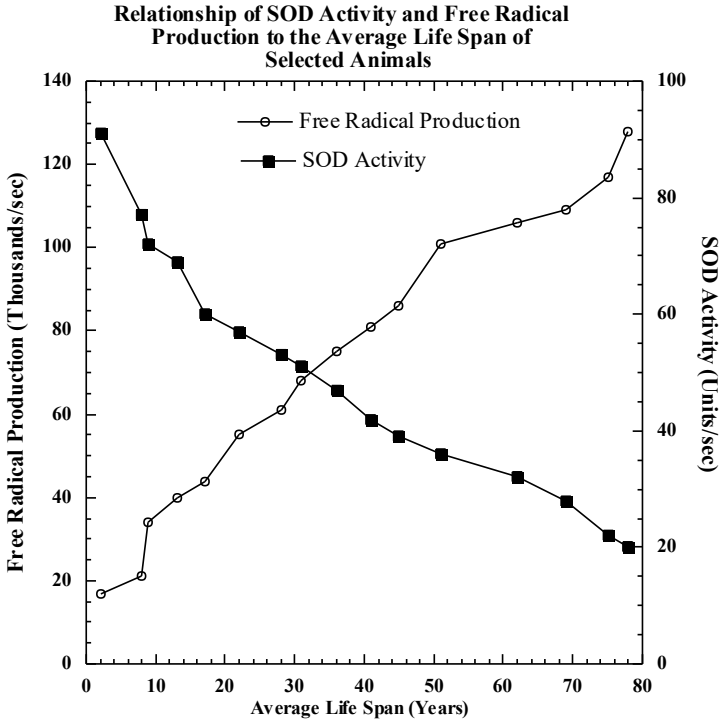


Figure 1

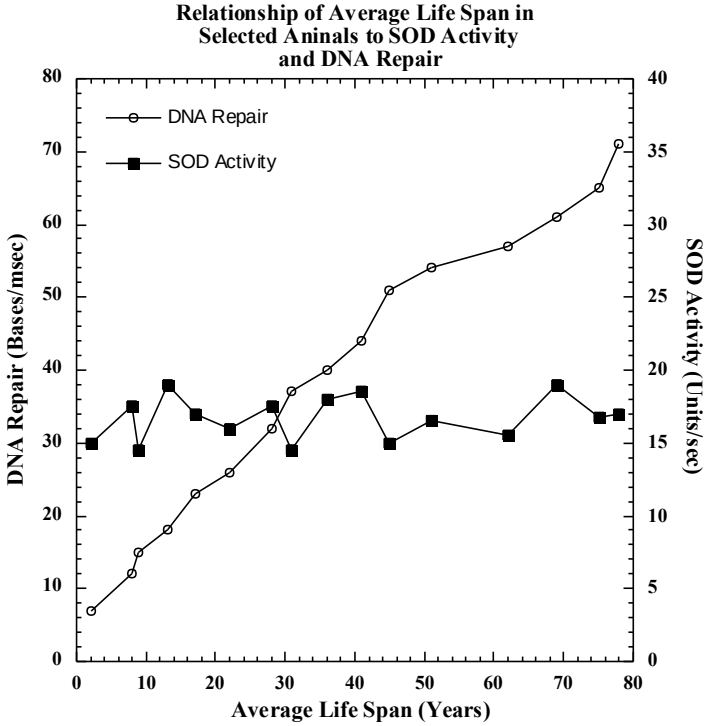


Figure 2

Ans: Free radicals occur when atoms or molecules have orbitals containing a single unpaired electron. They are highly unstable and extremely reactive chemical groups and are produced during normal metabolic processes. They can chemically alter many types of molecules, including proteins, nucleic acids and lipids; they may also damage tissues.

Figure 1. Animals that live longer have higher SOD activity and correspondingly lower free radical production. This suggests that higher levels of free radical production correlate with shorter life spans. In addition, the ability to destroy the superoxide free radical reflected in higher levels of SOD activity correlates closely with longer life span. Therefore, the graphs suggest that organisms with higher SOD activity and/or lower free radical production will live longer.

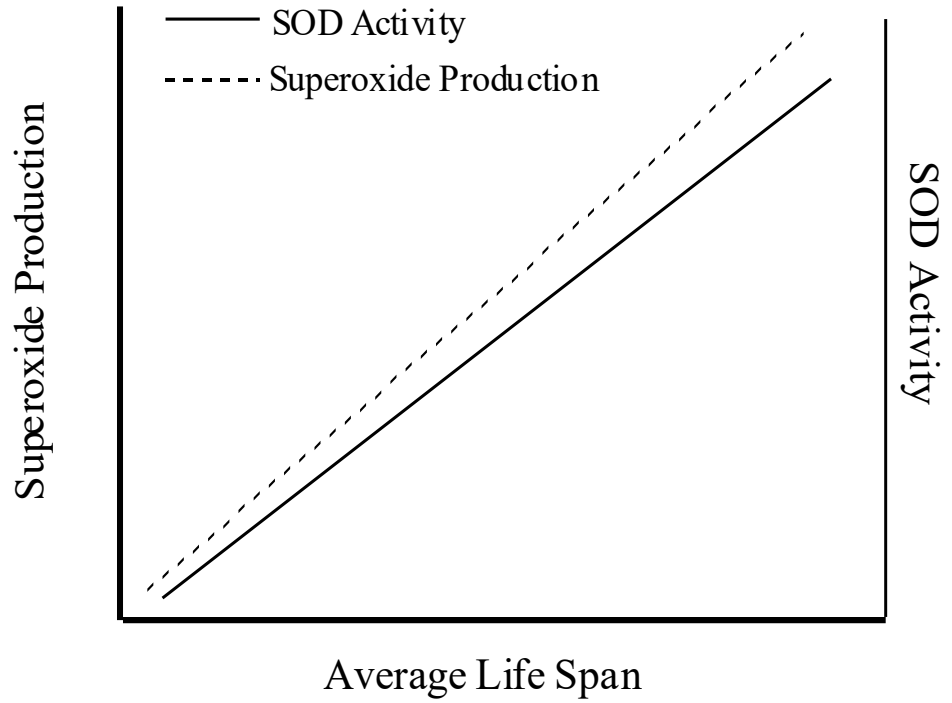
Figure 2. This graph suggests that increased life span does not correlate with increased SOD activity of the organisms being monitored. However, an ability to repair DNA more efficiently appears to give organisms a better chance at having longer lives. Some of the DNA damage being repaired by the elevated repair enzymes may be caused by the chemical activity of free radicals.

Difficulty: Difficult
Human Perspectives: Free Radicals as a Cause of Aging

56. Human Perspective Question 2.008
You isolate superoxide dismutase from two cell culture lines. One of the lines (SOD1) has a level of SOD activity similar to that found in liver, the tissue from which the cell line was originally obtained. The other cell line (SOD10) has elevated SOD activity. The enzyme in SOD10 is extremely efficient at converting the superoxide free radical to hydrogen peroxide. In a routine check of other critical enzyme activities, catalase was found to have activity levels that were severely depressed in SOD10, while they appeared normal in SOD1. Observations of SOD10 reveal that this cell line cannot be maintained as easily as SOD1. SOD10 cells appear to die at an accelerated rate. What, if anything, can you conclude from these data?
Ans: While SOD10 is very efficient at neutralizing superoxide free radicals by producing hydrogen peroxide, the peroxide is toxic in its own right. SOD10 also has a relatively ineffective catalase, which detoxifies hydrogen peroxide. Thus, SOD10 builds up hydrogen peroxide rapidly, but lacks the ability to neutralize it just as rapidly. The result is that these cells die at an accelerated rate.

Difficulty: Medium
Human Perspectives: Free Radicals as a Cause of Aging

57. Human Perspective Question 2.009
What would a graph similar to those above in question 7 look like if one could conclude from it that organisms that exhibit longer life spans also exhibit proportionately higher production of the superoxide free radical and correspondingly higher levels of SOD activity?
Ans:



Difficulty: Difficult
Human Perspectives: Free Radicals as a Cause of Aging

58. Human Perspective Question 2.010
Given what you have learned about SOD, what do you hypothesize would happen to fruit flies that have been genetically engineered to produce large amounts of SOD? Why might houseflies that are kept caged and unable to fly live longer than those allowed to fly?
Ans: Fruit flies genetically engineered to produce large amounts of SOD should live longer than untreated controls. Flying requires a lot of energy and thus high metabolic rates. A fly's mitochondria works very hard and produces many free radicals. As a result, flies that are unable to fly have much lower metabolic rates and therefore require less oxygen. Consequently, they would be expected to produce fewer free radicals, which according to some would slow up aging.

Difficulty: Difficult
Human Perspectives: Free Radicals as a Cause of Aging

59. Human Perspective Question 2.011
What are some common antioxidants found in the body?
Ans: Glutathione, vitamins E and C, beta-carotene (the orange pigment in carrots and other vegetables), and the parent compound for vitamin A.

Difficulty: Easy
Human Perspectives: Free Radicals as a Cause of Aging

60. Human Perspective Question 2.012
Red wine supposedly has health-related benefits. What antioxidant chemical is reputed to be responsible for these benefits? Where is this chemical normally found that explains its ending up in red wine? How is this chemical thought to exert its antioxidant effects?
Ans: Resveratrol. Resveratrol is a polyphenolic compound that is found at high concentration in the skin of red grapes. Rather than scavenging for free radicals, resveratrol appears to act by stimulating an enzyme (Sir2) that serves as a key player in promoting longevity in animal studies.

Difficulty: Medium
Human Perspectives: Free Radicals as a Cause of Aging

61. Human Perspective Question 2.013
If people are kept on diets containing about 25% fewer calories than would be required to maintain their initial body weight, what happens?
Ans: After a period of 6 months of calorie restriction, these individuals show remarkable metabolic changes. They have a lower body temperature, their blood insulin and LDL-cholesterol levels are lower, they have lost weight as would be expected and their energy expenditure is reduced beyond that expected due simply to their lower body mass. In addition, the level of DNA damage experienced by the cells of these individuals is reduced, which suggests a decrease in production of reactive oxygen species.

Difficulty: Medium
Human Perspectives: Free Radicals as a Cause of Aging

62. Human Perspective Question 2.014
If mice are maintained on very strict diets with reduced caloric intake, what happens to their life span as compared to littermates fed diets with normal caloric content? What is a possible explanation for the effect of this diet on these animals?
Ans: The mice on restricted calorie diets live 30 – 40% longer. The animals exhibit a marked decrease in superoxide free radical and hydrogen peroxide production, which could explain their increased longevity.

Difficulty: Medium
Human Perspectives: Free Radicals as a Cause of Aging

63. Human Perspective Question 2.015
What appears to be the effect of reduced calorie intake on rhesus monkeys?
Ans: The rhesus monkeys have lower blood levels of glucose, insulin and triglycerides, which makes them less prone to age-related disorders, such as diabetes and coronary artery disease. It is too early to tell if their longevity is increased; the study has not been conducted for a time sufficient to make this determination.

Difficulty: Medium
Human Perspectives: Free Radicals as a Cause of Aging

64. Human Perspective Question 2.016
What evidence suggests that lower blood levels of insulin may be important in promoting longevity?
Ans: Studies on nematodes and fruit flies suggest that reducing the activity of insulin-like hormones can dramatically increase life span in these invertebrates.

Difficulty: Medium
Human Perspectives: Free Radicals as a Cause of Aging

65. Human Perspective 2 Questions 2.001
What human disease was found to be similar to kuru in the brain abnormalities it caused? What disease in sheep contributes its name to the abnormal prion molecule, PrP^{SC}? What have been the causes of outbreaks of acquired CJD?
Ans: Creutzfeld-Jakob disease (CJD) is similar to kuru. The disease in sheep that contributes its name to the prion molecule is scrapie. Acquired CJD has been seen in recipients of organs and organ products that were donated by a person with undiagnosed CJD. Apparently, contaminated beef that the infected individuals had eaten years before has also been implicated as a cause of acquired CJD.

Difficulty: Medium
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

66. Human Perspective 2 Questions 2.002
What is spongiform encephalopathy?
Ans: This is a pathology in which certain brain regions are riddled with microscopic holes called vacuolations. It causes the tissue to resemble a sponge.

Difficulty: Easy
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

67. Human Perspective 2 Questions 2.003
When it was discovered that CJD could be acquired in addition to being inherited, why was it at first assumed that the infectious agent was a virus?
Ans: The infectious agent was found to pass through filters that retard the passage of bacteria. This is usually a characteristic of viral infections.

Difficulty: Medium
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

68. Human Perspective 2 Questions 2.004
How was it proved that CJD could be passed to another organism?
Ans: Extracts from the tissues of diseased individuals can be proved to be infectious if they transmit the disease to another individual. In the case of CJD, this was demonstrated across species with extracts from the brain biopsy of a human CJD victim causing disease in laboratory animals.

Difficulty: Medium
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

69. Human Perspective 2 Question 2.005
An infectious agent is discovered that causes a particular disease. It has a relatively low molecular weight. Treatment with phenol or proteolytic enzymes, treatments that destroy proteins, render the infectious agent harmless, while treatment with nucleases and ultraviolet radiation, treatments that damage polynucleotides, has no effect. What is your interpretation of the above data and why?
Ans: The sensitivity to protein-destroying treatments means that the agent contains protein and that the protein is important to the infectious process. The lack of effect of nucleic acid-destroying treatments suggests that nucleic acids are not important for infection and that the infectious agent is not a virus since nucleic acids are essential when viruses are responsible for an infection. The active part of the infectious agent above is clearly protein.

Difficulty: Medium
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

70. Human Perspective 2 Questions 2.006
How was it proved that the brains of patients suffering from CJD, an inherited disease, contain an infectious agent?
Ans: Carlton Gajdusek prepared extracts from a biopsy of the brain of a CJD victim. The extract was injected into a suitable laboratory animal. The animal developed a spongiform encephalopathy similar to that of kuru or CJD.

Difficulty: Medium
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

71. Human Perspective 2 Questions 2.007
Since replication is a property characteristic of nucleic acids, how might a prion, which lacks nucleic acids, "replicate" itself?
Ans: The mutant form of the protein in patients suffering from inherited CJD may act as a template that causes the conformation of the normal protein to convert to the abnormal form. The resultant two abnormal proteins could then convert two others, etc. The conversion of PrP^{C} to PrP^{Sc} has been accomplished in a test tube. Presumably, the appearance of the abnormal protein in the body, by whatever means, starts a chain reaction in which normal protein molecules in the cells are gradually converted to the abnormal prion form. How can the inherited form of CJD be transmitted to another person? A person who has the inherited form of CJD could transmit the disease to another person, if they donate tissue or blood to a person who does not have the disease. The proteins in the donated tissue could then cause normal proteins in the recipient to shift conformation to the abnormal form. This could eventually lead to clinical CJD.

Difficulty: Difficult
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

72. Human Perspective 2 Question 2.008
How was kuru passed from one native of Papua-New Guinea to another?
Ans: During a funeral ritual, the mourners would eat the brain tissue of recently deceased relatives. If they had suffered from kuru, the disease could, and often would, be passed from the deceased relative to the mourners.

Difficulty: Easy
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

73. Human Perspectives 2 Question 2.009
What is the derivation of the name prion for the agent that can transmit diseases like CJD and kuru?
Ans: Disease transmission is by “protein only”.

Difficulty: Easy
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

74. Human Perspective 2 Questions 2.010
Knockout mice are mice that have had one specific gene removed from their genome. This allows the role of the missing gene and its protein product to be assessed. Given this information, how would you explain the inability of mouse scrapie prions, which cause a malady similar to CJD, to cause the CJD-like disease scrapie in PrP knockout mice?
Ans: Since PrP knockout mice lack the PrP^{C} protein, there are no normal proteins in these mice to be converted to the mutant form; thus they do not develop the disease. With no PrP protein at all, normal or abnormal, the mice can still survive, since there appears to be no adverse effect if the protein is missing.

Difficulty: Difficult
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

75. Human Perspective 2 Questions 2.011
What physical properties of the abnormal form of the PrP protein probably account for its ability to cause CJD? What is odd about these differences given what is known about the structures of the two proteins?
Ans: Normal PrP (PrP^C) is a monomeric molecule that is soluble in salt solutions and readily destroyed by proteolytic enzymes. The abnormal PrP^{Sc} molecules are able to interact with each other to form insoluble fibrils that are resistant to enzymatic digestion. The two proteins can have the same amino acid sequence, but fold up differently to form significantly different three-dimensional structures. PrP^C consists largely of α-helical segments and interconnecting coils. The core of a PrP^{Sc} molecule consists largely of β-pleated sheet.

Difficulty: Medium
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

76. Human Perspective 2 Questions 2.012
How does inherited CJD lead to the production of abnormal forms of PrP?
Ans: Under normal circumstances, the newly synthesized PrP polypeptide almost invariably folds into the PrP^C conformation. People with inherited CJD have a gene that encodes a mutant protein whose amino acid sequence is different from that of the normal protein. The mutant protein is presumed to be less stable in the PrP^C conformation than the normal version of the protein and to be more likely to fold into the abnormal β-pleated sheet-rich conformation. Once formed, the β-rich proteins convert other proteins to the β-rich form and produce aggregates, which lead to disease.

Difficulty: Medium
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

77. Human Perspective 2 Questions 2.013
In what ways are CJD and Alzheimer's disease similar? What are the differences between the two diseases?
Ans: Both are fatal neurodegenerative diseases that can occur in either an inherited or sporadic form. The brains of both CJD and Alzheimer's disease patients contain fibrillar deposits of an insoluble material. In both diseases, these fibrillar deposits result from the self-association of a polypeptide composed primarily of β-pleated sheet. The proteins that form the disease-causing aggregates are completely unrelated. The parts of the brain that are affected are distinct and the protein responsible for Alzheimer's disease does not act like an infectious agent; it is nontransmissable.

Difficulty: Medium
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

78. Human Perspective 2 Questions 2.014
What surprising potential treatment for Alzheimer's disease has been demonstrated in a mouse animal model for the disease?
Ans: A group of investigators was able to create a strain of transgenic mice that developed amyloid brain plaques by introducing one of the mutant genes for human amyloid precursor protein (APP). They were able to block amyloid plaque formation by repeatedly injecting the animals with the same substance that causes the problem, the Aβ42 peptide. This caused the animals to produce antibodies against the peptides made in the brains of the mice by cleavage of the mutant APP protein. They were immunizing the animals against the disease. If the mice were injected when they were younger, they did not develop the amyloid deposits. If older mice whose brains already contained deposits were injected, many of the deposits were cleared out of the nervous system.

Difficulty: Medium
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

79. Human Perspective 2 Questions 2.015
What is presently the most widely accepted cause of Alzheimer's disease? How is the Aβpeptide reputed to cause AD?
Ans: Research on Alzheimer's disease has been dominated over the past two decades by the amyloid hypothesis, which contends that AD is caused by the production of a molecule, the amyloid β-peptide (Aβ). Aβ is originally part of a larger protein called the amyloid precursor protein (APP), which spans the nerve cell membrane. The Aβpeptide is released from the APP molecule following cleavage by two specific enzymes, β-secretase and γ-secretase. The length of the Aβpeptide is somewhat variable. The predominant species has a length of 40 amino acids (designated as Aβ40), but a minor species with two additional hydrophobic residues (designated as Aβ42) is also produced. Both of these peptides can exist in a soluble form that consists predominantly of α helices, but Aβ42 has a tendency to spontaneously refold into a very different conformation that contains considerable β-pleated sheets. It is the misfolded Aβ42 version of the molecule that has the greatest potential to cause damage to the brain. Aβ42 tends to self-associate to form small complexes (oligomers) as well as large aggregates that are visible as fibrils in the electron microscope. Evidence suggests that it is the soluble oligomers that are most toxic to nerve cells, rather than the insoluble aggregates. In the brain, the Aβ42 oligomers appear to attack the synapses that connect one nerve cell to another and eventually lead to the death of the nerve cells.

Difficulty: Medium
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

80. Human Perspective 2 Questions 2.016
What approaches other than immunization are being developed as treatments for Alzheimer's disease?
Ans: Drugs are being developed that inhibit the enzymes that cut the Aβ peptide out of the APP precursor, thereby reducing the production of the Aβ42 peptide. In an alternate approach, small peptides have been synthesized that can bind specifically to the α–helix-rich version of the Aβ42 peptide and prevent it from refolding to the β–pleated-sheet-rich version. These peptides are called β-sheet breakers. They have a sequence of amino acids that is similar to a stretch of hydrophobic residues in the Aβ peptide that are involved in abnormal folding. The β-sheet breakers also contain a proline residue that inhibits the formation of a β-sheet. Injection of these β-sheet breakers into the brain of a rat with amyloid deposits blocks the continued formation of amyloid fibers and reduces the size of existing amyloid deposits. Because peptides are quickly destroyed in the body and generally unable to reach the brain, they are not likely to be very effective as drugs, but nonpeptide drugs with a similar structure have been designed and synthesized and may one day play a role in preventing Alzheimer's disease.

Difficulty: Medium
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

81. Human Perspective 2 Questions 2.017
How is AD thought to develop in persons who suffer from an inherited form of AD?
Ans: Persons who suffer from an inherited form of AD carry a mutation that leads to an increased production of the Aβ42 version. Overproduction of Aβ42 can be caused by possession of extra copies (duplications) of the APP gene, by mutations in the APP gene, or by mutation in genes (PS1, PS2) that encode subunits of γ-secretase. Individuals with such mutations exhibit symptoms of the disease at an early age, typically in their 50s.

Difficulty: Medium
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

82. Human Perspective 2 Questions 2.018
What evidence is the strongest argument favoring amyloid formation as the underlying basis of the disease? What is the strongest argument against the amyloid hypothesis?
Ans: The fact that AD can be caused by mutations in genes that increase amyloid formation. The strongest argument against the amyloid hypothesis is the weak correlation that can exist between the number and size of amyloid plaques in the brain and the severity of the disease. Elderly persons who show little or no sign of memory loss or dementia can have relatively high levels of amyloid deposits in their brain and those with severe disease can have little or no amyloid deposition.

Difficulty: Medium
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

83. Human Perspective 2 Questions 2.019
What basic strategies have researchers been following in the pursuit of new drugs for the prevention and/or reversal of mental decline associated with AD?
Ans: The strategies are to prevent the formation of the Aβ42 peptide in the first place, to remove the Aβ42 peptide (or the amyloid deposits it produces) once it has been formed and to prevent the interaction between Aβ42 molecules, thereby preventing the formation of both oligomers and fibrillar aggregates.

Difficulty: Medium
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

84. Human Perspective 2 Questions 2.020
What is passive immunization? What is the name of the anti-Aβ42 antibody that has proven capable of restoring memory function in transgenic mice and has been shown to be safe and apparently effective in Phase I and Phase II clinical trials?
Ans: Passive immunization involves treating a patient with therapeutic antibodies that the patient does not produce themselves. In the case of passive immunization against Aβ, they administer antibodies directed against Aβ that have been produced outside the body. Bapineuzumab.

Difficulty: Medium
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

85. Human Perspective 2 Questions 2.021
When patients were immunized with Aβ42 in an early trial, many of the patients died of severe dementia but had virtually no amyloid plaques left in their brains. What does this finding strongly suggest? What are some possible interpretations of these results?
Ans: It suggests that removal of amyloid deposits in a patient already suffering the symptoms of mild-to-moderate dementia does not stop disease progression. The results could mean that the amyloid deposits are not the cause of the symptoms of dementia. Alternately, they could mean that irreversible toxic effects of the deposits had already occurred by the time immunization had begun and it was too late to reverse the course of the disease using treatments that remove existing amyloid deposits. It is important to note that amyloid deposits begin to form ten or more years before any clinical symptoms of AD have developed. Perhaps if treatments had started earlier with such patients, the symptoms might never have appeared.

Difficulty: Medium
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

86. Human Perspective 2 Questions 2.022
Which drug presently being tested for its efficacy against AD is a small molecule designed to bind to Aβpeptides and block certain interactions, thereby stopping molecular aggregation and fibril formation? What drug also being tested for use against AD is an NSAID? What is an NSAID? Why was Flurizan tested for its effectiveness against AD?
Ans: Alzhemed. Flurizan. A nonsteroidal anti-inflammatory drug. Some researchers reported that arthritis patients who were taking certain types of NSAIDs were much less likely to develop AD. Later research showed that the NSAIDs with apparent activity in preventing AD also altered the activity of γ-secretase.

Difficulty: Medium
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

87. Human Perspective 2 Questions 2.023
What protein, which functions as part of a nerve cell's cytoskeleton, develops into bundles of tangled cellular fragments and by what name are these bundles of tangled cellular filaments best known? Why have these bundles been largely ignored as a causative factor in AD pathogenesis?
Ans: The protein is called tau; the bundles of tangled cellular filaments are called neurofibrillary tangles or NFTs. They have been ignored largely due to the fact that the transgenic AD mouse models do not develop NFTs. This suggests that NFTs are not required for the cognitive decline that occurs in AD patients.

Difficulty: Medium
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

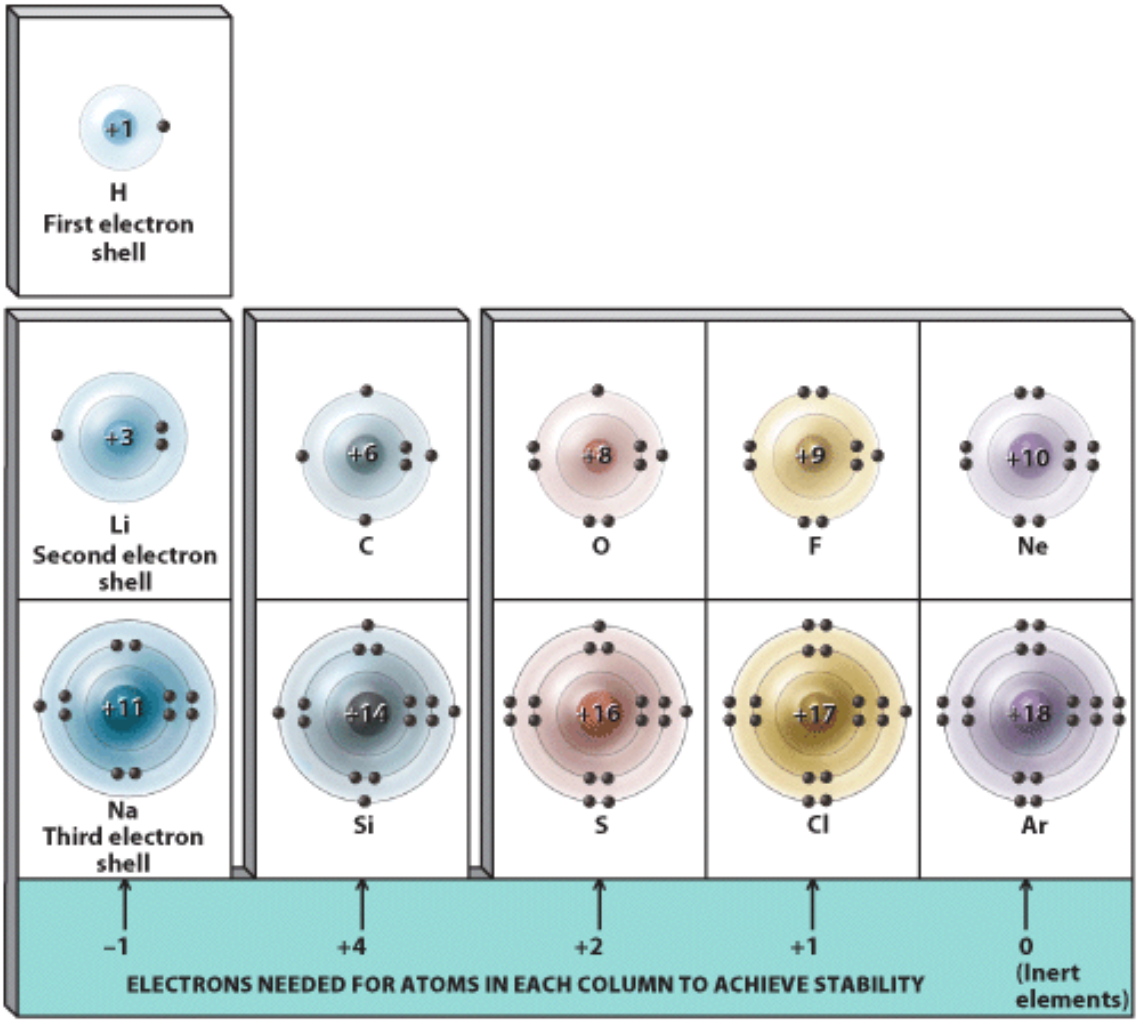
88. Human Perspective 2 Questions 2.024
A new drug has yielded promising results in AD treatments. In tests on more than 300 patients with mild to moderate AD in a Phase II trial, the drug has been found to reduce mental decline over a period of one year by an average of 81% compared to patients receiving a placebo. What is the name of this drug and what does it do?
Ans: The drug's name is methylthioninium chloride (brand name remberTM); it dissolves NFTs.

Difficulty: Easy
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

89. Human Perspective 2 Questions 2.025
What is a randomized, double-blind, placebo-controlled study?
Ans: Patients are randomly divided into two groups that are treated similarly except that one group is given the curative factor being investigated and the other group is given a placebo (an inactive substance that has no therapeutic value). In a double-blind study, neither the researchers nor the patients know who is receiving treatment and who is receiving the placebo.

Difficulty: Medium
Human Perspectives: Protein Misfolding Can Have Deadly Consequences

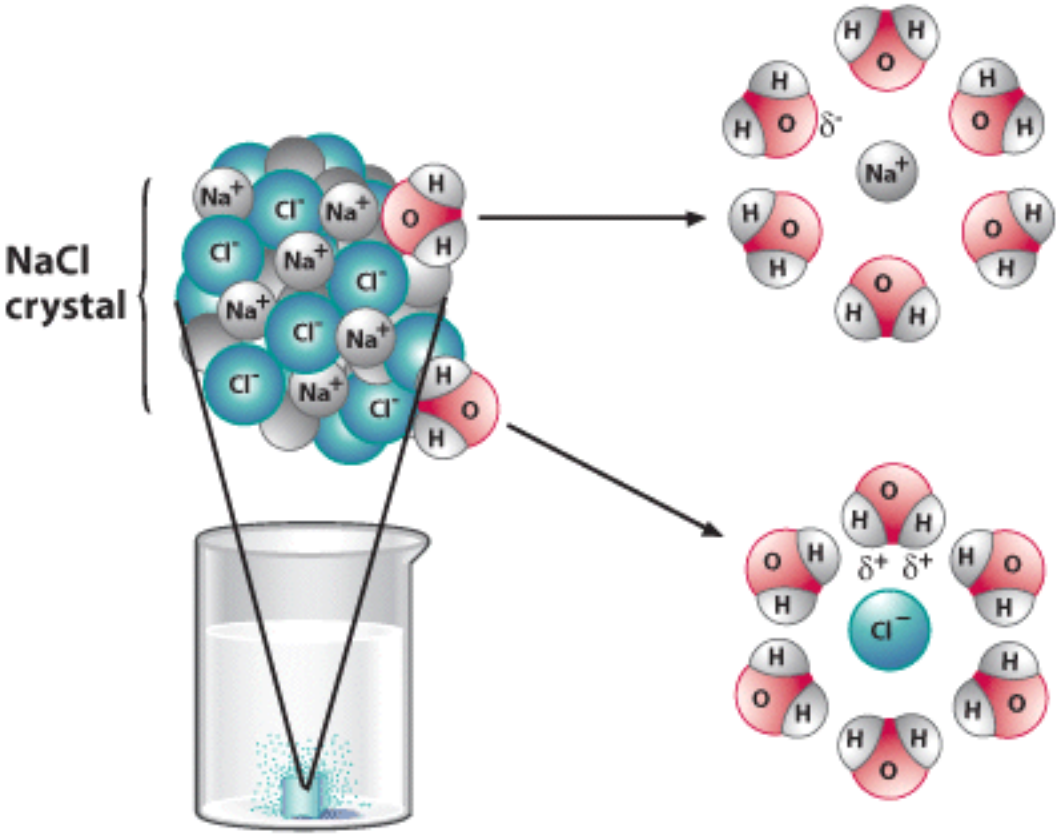
90. Art Question 2.001
Which atom(s) in the figure below are the least reactive and why?



Ans: Neon and argon are the least reactive atoms since they have full outer electron shells. Consequently, they are called inert (noble) gases.

Difficulty: Easy
2.1

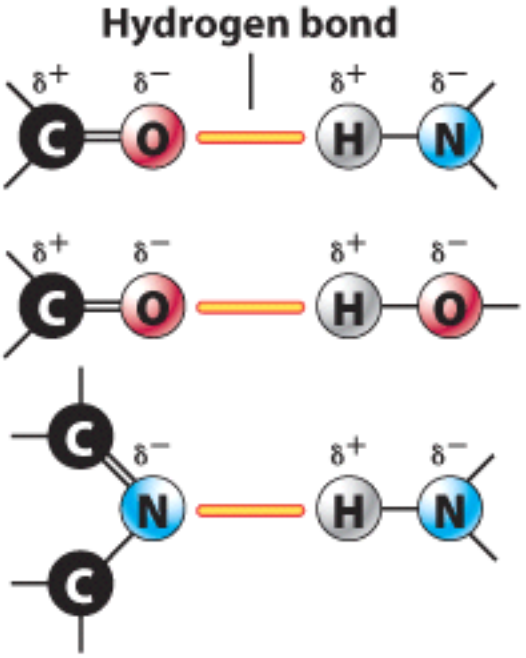
91. Art Question 2.002
In figure below, you see a drawing of a salt crystal held together by ionic bonds. Are ionic bonds plentiful in living organisms? Explain your answer.

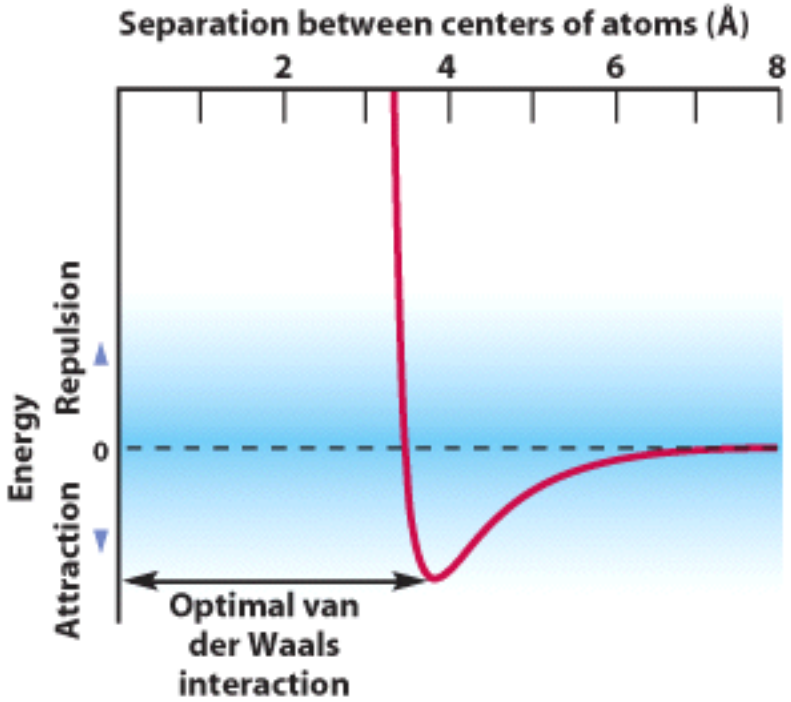


Ans: Ionic bonds are not very common in living organisms since their cells contain so much water, which interferes with such bonds. They can exist in areas of a living cell that restrict water, e.g., in the protein interior where hydrophobic R groups congregate.

Difficulty: Medium
2.2

92. Art Question 2.003
If H bonds are about 180 picometers long (Figure 2.4) and the strongest attraction between molecules participating in a single van der Waals interaction occurs when the molecules involved are separated by about 3.6 Å (Figure 2.6), which interaction is the strongest?





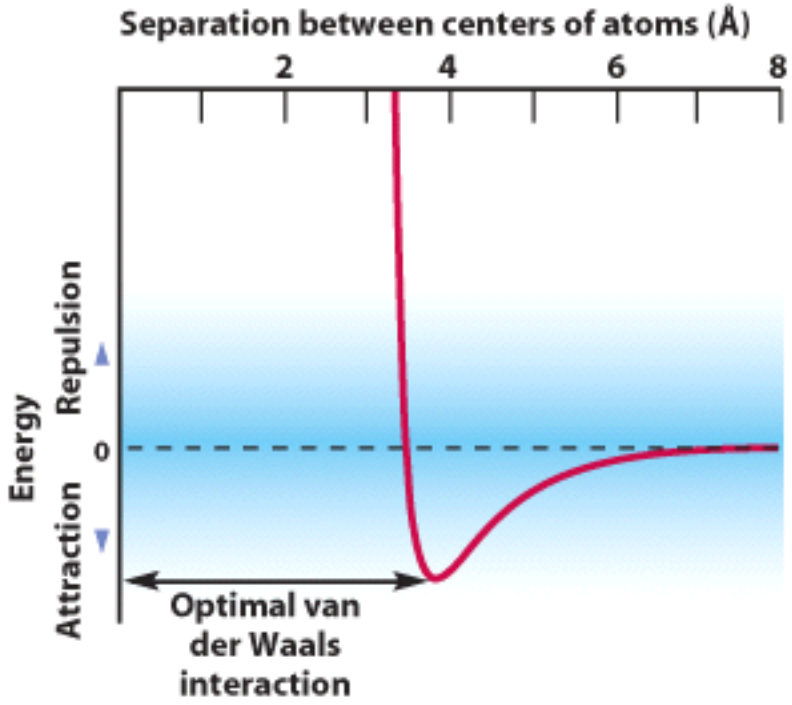
Ans: Since longer bonds are weaker as a general rule, the H bonds would be somewhat stronger than a single van der Waals interaction.

Difficulty: Easy
2.2

93. Art Question 2.004

a) The figure below exhibits the effect of distance on the attraction between two atoms. How would you describe the attraction or repulsion of two such atoms at a separation distance of 6 Å? What about at 4.5 Å? How can you tell from this graph the distance at which the optimal attraction between the two atoms occurs?

b) It is not unusual for a mutation to disrupt interactions such as these significantly. In these cases, one amino acid is often substituted for another. For example, a change in one amino acid in the hemoglobin? β chains leads to the molecular shape changes that cause sickle cell anemia. How could such a change eliminate van der Waals interactions such as those illustrated in the figure below?

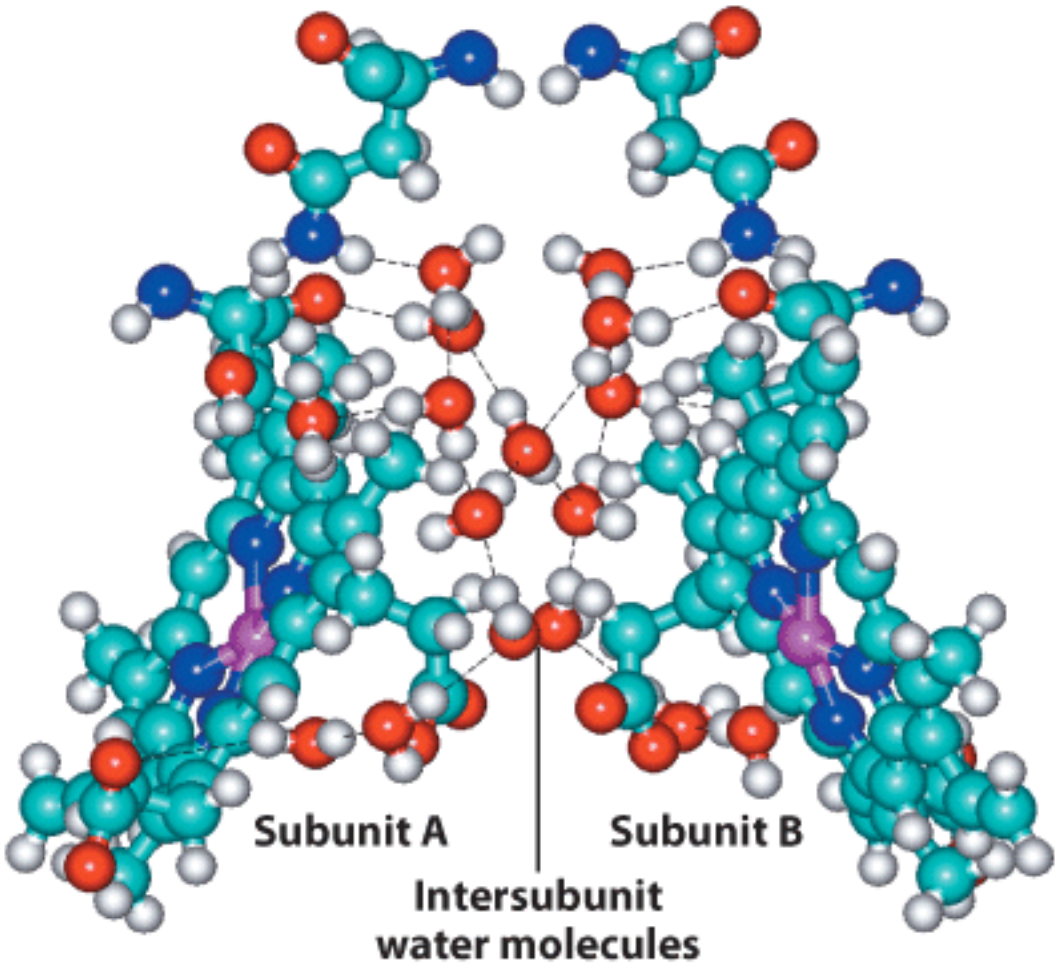


Ans: a) At a separation distance of 6 Å, there is virtually no attraction between two atoms. At 4.5 Å, there is a slight attraction between two atoms. The optimal attraction between the two atoms occurs at a distance of about 3.6 Å. This would be the separation distance on the x-axis corresponding to the point on the graph that projects farthest below 0 on the y-axis.

b) A mutation making a significant change in the polypeptide chain, for example, a hydrophobic amino acid residue exchanged for a polar, charged residue, would be likely to change the tertiary structure of the protein significantly. This might move normally adjacent parts of the molecule that are participating in a van der Waals interaction farther apart. If the distance between these two interacting parts of the molecule were increased by 2-3 Å, the effect would be large enough to abolish the van der Waals attraction completely or nearly so.

Difficulty: Medium
2.2

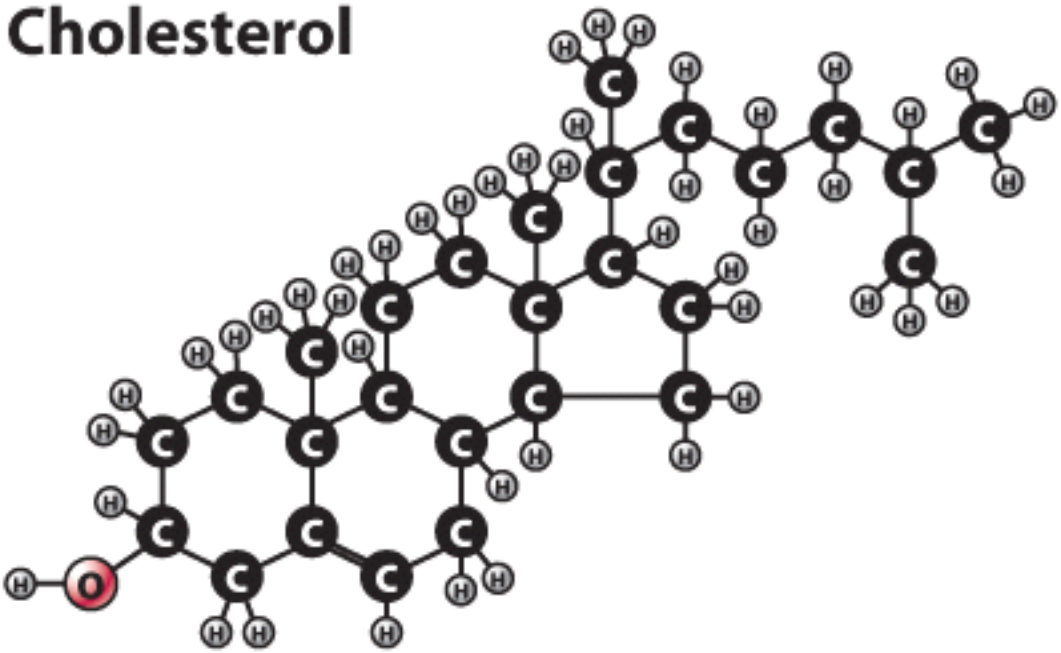
94. Art Question 2.005
The figure below shows the interaction of the two subunits of a clam hemoglobin molecule with water molecules via H bonds. What would be the significance of such interactions with respect to hemoglobin solubility?



Ans: In general, as the number of hydrogen bonds a molecule can make with water increases, the molecule's solubility will also increase.

Difficulty: Medium
2.2

95. Art Question 2.006
The figure below shows a ball and stick drawing of the structure of cholesterol. Are there any functional groups on this molecule that could allow even the slightest interaction with water? If so, what are they? If cholesterol is present in a membrane, which end is most likely to be directed to the outer surfaces of the membrane that are closer to the hydrophilic environments of the cell cytoplasm or the extracellular space?



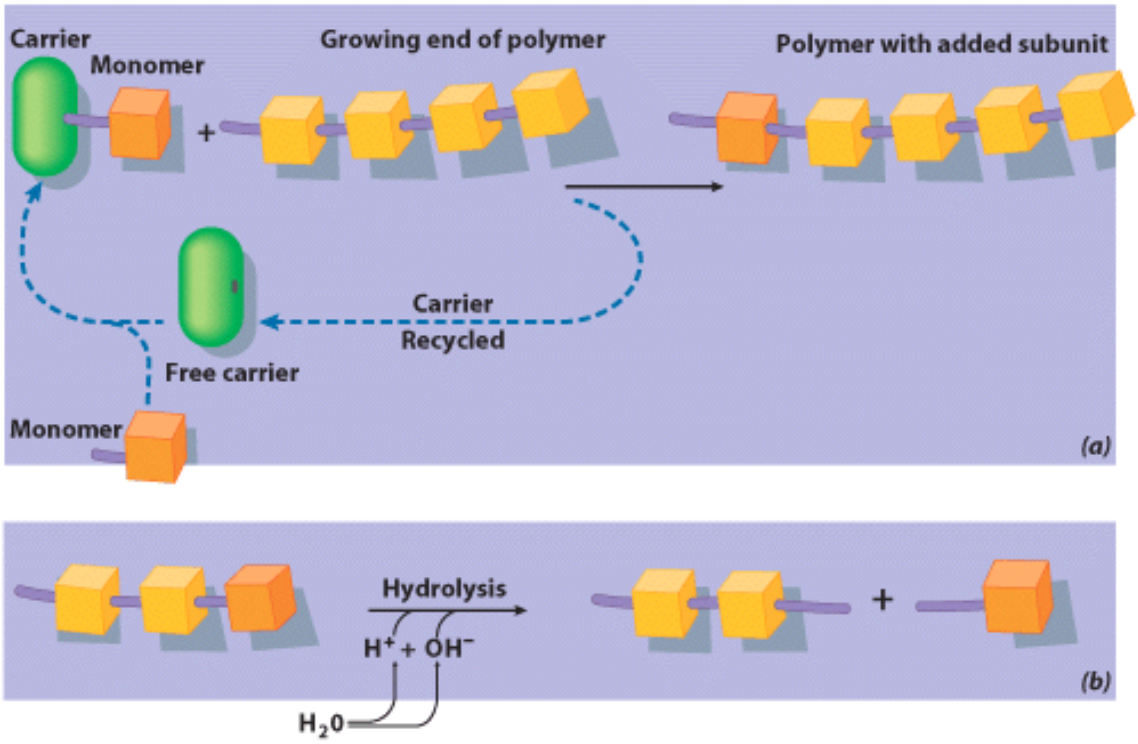
Ans: There is a hydroxyl group on the left side of the first ring in the figure. It could form H bonds with water. The end with the hydroxyl group would be most likely to be exposed to the polar heads of the membrane phospholipids and the hydrophilic environments surrounding the membrane.

Difficulty: Medium
2.4

96. Art Question 2.007

a) The figure below demonstrates that water is released as a byproduct during condensation reactions and reintroduced across the same bond during hydrolysis reactions, resulting in breakage of the bond. If 1000 glucose molecules ($C_6H_{12}O_6$) were hooked together by condensation reactions, how many glycosidic bonds would be found in the resulting polymer? After the formation of this polysaccharide, how many carbon, hydrogen and oxygen atoms are found in the polymer?

b) If a protein consists of 454 amino acids, how many hydrolysis reactions would be required to fully degrade the protein?

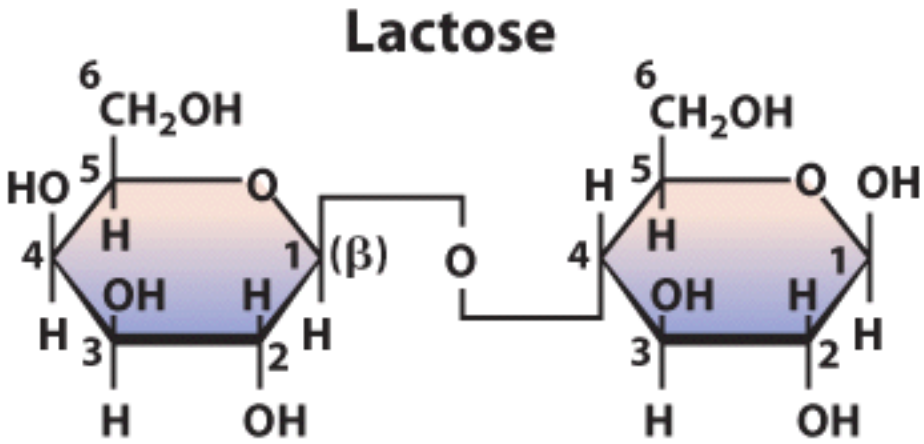


Ans: a) 999 glycosidic bonds. There would be 6,000 carbons, 12,000 hydrogens and 6,000 oxygens in 1000 glucose molecules. Since 999 glycosidic linkages would connect the 1,000 glucose molecules, 999 water molecules would be removed from the entire structure (1,998 hydrogens and 999 oxygens). Therefore, in the polysaccharide, there should be 6,000 carbons, 10,002 hydrogens, and 5,001 oxygens.

b) 453 hydrolysis reactions.

Difficulty: Difficult
2.4

97. Art Question 2.008
Some people are born with or can develop a condition known as lactose intolerance that causes them to suffer intestinal discomfort when they eat lactose-containing dairy products. This occurs because the lactose that can normally be metabolized and passed through the intestinal lining cannot do so in these individuals. Can you suggest an explanation for this? The structure of lactose is shown in the figure below.



Ans: People affected by lactose intolerance lack the enzyme that breaks the β-glycosidic bond between glucose and galactose, the two sugars that combine to form the disaccharide. Therefore, lactose remains in the intestine leading to the symptoms of lactose intolerance. They do possess the enzyme that can break the β-glycosidic linkage between the glucose and fructose of sucrose.

Difficulty: Medium
2.5

98. Art Question 2.009

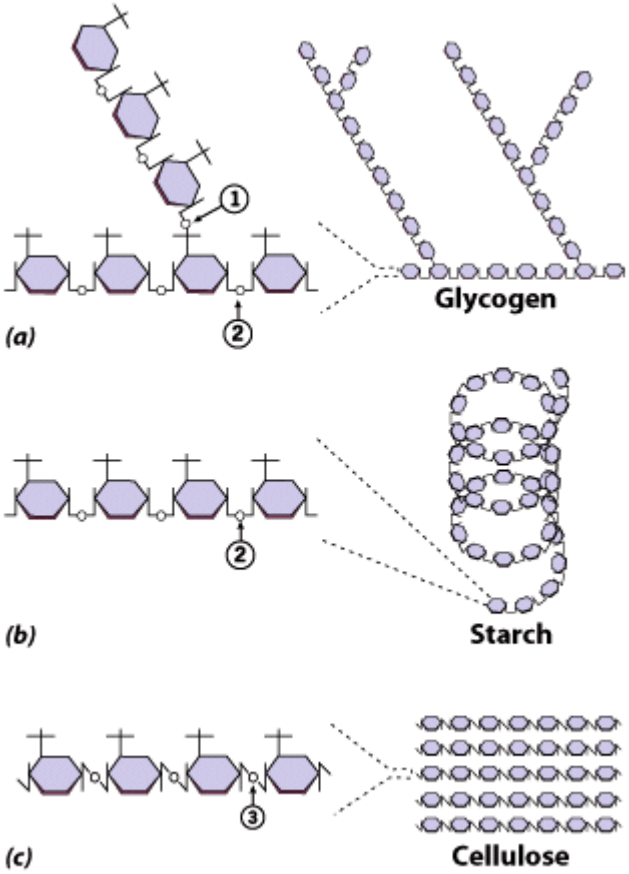
In the figure below, there are schematic drawings of glycogen, starch, and cellulose.

a) Which of these polysaccharides would be most likely to allow the quickest release of glucose monomers during hydrolysis? Why?

b) Which polysaccharide(s) could be used as a fuel source by an organism that lacks enzymes that break α-glycosidic linkages but possesses enzymes that break β-glycosidic bonds?

c) What kind of bond is marked by the number 3 in the figure?

d) What kind of bond is denoted by the number 1 in the figure? What feature of the molecule in question requires this bond? What are advantages of this feature? If this bond could not be formed, what would the molecule look like?



Ans: a) Glycogen. Because it is branched and thus possesses more free ends from which glucose can be released.

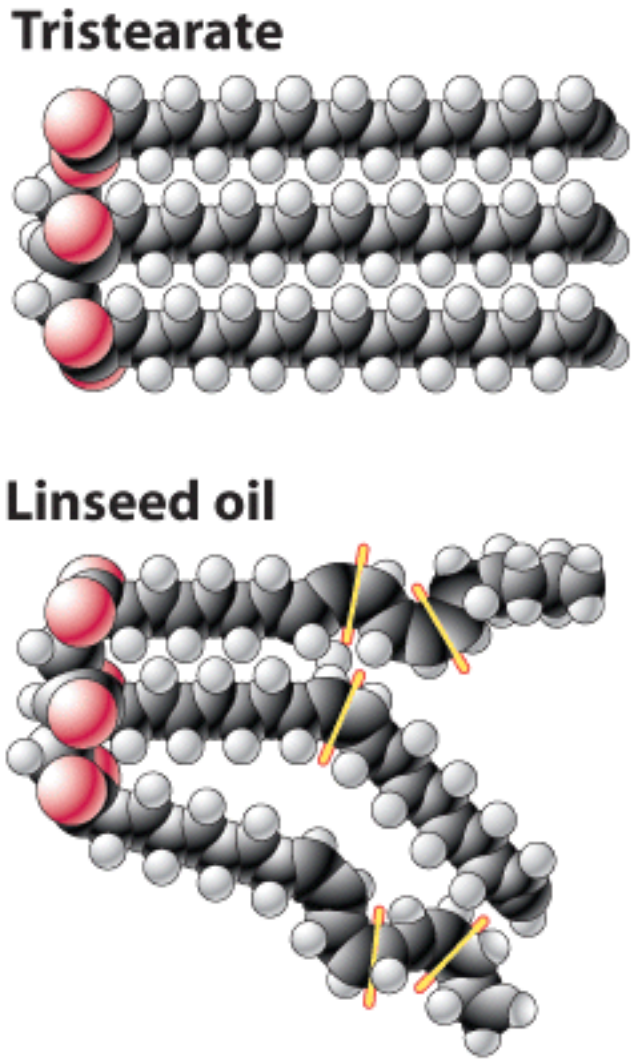
b) Cellulose.

c) β (1—> 4) glycosidic bond.

d) α (1—> 6) glycosidic bond. This bond is required for branching. The advantages are more efficient packing of more glucose residues in a smaller space and more free ends on the molecule to facilitate more efficient and rapid release of glucose monomers when they are needed. Without this bond, the molecule would be linear (or helical like the starch molecule) with no branching. All monomer glucose units would be connected with α(1—> 4) glycosidic bonds.

Difficulty: Medium
2.5

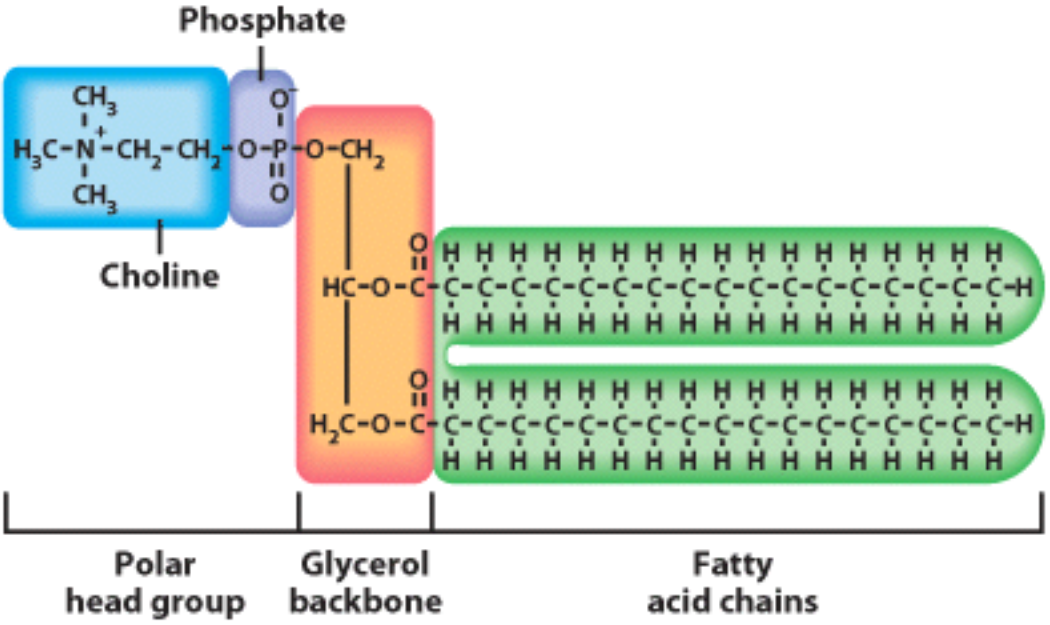
99. Art Question 2.010
Which molecule in the figure below contains double bonds in at least some of its fatty acid chains? Which molecule contains no double bonds in its fatty acids?



Ans: Linseed oil. Tristearate.

Difficulty: Easy
2.5

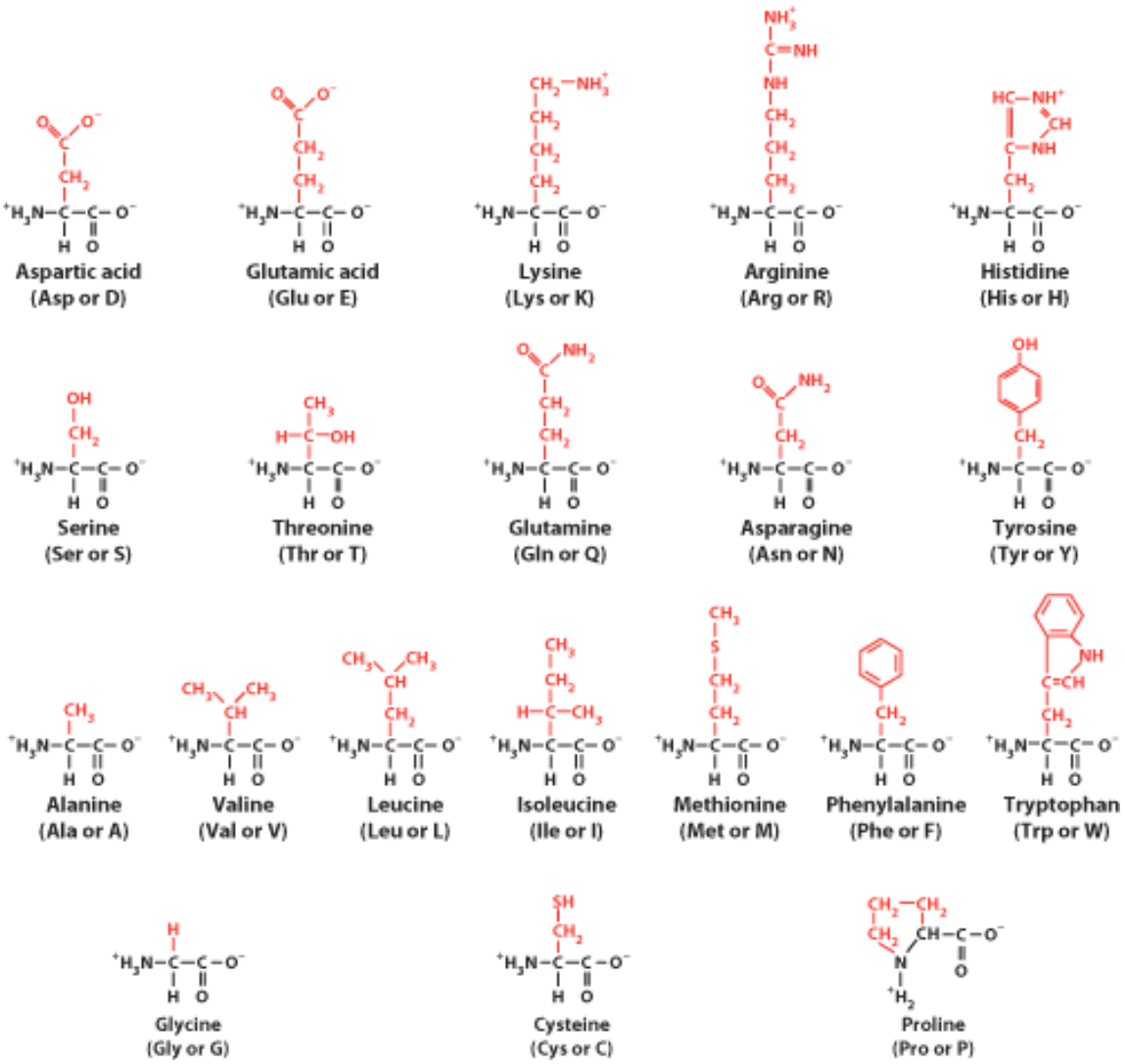
100. Art Question 2.011
Is the phospholipid in the figure below, saturated or polyunsaturated? How do you know?



Ans: It is saturated because the fatty acid tails contain no double bonds. Also, the chains are straight; they would be kinked if they were unsaturated. A kink would occur at each double bond.

Difficulty: Easy
2.5

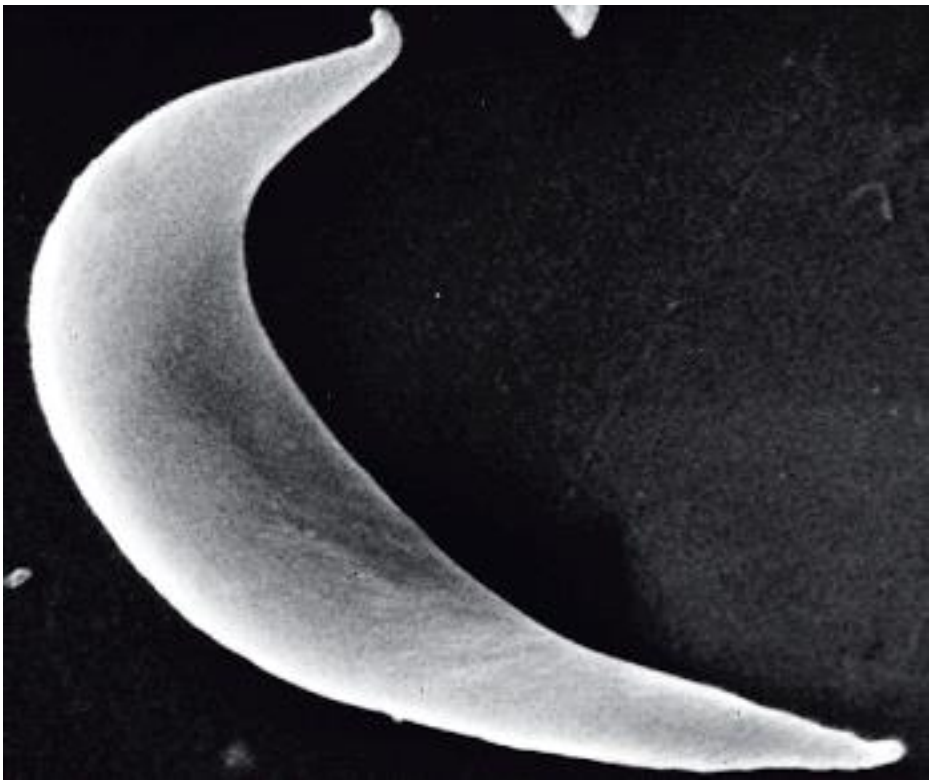
101. Art Question 2.012
Which amino acid in the figure below would be most likely to form covalent bonds between two different polypeptide chains? Which amino acid would be most likely to be found at a kink in an amino acid chain? Which amino acid can fit into either hydrophobic or hydrophilic environments and often resides at sites where two polypeptides come into close contact?



Ans: Cysteine. Proline. Glycine.

Difficulty: Medium
2.5

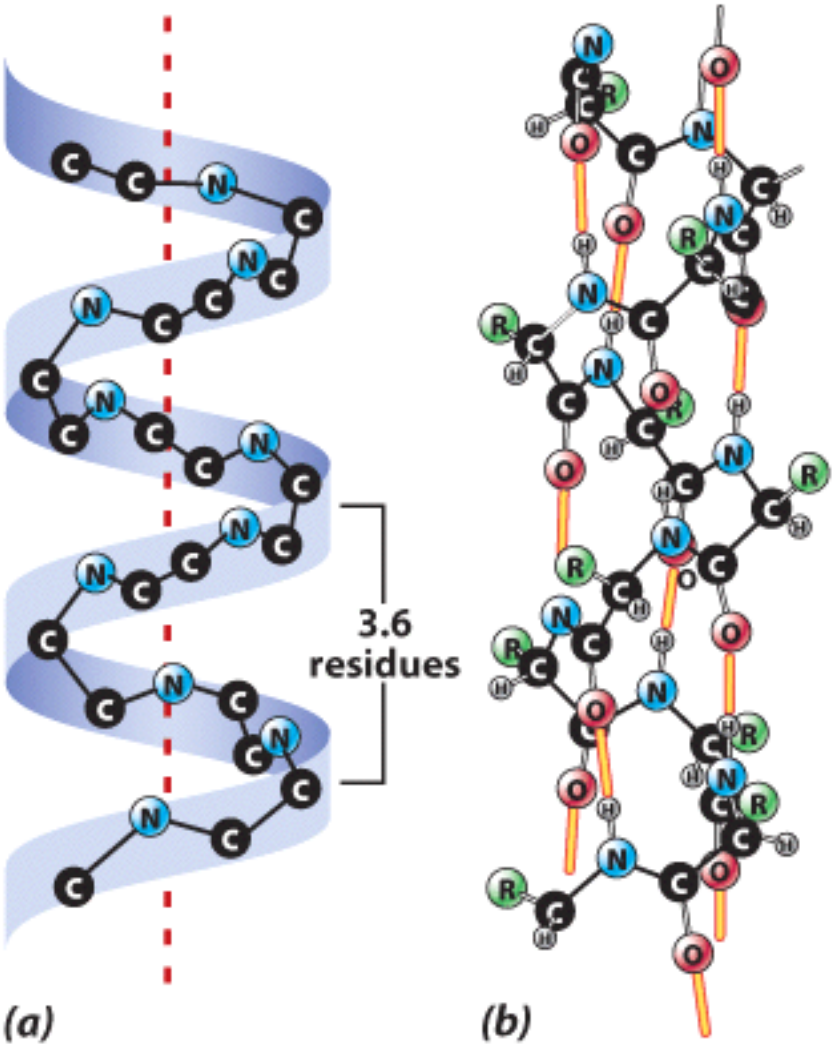
102. Art Question 2.013
In the figure below, there is a scanning electron micrograph of a sickled red blood cell. If hemoglobin were isolated from this cell and others like it and subjected to chromatographic separation after enzymatic digestion, one spot, representing a single peptide, would differ on the chromatograms of normal and sickle cell hemoglobin. How many amino acids are changed in the mutant form of hemoglobin to cause the difference in the two chromatograms?



Ans: The single affected peptide has a one amino acid difference between the normal and mutant forms of hemoglobin.

Difficulty: Medium
2.5

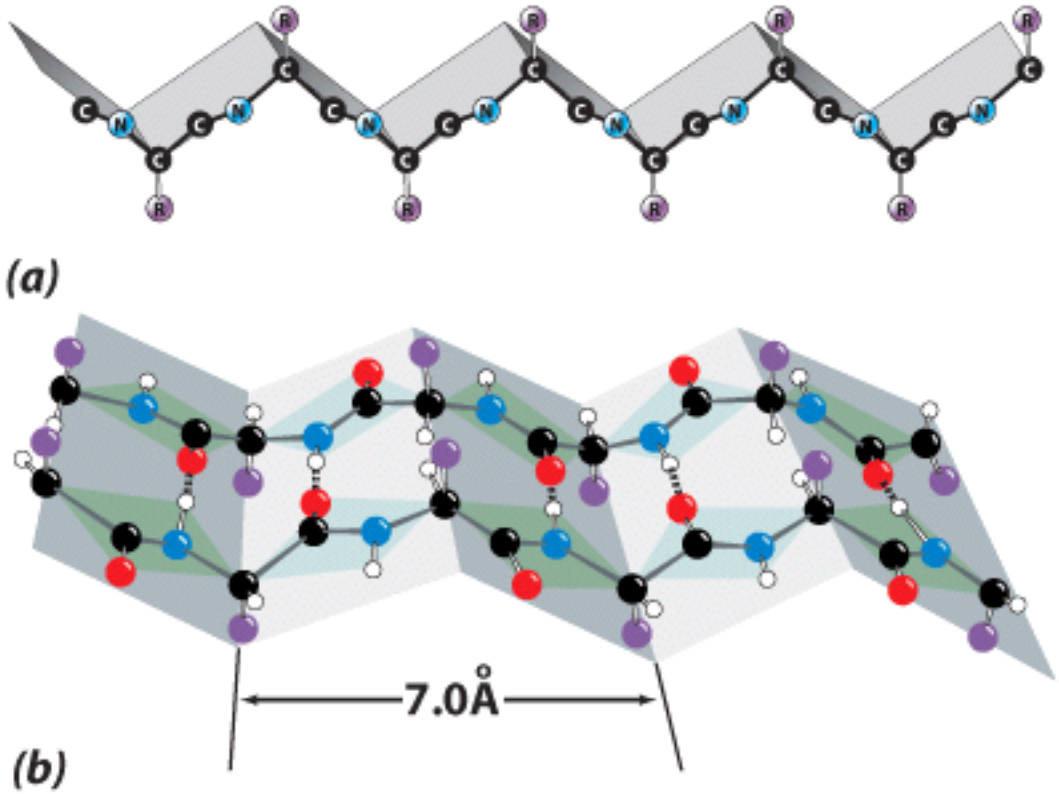
103. Art Question 2.014
Which of the structures shown in the figure below contains H bonds oriented perpendicular to the molecule's axis?



Ans: None of them. All of the structures are α-helix, the H bonds of which are oriented parallel to the molecule's axis.

Difficulty: Easy
2.5

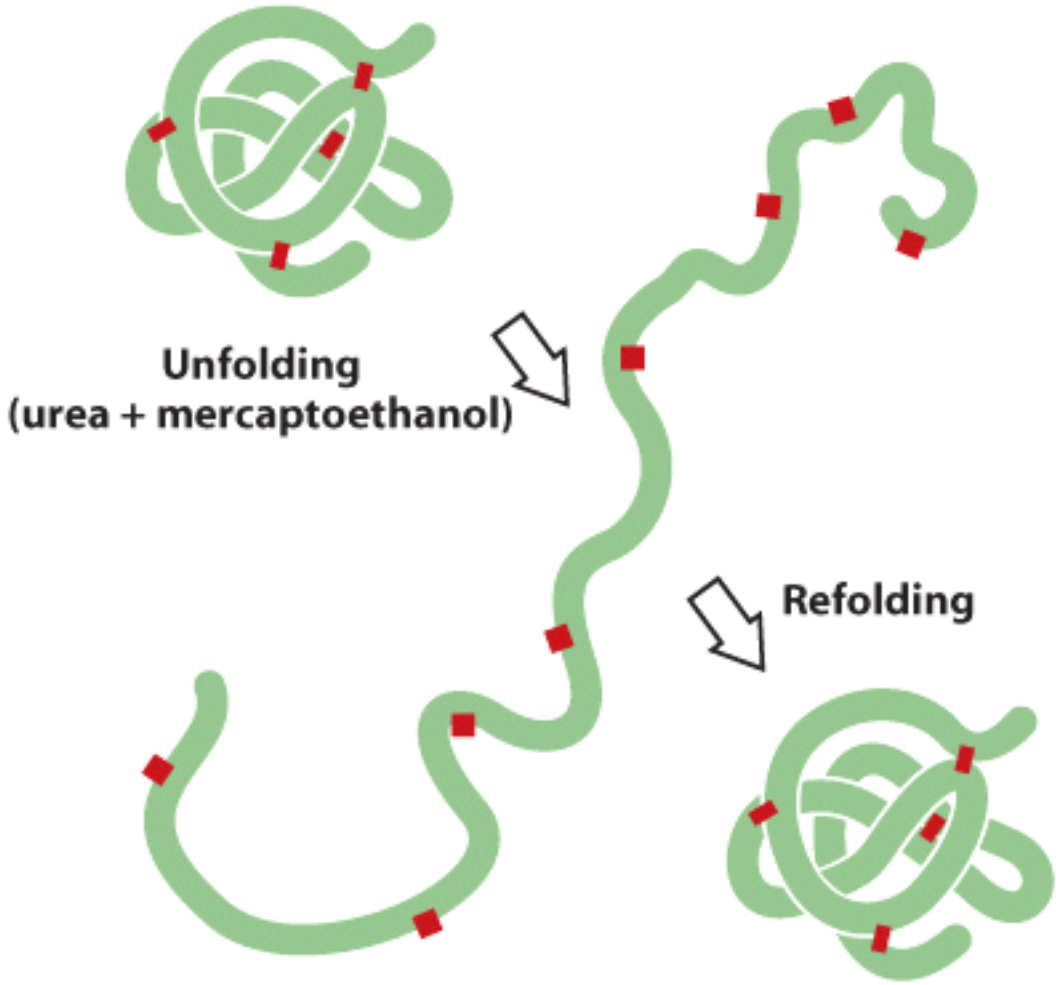
104. Art Question 2.015
Which of the structures shown in the figure below contains H bonds oriented parallel to the molecule's axis?



Ans: None of them. All of the structures are β-pleated sheet, the H bonds of which are oriented perpendicular to the molecule's axis.

Difficulty: Easy
2.5

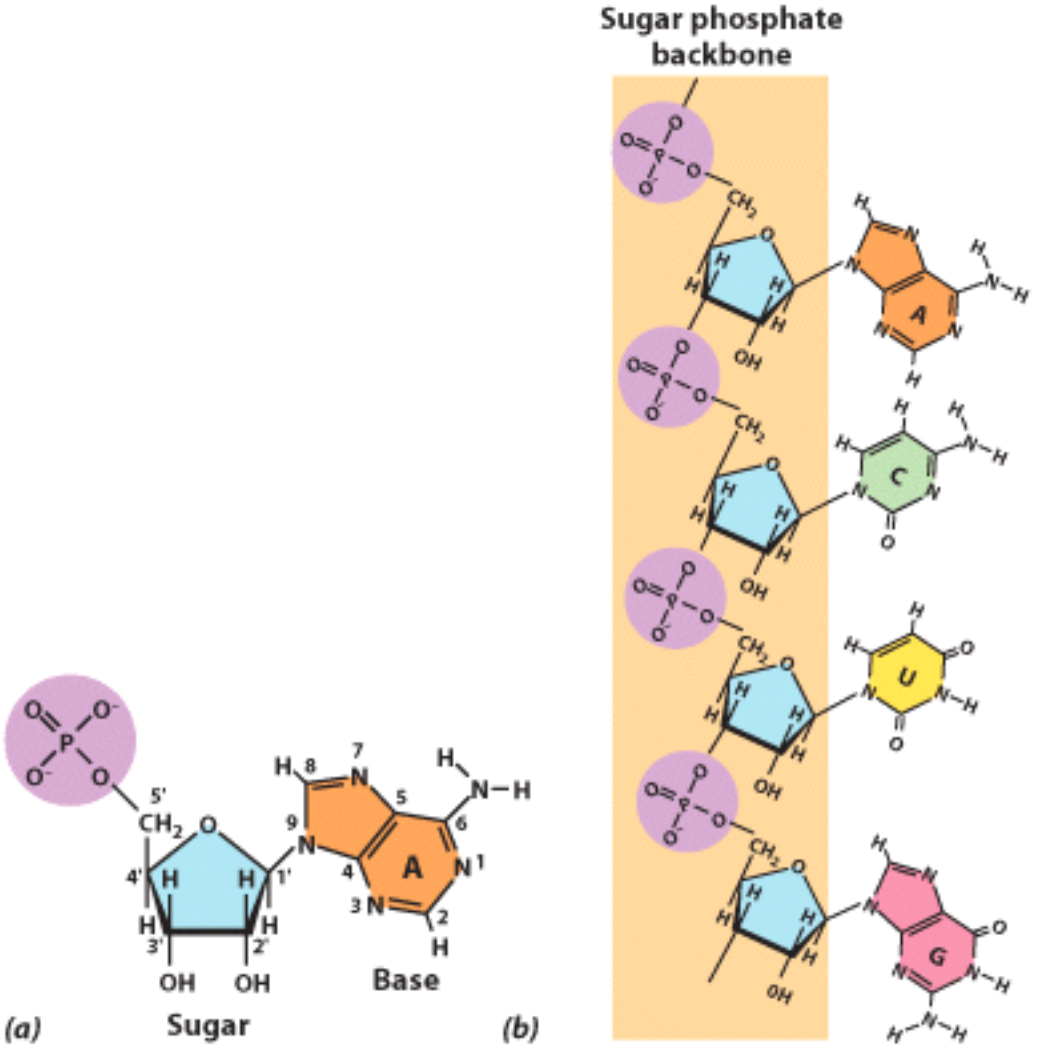
105. Art Question 2.016
The denaturation of ribonuclease is depicted in the figure below. What role in denaturation is played by β-mercaptoethanol?



Ans: β-mercaptoethanol breaks disulfide bonds making denaturation occur more readily.

Difficulty: Easy
2.5

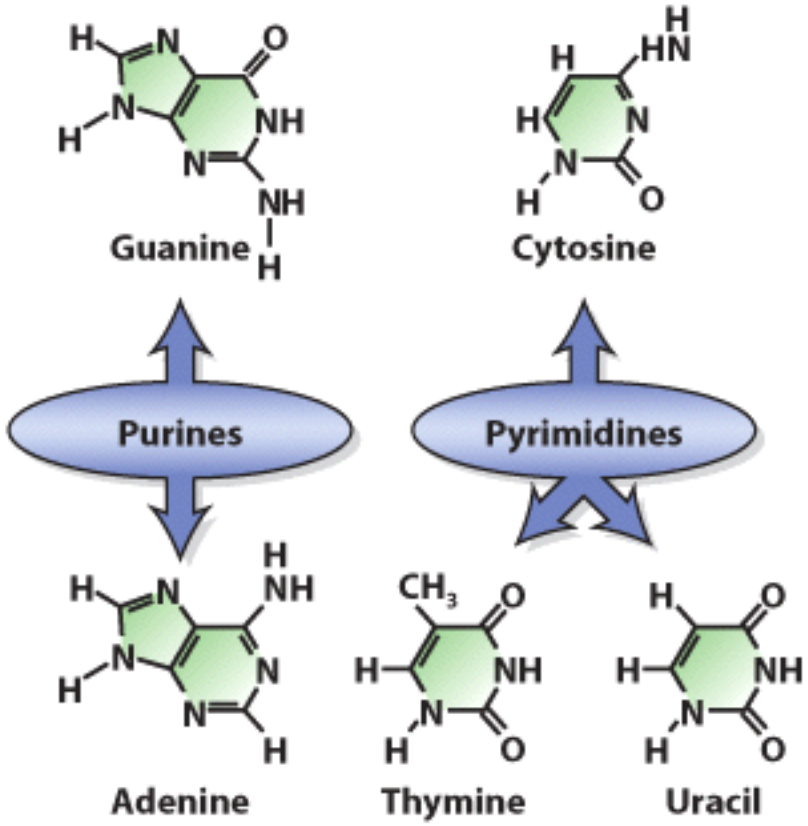
106. Art Question 2.017
In Figure A below, what kind of nitrogenous base appears in the drawing? To which carbon of the nucleotide sugar is it attached? Is the nucleotide in Figure A below a ribonucleotide or a deoxyribonucleotide and how do you know? In Figure B below, which end of the polynucleotide shown is the 5' end and which the 3' end?



Ans: It is a purine base, specifically adenine; it is attached to the 1'- carbon of the nucleotide sugar. It is a ribonucleotide because there is an oxygen atom attached to the 2'-carbon of the sugar. The end of the polynucleotide nearest to the top of the page is the 5' end. The end nearest to the bottom of the page is the 3' end.

Difficulty: Medium
2.5

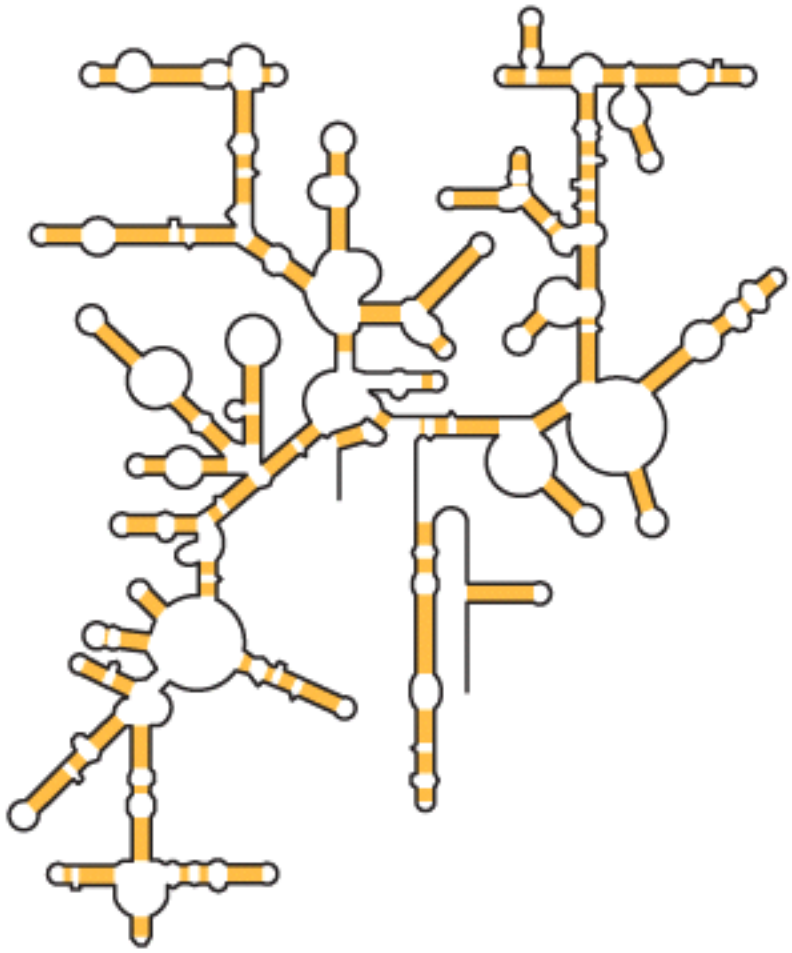
107. Art Question 2.018
Consult the figure below. What is the difference between the pyrimidine nitrogenous bases uracil and thymine?



Ans: Thymine differs from uracil by a methyl group attached to the ring.

Difficulty: Easy
2.5

108. Art Question 2.019
In the figure below, what is the 3-D shape of the shaded areas in the schematic drawing of the ribosomal RNA?



Ans: Since the shaded areas are double-stranded with base pairs between the nitrogenous bases opposite each other, the shaded areas are double helical.

Difficulty: Easy
2.5