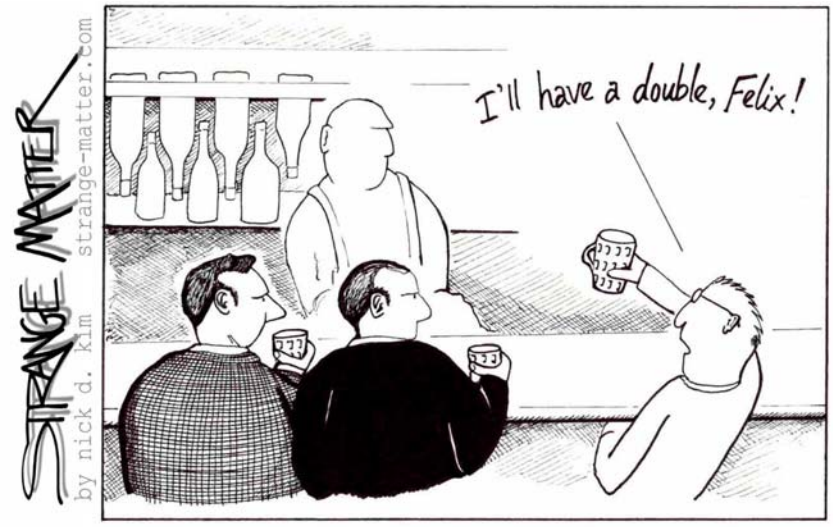
Recitation #01 Problems



Cambridge, 1953. Shortly before discovering the structure of DNA, Watson and Crick, depressed by their lack of progress, visit the local pub.

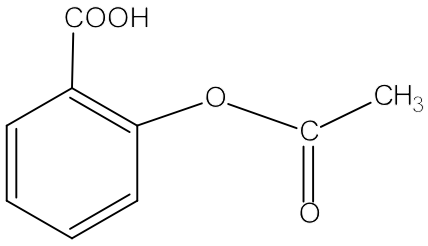
WARM UP

Student Companion, 3-3: Where stereoisomers of biomolecules are possible, only one is usually found in most organisms; for example, only the L amino acids occur in proteins. What problems would occur if, for example, the amino acids in the body proteins of herbivores were in the L isomer form, whereas the amino acids in a large number of the plants they fed upon were in the D isomer form?

QUESTIONS

1. *1995 Exam 1 Question 1—modified*

   Aspirin (acetyl salicylic acid) has a carboxylate with a pKa of 3.5. In order to enter the bloodstream, aspirin must pass through the membrane lining the stomach (pH approx. 1) or the small intestine (pH approx. 6). In general, electrically neutral molecules pass through a membrane more easily than charged molecules. Would you expect more aspirin to be absorbed in the stomach or small intestine? Why?



aspirin (acetyl salicylic acid)

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2. *Stryer, Chapter 3, Question 6:*
   Glycine is a highly conserved amino acid residue in the evolution of proteins. Why?

3. *1998 Exam 1 Question 1 – modified*
   Draw the chemical structure for the peptide with the sequence DPF (denoted in one letter abbreviations). Indicate the chiral centers (if any) as well as all covalent bonds (ignore those to hydrogen) that have free rotation. What is the net charge of the protein at pH 2 and pH 12.

4. *Student Companion, Chapter 3, Question 8*
   In a particular enzyme, an alanine residue is located in a cleft where the substrate binds. A mutation that changes this residue to a glycine has no effect on activity; however, another mutation, which changes the alanine to a glutamate reside, leads to a complete loss of activity. Provide a brief explanation for these observations.

5. *1999 Exam 1 Question 3 – modified*
   (A) Draw the chemical structure of dGTP
   (B) On the drawing in part (a), indicate with an asterisk (*) the nitrogen atom(s) and phosphorous atom(s) that, if radioactive, would lead to incorporation of radioactivity into DNA in an DNA polymerase reaction. Circle the atoms that make hydrogen bonding contact with cytosine in a Watson-Crick base pair. Explain briefly.

6. *2002 PSET*
   Write DNA, RNA, or BOTH next to the appropriate nucleic acid property:
   a) Contains a 3' oxygen
   b) Contains a 2' oxygen
   c) Uracil is a component base
   d) Thymine is a component base
   e) Adenine is a component base
   f) Typically double-stranded
   g) Typically A-form when double-stranded
   h) Typically B-form when double-stranded
   i) Contains phosphate backbone
   j) Can be covalently modified
   k) Half-life of less than 1 year
   l) Polymerization associated with proofreading activity

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7. *Modified exam question:*
Suppose you were given two strains of E. coli that were identical except that one strain lacked proofreading activity in a DNA Polymerase (the "mutant" strain). Not surprisingly, upon analyzing the DNA in the mutant strain, you find that there are errors that are made during replication. Curiously, you find the errors in the DNA from the mutant strain are found in local regions, separated by much longer regions of low-error DNA that are thousands of nucleotides in length. What is the most likely explanation for these results?

8. *Student Companion, Chapter 2, Question 5*
DNA has a remarkable ability to preserve complex information perfectly intact for millennia. Would it be a favorable situation if DNA could always be reproduced with absolutely no errors, and never had any mutations?

9. Why did the professor reverse the charges on the Isoelectric focusing gel overhead. Another words, why is low pH associated with a positive charge? Define it in terms of proteins and charges and pH.

10. *Exam 1 1995, Question 3*
Why would it be a mistake to add SDS to an isoelectric focusing gel?

11. *2002 PSET*
You are given a mixture of the following four peptides. Describe a protein purification scheme to purify each of the four peptides at physiological pH.

Glu-Ala-Asp	Trp-Ala-Ala-Lys-Arg-Gly-Trp-Lys
Trp-Lys-Ala	Gly-His-Glu-Asp-His-Glu-Pro-Ile

12. *Stryer, Chapter 5, Question 4*
What result would Meselson and Stahl have obtained if the replication of DNA were conservative? Give the expected distribution of DNA molecules after 1.0 and 2.0 generations for conservative.

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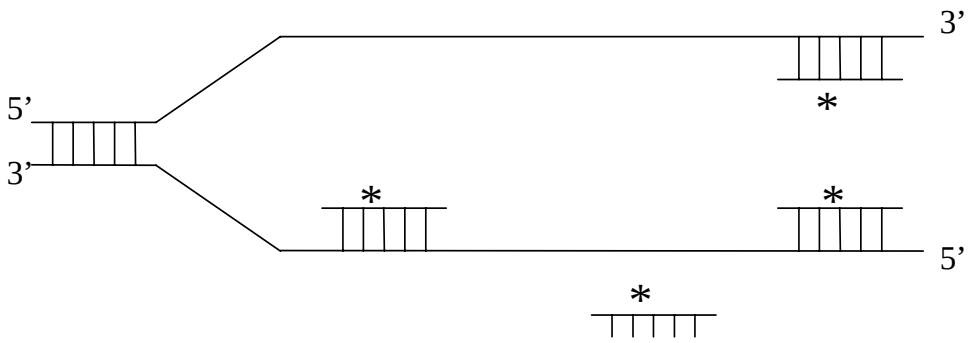
13. The fork



A) Label the leading and lagging strands
B) Indicate the overall direction of movement of the replication fork
C) Indicate where DNA will be polymerized from RNA Primers
D) Label an Okazaki fragment
E) Indicate position of DNA helicase
F) List in order of function the proteins involved in DNA replication

14. *Stryer, Chapter 27, Question 3*
An archaeon found in acidic hot springs contains a topoisomerase that catalyzes the ATP driven introduction of positive supercoils into DNA. How might this enzyme be advantageous to this unusual organism?

15. *2002 PSET 3*
The following pre-mRNA sequence is from a small, fictitious mammalian gene called XMPL1.

5’ucauaggacuaucgaugacuauuggacaaauauuagcaauuagguaaguacuucagauguauuuggaguagcauucca

ccaggguacuucuccucuacaggucaaggaccaauaaauagaugaauuacugcgcauaauaaaucaggacuuguaaggg3’

a. Indicate sequences that code for the translation start site, 5’ and 3’ splice sites and branch site, and the polyadenylation signal.

b. Draw the sequence of the intronic RNA removed in splicing and indicate which nucleotides are linked by a 5’-2’ ester (use letters- do not draw chemical structures). What type of structure does the intronic RNA form after splicing?

c. How would the XMPL1 protein be different if you expressed the gene in E. coli?

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16. Stryer, Chapter 28, Question 11
Cordycepin inhibits poly(A) synthesis at low concentrations and RNA synthesis at higher concentrations but does not inhibit DNA Pol I or Pol III.

(a) What is the basis of inhibition of cordycepin?
(b) Why is poly(A) synthesis more sensitive to the presence of cordycepin?
(c) Does cordycepin need to be modified to exert its effect?
(d) Why does it not inhibit DNA Pol I or Pol III but does inhibit RNA Polymerases?