

[2 pts] Feature(s) of DNA found in the Watson-Crick model of B-DNA include:

- a) two antiparallel polynucleotide chains coiled in a helix around a common axis.
- b) the pyrimidine and purine bases lie on the inside of the helix.
- c) the bases are nearly perpendicular to the axis.
- d) all of the above.
- e) none of the above.

[5 pts] The protein enzymes listed below all function in interactions with DNA. The binding of these proteins to DNA are either independent or dependent on the nucleotide sequence of the DNA with which they interact. From what you have learned about the principles of protein/DNA interactions, classify each protein's basis of interactions with DNA as:

- d** (Dependent on the DNA nucleotide sequence) or
- i** (Independent of the DNA nucleotide sequence)

Write **d** or **i** in the space provided

- _____ *Sa*/I restriction enzyme
- _____ Deoxyribonuclease I
- _____ DNA ligase
- _____ *Eco* RV restriction enzyme
- _____ *Thermus aquaticus* (*Taq*) DNA polymerase [for PCR]

[2 pts] **Circle the correct answer(s): B-DNA** occurs in cells most often in base paired regions of (mRNA, RNA-DNA hybrids, **DNA**, both RNA and DNA).

[2 pts each] **ANSWER TRUE OR FALSE**

- _____ Proteins whose binding to DNA is dependent on the specific base sequence of the DNA generally form hydrogen bonds between amino acids and functional groups located in the major groove of the DNA B helix.
- _____ The exact 3-dimensional structure of DNA is independent of its base sequence.
- _____ Proteins whose binding to DNA is not dependent on specific base sequences generally form hydrogen bonds with the sugar-phosphate backbone of the DNA B helix.

[12 pts] ****READ ALL PARTS OF THIS QUESTION BEFORE ANSWERING ANY OF IT****

Circular DNA from SV40 virus was isolated and subjected to agarose gel electrophoresis. The results are shown in **lane A** (the control) of the adjoining gel patterns. DNA migrates in this gel from top (-) to bottom (+)

[2 pts] On what basis does the DNA separate in agarose gel electrophoresis?

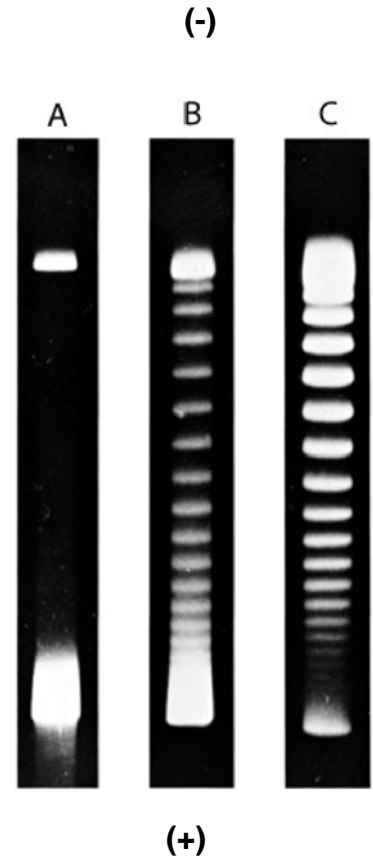
[4pts] How does the DNA in each band in **Lane A** differ?

The DNA was then incubated with topoisomerase I for 5 minutes and again analyzed by gel electrophoresis with the results shown in **lane B**.

[2 pts] What types of DNA do the various bands in **lane B** represent

Another sample of DNA was incubated with topoisomerase I for 30 min and again analyzed as shown in **lane C**.

[4 pts] What is the reason that more of the DNA is in slower moving forms in **lane C**?



[24 pts] 6) Match the molecules or structures in the left hand column with the function or features related to *E. coli* DNA replication in the right hand column. **[2 pts for each correct answer. Some answers are used more than once]**

PUT NUMBERS IN SPACES GIVEN

- | | |
|--|--|
| _____ Proofreads most of the newly-synthesized DNA | 1) Replication fork |
| _____ Joins lagging strand pieces together | 2) origin of replication |
| _____ Is an RNA polymerase | 3) Lagging strand |
| _____ Prevents unwound DNA from reforming base-paired helix | 4) leading strand |
| _____ Is synthesized discontinuously | 5) DNA helicase |
| _____ Relieves stress introduced by positive supercoiling | 6) single-strand binding protein |
| _____ Removes RNA primers | 7) DNA gyrase |
| _____ requires ATP to add negative supercoils to DNA | 8) Primase |
| _____ First place where primosome functions | 9) DNA polymerase III holoenzyme (an asymmetric dimer) |
| _____ Polarity of synthesis is opposite to replication fork movement | 10) DNA polymerase I |
| _____ Unwinds DNA at replication fork | 11) DNA ligase |
| _____ Synthesizes most of DNA during replication | |

[5 pts] How long would it take for *E. coli* DNA polymerase III to replicate the *E.coli* chromosome (4×10^6 base pairs) from 2 replication forks? **[Assume that Pol III can add 1,000 bases/second to each daughter strand being synthesized]**. Ignore removal of primers and filling gaps with Pol I.

[5 pts] If *E. coli* DNA polymerase I was needed to replicate all of the *E.coli* chromosome (4×10^6 base pairs) from 2 replication forks, how long would this replication take ? **[Assume that Pol I can add 20 bases/second to each daughter strand being synthesized]**. Ignore the need to remove primers and fill in gaps.

- Do Problems 5, 9 and 13 at end of Chapter 28.

Mutations and DNA Repair:

[9 pts] 3) In the left column, write nine (9) correct letters of corresponding items in the right column.

_____	Thymine dimer repair	A. DNA polymerase I
_____	Removal of uracil	B. MutHLS
_____	Mismatch repair	C. uvrABC excinuclease
		D. Uracil-DNA glycosidase
		E. DNA polymerase III
		F. DNA ligase

ANSWER TRUE OR FALSE

- _____ Mutations called transitions involve replacement of one pyrimidine base by the other.
- _____ Mutations called transversions involve replacement of a purine base by a pyrimidine base.
- _____ UV light causes formation of covalent links between thymine bases on opposite DNA strands.
- _____ A DNA repair system can distinguish thymine from uracil formed by deamination of cytosine.
- _____ Acridine dyes cause transversion mutations.
- _____ DNA repair enzymes probably interact with DNA by binding to specific base sequences.
- _____ A highly reactive, chemically-modified aflatoxin can cause mutations after linking to adenine in DNA.

Fill in the Blank Questions

_____ is a left-handed double helix.

DNA can serve as a _____ to direct synthesis of the complementary strand of DNA or RNA.

The small DNA pieces observed during DNA replication called _____ fragments have a short stretch of _____ at the 5' end .

Proteins that use ATP to melt (unwind) the DNA at specific sites are called _____.

The ends of eukaryotic chromosomes are called _____.

An assay used to determine carcinogenic potential is the _____ test which measures frequency of _____ of a mutant to a normal (wild-type) gene.

The topological state (degree of _____) of DNA can be modified by the enzymes known as _____.

The primer for DNA synthesis is an RNA molecule formed by the enzyme _____.

The DNA strand that is replicated continuously is known as the _____ strand.

DNA polymerase III is approximately _____ times faster than DNA polymerase I.

During DNA replication, the RNA primer pieces are removed by _____.

UV light causes damage to DNA by forming _____.

The human, genetic skin disease, caused by a mutation in components of the human nucleotide-excision-repair pathway is called _____.

_____ are intermediates in recombination pathways composed of four polynucleotide chains in a cross-like structure.

Multiple Choice Questions

How can the leading and lagging strands be synthesized in a coordinated fashion?

- A) Specific enzymes control the size of the DNA opening.
- B) Lagging-strand binding proteins inhibit leading-strand replication if the strands become disproportionate in size.
- C) Pol III is a dimeric holoenzyme, and the looped lagging strand allows the enzyme to proceed in the same direction with each strand.
- D) All of the above.
- E) None of the above.

Common types of mutations include

- A) the mismatch of bases in the DNA.
- B) the deletion of one or more bases in the DNA.
- C) the insertion of one or more bases in the DNA.
- D) b and c.
- E) a, b, and c.

Huntington's disease is caused by

- A) pyrimidine dimers.
- B) trinucleotide expansion.
- C) suppressor mutants.
- D) all of the above.
- E) none of the above.

Aflatoxin B1 is an example of a(n)

- A) intercalating chemical.
- B) alkylating agent.
- C) base analog.
- D) all of the above.
- E) none of the above.

Short-Answer Questions

1. Describe, in simple terms, some hallmark characteristic features of DNA structure.
2. Compare some major features of A- and B-DNA.
3. What features of real DNA did x-ray analysis of crystallized DNA reveal that are different from the original Watson-Crick model of DNA?
4. How do DNA topoisomerases (Types I and II) change the state of supercoiling of DNA?
5. How are breaks sealed in discontinuous lagging strand DNA fragments that are formed during replication?
6. What is a processive polymerase enzyme?
7. How is the processivity of DNA polymerase III accomplished?
8. How are single-stranded regions of DNA maintained during replication?
9. Describe the consequences of incorrect DNA replication or DNA damage.
10. Why is thymine used in DNA instead of uracil?