

Biology 13 2024 Winter Term - Exam 1

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Directions: Please put your name on **ALL** pages. Point values for each question are indicated and should serve as a rough guide for the amount of time you spend and/or the amount of writing you do. There are **50 points total**. You have 90 minutes to complete this exam. Good luck.

You must confine your answers to the page on which each question appears. **DO NOT WRITE ON THE BACK OF ANY EXAM PAGE** (answers on the back will not be graded). The space provided for each question should be sufficient for your answer.

You cannot hand in extra pages that contain answers.

You have 90 minutes to complete this exam. Please pace yourselves accordingly.

Remember the ideals of academic honor, as exemplified by the Dartmouth Honor Principle. Please keep these tenets in mind while completing this exam. Thank you.

NOTE: Use of ANY electronic device is prohibited during the exam.

In accordance with the Dartmouth Honor Principle, my signature below indicates that I submit this examination paper as totally my own, having neither received nor provided aid from or to anyone, during the course of the examination. My signature also indicates that all electronic devices (computers, phones, watches, calculators) have been placed in my bag or backpack for the duration of the exam.

Signature Jason Jiao Date 1/16/24

True/False. If false, state why it is false, and correct the statement if possible. (15 pt. total)

a) In ATP, adenosine attaches to ribose at the C3' position, and phosphates are attached at the C5' position.

False, adenosine attaches to ribose at C1' position

b) In all organisms with double stranded DNA genomes, the molar amounts of A+T equal the molar amounts of G+C.

False, molar amounts of $A+G = T+C$

c) Histone acetyl transferases alter chromatin structure resulting in a transcriptionally repressed state.

False, the result is actually transcriptionally active

d) Bacteria like *E. coli* produce multiple protein products from the same gene via alternative splicing.

True

e) Promoters with a poor match to the -10 and -35 consensus sequences result in RNA polymerase moving more slowly as it transcribes the gene.

False, RNA pol will have less efficiency binding but not necessarily move slower

f) In RNA synthesis, the alpha (α) phosphate of a nucleotide triphosphate is incorporated into the growing RNA chain.

False, it's the gamma phosphate

g) Griffith's experiments definitively demonstrated DNA was the genetic material that was responsible for the "transforming principle".

False, Griffith realized there was a "transforming principle" but didn't identify it as DNA specifically. Avery, Macleod, McCarty demonstrated this.

h) Viral genomes can consist of DNA or RNA and can be either single stranded or double stranded.

True

i) The polyA tail is added to the 3' end of the pre-mRNA by RNA polymerase II.

False, the proteins actually involved with adding the tail are CPSF, CstF, CFI, CFII, and PolyA polymerase

j) The Meselson-Stahl experiment would have given the same results if isotopes of sulfur had been used in place of nitrogen.

False, DNA does not include sulfur in its structure

k) A sequence corresponding to the poly A site is present in DNA.

False, they are added by Poly(A) polymerase

l) DNA helicases relieve torsional stress in DNA by cutting and rejoining DNA strands.

False, DNA gyrase does this, not helicase

m) Rho independent (i.e., intrinsic) transcription termination in *E. coli* does not require the activity of any proteins/enzymes.

True

n) Mutations in the -35 promoter region of bacterial promoters that make the sequence a poorer match to the consensus function primarily to lower the rate of closed complex formation.

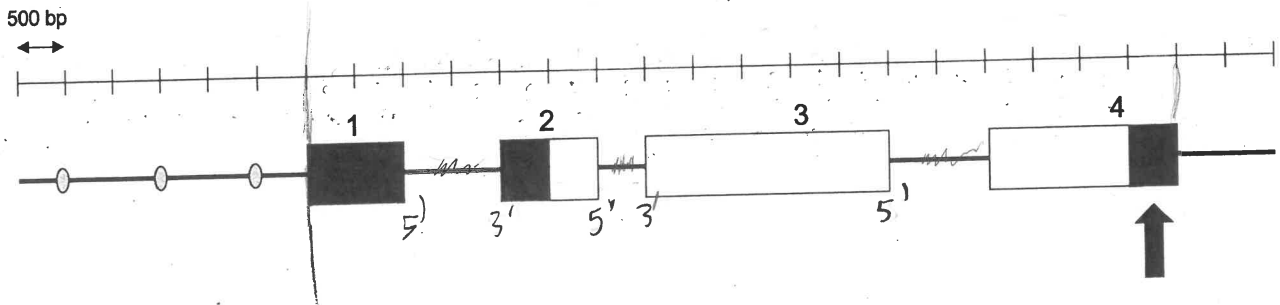
True

o) Repetitive DNA in intergenic regions is important for controlling the transcription of adjacent genes.

False, intergenic DNA does not do this

Short Answer. Point values vary.

- 1) The figure below shows a diagram of a region of a eukaryotic chromosome. The exons (boxes) for a single gene are shown. The white boxes indicate the coding region. The location of all of the important transcriptional regulatory elements (enhancers) in the control region for this gene are indicated by ovals. The ruler above provides a size scale. The gene is transcribed left to right (i.e. the 5' end of the mRNA is in exon 1). (10 pt total)



- a) How many introns does this gene have? (0.5 pt)

3

- b) How large is the mature mRNA for this gene? (2 pt)

$$13.500 = 6500 \text{ bp}$$

- c) What is the arrow on the right indicates? (1 pt)

3' UTR

- d) How large (in amino acids) is the protein? (1 pt)

$$(9.500)/3 = 1500$$

$$1500 - 1 = 1499$$

stop codon

- e) How large (in base pairs) is the gene? (2 pt)

$$23.500 = 11500 \text{ bp}$$

- f) Using the numbering system we discussed for genes, define the position of:

- a) the AUG (the start codon for the protein) (0.5 pt)

$$+2500$$

- b) the stop codon (0.5 pt)

$$17.500 = 8500 + 8500$$

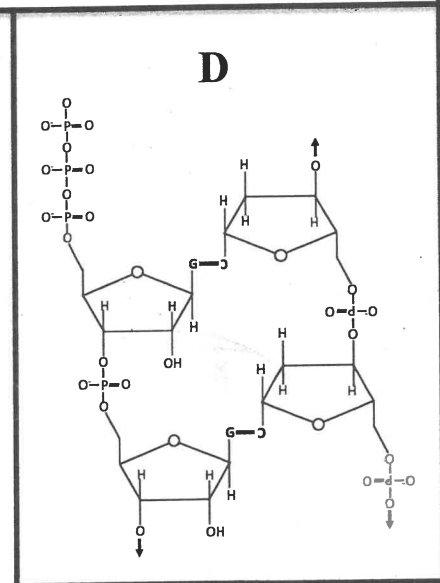
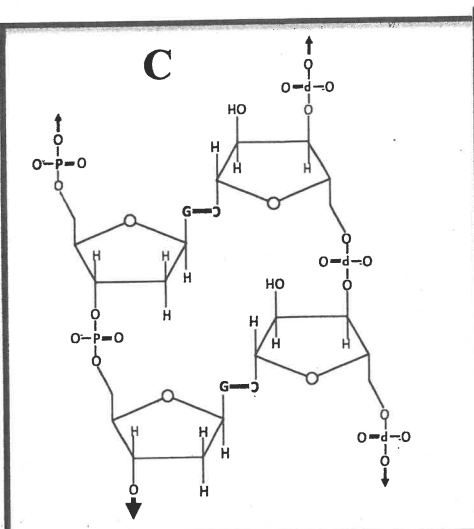
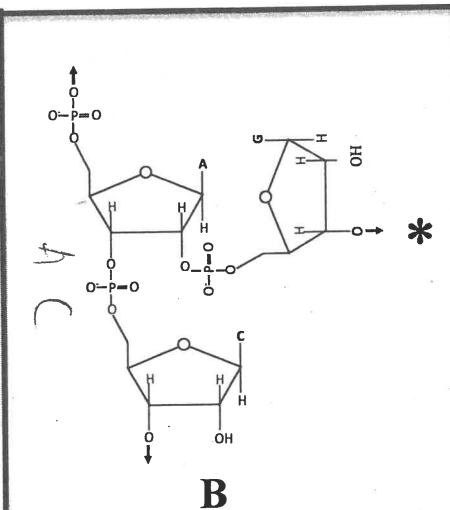
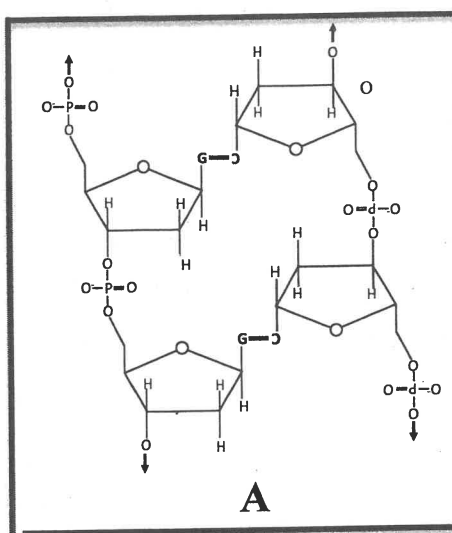
- b) location of three of the enhancers (0.5 pt)

$$-500, -1500, -2500$$

- g) Assume this gene is capable of alternative splicing involving exons 2 and 3. What spliced forms are possible? (2 pt)

Form 1: Don't use 3' or 5' splice junction so Exon 2 becomes part of intron
 Form 2: Don't use exon 2 5' splice junction and exon 3 3' splice junction, intron between exon 2+3 becomes part of one big exon

- 2) Below are four structures: A, B, C, and D. Arrows in the figure indicate that the polynucleotide chain continues in that direction. (11 pt total)



- a) What is structure A? (1 pt)

DNA

- b) Give one example of where you might find structure A in cells. (1 pt)

Nucleus

- c) What is structure B? (1 pt)

Part of spliceosome where branch-pt sequence is bound to the G at free end of intron.

- d) In B, what is the next nucleotide in the sequence at the position of the "*" ? (2 pt)

Uracil

- e) What is structure C? (2 pt)

RNA - DNA hybrid

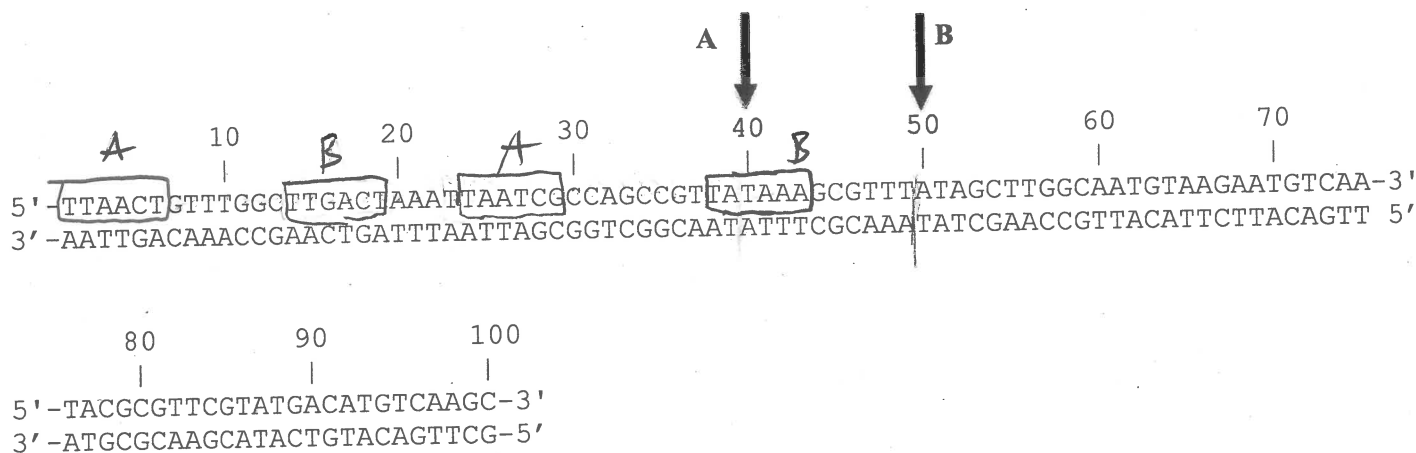
- f) Give one example of where C occurs in cells? (2 pt)

Nucleus during transcription when DNA and RNA are bound

- g) Give one example of where you might find structure D in cells. (2 pt)

Nucleus as mRNA is being polymerized in transcription bubble and NTPs are being added

- 3) You are studying a region of the *E. coli* genome. Two RNAs (A and B) are transcribed from the 100 base pair region, and the transcription start sites are indicated with arrows. (14 pt total)



Note: The sequence above is one sequence, drawn on two lines because it will not fit on one line.

- a) What are the first ten nucleotides of the RNA produced from transcription start site A? (3 pt)

UAAAGCGUUU

- b) What are the first ten nucleotides of the RNA produced from transcription start site B? (3 pt)

AUAGCUUGGC

- c) Put a box around the key promoter elements for both A and B? Label each element and make it clear whether it corresponds to A or B. (4 pt)

- d) Which promoter (A or B) directs higher levels of transcription? Clearly explain your reasoning. (4 pt)

B b/c both promoters clearly match the consensus sequence much more than A. In total, B matches 10 out of 12 bases while A matches roughly 6 out of 12. B/c B matches more closely, the RNA polymerase will bind more effectively, directing higher levels of transcription.