

Biology 223

Fall 2004

Exam I, 06 November 2004 9:00 am - 10:50 am

EXAM COPY #

No notes, no calculators, no phones.

Write your name and student ID number at the top of this page.

Use non-erasable ink, write on the back if needed.

Write legibly and succinctly, using proper terminology.

Show your work and justify your conclusions, partial credit may awarded.

Negative points may be assigned to unjustified, frivolous and grossly incorrect answers.

100 points possible, 110 minutes.

Note points per question and spend your effort accordingly!

codon chart

		Second base								
		U		C		A		G		
U		UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys	U
		UUC		UCC		UAC		UGC		C
		UUA	Leu	UCA		UAA	Ocr	UGA	Op1	A
		UUG		UCG		UAG	Amb	UGG	Trp	G
C		CUU	Leu	CCU	Pro	CAU	His	CGU	Arg	U
		CUC		CCC		CAC		CGC		C
		CUA		CCA		CAA	Gln	CGA		A
		CUG		CCG		CAG		CGG		G
A		AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser	U
		AUC		ACC		AAC		AGC		C
		AUA		ACA		AAA	Lys	AGA	Arg	A
		AUG	Met	ACG		AAG		AGG		G
G		GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly	U
		GUC		GCC		GAC		GGC		C
		GUA		GCA		GAA	Glu	GGA		A
		GUG		GCG		GAG		GGG		G

Question 1 for 5 points

What is the diameter of a double-stranded DNA in a B-form helix?

Question 2 for 5 points

Consider a diploid organism with 6 pairs of chromosomes, each parent contributing one of each pair. Assuming no crossing over, how many genetically distinct gametes would it be expected to produce?

Question 3 for 5 points

The 2 DNA oligonucleotides are heated in cooled together. Predict how they might hybridize:

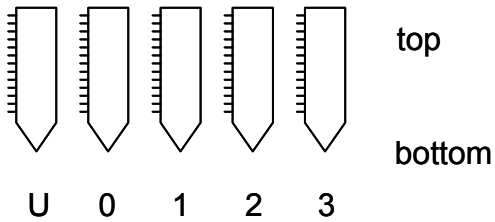
5' -GGCATTCTTATTAGGCGGCTTA-3'
5' -GCCTAATAAGAATGCCGCCAAT-3'

Question 4 for 5 points

Polio is a positive-stranded RNA virus that replicates via a negative-stranded RNA intermediate. If the positive strand is 30% G, and 20% A, and 10% C, what would be the expected composition of the negative strand?

Question 5 for 5 points

If an organism replicated its double-stranded DNA using a conservative mechanism, draw and label the centrifuge tubes of Meselson and Stahl would have seen without isotopically-enriched media (U), and after 0, 1, 2, and 3 generations after switching from isotopically-enriched media to natural abundance media.



Question 6 for 5 points

The single strand of DNA below was annealed to two RNA primers. Write out the final complete product(s) expected from the addition of *E. coli* DNA polymerase III and dNTPs in suitable buffer (Mg^{++} , etc).



Question 7 for 5 points

It takes a prokaryote with a single, double-stranded, circular genome 1 hour to replicate from a single origin of replication. Replication forks progress at 500 nucleotides per second. How many meters long is the genome?

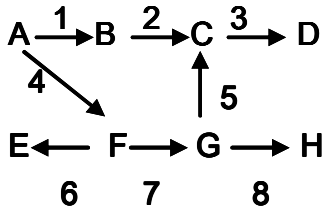
Question 8 for 5 points

Rank the following double-stranded DNAs (represented by one strand) in order of melting temperature, from low to high:

- 1 CGATCGGACTGAGGACTTGCGGCATGCTATA
- 2 AGCGCCGTAGCTAAGCCGTACCTCGTAGACG
- 3 ACTGACTACGATCGGATCGGACGGAGCTGCA
- 4 ACGTGGCCTACTTACGGACTTCAGGAGTACT

Question 9 for 10 points

In a prototrophic strain of *neurospora crassa*, intermediate A is a component of minimal medium. Consider the following hypothesis, where compounds D, E, and H are essential, but compound B is toxic. Predict the phenotypes that might be expected to result from null mutants of single genes 1-8, by indicating growth (+) or no growth (0) when minimal medium is supplemented by the addition of a single compound.



supplement	0	B	C	D	E	F	G	H
wild type								
mutant 1								
mutant 2								
mutant 3								
mutant 4								
mutant 5								
mutant 6								
mutant 7								
mutant 8								

Question 10 for 10 points

Consider a eukaryotic gene in which the following information is known:

Transcription starts at bp 1, translation starts at bp 200, the end of exon1 is at bp 500, the beginning of exon2 is at bp 750, the end of exon2 is at bp 900, the beginning of exon3 is at bp 1100, the end of exon3 is at bp 1325, the beginning of exon4 is at bp 1525, translation stops at bp 1900, the polyA site is at 2100, and the polyA tail is 150 long.

- What is the length of the pre-mRNA?
- What is the length of the mature mRNA?
- Assuming complete splicing and all possible exon skipping what would be the expected lengths of proteins in amino acids.

Question 11 for 10 points

The DNA coding for a phosphorylated protein was isolated and fragmented. The fragment below is known to contain the coding sequence for the part of the protein protein containing the phosphorylation site, meaning it has at least one threonine or serine. Identify the open reading frame and circle the codons for serine or threonine in the open reading frame in the non-template strand (sense strand).

5' -GATTTCTCCTCCCGCTAGACCGTCACGAGCTCTGAGAGACTACGACTCTAGCACAAGGAGAAC-3
 3' -CTAAAGAGGAGGGCGATCTGGCAGTGCTCGAGACTCTCTGATGCTGAGATCGTGTTCTCTTG-5'

Question 12 for 5 points

A fragment of a transcript encoding a polypeptide was hydrolyzed and found to contain no guanine. Which amino acids would not be expected to be in the polypeptide?

Question 13 for 10 points

I have received a double-stranded fragment of DNA of the following sequence that is supposed to begin somewhere in the promoter and end somewhere in the open reading frame.

Should it express in E. coli or humans, and why?

Mark the likely first nucleotide of the transcript by circling.

Indicate the first codon of the open reading frame by circling in the sense strand (non-template).

Design 24 nt primers such that the double-stranded product has base pair 13 at one end and base pair 129 at the other. Write their sequence 5' to 3'.

What is number of base pairs in the product?

1 5' - TCTGGCAAAT ATTCTGAAAT GAGCTGTTGA CAATTAATCA ATTCTTCGGC
 3' - AGACCGTTTA TAAGACTTTA CTCGACAAC TTTAATTAGT TAAGAAGCCG

51 TCGTATAATG TGTAGTGGGA TTGTGAGCGG ATAACTAAGG AGGTTGTATG
 AGCATATTAC ACATCACCCCT AACACTCGCC TATTGATTCC TCCAACATAC

101 AATGCGAGGA TGATGCCCCCT CTTTGAGCCC AAGGGCCGGG TCCTCCTGGT -3'
 TTACGCTCCT ACTACGGGGA GAAACTCGGG TTCCCGGCC AGGAGGACCA -5'

Question 14 for 10 points

You have been hired to design an Ames test for mutagens that cause T->A mutations. You choose to construct a histidine auxotroph by mutating the HIS3 gene, such that it has an early stop codon that can revert to the wild type sequence upon a single T->A substitution. Use the 5'-end of the open reading frame of the wild type HIS3 gene shown below to indicate which position(s) in the DNA would serve this purpose. The enzyme sequence is amino-Met Arg Pro Leu Cys Arg Cys Leu Thr----

5'-AUG AGA CCA UUA UGC AGG UGU CUA ACG----3'

Question 15 for 5 points

Some of the compounds below are expected to be formed when standard, unmodified nucleic acids are hydrolyzed. Label those compounds with a A, C, G, T, or U, to indicate their identity. Also indicate by circling the heavy atom (hydrogen is not a heavy atom) on those standard bases where the ribose or deoxyribose is attached.

