

BIS101 Exam 2

Dec. 16, 2014

Please make sure to include your name and student ID on each page. The final page of the exam can be used as scratch paper but will **not** be graded. **You must show your work.** Correct answers with no work shown will not necessarily receive full credit. Your exam will not be graded until you have signed below acknowledging your understanding of the code of academic conduct. If you do not sign the confidentiality statement you must arrange to pick up your exam directly from Dr. Ross-Ibarra or a TA.

I have read and understood the UC Davis code of academic conduct. _____

I agree to allow my exam to be placed in a common location for return, and acknowledge that this means other students may see my score and student ID. _____

I agree that maize is indeed the coolest organism on Earth. _____

1 Mutation

You treat DNA with a mutagen like 2-amino-purine that only causes mutations from A to G or T to C (but not G to A or C to T).

- Are these transitions or transversions? (3pts)
- Can treatment with this mutagen create stop codons? Why or why not? (5pts)

2 Kudla

Kudla *et al.* mutated 226 of the 240 possible 3rd positions in codons of the GFP gene to test their effect on expression. Why didn't they engineer mutations in the first or second position of codons as well? (5pts)

3 Genome size

Why is there a very low correlation between genome size and the number of genes in a genome? (6pts)

4 Ibarra-Laclette

Explain how *Utricularia* can have undergone four rounds of whole-genome-duplication but still have a tiny 82Mb genome. (5pts)

5 Lac Operon

You identify a strain of *E. coli* of unknown genotype that is unable to survive on a medium with lactose but no glucose. You make a merodiploid between this strain and a plasmid with the genotype $I^+O^+Z^+Y^-$, where “+” signifies wild-type versions of the repressor protein (I), the operator (O), and the gene β -galactosidase (Z). Y^- is a nonfunctional permease protein. Your merodiploid now grows successfully on normal glucose media as well as media with lactose but no glucose. Using reverse transcriptase and PCR, however, you are able to show that the merodiploid produces functional permease mRNA even when grown on glucose media with no lactose. What is the genotype of your original strain? (6pts)

7 Epigenetics

Retinoblastoma is a cancer that can occur when the RB1 gene is hypermethylated. RB1 is responsible for stopping progression through the cell cycle between G1 and S phase. Explain how you expect this increased methylation near the RB1 gene to change expression of RB1 and why this might lead to cancer. (5pts)

8 Expression

An in-frame deletion in the tryptophan operon removes all the tryptophan codons from the upstream leader polypeptide. What will the expression level of the operon be in the presence and absence of tryptophan? (5pts)

9 Yin

Yin *et al.* use a single-stranded guide RNA, along with a single-stranded DNA template and a CAS9 protein, to edit a splice site mutation in the FAH gene. What do you think would happen if they tried to use a double-stranded guide RNA? (5pts)

10 Expression

Your gene of interest has 3 exons of lengths 100, 60, and 140bp long. Your gene is expressed only in the eyes and the toes. You isolate mRNA from each tissue and run it out on a gel. You see a 240bp band in the toes, but a 300 bp band in the eyes.

- What explains this difference? (5pts)
- You sequence the protein from the eyes and find that it has 83 amino acids. Why does (or doesn't) this make sense? Why does (or doesn't) this make sense? (5pts)

11 DNA and proteins

A colleague sends you the DNA sequence of a gene for a novel short protein she has discovered:

5' CCGGT CAACG CACTA GTGGT TGAAG CACCA TTCTT 3'

- How long is the polypeptide? (5pts)
- Did she send you the template strand or the coding strand? (5pts)

12 Transposable Elements

The insertion machinery used by class I retrotransposons can sometimes accidentally reverse transcribe mRNAs from other genes, inserting the cDNA to a new genomic location.

- How would you expect the sequence of a gene copied in this manner to differ from the original gene sequence? (5pts)

- Most such genes are inserted far from any regulatory sequences, including promoters and enhancers.
 - Will the newly inserted copy be expressed (why/why not)? (5pts)

 - What do you expect would be the long term fate of such genes? (5pts)

13 Mapping

The colored (C) gene in corn produces purple kernels, and the recessive mutant c allele has a nonsynonymous mutation causing it to produce yellow kernels. The (Sh) gene produces full kernels, while the recessive mutant (sh) allele has a deletion causing it to produce shrunken kernels. The genes Sh and C are 20cM apart. You cross a C/c;Sh/sh line to a tester c/c;sh/sh. All 1,000 offspring survive, but half are shrunken and yellow, and half are purple and full. Draw a chromosomal arrangement in the C/c;Sh/sh line and explain how it could cause this phenomenon. (6pts)

Scratch Paper – will not be graded

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

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