7.013

Quiz 1 Answers

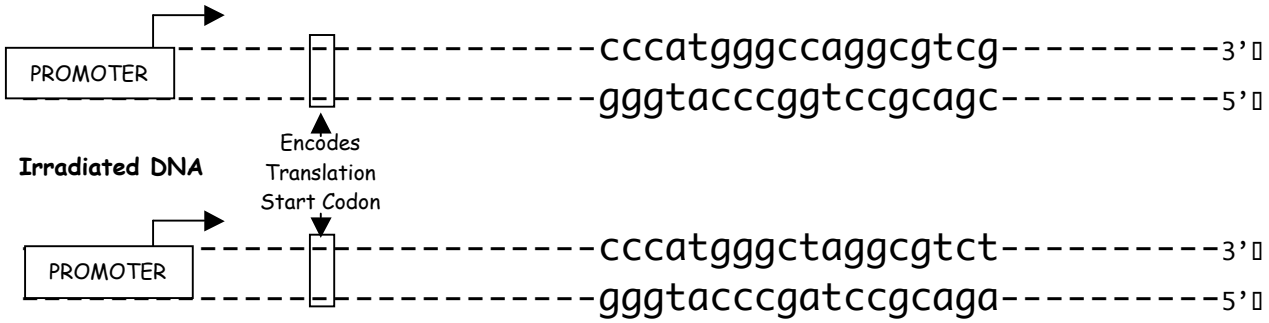
Question	Value
1	28
2	25
3	27
4	20
	100

Question 1

You've heard that too much sunbathing can be harmful, so before you splurge on a trip to the Bahamas, you decide to test the effects of prolonged UV exposure on DNA. You compare DNA encoding the Sun E protease from a WT *E. coli* strain with the corresponding DNA from a UV irradiated culture.

The highlighted bases below lie in internal piece of the *sun E* gene encoding the crucial serine (Ser111) in the Sun E protease active site.

WT DNA



a) Which of the following depicts the mRNA transcribed from the **WT DNA** nucleotides above? **5 pts**

i) 5'----------gcugcggaccggguaccc----------3'

ii) 5'----------cccaugggccaggcgucg----------3'

iii) 5'----------ggguacccgguccgcagc----------3'

iv) 5'----------cgacgccuggcccauggg----------3'

v) none of the above - it will be _____

b) Which of the following depicts the mRNA transcribed from the **Irradiated DNA** nucleotides? **5 pts**

i) 5'----------ggguacccgauccgcaga----------3'

ii) 5'----------ucugcggaucggguaccc----------3'

iii) 5'----------cccaugggcuaggcgucu----------3'

iv) 5'----------agacgccuagcccauggg----------3'

v) none of the above - it will be _____

c) Given that the first 3 nucleotides in the **WT mRNA** written out in a) are in the correct reading frame, what will the WT peptide sequence derived from this segment look like (in single amino acid code)? Written left to right, in the N'→C' direction. **4 pts**

i) GYPVRS
ii) RRLAHG
iii) AADRVP
iv) MGQAS
v) PMGQAS
vi) None of the above – it will be _____

d) Given that the first 3 nucleotides in the mRNA transcribed from the Irradiated DNA written out in b) are in the correct reading frame, what will the peptide sequence derived from this segment look like (in single amino acid code)? Written left to right, in the N'→C' direction. **4 pts**

i) RRLAHG
ii) GYPIRR
iii) MGQAS
iv) SADRVP
v) PMGQAS
vi) None of the above – it will be ____**PMG**_____

e) If this was the only region of the *sun E* gene affected by the UV rays, did irradiation affect the function of Sun E protease? **4 pts**

i) Absolutely
ii) Definitely not
iii) Can not be determined

f) Which of the following mutations encoding Ser 111 would NOT impair function of the Sun E protease? Choose your answer from the list below. **6 pts**

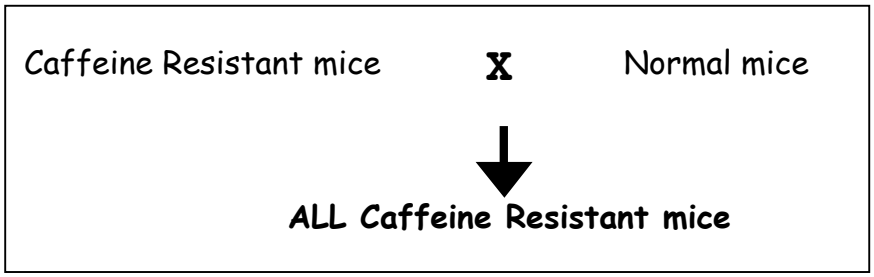
i) A and sometimes B
ii) A and sometimes C
iii) B and sometimes C
iv) B and sometimes A
v) C and sometimes A
vi) C and sometimes B

A . Missense mutation	B. Nonsense mutation	C. Silent mutation

	U		C		A		G	
U	UUU	**phe (F)**	UCU	**ser (S)**	UAU	**tyr (Y)**	UGU	**cys (C)**	U
	UUC	**phe (F)**	UCC	**ser (S)**	UAC	**tyr (Y)**	UGC	**cys (C)**	C
	UUA	**leu (L)**	UCA	**ser (S)**	**UAA**	**STOP**	**UGA**	**STOP**	A
	UUG	**leu (L)**	UCG	**ser (S)**	**UAG**	**STOP**	UGG	**trp (W)**	G
C	CUU	**leu (L)**	CCU	**pro (P)**	CAU	**his (H)**	CGU	**arg (R)**	U
	CUC	**leu (L)**	CCC	**pro (P)**	CAC	**his (H)**	CGC	**arg (R)**	C
	CUA	**leu (L)**	CCA	**pro (P)**	CAA	**gln (Q)**	CGA	**arg (R)**	A
	CUG	**leu (L)**	CCG	**pro (P)**	CAG	**gln (Q)**	CGG	**arg (R)**	G
A	AUU	**ile (I)**	ACU	**thr (T)**	AAU	**asn (N)**	AGU	**ser (S)**	U
	AUC	**ile (I)**	ACC	**thr (T)**	AAC	**asn (N)**	AGC	**ser (S)**	C
	AUA	**ile (I)**	ACA	**thr (T)**	AAA	**lys (K)**	AGA	**arg (R)**	A
	AUG	**met (M)**	ACG	**thr (T)**	AAG	**lys (K)**	AGG	**arg (R)**	G
G	GUU	**val (V)**	GCU	**ala (A)**	GAU	**asp (D)**	GGU	**gly (G)**	U
	GUC	**val (V)**	GCC	**ala (A)**	GAC	**asp (D)**	GGC	**gly (G)**	C
	GUA	**val (V)**	GCA	**ala (A)**	GAA	**glu (E)**	GGA	**gly (G)**	A
	GUG	**val (V)**	GCG	**ala (A)**	GAG	**glu (E)**	GGG	**gly (G)**	G

Question 2

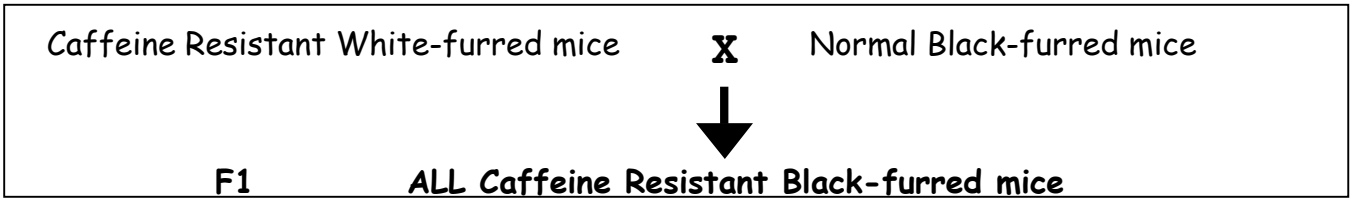
During a coffee break at Starbucks, you identify a colony of mice with a caffeine resistant phenotype; that is, they can consume sacks of caffeine-containing coffee beans without showing any of the jitteriness of normal mice. When you cross a pure breeding caffeine resistant mouse with a pure breeding normal mouse, the resulting mice are all caffeine resistant.



a) You cross two F1 mice from the above cross and obtain twenty offspring. How many of the offspring would you expect to have normal sensitivity to caffeine? 4 pts

5

You observe that ALL of the caffeine resistant mice from Starbucks have white fur. And ALL the pure breeding colony of mice with normal caffeine sensitivity have black fur. When you look again at the F1 generation, you observe that they all have black fur.



b). For each pair below, circle the **recessive** phenotype 4 pts

Caffeine Resistant / Normal White / Black

c) If you cross one of these F1 generation mice with the parental caffeine resistant white mice and produce 32 offspring, what would be their expected distribution? 6 pts

Caffeine resistant, white: _____16_____

Caffeine resistant, black: _____16_____

Normal caffeine sensitivity, white: _____0_____

Normal caffeine sensitivity, black: _____0_____

You perform a test cross of the F_1 caffeine resistant black mice with mice exhibiting both of the phenotypes that you have identified as recessive. You get progeny with the following characteristics.

Phenotype	# of progeny
Caffeine Resistant, white	449
Caffeine Resistant, black	51
normal, black	451
normal, white	49

e) What is the recombination frequency between the "caffeine resistance" and the "*fur color* " genes? Show your work. 5 pts
51+49/ 51+49 +449+451 = 50/500--> 10%

_____10%_____

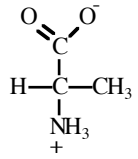
Previous studies revealed that the gene conferring black or white fur color maps 36 map units away from the *ear* gene which determines ear size.

f) Based on all the information above, draw two possible arrangements for the "*caffeine*", "*fur color*", and "*ear*" genes on the chromosomes below naming the genes in the boxes and indicating between them the distances in map units. Note, if the genes are unlinked, write UNLINKED.
10 pts

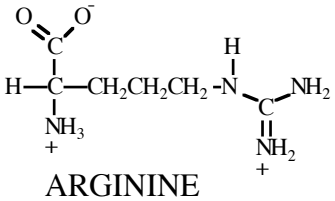
Arrangement 1:

Arrangement 2:

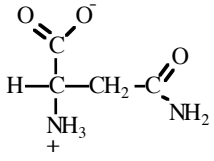
STRUCTURES OF AMINO ACIDS at pH 7.0



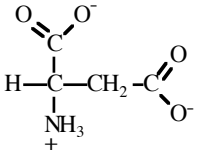
ALANINE
(ala)



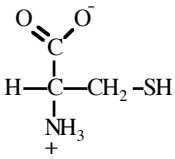
ARGININE
(arg)



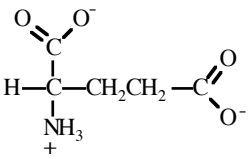
ASPARAGINE
(asn)



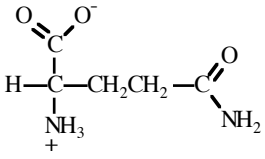
ASPARTIC ACID
(asp)



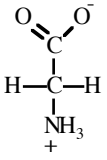
CYSTEINE
(cys)



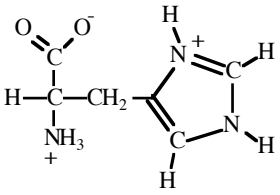
GLUTAMIC ACID
(glu)



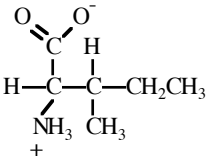
GLUTAMINE
(gln)



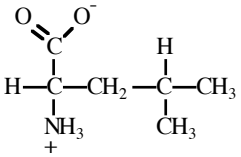
GLYCINE
(gly)



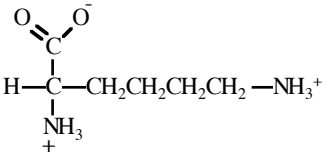
HISTIDINE
(his)



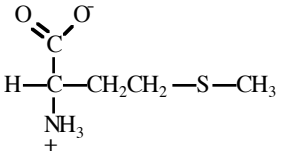
ISOLEUCINE
(ile)



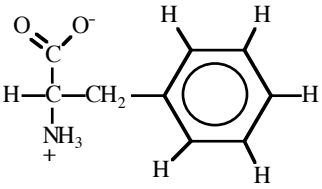
LEUCINE
(leu)



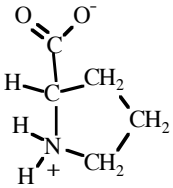
LYSINE
(lys)



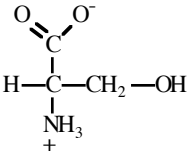
METHIONINE
(met)



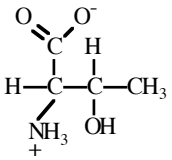
PHENYLALANINE
(phe)



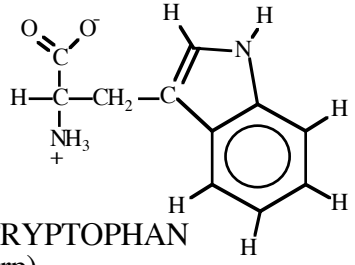
PROLINE
(pro)



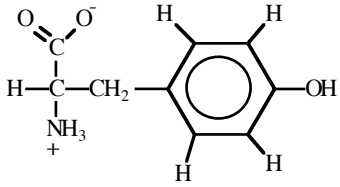
SERINE
(ser)



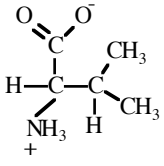
THREONINE
(thr)



TRYPTOPHAN
(trp)



TYROSINE
(tyr)



VALINE
(val)

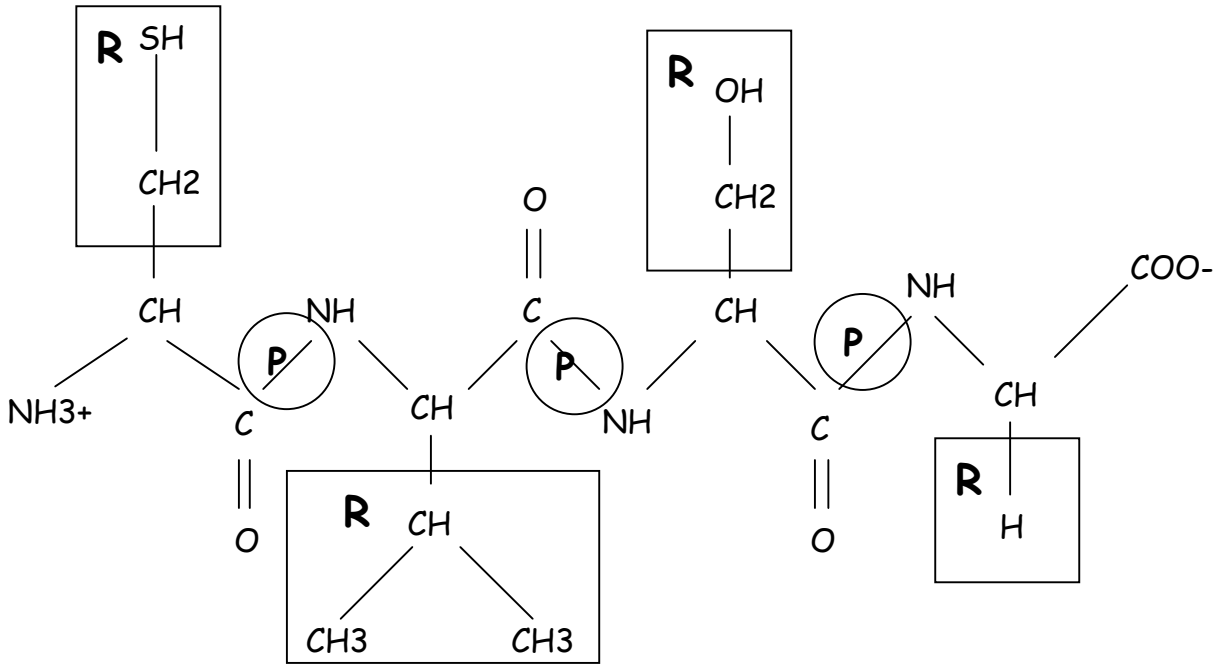
Question 3

A mysterious bacterium has stricken the world and threatens to wipe out its population. Luckily, you think you have found an enzyme, Panase, that specifically inactivates an essential protein, Pan-X, found only in the lethal bacteria. Before telling others of this news, you wish to learn more.

a) Drawn below are the first 4 amino acids of the Panase's primary sequence.

i) Circle each side chain and label it "R."

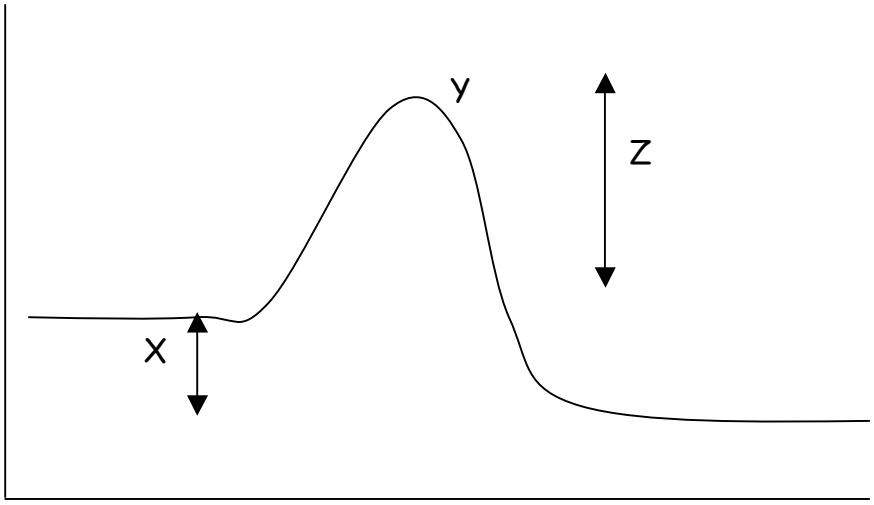
ii) Circle **each** peptide bond and label it "P." (When circling peptide bonds, only identify the line representing the bond itself and not the surrounding atoms.) 5 pts 4-sidechains, 1-pb



b) To learn how Panase binds to Pan-X you examine the active site. Listed below in the left hand column are amino acids known to be located in Panase's active site. In the center column are amino acids in Pan-X known to be in close proximity with the amino acids in the first column. Circle the **predominant** interaction between amino acids in each row. **12 pts**

AA found in Panase Active Site	**Adjacent Pan-X AA**	**Interactions**
Serine	Asparagine	Covalent **Hydrogen** Ionic VDW none
Valine	Isoleucine	Covalent Hydrogen Ionic **VDW** none
Glutamic Acid	Arginine	Covalent Hydrogen **Ionic** VDW none
Methionine	Cysteine	Covalent Hydrogen Ionic **VDW** none

c) A graph below shows the energetics of the inactivation of Pan-X in the presence of panase.



i) The interval labelled X on the graph is the….2 pts

Activation Energy Equilibrium **Δ G** ΔH Transition State

ii) The peak labelled Y on the graph is the….2 pts

Activation Energy Equilibrium Δ G ΔH **Transition State**

iii) The interval labelled Z on the graph is the….2 pts

Activation Energy Equilibrium Δ G ΔH Transition State

d) If enzyme were removed from this reaction… (Circle all that are true.) 4 pts

i) ΔG would increase.

ii) ΔG would decrease.

iii) the Activation Energy would increase.

iv) the Activation Energy would decrease.

v) the rate would increase.

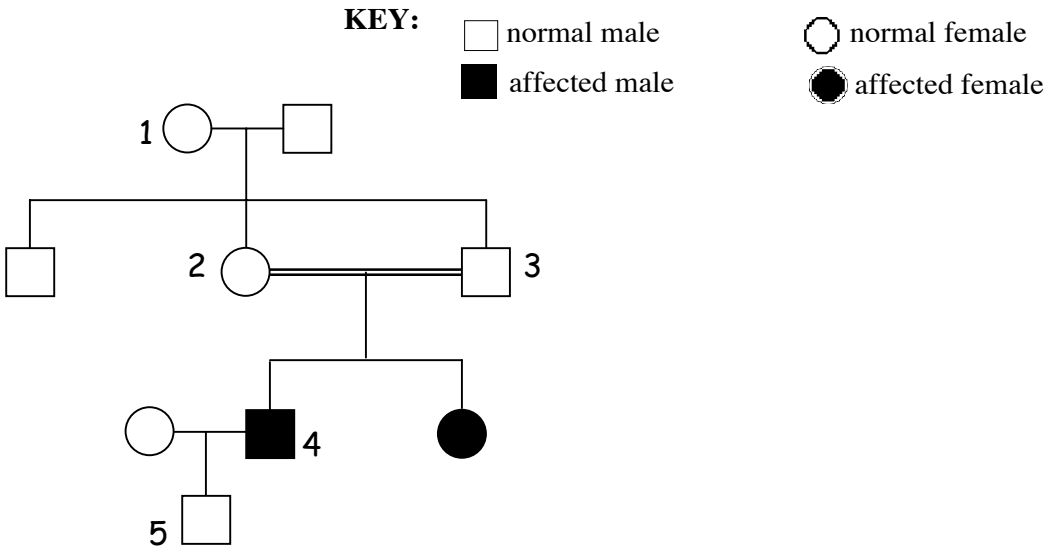
vi) the rate would decrease.

vii) at equilibrium, there would be more active Pan-X.

viii) at equilibrium, there would be less active Pan-X.

Question 4

You are studying a rare genetic disease in humans that you name "Mistalkism" causing those affected to mispronounce simple words. Below is a pedigree that you have been able to assemble from information from one family, named the Shrubs. Assume complete penetrance.



a) Circle the most likely mode of inheritance for Mistalkism? 5 pts

Autosomal Dominant	**Autosomal Recessive**	X-linked dominant	X-linked recessive	Y-Linked

b) **With respect to Mistalkism**, what is the genotype of… **12 pts**
(Circle **one** answer only for each individual.)

i) Individual 1?

Homozygous mutant	Homozygous wild-type
X^{mut} y	X^{wt} y
Heterozygous	**Can't be determined**

ii) Individual 2?

Homozygous mutant	Homozygous wild-type
X^{mut} y	X^{wt} y
Heterozygous	Can't be determined

iii) Individual 4?

Homozygous mutant	Homozygous wild-type
X^{mut} y	X^{wt} y
Heterozygous	Can't be determined

iv) Individual 5?

Homozygous mutant	Homozygous wild-type
X^{mut} y	X^{wt} y
Heterozygous	Can't be determined

c) If individuals 2 and 3 have a second daughter, what is the chance that she will be affected? **3 pts**

0%	12.5%	**25%**	33%	50%	66%	75%	100%