

GENETICS 310

EXAM 2

June 22, 2021

I. a) A cross of two true breeding **white** flowers gave an F1 that had all **purple** flowers and the F2 ratio on self-pollinating the F1 was 9 Purple to 7 white. Draw a pathway, using pigment colors and arrows (\rightarrow two dashes and a greater than symbol on a computer) for enzymes that will account for these observations.

E1 E2
white \rightarrow white \rightarrow purple

b) In another cross between a true breeding red and a true breeding white flower, all the F1 progeny were purple. How would you modify the pathway from part a to account for this observation and predict the F2 ratio expected from self-pollinating the purple F1 plants.

E1 E2
white \rightarrow red \rightarrow purple F2 ratio from self pollination: 9 purple : 3 red : 4 white

II. List 4 life-cycle features that made *Neurospora crassa* so advantageous for use by Beadle and Tatum to come up with the one gene-one enzyme hypothesis:

- | | | | |
|---|--------------------------------------|---|-----------------------|
| 1 | millions of identical asexual spores | 2 | haploid nuclei |
| 3 | defined growth medium, 1 vitamin | 4 | crosses could be made |

III. Tell whether the following are properties of prokaryotes (P), eukaryotes (E) both (B) or neither (N):

- | | | | |
|---|---|---|--|
| N | U in RNA pairs with T in DNA | E | three different RNA polymerases function |
| E | mRNA has a polyA tail | B | tRNAs include modified bases |
| P | DNA is in a double stranded circle | B | 3 amino acids have 6 codons & all are used |
| B | AUG is the start codon | P | translation begins during transcription |
| P | a sequence in the leader of mRNA binds a complement in rRNA to initiate translation | | |
| P | proteins in a pathway often made from 1 mRNA | | |
| B | activating amino acids (attaching to a tRNA) requires ATP for energy | | |
| E | genes are often much longer than the actual mRNA they code | | |
| E | initiation of translation requires a 5'-CAP binding protein | | |
| P | 'mycin' antibiotics prevent translation | | |
| E | organelles sometimes use a genetic code slightly different from the standard | | |
| E | snRNPs are involved in producing functional mRNA | | |

IV. Part of a mRNA was reported to have the sequence shown below, but the actual reading frame was not certain. It was known, however, that it coded the last 3 amino acids in a protein.
 a) Write the expected amino acids sequences that would be produced if the 1st, 2nd or 3rd bases in the sequence are shown is in the correct reading frame:

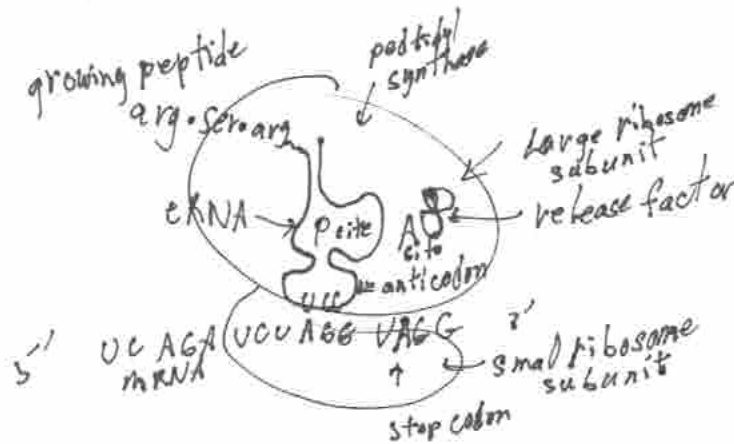
5'-- UCAGAUAGGUAGGUAG -----3'

starting with base 1 Ser-Asp-Leu-Gly-Arg stop

starting with base 2 Gln- Ile-stop

starting with base 3 Arg-Ser-Arg-stop

b) Draw a picture showing translation when the stop codon of the 'correct' mRNA you identified has just entered the A site on the large ribosomal subunit. Label all components.



V. CAG is a gln codon. a) What would be the effect of single base substitution mutations that changed the first, second or third nucleotide in that codon via transition or transversion?

1st base transition stop UAG transversion AAG Lys or GAG Glu

2nd base transition CGG arg. transversion CUG Leu, CCG Pro

3rd base transition CAA GLN (same) transversion CAU or CAC His

b) Which if any of these mutations is/are **not** missense mutations?

UAG stop and CAA Gln

VI. Tell whether activity of the lac operon enzymes β -gal'ase (Z), permease(Y), and transacetylase (A) would be always absent (A) constitutive (C) or regulated (R) in the following *E. coli* strains. Assume a minus component is inactive and that FS indicates a frameshift inside the gene it is on. Note that the last 4 strains have 2 copies of the Lac Operon per cell.

Strain	β -gal'ase	permease	TA'ase
P I P O ⁻ Z Y ⁻ A	C	A	C
P I ⁻ P O Z ⁻ Y A	A	C	C
P I P O Z Y A	R	R	R
P I P O Z ^{FS} Y A / P I P ⁻ O Z Y A	A	A	A
P I P O Z Y ⁻ A / P I P O Z ⁻ Y A	R	R	R
P I ⁻ P O Z Y ⁻ A / P I P O Z Y ^{FS} A	R	A	R
P I ⁻ P O Z Y ⁻ A / P ⁻ I P O Z ⁻ Y A	C	C	C

VII. a) What is the basic difference between alpha and beta thalassemia?

in alpha, not enough alpha globin protein is present (alpha globin gene defects) while it is the beta gene product that is too low or absent.

b) What is the basis for saying that human globin genes are developmentally regulated?

Different globin genes are expressed in embryonic, fetal and adult individuals

VIII. a) Which of the following are associated with increased risk of mutation? Check all that apply.

- | | |
|--|------------------------------------|
| <u>1 x</u> runs of mono, di or trinucleotides in the DNA | 2 x ___ radon |
| <u>3 x</u> The base analogue, 5BU | 4 ___ Caffeine |
| 5 ___ Thalidomide | 6 x ___ X-rays |
| <u>7 x</u> EMS (ethyl-methyl sulfonate) | 8 x ___ Tautomers of normal bases. |
| 9 ___ <i>E. coli</i> | 10 x ___ acridine dyes |
| <u>11 x</u> NaNO ₂ (nitrous acid) | 12 x ___ UV (254 nm) |
| <u>13 x</u> Free radicals from mitochondria | 14 ___ Fructose |

b) By number, which of the above that you identified as mutagens would contribute to spontaneous, that is, 'background' mutation rate. 1,2, 6?, 8, 11, 12,13

c) By number, which of the above is most likely to cause a frameshift mutation?

d) By number, which of the above is most likely to only affect dividing cells?

IX. a) Write a potential 4 base and a 6 base restriction endonuclease target cut site.

b) List 3 features of pUC cloning plasmids that make them especially useful in gene cloning.

c) list 2 features that can give virus cloning vectors an advantage over plasmid vectors.

d) What is the role of DNA ligase in cloning DNA fragments into a vector?