GENETICS 310
EXAM II
June 21, 2016

I. Use the hypothetical pigment biosynthetic pathways below to answer the questions that follow:

a) brown → tan → white

b) white → white → brown

c) tan → brown → tan

I-1 Assuming that genes A and B respectively code for the first and second enzymes, show genotypes for a true-breeding brown in pathways a, b and c:

a) ______aa______ b) _______AA, BB____ c) _______AA, bb____

I-2 Give the phenotype of Aa, bb individuals in pathways a, b and c.

a) _______tan______ b) _______white______ c) _______brown______

I-3 If Aa, Bb males are crossed to Aa, Bb females, give the phenotypic ratio expected for pathways a, b and c.

9 white 9 brown 13 tan
3 tan 7 white 3 brown
4 brown

a) ____________________ b) ____________________ c) ____________________

II. Check the following statements about Neurospora crassa, all of which are true, that were critical for its selection by Beadle and Tatum for the research they did to develop the one gene-one enzyme concept.

X It produces spores that are haploid  X Its spores can be multinucleate
X It requires biotin to grow  X Crosses can be made between strains
X It has a 40 megabase genome  X It can be grown on a defined minimal medium.
X It can repair DNA damage  X It has pathways for pigment production
X It only has about 10,000 functional genes  X It has mitochondria
X It uses CG methylation to regulate gene expression, a function lacking in E. coli
X It can produce millions of genetically identical spores in a short period of time.
X All the products of each meiosis are contained in a sac called an ascus.
III. The base sequence below comes from inside an exon in the middle of a gene and is in-frame for coding 4 amino acids.

5' CATTAAGCTATC 3'  
3' GTAATTTCGATAG 5'

a) Label the 3' and 5' ends for the strands above so that a mRNA would be made to code for 4 amino acids. (two possible answers without a stop codon; one shown)

b) Write the mRNA in a 5’ to 3’ direction. 5’GAUAGCUUAAUG 3’

c) Show a picture of translation when the 4th codon is just ready to be translated. Label the components, including the amino acids in the peptide being made, where it s being made.

d) Which, if any, of the codons in b could be changed by a single base substitution to create a stop codon? For each tell whether the change is a transition or transversion

for above: UUA → UAA transversion: for other  UCG → UAG or UAC → UAA/G transversions

e) What are the molecular sources of energy required for amino acid
activation  _______ATP_________

and for translation?  _______GTP_________
IV. Check the following attributes concerning DNA structure and replication that are correct:

✔ Replication occurs during the S phase of the cell cycle

✔ One new strand is synthesized 5’ to 3’ and the other 3’ to 5’

✔ After replication, one DNA double helix has both old strands and the other new strands

✔ The amount of A and T in each of the single strands will be equal

✔ The amount of purines will equal the amount of pyrimidines in each double helix

✔ Unwinding the strands requires an enzyme that uses ATP for energy

✔ One strand is made in fragments that start with RNA bases that are later removed

✔ Barring accidental mistakes, the two daughter helices will be identical

V. Using P for prokaryotes only, E for Eukaryotes only, B for both and N for neither, tell which type(s) of organisms the following apply to:

E  ✔ Most enzyme-coding genes contain introns.

P  ✔ Transcription and translation of a mRNA can occur simultaneously.

B  ✔ AUG is the normal start codon.

E  ✔ The 3’ end of messages have a poly-A tail.

N  ✔ Only 2 of the 3 potential stop codons are used.

P  ✔ The leader of a mRNA contains a sequence that compliments a sequence in rRNA.

P  ✔ The first amino acid inserted is F-met which is later removed.

B  ✔ mRNA first attaches to the small ribosomal subunit: the large subunit is added later.

P  ✔ Several proteins may be translated from a single mRNA.

B  ✔ A long pre-rRNA is cleaved into smaller components by specific enzymes.

E  ✔ Proteins are assembled in the cytoplasm outside the nucleus.

N  ✔ Only one tRNA is required for all 4 proline codons.

P  ✔ Translation is inhibited by streptomycin.

E  ✔ The 5’ end of mRNA is protected by a ‘cap’ made of a backwards G.

N  ✔ Any of the stop codons triggers the end of transcription.

B  ✔ Rare tautomers of A, T, G, or C can cause spontaneous mutations

VI. a) What genes are involved in α and β thalassemia, respectively

α  ✔ α-globin

β  ✔ β-globin

b) How do β0 and β+ homozygotes compare to each other and to normal?

β0 makes no beta globin so no normal HbA; β+ makes some but less than normal
VIII. a) Shown below are a series of lac operon maps from *E. coli*. For each tell whether β-galactosidase, permease and transacetylase production will be absent (ab) constitutive (C) or Regulated (R). Assume any component with a minus superscript is inactive and that a superscript F indicates the site of a frameshift mutation. The last 3 are partial diploids with 2 copies of the lac operon in the same cell.

<table>
<thead>
<tr>
<th>Genotype of strain</th>
<th>β-galactosidase</th>
<th>permease</th>
<th>TA’ase</th>
</tr>
</thead>
<tbody>
<tr>
<td>p⁻ i p O Z Y A⁻</td>
<td>C</td>
<td>C</td>
<td>ab</td>
</tr>
<tr>
<td>p i p O⁻ Z Y A⁻</td>
<td>C</td>
<td>C</td>
<td>ab</td>
</tr>
<tr>
<td>p i p⁻ O Z Y A</td>
<td>ab</td>
<td>ab</td>
<td>ab</td>
</tr>
<tr>
<td>p i p O⁻ Z Y A⁻⁸</td>
<td>C</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>p i p⁰ O Z Y A⁻⁻</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>p i p⁻ O Z Y A</td>
<td>C</td>
<td>C</td>
<td>ab</td>
</tr>
<tr>
<td>p i p O⁻ Z Y A⁻⁻</td>
<td>C</td>
<td>C</td>
<td>ab</td>
</tr>
</tbody>
</table>

b) What are the ‘p’s? ______ promoters ____________ How does the first p differ from the second?
   *The I promoter is very weak, seldom read but always ‘on’. The ZYA promoter is very strong so highly expressed unless the Operator is bound by repressor.*

IX. a) Which of the following would be "positive" in the Ame’s test? (Check all correct answers)
   ___caffeine; ___aspartame (NutraSweet); ✔ 5BU; ✔ UV light; ___dioxin; ___guanine; ✔ nitrous acid
   b) Give an example of a compound often found in food that is mutagenic ___ nitrite ______
   c) Give an example of a direct acting chemical mutagen ___ EMS, Mustard gas etc. ______
   d) give and example of an indirect acting chemical mutagen ___ 5-BU, 2-APetc ______
   e) Give an example of a human disease that results from a missense mutation ___ sickle cell ______
   f) What type of mutations do acridine dyes cause? ___ Insertions, Deletions: frameshifts ______
   g) Give 2 examples of non-chemical mutagens ___ UV ______ & ___ X-rays etc ______
X. a) Plasmids like pUC 19 were specifically engineered to be useful in expressing genes from other organisms in *E. coli*. Name and tell the function of 4 very useful features that are included in these pUC plasmids.

1. **origin of replication that allows many copies per cell**

2. **ampicillin resistance to detect presence in ampicillin sensitive host**

3. **Z gene with promoter to allow expression of inserted genes (& for blue white screening)**

4. **man-made sequence with a variety of unique restriction endonuclease cut sites to allow insertion of DNA into the beginning of the lac Z gene**

b) A researcher found that the amino acid in position 92 of an essential enzyme was glu and gly in two fairly closely related mammals. When she found that in more primitive organisms the amino acid at position 92 was thr, she suggested there must be a ‘missing link’. What was the reason for suspecting a missing link and predict the amino acid that the missing link would have at position 92.

   The 2 close species only need a single base change to account for the glu-gly difference; it would take 2 different changes to get from thr to either of these. The missing link could have ala with either codons GCA or GCG to allow a stepwise evolution pattern.

c) Fill in the missing bases for the double stranded DNA restriction endonuclease target site shown below:

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G A C G T C
C T G C A G
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