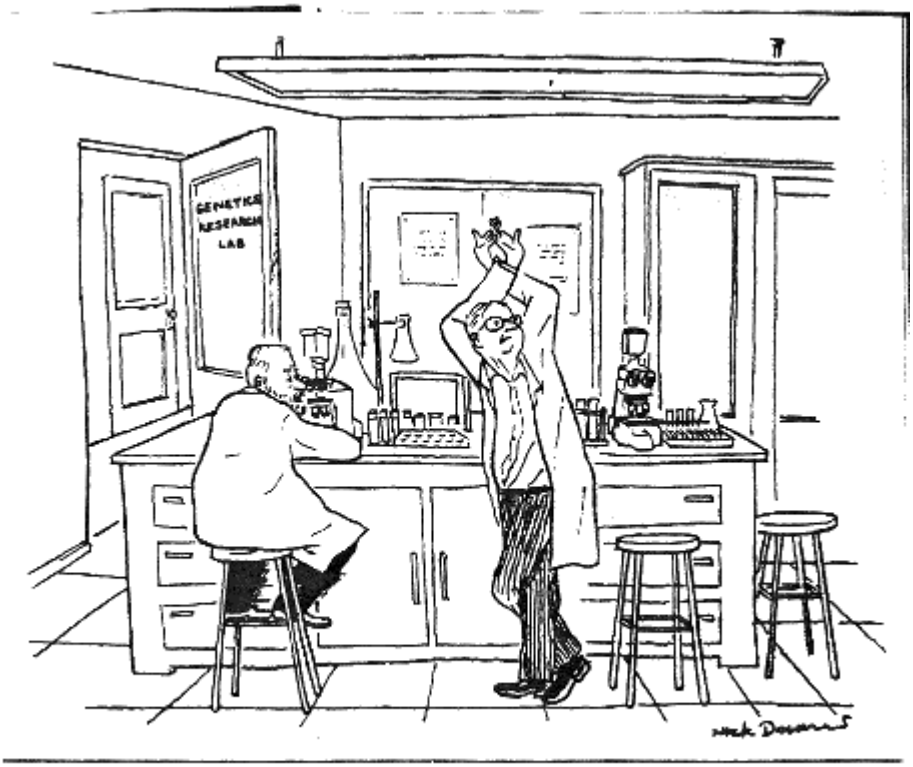
Name _____**KEY**_____

Biology 201 (Genetics)
Exam #2
26 October 2004

- Read the question carefully before answering. Think before you write.
- You will have up to 85 minutes hour to take this exam. After that, you MUST stop no matter where you are in the exam.
- If I can not read your handwriting, I will count the question wrong.
- Sign the honor pledge if applicable.
- Good luck!

I pledge that I have neither given nor received unauthorized assistance during the completion of this work.

Signature: _____



"Very good, Rothemund–you're a DNA molecule. Now get back to work."

8 pts. 1. You have two samples of DNA. Sample 1 is exposed to high temperature (about 95°C). Sample 2 is treated with an exonuclease. Based on what you know about the structure of DNA, what would you have left in each sample after the treatment described above? Be brief here!

Sample 1: Double helix would be denatured into single stranded DNA

Sample 2: DNA would be degraded into nucleotides

5 pts. 2. The observation that female mammals are mosaics for all heterozygous X linked alleles (ie some areas of the body express the materially derived alleles, while other areas express the paternally derived alleles) is a result of what genetic phenomenon?

Lyonization (or random inactivation of one X chromosome in each cell early in development

5 pts. 3. As a cytogenetisist, you perform a karyotype on an individual who exhibits relatively normal female external characteristics. You determine that the karyotype of the individual is (surprisingly) XY. Provide two possible genetics reasons for this discrepancy in genotypic and phenotypic sex.

(1) *sry* gene on Y chromosome is defective or missing
(2) genetic defect (androgen insensitivity) where the individual is unable to use the testosterone produced by the body (same disease as in the gender identification homework assignment)

Some students interpreted this question as to give two genetic *mechanisms* (ie deletion of *sry* and a point mutation in *sry*). This was, therefore, an acceptable answer.

10 pts. 4. In UR spiders, the dominant allele *R* allows the deposition of red pigment in the body while the *rr* spiders have blue pigment. At a second gene, the dominant allele *A* produces long legged spiders, while *aa* spiders have short legs. A red, long-legged spider was crossed to a blue, short-legged spider. The F_1 generation consisted of 45 red, short-legged; 5 red, long-legged; 5 blue, short-legged; and 45 blue, long-legged.

This question was similar to (1) question # 4 of your lab problem set 2, (2) one of the problems worked in class on linkage, and problem on page 176 of the book.

Are the pigment loci and the leg length loci linked? If so, how far apart are they?

Yes.
Map units = # recombinant progeny/#total progeny *100
= 10/100 *100
= 10 map units

What was the genotype of the red, long-legged parent? Include the chromosome arrangement of alleles.

$$\frac{Ra}{rA}$$

10 pts.

In *Drosophila melanogaster*, a bristleless female fly is mated to a male which is claret (dark eyes) and hairless. All the resulting progeny were wildtype. The wildtype F1 female progeny were mated to fully homozygous (mutant) males and the following progeny (1000 total) were observed in the F2 generation.

PHENOTYPES	***NUMBER OBSERVED***
bristleless	321
wildtype	38
claret, bristleless	130
claret	18
claret, hairless	309
hairless, claret, bristleless	32
hairless	140
hairless, bristleless	12

This question was similar to several question from your lab and lecture problem sets and one of the problems worked in class on linkage.

Are the genes linked and how did you know this (in 1 sentence)?

Yes. You do not obtain the ratio expected from a cross between a heterozygote and a tester strain, which would be 1:1:1:1:1:1:1:1, but instead get a skewed ratio.

Which gene is in the middle?

Hairless (h)

6 pts. 5. In the Hershey-Chase experiment that showed DNA was the genetic material in bacterial viruses (called bacteriophages), radioactively labeled bacterial viruses were used to infect *E. coli*.

Why were the radioactive ^{32}P and ^{35}S elements chosen for this experiment (in other words, why were P and S chosen instead of another element like C)?
This question was #5 from Ch 10 of the book.

^{32}P selectively labels nucleotides (via phosphate group) but not proteins because P is in nucleic acid but not protein. ^{35}S elements selectively labels proteins but not nucleic acids because S is in protein but not nucleic acids. Thus, the location of the DNA and proteins could be independently followed in the experiment. C would label both nucleic acids and proteins so would not be useful.

Does this experiment distinguish between RNA or DNA as the genetic material? Why or why not?

No, because P is in both DNA and RNA. I also accepted that the bacteriophage used in the experiment was known to *not* contain RNA so the experimenters could have eliminated RNA as the genetic material because of this.

6 pts. 6. Hydrogen bonding between molecules plays a critical role in information flow in all organisms. For each process listed below, provide one example of where hydrogen bonding plays a role (if applicable). There were other possible answers, but these are the main one:

a. DNA replication
- H bonding between the incoming nucleotide and the old strand to determine which nucleotide is put in the new strand.
- H bonding allow opening of the double helix to allow replication to initiate at the A-T rich origin of replication and to occur semi-conservatively.

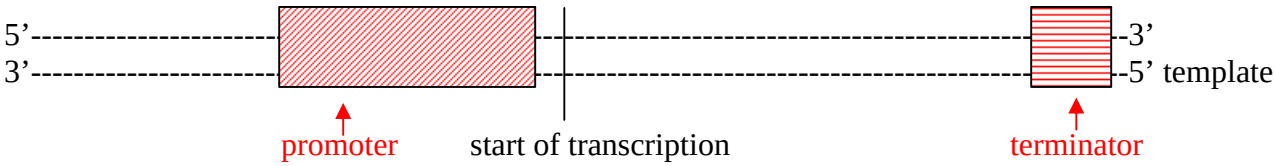
b. Transcription
- H bonding between the incoming nucleotide and the template strand to determine which nucleotide is put in the growing strand of RNA.
- H bonding allow opening of the double helix to allow transcription to initiate at the A-T rich promoter.

c. Translation
- H bonding between the incoming tRNA anticodon and the mRNA codon.
- H bonding between the ribosome binding site and the rRNA in the ribosome to position the mRNA in the correct position to start translation.

4 pts. 7. The following diagram represents a segment of a piece of DNA encoding a prokaryotic gene. The template strand is indicated.

a. On the figure below, indicate the approximate location of the promoter and transcriptional terminator for this gene.

b. What would happen to transcription of this gene if you deleted the promoter?
No transcription would occur.



12 pts. 8. You isolate several mutant strains of *E. coli*, each of which displays one of the characteristics listed below. For each phenotype listed below, predict what factor of DNA replication is most likely mutated and thus causing the aberrant phenotype. This question was similar to #21 from Ch 11 in the book.

a. No initiation of synthesis occurs

Defective DnaA, oriC, primase/primer

b. Newly synthesized DNA contains mutations (mismatched base pairs)

Defective DNA polymerase III or I proofreading/exonuclease/repair subunit
Defective DNA polymerase II was also accepted.

c. Okasaki fragments accumulate and DNA synthesis is never completed.

Defective ligase or DNA polymerase I.

10 pts. 9. The following represents a segment of a piece of DNA encoding a gene. The gene encodes a polypeptide that is three amino acids long. This question was similar to # 18 from Extra Questions from Ch 13/14 posted on Blackboard.

3′ TAC CCC CCC ATG ATT CCC AAT AAA CAT GTA 5′
5′ ATG GGG GGG TAC TAA GGG TTA TTT GTA CAT 3′ template

a. Label the strand of the DNA that is transcribed by writing template next to it.

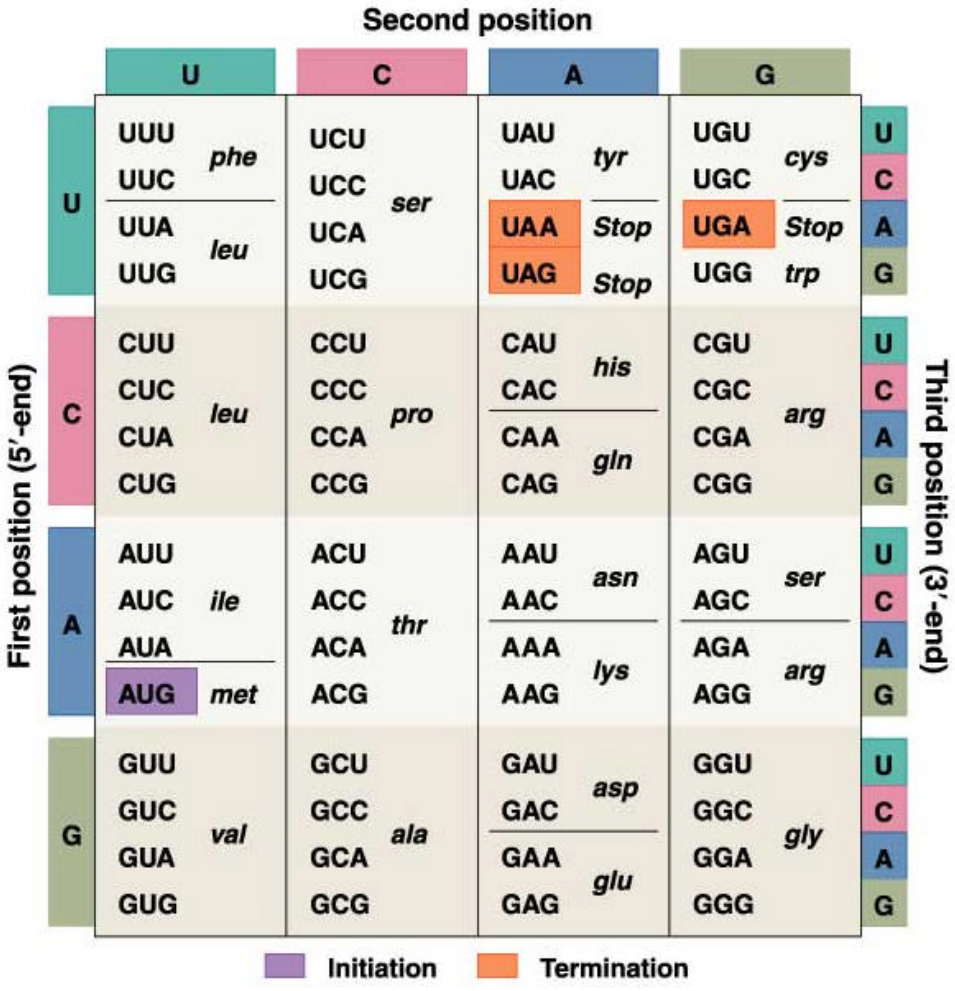
See above

b. Label the 5' and 3' ends of each DNA strand.

See above

c. Give the amino acid sequence of the 3 amino acid polypeptide that is encoded by this gene.

Met-Tyr-Lys



Multiple choice section: (24 points total – 4 points per question)

Choose the **BEST ANSWER** for each question. Write your answer in the blank provided to the left. IF you want to explain your answer, you can do so next to the question

C 1. What genetic phenomenon explains the following paradox: There are 64 possible codons, but only 30-40 tRNA types

a. Non-redundancy
b. Commaless code
c. Wobble
d. Petidyl transferase
e. Translocation

B 2. If the GC content of a DNA molecule is 60%, what are the percentages of the four bases (G, C, T, A)?

a. G = 60%, C = 60%, A = 40%, T = 40%.
b. G = 30%, C = 30%, A = 20%, T = 20%.
c. G = 30%, A = 30%, C = 20%, T = 20%.
d. G = 60%, C = 60%, A = 40%, U = 40%.
e. G = 30%, C = 30%, A = 20%, U = 20%.

A 3. What would be the ***most likely*** affect of a nucleotide change in the region of the gene that will be an intron in the mRNA?

a. Nothing
b. Amino acid will be changed in protein
c. The reading frame would change
d. No capping would occur
e. No translation would occur

E 4. If you add thymidine monophosphate in place of thymidine triphosphate in a DNA synthesis reaction, what would happen?

a. Leading strand synthesis would not occur.
b. Lagging strand synthesis would not occur.
c. Primase synthesis would not occur.
d. DNA synthesis would be unaffected.
e. A and B

A or C A new inhibitor of prokaryotic protein synthesis was discovered at UR called Spiderdyne. If Spiderdyne is added to *E. coli*, protein synthesis stops. More detailed analysis indicates that the amino acids are never linked together. Spiderdyne most likely inhibits protein synthesis by blocking:

a. Peptidyltransferase activity
b. Translocation
c. tRNA charging
d. A and B
e. all of the above

A 6. A ribosome "knows" where to start translation because the

a. Ribosome binding site on the mRNA binds to rRNA and positions AUG in P site
b. Ribosome binding site on the mRNA binds to rRNA and positions AUG in A site
c. First AUG of the mRNA is positioned in the P site
d. First AUG of the mRNA is positioned in the A site
e. TATA box in the promoter aligns the ribosome.