PCB 3063-02 EXAM 3 Spring 1999
Instructor: Bass

SECTION
I (VOCAB) 14
II (DEFINITIONS) 12
III (MULTIPLE CHOICE) 24
IV (SHORT ANSWER) 16
V (LONG PROBLEMS) 34
(bonus) 5
TOTAL (100 PTS) 100

Class Average
Class Range

HONOR CODE
"I did not give or receive help on this exam"

(SIGN) _______________________
I. VOCABULARY: (14 points, 1 point for each blank)

1) ______________________ are the short, discontinuous strands of DNA produced during DNA synthesis.

2) The ______________ is the triplet of nucleotides in the mRNA molecule that specifies a single amino acid.

3) The ______________ molecule is drawn as a cloverleaf structure and has many modified bases.

4) DNA ______________ is the polynucleotide joining enzyme; forms a covalent bond between the 5'-end of one polynucleotide chain and the 3'-end of another polynucleotide chain.

5) ______________ is the nuclear process of removing introns from newly transcribed pre-mRNAs.

6) The ______________ is added to the 3'-end of pre-mRNA after transcription.

7) ________________________ - an enzyme that removes terminal nucleotides in a polynucleotide chain by cleavage of the terminal phosphodiester bond.

8) One type of protein secondary structure is called the ________________ (name any one of several possible correct answers).

9) _______________ discovered jumping genes (mobile genetic elements) in maize.

10) Meselson and Stahl proved that DNA replication was ______________ using isotopes of N

11) A ______________ is a an extrachromosomal, circular DNA molecule that replicates independently of the bacterial host chromosome.

12) Another name for an RNA gel blot is a ______________________

13-14) The translation initiation complex consists of the charged start tRNA, initiation factors, _______________ and _______________
II. (12 points, 3 points each) DEFINITIONS:
Give brief definitions, 30 words or less

1) Polysome:

2) Knockout Mouse:

3) cDNA Library:

4) Restriction Enzyme:
III. (24 Points) MULTIPLE CHOICE (Circle ONE letter, 2 pt each):

1) A base substitution that changes one purine into another is a
   A. transition
   B. transversion
   C. transduction
   D. translocation
   E. transpurination

2) The Luria-Delbruck fluctuation test was designed to address the question of
   A. adaptive vs. random mutations
   B. DNA vs. protein as the genetic material
   C. DNA vs. RNA as the genetic material
   D. how proflavin causes mutations
   E. gene regulation in auxotrophs

3) Mutations whose effect can be turned on or off are called
   A. Permissive
   B. Spontaneous
   C. Induced
   D. Conditional.
   E. Somatic

4) Base substitutions in coding regions that result in changed amino acids are called
   A. Conditional mutations
   B. Permissive mutations
   C. Missense mutations
   D. Nonsense mutations
   E. Silent mutations

5) Which of the following chemicals is a base analog?
   A. Nitrous acid
   B. 5-bromouracil
   C. Ethyl methane sulfonate
   D. Nitrogen mustard
   E. Both B and D

6) What mechanisms of DNA repair can be used to repair thymidine dimers?
   A. Postreplication repair
   B. Photoreactivation
   C. SOS repair
   D. Excision repair
   E. Both B and D
7) A test for carcinogens and mutagens that looks for an increased reversion frequency in a His-strain of bacteria is called the
A. Amber test  
B. Mutagen test  
C. Ames test  
D. Salmonella reversion test  
E. Auxotrophic reversion test

8) The base guanine is always paired with
A. Adenine  
B. Guanine  
C. Cytosine  
D. Thymine  
E. Guanine is never paired with another base in a molecule of DNA

9) Which of the following statements is true regarding gene expression?
A. The 3' end of mRNA corresponds to the carboxyl terminus of the protein  
B. The first step is the association of mRNA with ribosomes  
C. Involves proof-reading of the mRNA  
D. Prokaryotic RNA usually undergoes nuclear processing  
E. Polypeptides are synthesized by addition of amino acids to the amino terminus

10) Plasmids used in vitro to clone foreign DNA fragments are called
A. Transgenic  
B. cDNA  
C. Clones  
D. Vectors  
E. Conjugants

11) Which enzyme functions to polymerize DNA from an RNA template?
A. DNA polymerase  
B. RNA polymerase  
C. Reverse transcriptase  
D. Ligase  
E. Endonuclease

12) Which vector element below can accept the largest DNA fragments in cloning experiments?
A. Plasmid  
B. Bacteriophage lambda  
C. YACs  
D. Cosmids  
E. Phage P1
IV (Short Answers, 16 points)

1) (4 points) Name and briefly describe the mechanism for one type of biological DNA repair process or mechanism.

2) (4 points) Name and describe the mode of action of:
   1) one example of a frame-shift mutagen
   2) one example of a base substitution mutagen

3) (4 points) You have been restriction mapping a 3 Kbp clone of linear DNA, using gel electrophoresis to determine the length of the resulting restriction fragments. After carrying out 3 different restriction digestion reactions on your clone, you found the following:
   - *Eco* RI digest - 3 fragments on the gel, sizes (in Kbp) = 1.4, 0.9, and 0.7.
   - *Hind* III digest - 2 fragments on the gel, sizes (in Kbp) = 2.0, and 1.0
   - Double digests with *Eco* RI plus *Hind* III -
     - 4 fragments on the gel, sizes (in Kbp) = 1.0, 0.9, 0.7, and 0.4

   Draw the restriction map and indicate the distance between the sites.

4) (4 points) Draw and label an mRNA molecule, identifying the name and location of standard key features (such as 5' cap, ORF, stop codon, 5'-3' polarity, etc.). Draw a line (not NT sequence) for the mRNA.
V (Long Problems, 34 points)

1) (14 pt.) Draw and label DNA replication. Indicate strand polarity, draw and label the approximate position of 4 or more proteins (such as helicase, polymerase, ...).

2) (10 pt.) You have identified the ragweed protein that causes allergic reactions and you have isolated the clone for the corresponding gene. You have also identified a **4 amino acid region** in the middle of the protein that is always present in the most allergenic strains of ragweed. In order to test the role of that region, you decide to carry out a site-directed mutagenesis experiment where the modified proteins will be tested for allergenicity. The 4 amino acids are **Ser-Gly-Gln-His**. (see codon table).

You start by testing missense mutations for the **Gln**, which in your clone is encoded by **CAA**. So you design three different oligonucleotides that each differ from the gene by only 1 nucleotide.

Write out the following 4 DNA sequences, (original + 3 synthetic oligonucleotides) that can be used to make a single amino acid substitution via site-directed mutagenesis:

1st- the original (you can use any codon for Ser, Gly, and His - but must use CAA for Gln)
2nd- A single nt change that would change Gln to another A.A. (name the A.A. such as Pro)
3rd- A different single change that would change Gln to another A.A. (name the A.A.)
4th- Another different change that would change Gln to another A.A. (name the A.A.)
3) (10 pt.) Genetic analysis of the biochemical pathway for a fluorescent fungus has resulted in the discovery that 3 genes (Glo1, Glo2, and Glo3) are required to produce the final fluorescent product, glowline. The mutants are glo1, glo2, and glo3. Without glowline, the fungus does not glow and is said to exhibit the "dud-mold phenotype". You identified the metabolic intermediates (poline, moline, yoline) that can be supplied in pure form to rescue some of the dud-mold mutants.

Now carry out a genetic dissection of the metabolic pathway by analyzing which compounds can be added to which mutants to regenerate the glow (convert dud-mold -> glowing fluorescent fungus).

Observations:
- glo1 dud-mold mutants can be made to glow by addition of moline or yoline
- glo2 dud-mold mutants remained dud-mold even after adding poline, moline, or yoline
- glo3 dud-mold mutants can only be made to glow by addition of yoline

Label which gene is responsible for each step below:

| poline | ______ | moline | ______ | yoline | ______ | glowline |

Extra Credit: (5 pt.)

How can one gene encode more than one protein? (2 pt)

List 2 different types of post-translational modifications of proteins (2 pt)

True or False? (1 pt) Glo3 is epistatic to Glo2