

Genetics 301 Sample Second Midterm Examination  
Solutions

Spring 2002

100 Points Possible

10 Multiple Choice Questions-4 pts. Each. A. Choose the best answer.

1. Translation involves:
  - a. mapping genes in bacteria using a viral carrier
  - b. reading an mRNA to yield an amino acid sequence in a protein
  - c. taking up DNA into a cell and changing its genetic makeup
  - d. reading a DNA strand and making an mRNA copy
  
2. Which of the following are similar between transcription in prokaryotes and eukaryotes?
  - a. RNA polymerases produce mRNAs which grow in the 5' to 3' direction.
  - b. RNA polymerases bind to ribosomes to allow transcription.
  - c. A poly A tail is added to the 3' end of messenger RNAs.
  - d. Introns are present in genes which are spliced out after transcription.
  - e. 5' cap is added to the mRNA after transcription.
  
3. In an interrupted mating experiment conducted with *E. coli*:
  - a. The P1 virus carries genes to the recipient bacterium.
  - b. A DNA solution is added and then rinsed away.
  - c. The lambda phage is integrated into the bacterial chromosome.
  - d. The F factor is integrated into the chromosome in the donor bacterium.
  
4. Which of the following is NOT a property of the genetic code:
  - a) non-overlapping
  - b) redundant
  - c) almost universal
  - d) four stop codons
  - e) triplet

5. The normal function of a promoter is to:
  - a) bind the small subunit of the ribosome
  - b) serve as an origin of DNA replication
  - c) serve as an acceptor for transfer RNA
  - d) serve as a binding site for RNA polymerase
  - e) interfere with the progression of tumor development
  
6. Gene duplication is thought to have been important in evolution because:
  - a. fewer copies of genes allows more rapid DNA replication.
  - b. Changing in the position of genes usually changes their expression.
  - c. An extra copy of a gene can sometimes undergo adaptive changes while the first copy continues to serve its original function.
  - d. Introns represent much of the extra DNA found in eukaryotes.
  - e. The genetic code can be more flexible in this situation.
  
7. The process of DNA replication involves:
  - a. multiple origins of replication per chromosome in eukaryotes.
  - b. Binding of ribosomes to origins of replication.
  - c. Activation of oncogenes to a new form.
  - d. Continuous synthesis on both strands of the double helix.
  - e. Conservative replication, with one original double helix and one totally new double helix as products.

8. Choose the correct statements about the most common structure of DNA.
- (1) The two strands are paired by hydrogen bonds between the bases, with A pairing with T, and G pairing with C.
  - (2) The two strands run in opposite orientations (one 5'-3', one 3'-5') with respect to each other.
  - (3) Backbone consists of alternating sugars and phosphate groups.

a. 1,2,3

b. 1,2

c. 1,3

d. 2,3

e. 1

f. 2

g. 3

9. The polymerase chain reaction represented a major advance in which of the following:
- a. Ability to quickly make many copies of a specific region from a small amount of DNA.
  - b. Protein synthesis in a test tube.
  - c. Binding of tRNAs to ribosomes in a test tube.
  - d. Production of large quantities of RNA polymerase in the laboratory.
10. What is the difference between spontaneous and induced mutations?
- a. Spontaneous mutations involve base substitutions but not frameshift mutations.
  - b. Induced mutations are caused by known exposures to chemicals or radiation.
  - c. Induced mutations involve nonsense mutations but not missense mutations.
  - d. Spontaneous mutations involve nonsense mutations but not missense mutations.
  - e. Induced mutations involve base substitutions but not frameshift mutations.

10 Short Identification- 2 Pts. each

11. lysogeny- insertion of a bacterial virus (phage) DNA into the bacterial chromosome, with survival and division of the resulting bacterium.
12. thymine dimer- crosslinks between adjacent thymine bases, resulting typically from exposure to ultraviolet light.
13. primase- an enzyme which synthesizes short RNA primers which are involved in initiation of DNA replication.
14. peptide bond- bond which joins amino acids in forming a polypeptide chain.
15. wobble pairing- unusual hydrogen bond pairing between bases in the tRNA anticodon and the mRNA codon which allows a single tRNA to pair with more than one codon.
16. Okazaki fragment- small, single strand fragments of DNA which are intermediates in DNA replication and are formed during the discontinuous synthesis on one of the two strands being synthesized.
17. specialized transduction- a bacterial virus leaves the bacterial chromosome and carries bacterial DNA adjacent to the insertion site to another bacterium.
18. paracentric inversion- inversion which does not include the centromere.
19. transposase- enzyme which allows movement of transposable elements. This may be coded by the element itself, or independently.
20. minimal medium- the simplest medium which will support the growth of wild type bacteria, normally containing glucose + simple salts.

5 Problems (40 Points total)

21. (7 Pts.) Based on the results which have been observed from the Ames test and from cancer trials with mice and rats, what is the relationship between chemicals causing mutations and chemicals causing cancer?

Chemicals which cause mutations almost always cause cancer. In some cases, those chemicals are not "direct mutagens" but require activation to a mutagenic form by enzymes in the liver of animals.

22. (6 pts.) Determine the gene order (i.e., which gene is in the middle) from the following data set from a transduction experiment. Bacteria were selected for the presence of A+.

A+ B- C-	605
A+ B+ C+	92
A+ B+ C-	302
A+ B- C+	1

B appears to be in the middle. B is closer to A than C is, based on the cotransduction frequencies. The fact that transduction with C almost always carries B along suggests that it is beyond B from A on the chromosome. There is one apparent double crossover event.

23. (4 pts.) Suppose that a mutation in the anti-codon region of a transfer RNA allowed a tRNA which normally carries an amino acid to pair with a stop codon which leads to insertion of an amino acid during protein synthesis. What would the effect of this be on (a) a nonsense mutation involving the relevant stop codon, and (b) protein synthesis in general.

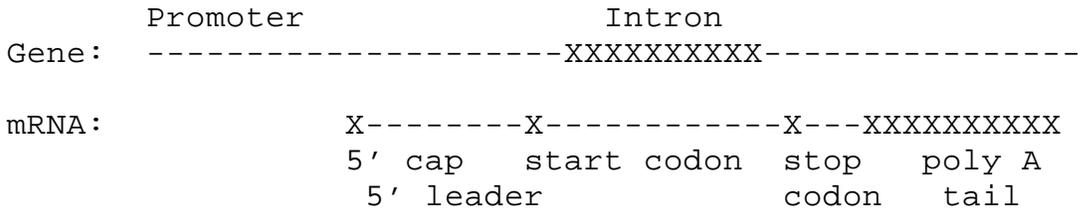
a. The mutation in the tRNA might suppress or prevent the effect of the nonsense mutation by substituting an amino acid where the stop codon was located. A full size protein might then be produced rather than the short protein expected with the nonsense mutation.

b. Some normal stop codons might not be recognized, resulting in longer than normal proteins.

24. (11 pts.) Place the major steps in eukaryotic gene expression (translation, transcription, RNA processing) in their proper order, and indicate which of them involve the following eight components: spliceosome, promoter, ribosome, transfer RNA, RNA polymerase, initiation codon, stop codon, addition of 5' cap.

1. Transcription (promoter, RNA polymerase)
2. RNA processing (spliceosome, addition of 5' cap)
3. Translation (ribosome, tRNA, initiation codon, stop codon)

25. (12 pts). Diagram a eukaryotic gene with one intron and the corresponding messenger RNA, indicating the locations of the following: 5' cap, 5' leader, promoter, start codon, intron, poly A tail, stop codon.



Points: -1 each lost for misplacement of any of the seven components listed above. Additional points may be lost for not clearly labelling the gene or the mRNA, or for not indicating the proper position or number of introns.