

## Biology 210 – Genetics & Evolution – Exam II – Spring 2009

Name (see below): Key

### Instructions:

- 1) Print your name (first name first, middle initial and last name) on the line above. Please use the form of your name that matches university records (e.g., no nicknames, or recently changed names).
- 2) Read each question carefully before you begin work on it.
- 3) Be sure to put your final answers in the spaces provided.

1. Suppose that you are involved in a study on hereditary factors in cancer. In the course of your research you find a gene that is mutated in lung tumors and you determine the DNA sequence of this gene. You want to find out if this lung-cancer associated gene is similar to any others that are known, so you decide to search the NCBI database for genes with similar sequences. What alignment/search algorithm would be most suitable for this purpose?

BLAST

2. Suppose that you are studying genes and gene products involved in the synthesis of amino acids by bacteria. You decide to start by using replica plating to isolate mutants of *E. coli* that **cannot** synthesize the amino acid **proline**. You start with several hundred colonies of *E. coli* growing on a plate that was made with complete medium. You will next need to replica plate these colonies onto two other plates. What are the types of medium that should be on each of these two other plates?

- 1) minimal medium
- 2) selective medium OR minimal medium + proline

3. What are the **units** for the map distances on genetic maps of bacterial chromosomes that are based on conjugation (interrupted mating).

minutes

4. Which of the three operons that we have studied is inducible and has a **single protein** that is involved in **both** positive and negative regulation of the operon?

*ara*

5. For induction of the *lac* operon to occur, it is necessary that the operon expresses the *lacZ* gene at least a little even when the operon is repressed. Why is this?

the *lacZ* gene product is needed to convert lactose to the inducer, allolactose

6. The table below lists genotypes and availability of substrates for the *lac* operon of *E. coli*. For each combination of genotype and substrates (row), indicate at what level a wild-type *lacZ* gene would be expressed: **leaky** (repressed), **low** (derepressed but not activated by CAP) or **high** (derepressed and activated by CAP).

+ indicates a wild-type allele

– indicates a non-functional allele or absent gene

$I^S$  indicates the super repressor allele of *lacI*

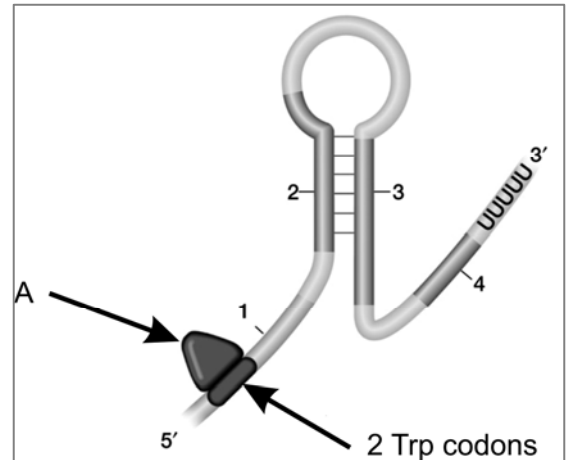
$O^C$  indicates a constitutive operator mutation

Wild-type <i>lac</i> operon								
Genomic Copies			F' Plasmid Copies			Substrates		Expression of <i>lacZ</i>
<i>lacI</i>	<i>O</i>	<i>lacZ</i>	<i>lacI</i>	<i>O</i>	<i>lacZ</i>	Glucose	Lactose	leaky / low / high
+	+	+	–	–	–	–	–	leaky
+	+	+	–	–	–	–	+	high
+	+	+	–	–	–	+	–	leaky
+	+	+	–	–	–	+	+	low

Mutant operons								
Genomic Copies			F' Plasmid Copies			Substrates		Expression of <i>lacZ</i>
<i>lacI</i>	<i>O</i>	<i>lacZ</i>	<i>lacI</i>	<i>O</i>	<i>lacZ</i>	Glucose	Lactose	leaky / low / high
$I^S$	+	+	–	–	–	+	+	leaky
+	$O^C$	+	–	–	–	+	+	low
$I^S$	+	+	–	–	–	–	+	leaky
+	$O^C$	+	–	–	–	–	+	high
$I^S$	$O^C$	+	–	–	–	+	+	low
$I^S$	$O^C$	+	–	–	–	–	+	high

Merozygotes								
Genomic Copies			F' Plasmid Copies			Substrates		Expression of <i>lacZ</i>
<i>lacI</i>	<i>O</i>	<i>lacZ</i>	<i>lacI</i>	<i>O</i>	<i>lacZ</i>	Glucose	Lactose	leaky / low / high
–	+	+	–	+	–	–	+	high
–	+	+	–	+	–	+	–	low
+	$O^C$	–	–	+	+	–	+	high
+	$O^C$	–	–	+	+	+	–	leaky

Questions 7 - 9 refer to the diagram to the right, which represents a form of transcriptional regulation found in the *trp* operon.



7. What is the structure with the arrow pointing to it from A?

a ribosome

8. As this scene is depicted, is the concentration of tRNA-tryptophan high or low?

low

9. Which of the numbered sections would form a terminator if base-paired?

3 and 4

Questions 10-15 refer to the diagram on the right, which represents the promoter region of phage  $\lambda$ . For each question, list the one or more genes.

10. Which of the genes shown encode proteins that act as repressors?

cI and cro

11. Which of the genes shown encodes an antiterminator?

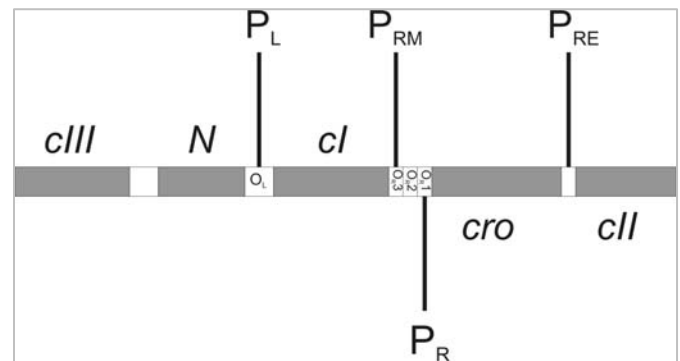
N

12. Which of the genes shown would you remove to create a phage that always entered lysogeny?

cro

13. Which of the genes shown have products that are either required for transcription from PRE or favor it?

cII and cIII



14. Which of the genes shown has a product that allows transcription of delayed early genes?

N

15. Which of the genes shown has a product that is cleaved by RecA during the SOS response?

cI

16. What is the eukaryotic promoter element to which TFIID binds to begin the formation of the pre-initiation complex (PIC)?

TATA box

17. How is the rate of transcription usually affected by mutations in either the CCAAT box or GC box?

decreased

18. What type of sequence element increases the rate of transcription a gene, even if it is several thousand nucleotides away from a eukaryotic gene?

enhancer

19. What determines whether a thyroid hormone receptor protein will increase or decrease transcription when bound to a THRE?

whether or not thyroid hormone is bound to the receptor protein

20. What is a common function of protein domains that have the helix-turn-helix motif?

DNA binding

21. What does a leucine zipper do?

holds together two peptides

22. List three mechanisms by which repressors decrease eukaryotic transcription

1) compete for sequence element binding sites

2) block DNA binding domains on proteins

3) block activation domains on proteins

23. What type of transcription-regulatory RNA is bound by the Argonaute protein as part of the RISC complex?

miRNA

24. How does the distribution of DNase I hypersensitive sites compare with the locations of transcriptionally active genes?

The hypersensitive sites are near (upstream from) transcriptionally active genes

25. Why effect does acetylation of histones have on the binding of histones to DNA?

loosens the binding