DO NOT OPEN UNTIL TOLD TO START

BIO 312, Section 1: Fall 2012
December 4th, 2012 – Exam 3

Name (print neatly) _____

Signature _____

7 digit student ID _____

INSTRUCTIONS:

1. There are 12 pages to the exam. Make sure you have all of the pages.
2. There are 46 scantron problems.
3. Each problem will count equally to your overall score.
4. Be sure to provide your student information on this page and on the scantron.
5. Mark all of your answers correctly and clearly on the scantron using a #2 pencil.
6. You have 75 minutes to complete the exam.
7. When done, turn in both your exam copy **with your signature** and your scantron.
8. Keep your eyes on your own exam, keep your exam concealed (do not hold up).
9. Calculators are not allowed for this exam.
10. Turn off phones and put away all electronic devices.

Instructions: For each problem choose the correct answer from the provided choices. On the scantron, fill in the circle underneath the letter of your selected answer using a **# 2 pencil**.

Problems 1-5.
For the following haploid (1) and partial diploid (2-5) *E. coli* genotypes, use your knowledge of the lactose system to fill in the table as to whether each protein is produced when there is either No IPTG or IPTG present. The "+" sign indicates protein production and the "-" sign indicates no protein production.

		β-galactosidase		Permease	
	Haploid Genotype	No Lactose	Lactose	No Lactose	Lactose
1	*I+ P- O+ Z+ Y+*	1	2	3	4
	Diploid Genotype				
2	*I+ P+ O^C Z- Y+ / I^S P+ O+ Z+ Y-*	1	2	3	4
3	*I+ P+ O^C Z- Y+ / I^S P- O^C Z+ Y-*	1	2	3	4
4	*I+ P+ O+ Z- Y+ / I- P+ O+ Z+ Y-*	1	2	3	4
5	*I- P+ O+ Z- Y+ / I^S P+ O^C Z+ Y-*	1	2	3	4

For each problem, choose the one correct answer from the choices. The order of the answers below corresponds to 1, 2, 3, and 4 in the above table.

1. A. +, +, +, + B. -, +, -, + C. -, -, -, - D. -, -, +, + E. +, +, -, -

2. A. +, +, +, + B. -, +, -, + C. -, -, -, - D. -, -, +, + E. +, +, -, -

3. A. +, +, +, + B. -, +, -, + C. -, -, -, - D. -, -, +, + E. +, +, -, -

4. A. +, +, +, + B. -, +, -, + C. -, -, -, - D. -, -, +, + E. +, +, -, -

5. A. +, +, +, + B. -, +, -, + C. -, -, -, - D. -, -, +, + E. +, +, -, -

6. The class of mutants known as "super-repressor mutants" alter the Lac repressor's .....

A. allosteric site. B. DNA-binding domain. C. expression.

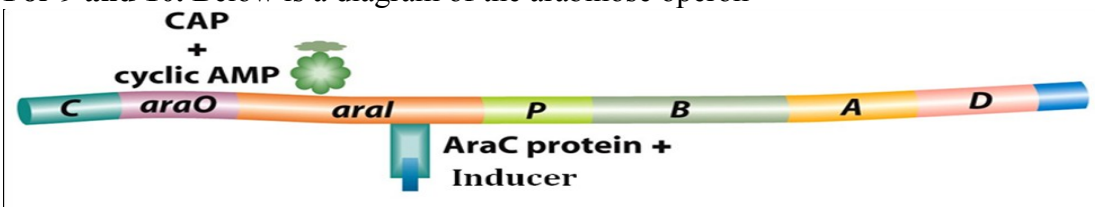
7. Which of the following mutations is/are considered to be "cis-acting"?

A. O^C B. P^- C. I^S D. I^- E. both A and B

8. A bacterial cell has the genotype $I^+ P^+ O^C Z^+$ and CAP^+ (also known as *crp*). At what level would the β-galactosidase protein be expressed in media containing (i) Glucose only, (ii) Lactose only, and (iii) Glucose and Lactose?

A. (i) 0% (ii) 100 (iii) 1%
B. (i) 1% (ii) 100% (iii) 1%
C. (i) 100% (ii) 100% (iii) 100%
D. (i) 100% (ii) 100% (iii) 1%
E. (i) 1% (ii) 100% (iii) 0%

For 9 and 10. Below is a diagram of the arabinose operon



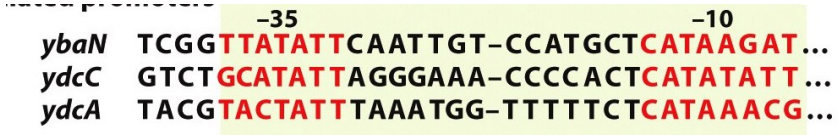
9. What is the natural "Inducer" for this operon?

A. IPTG B. Lactose C. Glucose D. Arabinose E. CAP

10. If AraC and CAP-cAMP are bound to *araI* and *araO* as shown above, what is the carbohydrate environment that this operon finds itself in?

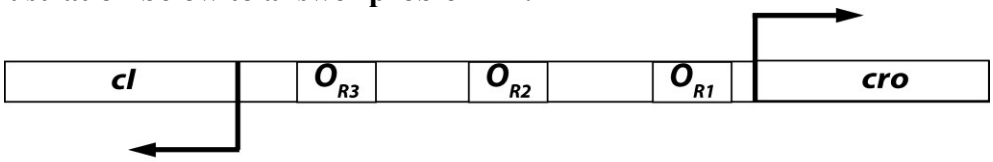
A. No Glucose and No Arabinose
B. Glucose present and No Arabinose
C. Arabinose present and Glucose present
D. Arabinose present and No Glucose

11. The *Bacillus subtilis* genes *ybaN*, *ydcC*, and *ydcA* have the below sequences 5' of their +1 site. These similarities in DNA sequences make these genes part of a ____(i)____ . These similar DNA sequences are bound by _____(ii)_____ .



A. (i) regulon (ii) RNA polymerase
B. (i) poly-cistron (ii) TBP
C. (i) operon (ii) a sigma factor
D. (i) operon (ii) RNA polymerase
E. (i) regulon (ii) a sigma factor

Use the illustration below to answer problem 12.



12. A mutation destroying the O_{R3} DNA sequence in the bacteriophage λ genome would .....

A. prevent binding of the cro protein, resulting in expression of the *cI* gene which causes the bateriophage to enter the lysogenic life cycle.
B. prevent binding of the λ Repressor protein, resulting in expression of the *cro* gene which causes the bacteriophage to enter the lysogenic life cycle.
C. prevent binding of the cro protein, resulting in expression of the *cI* gene which causes the bateriophage to enter the lytic life cycle.
D. prevent binding of the λ Repressor protein, resulting in expression of the *cro* gene which causes the bacteriophage to enter the lytic life cycle.

For 13 - 15. Is *GAL1* gene expression "ON" or "OFF" for the following yeast mutants in medium containing (i) Galactose only, (ii) Glucose only, and (iii) Galactose and Glucose?

13. *Mig1* gene null mutant.

A. (i) ON (ii) ON (iii) ON
B. (i) OFF (ii) OFF (iii) OFF
C. (i) ON (ii) OFF (iii) OFF
D. (i) ON (ii) OFF (iii) ON
E. (i) OFF (ii) ON (iii) OFF

14. *GAL3* gene null mutant.

A. (i) ON (ii) ON (iii) ON
B. (i) OFF (ii) OFF (iii) OFF
C. (i) ON (ii) OFF (iii) OFF
D. (i) ON (ii) OFF (iii) ON
E. (i) OFF (ii) ON (iii) OFF

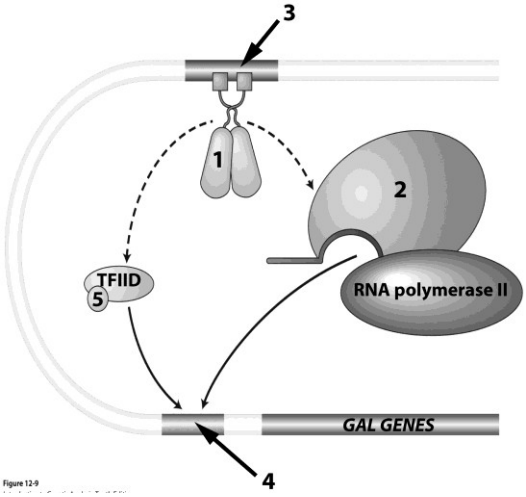
15. *GAL4* gene null mutant.

A. (i) ON (ii) ON (iii) ON
B. (i) OFF (ii) OFF (iii) OFF
C. (i) ON (ii) OFF (iii) OFF
D. (i) ON (ii) OFF (iii) ON
E. (i) OFF (ii) ON (iii) OFF

16. The ground state for eukaryotic gene expression is considered to be .....

A. "OFF"
B "ON"

For 17 and 18. The image below represents aspects of the regulation of *GAL* gene expression. Use this image to answer questions 20 and 21. The protein numbered "1" is GAL4.



17. The arrow labeled "3" is pointing to.....

A. a UAS element.
B. allosteric site.
C. an insulator.
D. the TATA box
E. an ICR.

18. The protein numbered "2" does not directly interact with DNA and is known as ___(i)___ . This protein is an example of a ___(ii)___ .

A. (i) Mediator (ii) transcription factor
B. (i) TBP (ii) coactivator
C. (i) TBP (ii) transcription factor
D. (i) Mediator (ii) coactivator
E. (i) Mediator (ii) corepressor

19. Screens for mutant yeast that could not switch mating types and that could not ferment sugars identified _____ .

A. the first enhanceosome.
B. the occurrence of combinatorial regulation.
C. a phenotype known as position effect variegation.
D. a mutation in an enhancer blocking insulator.
E. a protein that functions in nucleosome remodeling.

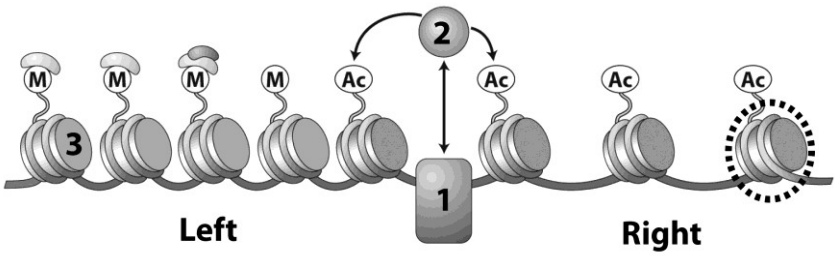
20. Genes that are "highly expressed" typically possess .....

A. hypoacetylated histones.
B. hyperacetylated histones.
C. methylated cytosines.
D. both A and C
E. both B and C

21. The control of a-specific, α–specific, and haploid-specific gene expression in yeast demonstrates the use of _____ in the control of gene expression.

A. chromatin remodeling
B. imprinting
C. combinatorial regulation
D. an enhanceosome
E. an enhancer blocking insulator

For 22 - 24. The image below represents a chromatin environment. "M" stands for Methyl and "Ac" stands for Acetyl. The protein labeled "2" is a histone acetyltransferase.



22. Which of the following types of organisms would have chromatin like this?

A. virus
B. bacteria
C. yeast
D. fruit fly
E. both C and D

23. What type of DNA sequence is bound by the protein complex labeled "1"?

A. enhancer blocking insulator
B. ICR
C. barrier insulator
D. promoter
E. enhanceosome

24. Genes located on the (i) side of the protein complex labeled "1" are in a chromatin environment favorable for gene expression. This favorable environment is called (ii).

A. (i) Left (ii) euchromatin
B. (i) Left (ii) heterochromatin
C. (i) Right (ii) euchromatin
D. (i) Right (ii) heterochromatin

25. The phenomenon in *D. melanogaster* known as Position-Effect Variegation (PEV) results from:

A. combinatorial regulation.
B. imprinting.
C. dosage compensation.
D. post-transcriptional regulation.
E. heterochromatin spreading.

Problems 26 and 27 pertain to imprinting.

26. The gene *UBE3A* is **paternally** imprinted in humans and individuals lacking functional UBE3A protein develop a genetic condition known as Prader-Willi (P-W) syndrome. Would children inheriting a *UBE3A* wild type allele ($UBE3A^M$) from their mother and a null allele from their father ($UBE3A^P$) have P-W syndrome phenotypes?

A. No, they would not have P-W syndrome. B. Yes, they would have P-W syndrome.

27. Which allele would be associated with methylated cytosines, the allele inherited from mom ($UBE3A^M$) or dad ($UBE3A^P$)?

A. $UBE3A^M$ allele B. $UBE3A^P$ allele

28. The image below is of a "Tortoiseshell" cat phenotype. This is found in ____(i)____ cats due to the occurrence of _____(ii)_____.

A. (i) female cats (ii) dosage compensation
B. (i) male cats (ii) dosage compensation
C. (i) female cats (ii) genomic imprinting
D. (i) male cats (ii) genomic imprinting
E. (i) female and male cats (ii) position effect

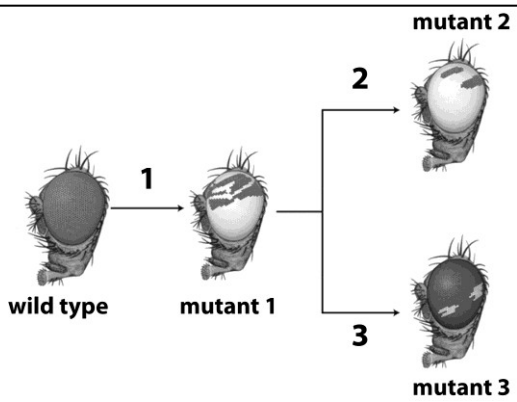
29. Which of the following best describes the phenotypes seen for homeotic mutants?

A. One body part is missing.
B. One body part looks like a part from a different species.
C. One body part has been duplicated.
D. One body part is changed into another body part.
E. One body part is much greater in size.

30. The maternal-effect *bicoid* gene makes a protein that functions as a _____.

A. signaling ligand
B. DNA methytransferase
C. transcription factor
D. histone acetyltransferase
E. signaling receptor

31. The "mutant 1" fly was exposed to the mutagen EMS, resulting in some progeny with new phenotypes similar to that shown above for mutant 2 and mutant 3. The mutant 3 phenotype results from mutations in _____ .



A. *E(var)* genes that normally function in euchromatin formation.
B. *E(var)* genes that normally function in establishing imprinting.
C. *E(var)* genes that normally function in heterochromatin formation.
D. *Su(var)* genes that normally function in euchromatin formation.
E. *Su(var)* genes that normally function in heterochromatin formation.

32. All eight *Drosophila Hox* genes encode proteins containing a highly conserved 60-amino-acid motif called the _____(i)_____ . This motif functions to _____(ii)_____ .

A.	(i) homeobox	(ii) bind a signaling ligand
B.	(i) homeobox	(ii) bind to DNA sequences
C.	(i) homeodomain	(ii) bind a signaling ligand
D.	(i) homeodomain	(ii) bind to DNA sequences
E.	(i) chromatindomain	(ii) bind to nucleosomes

33. The class of genes required for establishing the formation of a contiguous block of segments is: _____ .

A. the maternal-effect genes
B. the gap genes
C. the pair-rule genes
D. the segment polarity genes
E. the *Hox* genes

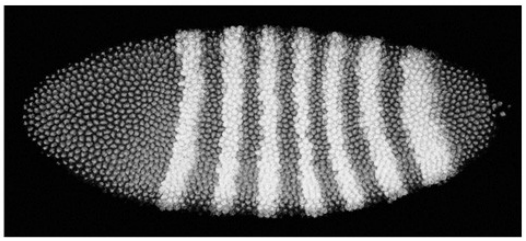
34. *bicoid* is a maternal-effect gene whose wild type function is needed for the anterior end of fruit flies to develop. The following cross was performed, where *bicoid-* is a null allele:

♂ *bicoid+/bicoid-* X ♀ *bicoid-/bicoid-*

What percentage of the cross progeny **WILL** possess a wild type anterior end?

A. 0%
B. 25%
C. 50%
D. 75%
E. 100%

For problems 35 and 36. Below shows a seven stripe pattern of protein expression for a particular *Drosophila* toolkit gene that is expressed during embryonic development.



35. Based on this expression pattern, it can be concluded that this is a:

A. pair-rule gene.
B. segment-polarity gene.
C. gap gene.
D. maternal effect.
E. *HOX* gene.

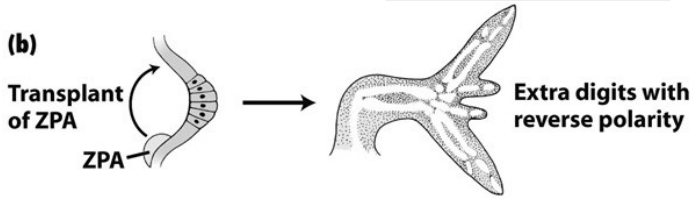
36. The expression of which gene class(es) would be altered in homozygous mutant embryos for the gene pictured above?

A. selector genes only.
B. pair-rule and gap genes.
C. maternal-effect, gap, and segment-polarity genes
D. segment-polarity and *HOX* genes.
E. gap and maternal-effect genes.

37. A child was identified with polydactyly (seven fingers on each hand and seven toes on each foot) but that had no additional mutant phenotypes. Genetic mapping identified that this mutation lies within the *Sonic hedgehog* gene. Based upon the phenotype and what you know about the *Sonic hedgehog* gene, this mutation would be located in _____ .

A. the protein coding sequence
B. an enhancer (cis-regulatory element)
C. the 3' UTR
D. the 5' UTR
E. the promoter

38. Sonic Hedgehog protein is produced in the ZPA, a region of cells known as _____(i)_____ and this protein functions as a _____(ii)_____ .



A. (i) the blastopore lip (ii) morphogen
B. (i) the blastopore lip (ii) inducer
C. (i) a morphogen (ii) organizer
D. (i) an organizer (ii) morphogen
E. (i) an inducer (ii) organizer

39. Opsin genes encode proteins that are a group of light-sensitive cell membrane-bound receptors that are exclusively expressed in photoreceptor cells of the retina. These genes are best classified as .....

A. allosteric genes
B. differentiation genes
C. housekeeping genes
D. homeotic genes
E. toolkit genes

40. In the 4-cell stage *C. elegans* embryo, the production of GLP-1 protein in the two anterior cells but not the posterior cells demonstrates how _____ .

A. gene expression can be controlled by an RNA binding protein that represses translation.
B. a miRNA can function as a toolkit regulating gene expression during development.
C. chromatin modifying proteins can regulate gene expression during development.
D. a cascade of alternate RNA splicing can regulate gene expression during development.
E. an "enhancer" can limit gene expression to certain cells during development.

41. Technique that makes visible the locations where a gene's mRNAs are expressed

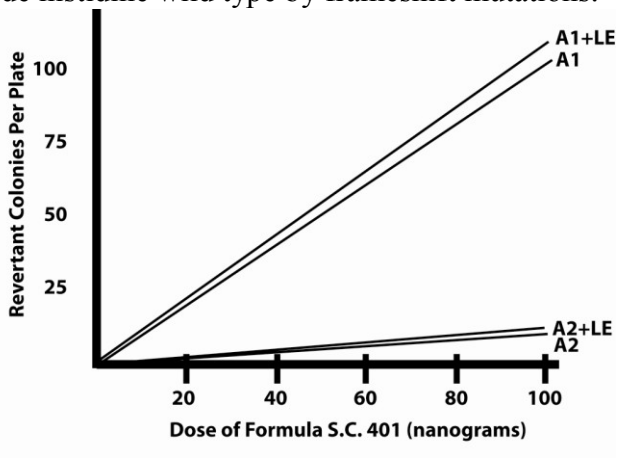
A. RNAi
B. DNA microarray
C. immunolocalization
D. *in situ* hybridization
E. zoo blot

42. A mutation that changes a codon from AAA (encoding lysine) to AGA (encoding arginine) is called a _____ .

A. synonymous mutation
B. indel mutation
C. nonsense mutation
D. missense mutation
E. frameshift mutation

43. In this experiment two histidine mutant bacteria strains (A1 and A2) were given the chemical compound S.C. 401 at increasing doses in the presence of a rat liver extract (A1+LE and A2+LE) and without the extract (A1 and A2). These bacterial cultures were plated onto nutritional media lacking histidine and the number of surviving colonies ("revertant") were recorded and plotted on this graph.

Note: The A1 strain can only be made histidine wild type by base-substitution mutations and the A2 strain can only be made histidine wild type by frameshift mutations.



It can be concluded that compound S.C. 401 .....

A. is a indel causing mutagen that is made non-mutagenic by metabolism.
B. is a base-substitution causing mutagen that is not altered by metabolism.
C. is not a mutagen, but it is converted by metabolism into a base-substitution causing mutagen.
D. is a base-substitution causing mutagen that is made non-mutagenic by metabolism.
E. is not a mutagen, but it is converted by metabolism into a indel causing mutagen.

44. A mutation that changes an "A" nucleotide to a "C" nucleotide is called a _____ .

A. indel mutation
B. transition mutation
C. spontaneous mutation
D. induced mutation
E. transversion mutation

45. True or False: Mutations in tumor suppressor genes are recessive and cause the gene's normal function to be lost.

A. True
B. False

46. In the figure below, the left most image shows the wild type points of migration following electrophoresis and blotting for the gene products for *LacZ*. Choose the points of migration (select either A, B, C, or D) that would occur for a *LacZ* allele with a **nonsense** mutation.