DO NOT OPEN UNTIL TOLD TO START

BIO 312, Section 1: Fall 2012
October 25th, 2012 – Exam 2

Name (print neatly) ____

Signature ____

7 digit student ID ____

INSTRUCTIONS:

1. There are 13 pages to the exam. Make sure you have all of the pages.
2. There are 50 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 65 minutes to complete the exam.
7. When you are done, turn in both your exam copy **with your signature** and your scantron.

9. Keep your eyes on your own exam, keep your exam concealed (do not hold up).
10. You may use a simple calculator but not any other electronic devices.
11. Make sure you fill in your scantron properly.

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 number 2 pencil.

For problems 1 – 4. A cross is made between an **Hfr** bacterium that is ***met*⁺ *thi*⁺ *pur*⁺** and an **F⁻** bacterium that is ***met*⁻ *thi*⁻ *pur*⁻** . Interrupted-mating studies show that *met*⁺ enters the recipient last, and so *met*⁺ recombinants are selected on a medium containing supplements that satisfy only the *pur* and *thi* requirements. These recombinants are tested for the presence of the *thi*⁺ and *pur*⁺ alleles. The following numbers of individuals are found for each genotype:

Genotype	# of Recombinants
met+ thi+ pur+	360
met+ thi+ pur-	100
met+ thi- pur+	0
met+ thi- pur-	40

1. What process of genetic exchange is occurring here?

A. Transformation
B. Specialized Transduction
C. Generalized Transduction
D. Conjugation
E. Transfection

2. Assigning met as the leftmost gene, what is the gene order?

A. *met thi pur*
B. *met pur thi*

3. What is the map distances in recombination units (rounded to nearest integer) between the *met* and *thi* genes?

A. 8
B. 11
C. 20
D. 28
E. 39

4. What is the map distances in recombination units (rounded to nearest integer) between the *met* and *pur* genes?

A. 8
B. 11
C. 20
D. 28
E. 39

5. In laboratory mice, the "short tail" phenotype is dominant to the wild-type ("long tail") phenotype. However, crosses between any two short-tailed mice always produce mixtures of short- and long-tailed offspring, and overall there were twice as many mice with the long tail phenotype. Assuming that tail length is controlled by a single locus, a likely explanation for these results is that the "short tail" allele is:

A. a codominant allele.
B. a dominant negative allele.
C. haplosufficient.
D. an incompletely dominant allele.
E. a recessive lethal allele.

6. A flowering plant with pink petals was crossed to a second plant with pink petals. 10 cross progeny had red petals, 10 progeny had white petals, and 20 progeny had pink petals. What is the genetic explanation for this outcome?

A. recessive epistasis
B. dominant epistasis
C. incomplete penetrance
D. incomplete dominance
E. codominance

For problems 7 and 8. A father with the disease phenotype Osteogenesis imperfecta (called OI) has a mutant allele for the *COL1A1* gene that produces a malformed protein. In heterozygotes, this mutant allele's protein product distorts the shape and function of the COL1A1 protein produced by a second wild type *COL1A1* allele.

7. This mutant allele for *COL1A1* is known as a ....

A. dominant negative allele
B. codominant allele
C. hypomorphic allele
D. semidominant allele
E. null allele

8. This father has five children, three that were found to have inherited the *COL1A1* mutant allele. Of the three children with this mutant allele, one has a severe OI phenotype, one has a mild OI phenotype, and one is phenotypically wild type. This is a genetic example of ....

A. complementation.
B. incomplete penetrance.
C. variable expressivity.
D. incomplete dominance and variable penetrance.
E. incomplete penetrance and variable expressivity.

For problems 9 and 10. In humans, PKU (phenylketonuria) is a recessive disease caused by *PAH* gene null alleles (*PAH*-), which results in an enzyme deficiency at step A in the reaction below. AKU (alkaptonuria) is a recessive disease caused by *HGD* gene null alleles (*HGD*-), which results in an enzyme deficiency at step B.

$$\text{phenylalanine} \xrightarrow{A} \text{tyrosine} \xrightarrow{B} CO_2 + H_2O$$

9. A person with PKU marries a person with AKU. What phenotype do you expect for their children?

A. All children will be phenotypically normal.
B. All children will have AKU.
C. All children will have PKU
D. All children will have AKU and PKU
E. Children can be phenotypically wild type, AKU, PAH, or AKU and PKU.

10. The children's phenotypes from the parents in problem 9 are an example of the genetic phenomenon known as ....

A. hypostasis
B. epistasis
C. complementation
D. non-complementation
E. suppression

11. Part of a metabolic pathway responsible for the wild type Black melanin fur color for mice is shown below. Recessive mutants for gene *A* have a White fur color. Recessive mutants for gene *B* have a Tan fur color. Several mice each of genotype *A/a ; B/b* were crossed and hundreds of progeny were generated. What is the expected phenotypic ratio?

White intermediate	Gene *A* → Enzyme A	Tan intermediate	Gene *B* → Enzyme B	Black melanin

A. 9 : 3 : 3: 1
B. 9 : 7
C. 9 : 3 : 4
D. 9: 3 : 3
E. 10 : 3 : 3

For problems 12 and 13. A biosynthetic pathway is being mapped out for a novel haploid fungus strain. Four auxotrophs were identified that cannot grown in the absence of arginine. Each mutant was tested for growth (+) or no growth (-) following the addition of a single compound to minimal media (one of arginine, citrulline, glutamate, ornithine or succinate).

Mutant	**arginine**	**citrulline**	**glutamate**	**ornithine**	**succinate**
arg-1	+	-	-	-	+
arg-2	+	+	-	+	+
arg-3	+	-	-	-	-
arg-4	+	+	-	-	+

12. What is the order that the compounds are produced in this pathway?

Steps	1		2		3		4	
A. arginine	→	succinate	→	citrulline	→	ornithine	→	glutamate
B. glutamate	→	ornithine	→	citrulline	→	succinate	→	arginine
C. citrulline	→	ornithine	→	glutamate	→	succinate	→	arginine
D. glutamate	→	succinate	→	citrulline	→	ornithine	→	arginine
E. ornithine	→	glutamate	→	succinate	→	citrulline	→	arginine

13. At which step does the *arg-4* gene act in this biosynthetic pathway?

A. Step 1 B. Step 2 C. Step 3 D. Step 4

For problems 14 and 15. Three new arginine auxotrophs were identified (*arg-5*, *arg-6*, and *arg-7*) that cannot grow on medium lacking the amino acid arginine.

14. An *arg-5* mutant cell was fused together with an *arg-6* mutant to form a ....

A. meiocyte. B. heterokaryon. C. codominant.
D. pleiotrop. E. tetrad.

15. When fused, these combined mutant cells could grow in minimal medium lacking arginine, an occurrence known as _____(a)_____ and indicates that the *arg-5* and *arg-6* mutants occur in _____(b)_____.

A. (a) = epistasis , (b) different genes
B. (a) = epistasis , (b) the same gene
C. (a) = complementation , (b) different genes
D. (a) = complementation , (b) the same gene
E. (a) = non-complementation , (b) the same gene

16. Phenylketonuria, or PKU disease, is a recessive disorder caused by mutations in the PAH gene that results in a toxic build up of phenylpyruvate that leads to severe cognitive impairment (mental retardation). Individuals with the PKU genotype that avoid dietary phenylalanine have wild type cognitive abilities (they lack the PKU phenotype). Thus, PKU can be considered an example of ....

A. variable expressivity.
B. pleiotropy.
C. incomplete dominance.
D. synthetic lethality.
E. incomplete penetrance.

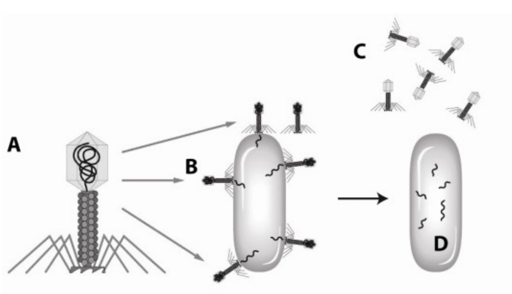
17. Human blood group (for example the Human ABO) phenotypes are controlled by ....

A. incompletely dominant alleles
B. dominant negative alleles
C. co-dominant alleles
D. hypomorphic alleles
E. epistatic alleles

18. Dominant epistasis has occurred when a cross of two dihybrids results in a phenotypic ratio of ....

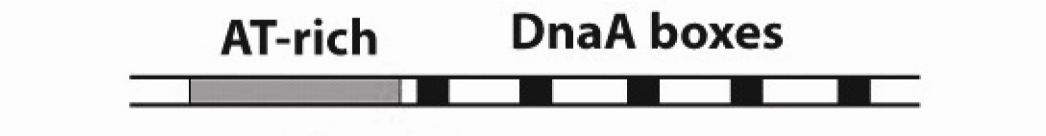
A. 9:3:3:1 B. 9:7 C. 12:3:1 D. 13:3 E. 10:6

19. Hershey and Chase prepared T2 phage that incorporated radioactive ^{35}S, shown in part "A" of the below image. The radioactive phages were allowed to infect non-radioactive bacteria (shown in part B). Following phage infection, Hershey and Chase detected ^{35}S radioactivity in the ....



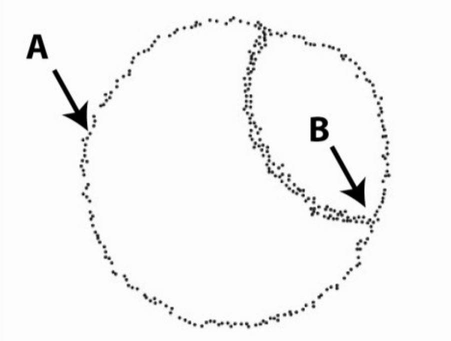
A. phage ghost (shown in part C)
B. bacterium (shown in part D)

20. The image below represents ....



A. an E. coli origin of replication.
B. an E. coli gene promoter.
C. a eukaryotic origin of replication.
D. a eukaryotic promoter.
E. the prokaryotic signal to terminate transcription.

21. In John Cairns famous experiment, he allowed non-radioactive bacteria to replicate in the presence of radioactive thymidine. The image below is taken from this experiment's results. The arrow labeled "B" is pointing to evidence



A. that the bacterial chromosome was replicated conservatively.
B. for the existence of a replication fork.
C. for the existence of the Okazaki fragment.
D. that RNA polymerase interacts with a template strand.
E. that RNA did not last long.

22. What protein adds repeated sequences of TTGGGG to the ends of chromosomes.

A. DNA gyrase
B. CAF-1
C. WRN
D. Primase
E. Telomerase

23. The main finding from the eukaryotic pulse-chase experiments was that:

A. RNA transcription requires a promoter and promoter proximal sequences.
B. RNA is under-going cotranscriptional processing.
C. RNA did not last long in cells.
D. That multiple RNAs can be transcribed simultaneously from the same gene.
E. RNA could transfer DNA information to the cytoplasm where proteins are produced.

24. What protein functions as a part of the replisome where it keeps the main DNA polymerase tethered to the parental DNA strand and capable of replicating long stretches of DNA?

A. CAF-1 B. β-clamp C. DNA gyrase D. Helicase E. DnaA

25. This protein functions as a part of the replisome where it removes RNA primers and adds the needed nucleotides.

A. β-Clamp
B. primase
C. DNA polymerase I
D. DNA polymerase III
E. Ligase

26. Which nucleotides are known as "purines"?

A. cytosine and guanine
B. uracil, adenine, and guanine
C. adenine and thymine
D. uracil, thymine and cytosine
E. adenine and guanine

27. A scientist was determining the nucleotide composition for 5 samples of DNA in order to recreate Erwin Chargaff's famous rules. These samples came from a virus with a single stranded genome, *E. coli* bacteria, *S. cerevisiae* yeast, rat brain, and frog liver. The results are listed in the table below:

Sample #	Adenine	Thymine	Guanine	Cytosine	(A+T)/(G+C)
1	30	30	20	20	1.50
2	20	20	30	30	0.67
3	25	25	25	25	1.00
4	30	20	30	20	1.00
5	32	32	18	18	1.78

Which sample must be from the single-stranded virus?

A. sample 1 B. sample 2 C. sample 3 D. sample 4 E. sample 5

28. What is attached to the 5' carbon of a nucleotide?

A. an R-group
B. a hydroxyl group (OH)
C. a nitrogenous base
D. a deoxy group (H)
E. a phosphate group

29. Which cell type WOULD NOT be expected to produce the protein telomerase?

A. a somatic brain cell
B. a stem cell
C. a cancer cell
D. a germ cell
E. NONE OF THE ABOVE

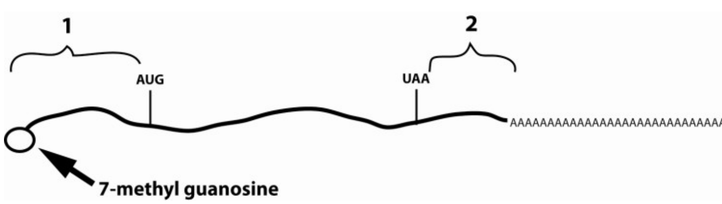
30. Which of the following statements **is/are true** about eukaryotic mRNA?

A. The sigma factor is essential for the correct initiation of transcription
B. RNA processing takes place in the cytoplasm
C. Transcription termination involves the use of a hairpin loop or the rho protein hexamer.
D. Processing of newly transcribed RNA into mRNA begins before transcription is completed.
E. Both C and D.

31. What is the function of the TATA-binding protein (TBP)?

A. Adds poly-A tail to the cleaved end of mRNAs
B. Facilitates prokaryotic RNA polymerase to bind to the promoter of genes.
C. Facilitates eukaryotic RNA polymerase II to bind to the promoter of genes.
D. Interacts with intron GU and AG sequences.
E. Adds the 7-methylguanosine cap to nascent RNA transcripts.

32. Does the below image (1) represent a prokaryotic or eukaryotic mRNA and (2) which region is the 3' UTR?



A. prokaryotic and region 1
B. eukaryotic and region 1
C. prokaryotic and region 2
D. eukaryotic and region 2

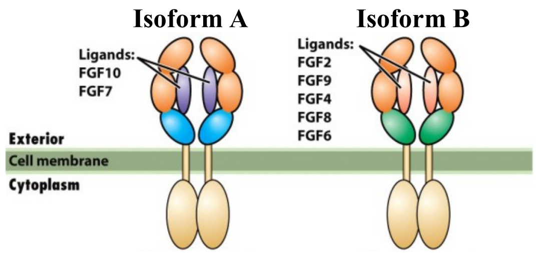
33. True or False: The genetic code was found to be overlapping in the specification of amino acids.

A. True
B. False

34. What protein interacts with -35 and -10 regions of prokaryotic genes?

A. Ubiquitin
B. TATA Binding Protein
C. Dicer
D. Poly-A binding protein
E. Sigma Factor

35. Below is a schematic of two isoforms of the Fibroblast growth factor receptor 2, which interact with different Ligands.



How are these (and other) isoforms produced?
A. Phosphorylation
B. Ubiquitination
C. Polyadenylation
D. Folding
E. Alternative splicing

36. The importance of an AUUAAA or AAUAAA sequence at the end of eukaryotic RNAs:

A. is to interact with miRNAs.
B. is to interact with the Rho protein hexamer.
C. is to initiate cleavage and polyadenylation.
D. is to signal for splicing of nascent RNAs.
E. is to stop the translation of mRNAs.

37. "____________________________" of certain amino acids can change a protein's conformation often resulting in a switch from an inactive to an active state or vice versa.

A. Alternative splicing
B. Signal sequences
C. Deacetylation
D. Phosphorylation
E. Ubiquitination

38. Matthew Meselson and Frank Stahl performed an experiment that involved growing bacteria with ^{15}N for one and two generations. This experiment ultimately demonstrated that ....

A. there was a lagging strand created during DNA replication.
B. DNA was the hereditary material.
C. DNA replication was dispersive.
D. DNA replication was conservative.
E. DNA replication was semiconservative.

39. Recent data indicates that ________________ is responsible for joining two amino acids together in the ribosome during translation.

A. a Release Factor
B. Initiation Factor 3
C. Elongation Factor Tu
D. Elongation Factor G
E. rRNA

40. DNA is transcribed in the ______(A)______ direction and RNA is transcribed in the ______(B)______ direction.

A. (A) 5' to 3' and (B) 3' to 5'
B. (A) 5' to 3' and (B) 5' to 3'
C. (A) 3' to 5' and (B) 5' to 3'
D. (A) 3' to 5' and (B) 3' to 5'

41. What needs to be included with mRNA sequence and where within the mRNA, in order for translation to be initiated by prokaryotic ribosomes?

A. a Kozak sequence and surrounding the initiator AUG sequence.
B. a Shine-Dalgarno sequence that is placed 3' of the initiator AUG sequence.
C. a Shine-Dalgarno sequence that is placed 5' of the initiator AUG sequence.
D. a hairpin loop that is 5' of the initiator AUG sequence.
E. a Kozak sequence that is 3' of the initiator AUG sequence.

42. The alpha-helix and beta-pleated sheet are examples of protein ....

A. primary structure.
B. secondary structure.
C. tertiary structure.
D. quaternary structure.
E. quinternary structure.

43. The aminoacyl-tRNA synthetase enzymes are responsible for:

A. moving tRNAs from the "A site" to the "P site" during translation.
B. adding amino acids to appropriate tRNAs (charging the tRNA).
C. regulating the process of amino acid synthesis.
D. catalyzing the formation of peptide bonds during translation.
E. matching each tRNA with the appropriate mRNA codon.

44. Evidence that amino acids were "illiterate," or passively added to the newly synthesized protein at the direction of the tRNA to which they are attached, was derived from experiments with:

A. nickel hydride-based experiments, altering the amino acids attached to charged tRNAs to determine if they were still utilized by the ribosome.
B. proflavin-based mutations on subsets of anticodons to determine if the mutations affect the charging of tRNAs.
C. exposing T2 phages to the chemical proflavin.
D. synthesis of RNAs with specific bases.
E. eukaryotic ribosomes combined with prokaryotic tRNAs.

45. The role of most microRNAs within a eukaryotic cell is to:

A. shuttle amino acids to ribosomes.
B. bind with other RNAs to stabilize their secondary structure.
C. catalyze peptide bond formation during translation.
D. associate with snRNPs to remove introns.
E. repress the protein expression for other genes.

46. Translation is terminated by ....

A. a release factor interacting with a nonsense codon in the ribosomal A site.
B. a chaperone protein binding to a nonsense codon.
C. a tRNA interacting with a nonsense codon in the ribosomal A site.
D. an rRNA complementary base pairing with a nonsense codon in the ribosomal P site.
E. the rho protein hexamer interacting with a poly-C sequence in the mRNA

For problems 47 - 50. Complete the following table using as needed the provided codon dictionary at the end of the exam. Note that the mRNA is transcribed from left to right. Use your completed table to answer the questions below.

1	**G**								**T**		**C**		**DNA strand**
2	**47**			**48**				**G**					**DNA strand**
3			**A**				**49**			**G**			**mRNA strand**
4	**G**						**A**					**U**	**tRNA anticodon**
5	**A**	**r**	**g**	**M**	**e**	**t**				**50**			**amino acid in protein**

47. From left to right, what are the three bases in the rectangle numbered 47?

A. CGU B. CGA C. CGT D. CTA E. GGA

48. From left to right, what are the three bases in the rectangle numbered 48?

A. ATG B. TAC C. AUG D. UAC E. AAG

49. From left to right, what are the three bases in the rectangle numbered 49?

A. ACT B. TGA C. AGU D. UGA E. UCU

50. What amino acid belongs in the box numbered 50?

A. Ala B. Arg C. Pro D. Gly E. None