

Exam Procedures:

STEP 1- NAME (Print clearly)

(first)

(last)

STEP 2 – Fill in your answer sheet, using a #2 scoring pencil, as follows:

- Your Student PID Number (excluding “A”)
- Your last name and first name
- Course ID in “subject” **this is BMB 526 Exam #1**
- Date **11/4/13**
- Exam form in “period”**this is form A**
- By signing this coversheet for this exam, the student certifies that he/she has adhered to the policies of academic honesty in the performance of this exam.

Signature

STEP 3 - Read these instructions:

- Make sure your exam has **34** questions.
- Read each question very carefully. Choose the single, best answer and mark this answer on your answer sheet. No points will be added for correct answers which appear on the exam page but not on the answer sheet.
- Cell phones must be off (not on vibrate) and stored with your bags/backpacks/other materials.
- The proctors have the authority/responsibility to assign any student a different seat at any time, without implication and without explanation, before or during the examination, as they deem necessary. Accomplish any relocation quietly and without discussion.
- We will not answer questions of clarification. However, if you think there is an error on your exam, summon an exam proctor.
- When you finish, place all exam materials (except the tear sheet) into the manila envelope. When you leave the exam room, please turn in your envelope to the proctors. Once you exit the auditorium, please leave the area. Hallway conversations disturb those still taking the exam.
- There will be answer keys to this exam posted on the course website by 5:00 p.m. the day of the exam. You may wish to copy your responses from your answer sheet onto the answer grid on the LAST page of this exam so that you can check your results. You can tear off the last page and take it with you.
- We will close the exam promptly at **9:10 a.m.** At the announcement of the examination end time, the examination and scantron and images (if provided as part of the examination) must immediately be placed into the manila envelope provided.

STEP 4 – Wait until instructed to proceed with the exam!

INFORMATION THAT MAY BE USEFUL FOR THE EXAM

		Second Base				
		U	C	A	G	
First Base	U	UUU } phe F UUC } UUA } leu L UUG }	UCU } UCC } ser S UCA } UCG }	UAU } tyr Y UAC } UAA } Stop UAG } Stop	UGU } cys C UGC } UGA } Stop UGG } trp W	U C A G
	C	CUU } CUC } leu L CUA } CUG }	CCU } CCC } pro P CCA } CCG }	CAU } his H CAC } CAA } gln Q CAG }	CGU } CGC } arg R CGA } CGG }	U C A G
	A	AUU } AUC } ile I AUA } AUG } met (start) M →	ACU } ACC } thr T ACA } ACG }	AAU } asn N AAC } AAA } lys K AAG }	AGU } ser S AGC } AGA } arg R AGG }	U C A G
	G	GUU } GUC } val V GUA } GUG }	GCU } GCC } ala A GCA } GCG }	GAU } asp D GAC } GAA } glu E GAG }	GGU } GGC } gly G GGA } GGG }	U C A G
						Third Base

The "Wobble" Rules of Codon-Anticodon Pairing	
5' Nucleotide of Anticodon	3' Nucleotide of Codon
C	G
A	U
U	A or G
G	C or U
I	U, C, or A
3' Nucleotide of Codon	5' Nucleotide of Anticodon
G	C, U
A	I, U
C	I, G
U	I, G, A

INFORMATION ON COMPONENTS OF RIBOSOMES

I. Prokaryotes (e.g. *E. coli*)

RIBOSOME (70S)

Large Subunit (50S) --- 5S and 23S rRNAs + many proteins

Small Subunit (30S) --- 16S rRNA + many proteins

II. Eukaryotes (e.g. human)

RIBOSOME (80S)

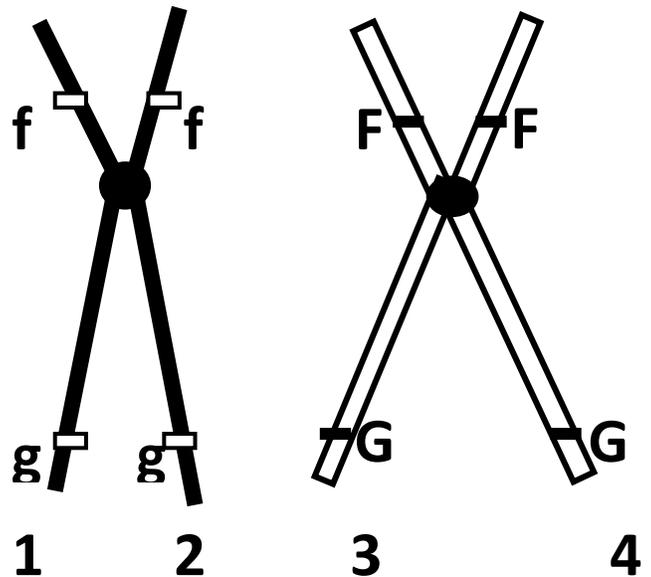
Large Subunit (60S) --- 5S, 5.8S, and 28S rRNAs + many proteins

Small Subunit (40S) --- 18S rRNA + many proteins

1. Targeting of a particular mRNA by a miRNA would likely result in:

- A. A gene knockout
- B. An alternatively spliced product
- C. A gene knockdown
- D. Translational activation
- E. An edited RNA product

The following 3 questions refer to the homologous chromosome pair in the figure to the right.



2. Which of these chromatids (numbered 1-4) are sister chromatids?

- A. 1 & 3
- B. 2 & 3
- C. 2 & 4
- D. 3 & 4
- E. 1 & 4

3. Assuming these are human chromosomes, what would the 'n' and 'c' of the cell be when the chromosomes were lined up as shown (side by side)?

- A. 1n, 1c
- B. 1n, 2c
- C. 2n, 2c
- D. 2n, 4c
- E. 4n, 4c

4. During gametogenesis, if a cross over were to occur on the p arm of these chromosomes, in what phase would the alleles **G** and **g** segregate?

- A. Anaphase of mitosis
 - B. Anaphase of meiosis I
 - C. Interphase of meiosis II
 - D. Anaphase of meiosis II
 - E. They would not segregate
-

5. The metaphase plate is also known as the equatorial plate. In what process does this association of terms **not** hold true (the exception to the rule)?

- A. Mitotic divisions to maintain spermatogonia
- B. Meiotic divisions in spermatogenesis
- C. Mitotic divisions to maintain oogonia
- D. Meiotic divisions in oogenesis



6. What is the **most** likely consequence of a mutation at the position indicated by the arrow in the above schematic of an hnRNA?

- A. None; this region has no possible function
- B. Aberrant splicing of the RNA
- C. Altered response to regulatory factors
- D. The mRNA would be improperly capped
- E. The mRNA would be unstable and prone to degradation

Use the scenario below to answer the next 5 questions

The DNA sequence preceding the gene encoding ovalbumin contains an estrogen responsive element which is bound by the estradiol:estrogen receptor complex to promote recruitment of TFII-D.

7. This is an example of what level of gene regulation?

- A. Transcriptional
- B. RNA stability/turnover
- C. Translational
- D. Post-translational
- E. Chromatin packing

8. The estrogen responsive element would be classified as what kind of signal?

- A. core promoter element
- B. operator
- C. silencer
- D. enhancer
- E. TATA box

9. The estrogen receptor can only bind DNA when in complex with the molecule estradiol. This protein complex which then affects expression of nearby genes would be considered:

- A. An alternative sigma factor
- B. A specific transcription factor
- C. A general transcription factor
- D. An enhancer sequence
- E. A promoter

10. What would you predict about the structure of the estrogen receptor with estradiol bound to it?

- A. It would be a single domain protein with DNA binding capacity
- B. It would be a single domain protein with regulatory function
- C. It would have to be able to bind directly to RNAPII
- D. It would be a multidomain protein with DNA binding and regulatory functions
- E. It would be a multidomain protein with RNA polymerase and regulatory functions

11. The sequence of an estrogen responsive element is given below. What would be the **most** likely consequence of insertion of this sequence approximately 200 bases upstream (-200) of the +1 transcription initiation site of the gene encoding the enzyme mucinase?

5'- TGGTCAGGCTGGCT-3'

- A. The expression of mucinase would become estrogen responsive
 - B. Basal expression of mucinase would increase
 - C. The mucinase protein would be less stable
 - D. The amino acid sequence of mucinase would be altered
 - E. Transcription termination of the mucinase gene would be defective
-



12. What cellular machinery (proteins/RNAs) would be required to generate the RNA depicted above?

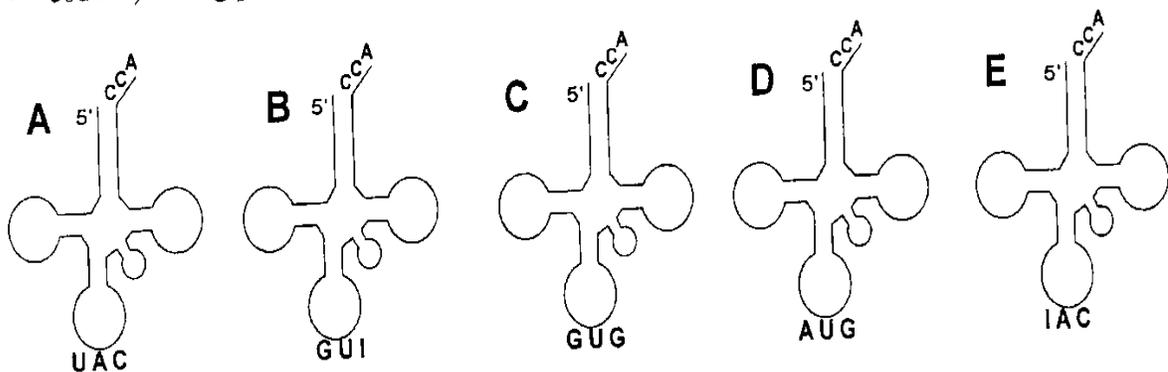
- A. RNAP II and σ (sigma) factor
- B. -10, -35 box sequences and 5.8 S rRNA
- C. RNAP and TATA box sequence
- D. σ (sigma) factor and RNAP
- E. RNAP II and TFII-D

13. What is the purpose of RNA editing in different cells/tissues?

- A. Increase effective genetic diversity
- B. Repair DNA damage
- C. Provide catalytic activity to RNA
- D. Proofread newly synthesized RNA
- E. Process RNA from inactive to an active form

14. You are seeing a 5 year old male patient with sinusitis of 14 days duration. He has a fever of 102 °F and is mildly lethargic. You suspect a bacterial infection. What would be the best prescription for your patient from the options listed below?

- A. Puromycin
- B. Cyclohexamide
- C. Diphtheria vaccine
- D. No treatment needed
- E. Erythromycin



15. Which of the above tRNA molecules (A-E) would be **least** likely to exist in the cell?

16. Which post-translational modification is most commonly used to alter the activity of enzymes in response to hormones such as glucagon?

- A. Acetylation
- B. Site specific proteolysis
- C. Hydroxylation
- D. Phosphorylation
- E. Glycosylation

17. Which form of DNA damage is **least** likely to be encountered on a day to day basis?

- A. Double strand breaks
- B. Hydroxylation
- C. Deamination
- D. Pyrimidine dimers
- E. Tautomerization

18. During DNA replication, the primers used for leading and lagging strand initiation must be removed by what kind of enzymatic activity?

- A. 3' to 5' exonuclease
- B. 5' to 3' exonuclease
- C. 3' to 5' endonuclease
- D. 5' to 3' endonuclease
- E. DNA glycosylase

19. After replication, the enzymes of the mismatch repair pathway are able to identify and repair mismatched bases in the newly synthesized DNA strand due to the delay in the activity of what enzyme(s)?

- A. DNA methyltransferase 1
- B. DNA methyltransferase 2
- C. DNA methyltransferase 3A & 3B
- D. DNA ligase
- E. Uracil DNA glycosylase

20. Which of the following processing events occurs in the generation of mature tRNA molecules?

- A. Polyadenylation at the 3' end
- B. Addition of a 5' cap
- C. Covalent modification of bases
- D. Intron removal to create an ORF
- E. Cleavage of multiple functional molecules from a larger precursor

21. Which of the following aspects of gene regulation is unique to eukaryotes?

- A. Presence of promoters
- B. Transcriptional repressor proteins
- C. Sequence-specific DNA binding proteins
- D. Alternative sigma factors
- E. Covalent modification of histone proteins

22. Which statement about rRNA molecules is true?

- A. The presence of modified nucleotides predominantly determines structure
- B. Each molecule folds into a common 3D structure for function
- C. They undergo extensive processing to add a cap and poly A tail
- D. They function as complex protein:RNA complexes
- E. They are the enzymatic components of splicing complexes

23. Translation of the mRNA encoding the collagen polypeptide takes place on the rough endoplasmic reticulum. Knowing where collagen polypeptides must ultimately end up, you would predict which of the following features for the first 20 amino acids of the just-translated collagen polypeptide?

- A. The sequence will form an amphipathic helix.
- B. The sequence will contain many hydrophobic residues.
- C. The sequence will contain many arginine and lysine residues.
- D. The sequence will contain leucine residues with requisite spacing.
- E. The sequence will contain saccharide residues in place of amino acids.

24. Patients with Rett syndrome are deficient in the protein MECP2 (Methyl CpG Binding Protein 2) which is involved in gene silencing in neuronal cells. To what specific substrate does this protein bind?

- A. 5' position of cytosine in a CpG dinucleotide
- B. C5 position of cytosine in a CG base pair
- C. C5 position of cytosine in a CpG dinucleotide
- D. 5' position of guanosine in a CG base pair
- E. C5 position of guanosine in a CpG dinucleotide

Use the information below to answer the next 2 questions.

The gene *noey2* is present on chromosome 1, and in healthy individuals is only expressed from the chromosome of paternal origin while it is silenced on the chromosome of maternal origin.

25. What molecular mechanism most likely accounts for this phenomenon?

- A. This region is deleted from the maternal chromosome by transposons
- B. This region has histones that are highly acetylated
- C. This region is highly methylated on the maternal chromosome
- D. Maternal chromosome 1 is inactivated
- E. This gene uses an alternative sigma factor

26. In a healthy female of 30 weeks gestation, what would be the expected imprinting pattern of the *noey2* gene?

- A. All copies of the *noey2* gene will have a female (maternal) imprint
- B. One copy of the *noey2* gene will have a female (maternal) imprint in her somatic cells
- C. All copies of the *noey2* gene will reset after birth to have a female (maternal) imprint
- D. One copy of the *noey2* gene will have a male (paternal) imprint in her germ cells
- E. All copies of the *noey2* gene with a male (paternal) imprint will be silenced

27. The histone modification of sumoylation usually results in:

- A. Increased acetylation and ubiquitylation of other histones
- B. Gene activation
- C. Gene silencing
- D. Recruitment of transcription factors
- E. Altered promoter sequences

28. Which statement about epigenetic reprogramming is **true**?

- A. Somatic cells undergo extensive demethylation postnatally (newborn period)
- B. Somatic cells erase genomic imprints to reestablish totipotency
- C. Germ cells of females only erase and reestablish genomic imprints in the embryonic period
- D. Somatic cells do not erase inherited genomic imprints
- E. Germ cells undergo extensive demethylation beginning at puberty

29. Cancer cells avoid replicative senescence by maintaining integrity of their chromosome ends through increased activity of:

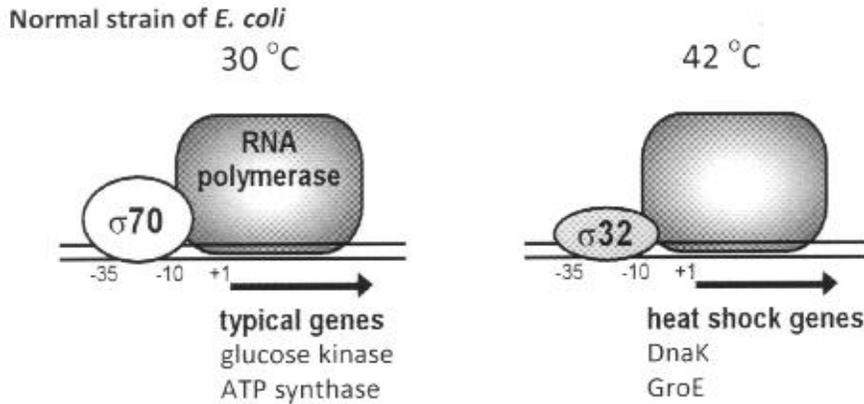
- A. Topoisomerase
- B. DNA polymerase
- C. Helicase
- D. RNA polymerase I
- E. Telomerase

30. The nucleotide sequence surrounding the translation start site for a protein is shown below. Deamination of an adenine nucleotide in the DNA corresponding to the **third** codon would lead to which kind of mutation?

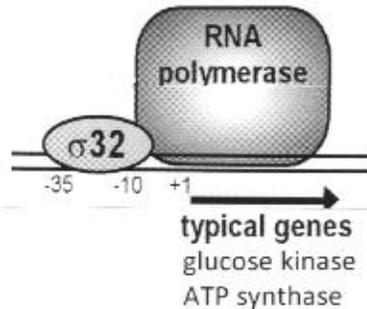
5' CAP ...AGGAGCAACCGUAGGCCCAUGGGUCCAUGGCGCAGA...

- A. Missense
- B. Nonsense
- C. Silent
- D. Frameshift

31. In a normal strain of *E. coli*, σ_{70} stimulates the transcription of "typical genes" at 30°C. The level of σ_{32} at 30°C is too low to allow the transcription of the "heat shock genes." When the temperature is raised to 42°C, however, the level of σ_{32} rises to stimulate the transcription of the "heat shock genes." On the other hand, σ_{70} heat denatures and therefore, the transcription of the "typical genes" is shut off at 42°C.



Mutant strain of *E. coli*
(in which the promoter regions of "typical genes" has been altered such that σ_{32} binds in place of σ_{70})



In this mutant strain of *E. coli*, the levels of the two sigma factors behave as in the normal strain: σ_{70} is high at 30°C while σ_{32} is high at 42°C. Which of the following correctly predicts the transcriptional status of the "typical genes" in the mutant strain of *E. coli*?

- | | <u>transcription at 30 °C</u> | <u>transcription at 42 °C</u> |
|----|-------------------------------|-------------------------------|
| A. | activated | activated |
| B. | activated | silent |
| C. | silent | silent |
| D. | silent | activated |

32. The mRNA for the Alzheimer-related gene is 2400 nucleotides long when isolated from neurons, but 2900 nucleotides long when isolated from glial cells. Genomic DNAs isolated from the two cell types show the identical nucleotide sequence. Which of the following mechanisms **best** accounts for the difference in the sizes of the mRNAs?

- A. site-specific recombination
- B. transposition
- C. alternative splicing
- D. post-translational modification
- E. variations in terminal glycosylation

33. There are 20 primary amino acids specified by the genetic code. Which step in the translation process requires a separate and specific enzyme for each amino acid?

- A. joining an individual amino acid to its specific tRNA
- B. delivering aminoacyl-tRNAs to the ribosome
- C. initiating translation
- D. peptide bond formation
- E. translocation of the ribosome to the next codon along the mRNA

34. During translation of a protein in a human liver cell, how will the initiation codon be recognized?

- A. The small ribosomal subunit will scan from the 5' end to the first start codon.
- B. Small nuclear RNAs (snRNAs) will recognize a consensus sequence at the start codon.
- C. The 16S rRNA will form basepairs with a sequence near the start codon.
- D. The first three nucleotides at the 5' end will be used as the start codon.
- E. The mRNA will have only one codon that can be recognized by a methionine tRNA.

END OF EXAMINATION - Tear off this sheet and save to check your answers.

- You may write in your answer to each question on this sheet. DO NOT make any other marks on this sheet. If there are any extraneous marks on this page it will be confiscated.
- Only the answer on the scantron is the official answer. **WE CANNOT USE THE ANSWERS ON THIS TEAR OFF SHEET TO DETERMINE YOUR GRADE.**

Please remember to:

- Write in the **letter of your form** in the area titled "Period" on the exam scantron.
- Return your examination** in the envelope provided to a proctor **before leaving the exam room.**

BMB 526 FS 2013 Exam #1

FORM: A

- | | |
|-----------|-----------|
| 1. _____ | 18. _____ |
| 2. _____ | 19. _____ |
| 3. _____ | 20. _____ |
| 4. _____ | 21. _____ |
| 5. _____ | 22. _____ |
| 6. _____ | 23. _____ |
| 7. _____ | 24. _____ |
| 8. _____ | 25. _____ |
| 9. _____ | 26. _____ |
| 10. _____ | 27. _____ |
| 11. _____ | 28. _____ |
| 12. _____ | 29. _____ |
| 13. _____ | 30. _____ |
| 14. _____ | 31. _____ |
| 15. _____ | 32. _____ |
| 16. _____ | 33. _____ |
| 17. _____ | 34. _____ |