Molecular Biology
Midterm Exam 3

1. The UAS/GAL4 system is used to target expression of genes to tissues in Drosophila. A transgenic fly containing the an enhancer from the myosin gene fused to the GAL4 gene (my-GAL4) was crossed to another transgenic fly containing UAS sequences fused to GFP (UAS-GFP). The resulting progeny expressed GFP within all muscle cells. Which of the following components is responsible for directing expression of GFP to the muscle cells?
A. GFP reporter
B. UAS binding sites
C. GAL4 transcription factor
D. Myosin enhancer element

2. Which of the following is the best reason for why a fly containing an enhancer from the actin gene fused to sequences encoding the GAL4 transcription factor (actin-GAL4) has no phenotypic effect on Drosophila development?
A. The actin gene is not expressed in Drosophila.
B. Drosophila lacks the target sequences for the GAL4 transcription factor.
C. The GAL4 transcription factor is unable to interact with the mediator complex.
D. GAL4 is unable to phosphorylate the C-terminal tail of RNA polymerase.

3. Which of the following is the best reason for why a Drosophila strain containing a GFP reporter fused to ten UAS sequences (UAS-GFP) does not express the GFP in the developing fly brain?
A. GFP folds properly and is activated only within jellyfish.
B. Neurons within the brain interfere with the binding of GAL4 to the UAS sequences.
C. Neurons within the brain express a transcriptional repressor that binds to the UAS sequences and blocks activation of transcription of GFP.
D. The fly genome does not contain a gene that codes for the GAL4 transcription factor.

4. Translation of retrotransposon RNA will yield two proteins: an integrase and reverse transcriptase. The latter enzyme goes on to participate in the conversion of all RNAs into cDNA. Which of the following is the best explanation for why cDNAs from host messenger RNAs are not integrated into the host genome?
A. Host cDNAs lack inverted-repeat sequences therefore the integrase cannot bind and integrate these molecules into the genome.
B. Reverse transcriptase will only recognize and convert retrotransposon RNA into cDNA therefore the host mRNAs are never converted into cDNA and are thus not integrated into the genome.
C. Compared to host cDNAs, the retrotransposon cDNAs are present in excess quantities and therefore are more likely to be bound and incorporated into the genome by the integrase.
D. None of the above

5. As the number of Tn10 elements increases within a bacterial genome it is important that new elements do not integrate and disrupt existing elements. Which of the following best describes the mechanism by which existing Tn10 elements are protected from integration of new Tn10 elements?
A. Tn10 elements lack the inverted repeat sequences so they cannot be integrated into the genome.
B. As the number of Tn10 elements increases there are not enough RNA polymerase molecules to transcribe all Tn10 elements: therefore very little transposase protein is made and new Tn10 elements cannot insert within the genome.
C. Since Tn10 elements lack a functional transposase gene, transposase proteins are not generated and new Tn10 elements cannot integrate into the genome.
D. Complementary base pairing between the short and long Tn10 mRNAs prevents their translation thus new transposase protein is not made and new Tn10 element insertions cannot occur.

6. Which of the following is the best explanation for why individual Tn10 transposons are not converted into thousands of new copies that are integrated into the genome.
A. RNA polymerase does not transcribe Tn10 elements; therefore there is no Tn10 mRNA to be converted into cDNA by the cellular reverse transcriptase.
B. The Tn10 element does not contain a reverse transcriptase so the Tn10 mRNA cannot be converted into cDNA.
C. The mRNA that is transcribed from Tn10 elements lacks a 5`cap and the poly-A tail. This allows for cellular nucleases to degrade the mRNA before it can be converted into cDNA by the cellular reverse transcriptase.
D. The cellular reverse transcriptase will not recognize the 3` end of the Tn10 mRNA so they will not be converted into cDNA and will not be integrated into the genome.

7. Which of the following elements serves as a docking site for the general transcription factor machinery?
A. Enhancer element
B. Promoter
C. 5` and 3` UTRs
D. Transcriptional start site

8. Which of the following elements is transcribed and translated?
A. Promoter
B. 5` UTR
C. Exon
D. Intron

9. Which of the following elements is transcribed but not translated?
A. Enhancer element
B. Promoter
C. Exon
D. Intron

10. Which of the following is a false statement regarding prokaryotic and eukaryotic promoters?
A. Promoter elements (such as the -10 element) are located upstream of the transcriptional start site.
B. Eukaryotic promoters generally have more binding sites for general transcription factors than prokaryotic promoters.
C. Prokaryotic and eukaryotic promoters are bound by the general transcription factor machinery
D. Eukaryotic promoters can be located either close or far (100kb) away from the transcriptional start site

11. Which of the following is a true statement regarding the termination of transcription in both prokaryotes and eukaryotes?
A. A stem loop structure followed by poly U stretch is the signal for termination in prokaryotes
B. In eukaryotes a sequence embedded within the mRNA strand is recognized as a signal to stop transcription
C. Both A and B
D. None of the above

12. What would happen if a methylated guanine residue were not added to the 5` end of eukaryotic messenger RNAs?
A. The mRNAs will be degraded at a faster rate than those mRNAs containing the 5`-cap.
B. The mRNAs will not be exported into the cytoplasm.
C. The mRNAs will be translated less efficiently than those mRNAs containing the 5`-cap.
D. All of the above

13. What would happen if the stretch of adenine residues were not added to the 3` end of eukaryotic messenger RNAs?
A. The mRNAs will be translated more efficiently than those mRNAs containing a poly-A tail.
B. The mRNAs will be degraded at a faster rate than those containing the poly-A tail.
C. The mRNAs will not be exported into the cytoplasm.
D. The mRNAs will not be translated.

14. Which of the following is the most likely explanation for why prokaryotic messenger RNAs are not modified at the 5` and 3` ends?
A. Prokaryotic cells lack the machinery to degrade mRNAs so there is no need to protect mRNAs
B. The ribosome protects the mRNA in prokaryotes so 5` and 3` modifications are not required.
C. The prokaryotic cell cycle is very short (only 20 min) so fast mRNA turnover is required.
D. The 5` and 3` UTRs form stem loop structures that protect the message from degradation therefore the 5`-cap and the poly-A tail are not required to prevent degradation

15. A DNA sample was treated with the restriction enzyme EcoR1. The resulting DNA fragments were run through an electrophoretic gel. Which of the following fragments is predicted to migrate through the gel the farthest distance?
A. 2000bp
B. 1500bp
C. 1250bp
D. 1000bp

16. A Northern Blot is used to analyze the presence of individual transcripts within RNA samples. Which of the following sequences would make the most specific probe?
A. Promoter
B. Exon
C. Intron
D. Poly-A tail

17. Introns are removed from messenger RNAs during the splicing process. Which of the following is a true statement regarding introns?
A. Prokaryotic genes do not contain introns.
B. Eukaryotic genes have variable numbers of introns with some genes lacking introns all together.
C. Introns can be variable in length
D. All of the above

18. Several mRNAs including human T-antigen and troponin as well as Drosophila Dscam are subjected to alternate splicing. Which of the following is the best explanation of the advantage (if there is one) for the process of alternate splicing?
A. Alternate splicing allows a single gene to code for many protein isoforms thus the overall size of the genome can be smaller.
B. Alternate splicing allows for introns to be converted into exons under special circumstances.
C. Alternate splicing allows for the production of smaller mRNAs: this is important for efficient transport from the nucleus to the cytoplasm.
D. Since many genes are not alternatively spliced (i.e. prokaryotic genes) there is no advantage for the evolution and maintenance of this system.

19. If RNA splicing does not occur properly then exon skipping or inappropriate splicing at pseudo-splice sites can take place. Which of the following proteins aids the splicing machinery to improve the efficiency of the splicing process?
A. SR proteins
B. The ribosome
C. TATA binding protein
D. Sigma Factors

20. Mammalian cells use the enzyme cytidine deaminase to convert cytosine [C] nucleotides to uracil [U] residues within mRNA sequences. This is the process of RNA editing. Which of the following best explains the advantage (if there is one) for the process of RNA editing?
A. RNA editing allows for alteration of the 5`-cap and the poly-A tail sequence so that mRNAs can be degraded by the cellular machinery.
B. RNA editing is used by mammalian cells to specifically change mRNA sequences from only bacterial and viral sources. This allows the host cell to protect itself from infections.
C. RNA editing allows a single gene to code for many protein isoforms thereby allowing for the maintenance of a smaller genome.
D. RNA editing allows for sections of the genome to be converted into RNA so it the genome can be directly translated by ribosomes.

21. The Eya1 protein is normally found in both the nucleus and the cytoplasm of cells within the human retina. Imagine that it contains four domains (A,B,C,D). Each domain is fused to GFP (A-GFP, B-GFP, C-GFP and D-GFP) and the resulting chimeric mRNAs are injected into mammalian tissue culture cells. B-GFP protein is the only chimeric protein to be found within the nucleus while the D-GFP chimeric protein was localized exclusively to the cytoplasm. Which of the following best explains these results?
A. The A-GFP and the C-GFP mRNAs are not translated and thus cannot be visualized.
B. The A-GFP and the C-GFP proteins are quickly degraded so they cannot be visualized.
C. The B domain contains a NLS while the D domain contains an NES.
D. The B-GFP mRNA is translated within the nucleus and the D-GFP mRNA is translated within the cytoplasm.

22. The genetic code is called “degenerate”. Which of the following best explains this concept?
A. Multiple codons can code for the same amino acid.
B. A single codon can code for multiple amino acids.
C. A single tRNA can bind to multiple codons.
D. Multiple tRNAs can be physically bound to the same amino acid.

23. The current genetic code is read in sets of three bases (codon) and the total number of codons is 64. How many codons would there be if the genetic code were to be read in sets of five bases.
A. 125
B. 625
C. 1024
D. 3125

24. If the following mRNA sequence were translated by a ribosome what would be the resulting protein product (5`-UUUCUGAUGUACUGUAGUUAA-3`)?
A. Phe-Leu-Met-Tyr-Cys-Ser
B. Met-Tyr-Cys-Ser
C. Asn
D. Asn-Cys-His-Val-Val-Phe

25. Which of the following best describes the meaning of the wobble effect?
A. The first base of the anti-codon (the 5` end) can loosely interact with different bases at the third base position of each codon (3` end) while the second and third bases of the anti-codon will form classic Watson-Crick base pairs with the first and second bases of the codon.
B. RNA polymerase and ribosomes are bound simultaneously to a single mRNA
C. Two different tRNAs can bind to the same amino acid
D. none of the above

26. Imagine that DNA Polymerase makes a mistake during DNA replication that eventually leads to the incorporation of Leu instead of a Phe into the Optix protein at position 98 of the polypeptide chain. Which of the following terms best describes this mutation?
A. Missense Mutation
B. Nonsense Mutation
C. Silent Mutation
D. Frameshift Mutation

27. Imagine that DNA Polymerase makes a mistake during DNA replication that eventually leads to the incorporation of a stop codon instead of a codon for Tyr within the Optix mRNA. Which of the following terms best describes this mutation?
A. Missense Mutation
B. Nonsense Mutation
C. Silent Mutation
D. Frameshift Mutation

28. Imagine that DNA Polymerase makes a mistake during DNA replication that does not change the amino acid sequence of the Optix protein. Which of the following terms best describes this mutation?
A. Missense Mutation
B. Nonsense Mutation
C. Silent Mutation
D. Frameshift Mutation

29. Which of the following is a true statement regarding the process of translation?
A. Translation is the process by which the instructions that are encoded in messenger RNAs are converted into proteins.
B. In prokaryotes transcription and translation occurs simultaneously both temporally and spatially.
C. In eukaryotes translation occurs in the cytoplasm and is therefore separated temporally and spatially from transcription, which happens in the nucleus.
D. all of the above

30. What is the molecular trigger for a cell to degrade messenger RNAs that lack stop codons (non-stop mediated decay)?
A. The trigger for non-stop mediated decay is the translation of the entire poly-A tail into nearly 70 or more consecutive Lys residues.
B. The trigger for non-stop mediated decay is the recognition by RNA Polymerase that stop codons are absent from the DNA template.
C. The trigger for non-stop mediated decay is the translation of the first AAA codon of the poly-A tail – normally there are no lysine residues within an mRNA.
D. The trigger for non-stop mediated decay is lack of a termination stem loop at the 3` end of the messenger RNA.

31. What is the molecular trigger for a cell to degrade messenger RNAs that have premature stop codons (nonsense mediated decay)?
A. The trigger for nonsense-mediated decay is the recognition by the ribosome complex of multiple stop codons within a single messenger RNA.
B. The trigger for nonsense-mediated decay is the recognition of exon junction proteins located beyond a stop codon by the ribosome complex.
C. The trigger for nonsense-mediated decay is the generation of proteins that are shorter than 100 amino acids.
D. The trigger for nonsense-mediated decay the absence of the 70 Lys residues that are expected from the translation of the poly-A tail.

32. Chromatin immunoprecipitations (ChIP) assays are used to identify which of the following interactions?
A. DNA – RNA Polymerase
B. DNA – Histones
C. DNA – Site Specific Transcription Factors (ie activators and repressors)
D. DNA – Restriction Enzymes

33. Which of the following best describes the interaction sites between Site Specific Transcription Factors and DNA?
A. alpha helix – major groove
B. beta sheet – major groove
C. alpha helix – histone N-terminal tail
D. alpha helix – methyl group on C residues

34. The lac operon consists of three genes (lacY, lacA and lacZ) and is used by bacterial cells to regulate glucose levels. Which of the following conditions will trigger transcription of the lac operon?
A. High lactose levels
B. Low glucose levels
C. Low lactose levels
D. High glucose levels

35. Under conditions of high lactose levels which of the following best describes the molecular mechanisms for activation of the lac operon?
A. Lactose binds directly to the lacI repressor gene and prevents transcription of the repressor.
B. Lactose binds to RNA Polymerase resulting in its release from the sigma factors.
C. Lactose binds to an activator sequence within the operon thereby stimulating transcription.
D. Lactose binds to the LacI repressor protein and prevents it from binding to the lac operon.

36. Based on your reading of the article entitled "Target Acquired" which of the following is a true statement?
A. Some cancers such as cervical cancer are caused by viral infections.
B. Glioblastomas (brain tumors) are associated with the presence of a form of herpes virus called cytomegalovirus. Normal tissue and non-malignant tumors do not contain this virus.
C. Antibodies against cytomegalovirus slowed the rate of tumor growth suggesting that a vaccine could be developed to cure glioblastomas.
D. all of the above

37. Based on your reading of the article entitled "Stemming the Tumorous Tide" which of the following is a true statement?
A. Tumors contain populations of stem cells.
B. Cancer stem cells are resistant to traditional chemotherapies.
C. A promising therapy appears to be the generation of chemicals or antibodies that target cell surface proteins that are specific to individual types of cancer stem cells (i.e. breast or blood).
D. all of the above

38. Based on your reading of the article entitled "The Price of Silent Mutations" which of the following is a true statement?
A. A silent mutation is one in which the DNA sequence can change but the resulting codon still codes for the same amino acid.
B. Nearly 50 human diseases have been attributed to the presence of silent mutations.
C. Silent mutations, while preserving the amino acid sequence, can inhibit the efficiency of splicing if the mutation occurs within the ESE sites.
D. all of the above

39. Based on your reading of the article entitled "A Strand Apart" which of the following is a true statement?
A. Stem cells can divide asynchronously to produce a stem cell and a cell that will differentiate.
B. The daughter stem cell will receive the old chromosomes while the cell that is destined to differentiate will receive only the newly synthesized chromosomes.
C. The daughter cells containing the newly synthesized chromosomes thus contain more mistakes that are made by DNA Polymerase than the daughter stem cell.
D. all of the above

40. Based on your reading of the article entitled "New Ways to Squash Superbugs" which of the following is a true statement?
A. Most antibiotics that are used in modern medicine are produced by bacteria and fungi or are chemically modified derivatives of these natural antibiotics.
B. The generation of superbugs (ones that are resistant to multiple antibiotics) is due in part to the exchange of plasmids, small circular pieces of DNA that carry antibiotic resistance genes.
C. Some scientists are trying to determine if apparently dormant genes could be coaxed into producing novel antibiotics.
D. all of the above

EXAM 3 ANSWER KEY

1. D
2. B.
3. D
4. A
5. D
6. B
7. B
8. C
9. D
10. D
11. C
12. D
13. B
14. C
15. D
16. B
17. D
18. A
19. A
20. C
21. C
22. A
23. C
24. B
25. A
26. A
27. B
28. C
29. D
30. A
31. B
32. C
33. A
34. A
35. D
36. D
37. D
38. D
39. D
40. D