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LS3.1, MIDTERM EXAM I

5pm-6: 50pm, Thursday, Oct. 17, 2013

1. Write your name and student ID on the **Scantron** provided.
2. Check the exam to make sure you have every page before starting. Read carefully the questions, the multiple choices, and figures included. You should select only one or the **BEST** answer for each question, and register your answer on both the Scantron and your question sheets.
3. Hand in only the Scantron to TAs after you complete the exam. You keep the question sheets and compare your answers with the key that will be posted online.
4. Midterm I has 40 multiple-choice questions, 2.5 points each, 100 points total.
5. Do not spend too much time on any single question.
Good luck!

Version A

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1. Which of the following description about DNA and RNA is *incorrect*?
 - A). A DNA molecule is a right-handed helix
 - B). RNA molecules are usually single-stranded, but may contain double-stranded regions
 - C). DNA contains uracils, RNA contains thymines
 - D). Many RNAs have molecular-specific secondary structures, DNA does not have molecular-specific secondary structures
 - E). DNA has 3'-hydroxyl groups, RNA has 2' and 3'-hydroxyl groups, but both DNA and RNA have 5' phosphate groups

2. What is the most important non-covalent bond in DNA that holds the two strands together?
 - A). Hydrogen bond
 - B). Ionic interaction
 - C). van der Waal interaction
 - D). Phosphodiester bond
 - E). Metallic bond

3. What is the covalent bond that link individual deoxyribonucleotides of a deoxyribonucleic acid?
 - A). hydrogen bond
 - B). phosphodiester bond
 - C). Disulfide bond
 - D). Ionic bond
 - E). All of above

4. Which of the following is incorrect about the term "transformation" that is specifically used in molecular biology?
 - A). Transformation refers only to the transition of a rough bacterial strain to a smooth bacterial strain.
 - B). Transformation usually refers to transformation of one organ to another.
 - C). Transformation usually refers to transforming of a somatic cell to a stem cell in the SCNT therapeutic cloning.
 - D). Transformation refers to PCR cloning of a cDNA
 - E). All of above.

5. What is the chemical reaction common to the biosynthesis of DNA, RNA, and proteins?
 - A). Hydrolysis, in which a covalent bond is cleaved by addition of water
 - B). Ionization, in which an atom or a molecule acquires a negative or positive charge by gaining or losing electrons
 - C). Condensation, in which two molecules combine to form a larger molecule, together with the loss of a small molecule
 - D). Acetylation, in which an acetyl group is added to a polymer
 - E). Phosphorylation, in which a phosphate group is added to a macromolecule

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6. DNA is a nucleic acid composed of nucleotides connected by:

- A). 3'-phosphate group and 5'-hydroxyl group of the nucleotides
- B). 5'-hydroxyl group and 4'-phosphate group of the nucleotides
- C). 2'-phosphate group and 3'-hydroxyl group of the nucleotides
- D). 5'-phosphate group and 5'-hydroxyl group of the nucleotides
- E). 5'-phosphate group and 3'-hydroxyl group of the nucleotides

7. What is a gene?

- A). Any DNA molecule that is part of a genome
- B). Any RNA molecule that is normally used in transcription
- C). Any protein molecule that normally catalyzes a biochemical reaction in the cell
- D). Any DNA molecule that is normally transcribed to a RNA in the cell
- E). None of above

8. When was DNA first established to be the genetic material?

- A). When Fredrich Miescher first isolated DNA in 1869
- B). When Frederick Griffith first discovered that the R strain of *Streptococcus pneumoniae* was transformed by the dead bacteria in 1928
- C). When Oswald Avery, Colin Macleod, and Maclyn McCarty showed that the S substance is resistant to one endonuclease but sensitive to another endonuclease in 1944
- D). When James Watson and Francis Crick proposed the 3-D structure of DNA molecule in 1953.
- E). All of above

9. Which of the following descriptions about DNA and RNA structure and function is *incorrect*?

- A). DNA and RNA are polar molecules
- B). DNA and RNA are both positively charged
- ~~E). DNA and RNA are both polymers connected by covalent bonds~~
- C). DNA and RNA are both found in all cellular organisms
- D). DNA and RNA are both required for protein synthesis
- E). None of above

10. What is the sequence homology between the following sequences?

5'TAA TTGC TTAAGGCGTAGTC3' and 3'AUAAGCUUGGCCAAUGGCGC5'

- A). 10%
- B). 20%
- C). 30%
- D). 40%
- E). None of above

11. Which of the following description is *incorrect* about DNA or RNA hybridization?

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- A). DNA hybridization occurs between similar DNA molecules after denaturation
- B). A human genomic fragment may hybridize to a mouse genomic DNA fragment after the two DNA samples are heated and then cooled down
- C). DNA can hybridize to a RNA under appropriate conditions
- D). DNA hybridization occurs faster between DNAs that have lower homology than between DNAs that have higher homology
- E). DNA and RNA hybridization are both involved with formation of hydrogen bonds

12. What of the following description of T_m is *incorrect*?

- A). The melting temperature at which the DNA is completely denatured.
- B). The transcriptional method to produce mRNA.
- C). The transmission membrane used in Southern hybridization.
- D). The transformation method used in DNA cloning.
- E). All of above.

13. Which of the following is correct about the C-value paradox?

- A). The genome size is always consistent with the phenotypic complexity
- B). The size of human genome is always larger than that of the yeast genome.
- C). The DNA content of a genome is not consistent with the C value of that organism.
- D). The genome size does not correlate with the organismal complexity
- E). The size of the nuclear genome is always larger than that of an organellar genome.

14. The base composition of DNA is different in different organism, but they all obey the following rules: $[A]=[T]$, $[G]=[C]$, $[A+T] \neq [C+G]$, how to explain these rules?

- A). Because DNA contains deoxythymidine but RNA contain uridine
- B). The nucleotides of DNA have no 2' hydroxy group
- C). There is a specific rule that governs the GC or AT content of a genome
- D). In DNA double helix, purines can form hydrogen bonds to purines, but pyrimidines only form hydrogen bonds to purines
- E). None of above

15. Which of the following about gene structure is *incorrect*?

- A). The structure of a gene is defined by the DNA sequence
- B). A gene always has a promoter
- C). A promoter is the transcription regulatory sequence at the 3' end of the transcribed region of the gene
- D). Most eukaryotic genes contain introns, which are transcribed regions of a gene that are removed from mRNA after transcription.
- E). A prokaryotic polycistronic gene often encodes several different enzymes used in the same metabolic pathway.

16. RNA is less stable in alkaline solution because

- A). RNA contains the 2' hydroxyl group
- B). RNA has double-stranded regions
- C). RNA contains uracils instead of thymines

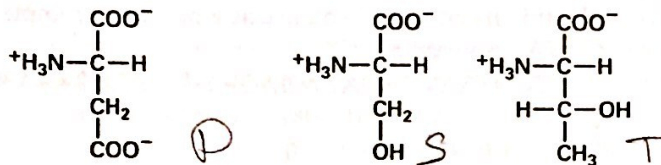
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- D). RNA contains the 3' hydroxyl group
- E). All of above

17. Among the following RNAs, which is used by cells to encode a protein?

- A). tRNA
- B). mRNA
- C). miRNA
- D). rRNA
- E). All of above

18. Which is correct about the following amino acids?



- A). They are hydrophobic amino acids
- B). They are basic and hydrophilic amino acids
- C). They are acidic and basic amino acids
- D). They are acidic and hydrophilic amino acids
- E). None of above

19. The X polypeptide has the sequence: "DEDDDEEEALDDDALLFTDDDDDEEE".

Given the property of amino acids you must have learned before or in LS3, which of the following polypeptides is most likely to interact with the X polypeptide?

- A). RRRRFMKKLRRKAKKKRRKIWRKRRK
- B). MLAYFMDDEEDDDDEEEKDWGGRK
- C). DDDEEEMCEEEEDDDCEKGFYSDEEN
- D). LLLMMMTTSSNDLLLNWAGTVCCSM
- E). HHHHHHLLMTGSNPPHALSTWGSV

20. Which one of the following sequences is most likely recognized by a restriction enzyme?

- A). CTGACT
- B). GAAATC
- C). ATCCTC
- D). GGCCAA
- E). CCTTTC

21. Select the component that is most critical to the function of a plasmid.

- A). tetracycline resistant gene
- B). lac promoter

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- C). *Eco*RI site
- D). origin of replication
- E). histidine tag

22. Which of the following is *incorrect* about transcription?

- A). Transcription is the first step of gene expression.
- B). Transcription needs free deoxyribonucleotides
- C). Transcription follows the base-pair rules to make copies of RNA from DNA.
- D). Transcription cannot occur without proteins.
- E). Transcription needs RNA polymerase.

23. Which of the 5 oligonucleotide listed would you use as a primer to completely amplify the following 43bp DNA fragment by PCR?

5'ATGCCGATGTAGGGCGGGATGGAGAGATAGAGAGAGTCACAAT3'

- A). 5'-AGTCACAAT-3'
- B). 3'-TGGAGAGAT-5'
- C). 5'-ATTGTGACTC-3'
- D). 5'-GTAGGGCGGG-3'
- E). 5'-TACATCGGCAT-3'

24. In SDS-PAGE, which of the following does not directly affect the migration of the polypeptides through the gel?

- A). The size of the polypeptide
- B). The electrode of the electric field
- C). The molecular mass of the protein
- D). The native charge on the polypeptides
- E). SDS

25. Tony Smith conducted an UV spectrometry experiment to compare the base composition of 5 DNA samples. His results are shown in the table below. He found that ultraviolet light absorption (A_{260}) for 4 of the 5 DNA samples at T_m are smaller than 0.3, except one sample, for which $A_{260} = 0.32$. Which DNA sample should it be?

	DNA1	DNA2	DNA3	DNA4	DNA5
%G+C	23	73	82	58	24
%A+T	77	27	18	42	76

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- A. DNA1
- B. DNA2
- C. DNA3
- D. DNA4
- E. DNA5

26. Which of the following methods is used in DNA fingerprinting?

- A). Northern blot hybridization
- B). Southern blot hybridization
- C). DNA sequencing reaction
- D). In situ hybridization
- E). Reverse transcription polymerase chain reaction

27. Margaret Lam wants to select a restriction enzyme and use it to cut a 22.1kb DNA fragment into more than 10 pieces for her Southern blot analysis. How many enzymes in the given table (Py: any pyrimidine, Pu: any purine) can be used for Margaret's experiment?
($4^4=256$, $4^5=1,024$, $4^6=4,096$, $4^7=16,385$, $4^8=65,536$)

- A). 1
- B). 2
- C). 3
- D). 4
- E). 5

Enzyme	Recognition Sequence*
<i>AclI</i>	AG↓CT
<i>BamHI</i>	G↓GATCC
<i>BglII</i>	A↓GATCT
<i>ClaI</i>	AT↓CGAT
<i>EcoRI</i>	G↓AATTC
<i>HaeIII</i>	GG↓CC
<i>HindIII</i>	GTPy↓PuAC
<i>HincII</i>	A↓AGCTT
<i>HpaII</i>	C↓CGG
<i>KpnI</i>	GGTAC↓C
<i>MboI</i>	↓GATC
<i>PstI</i>	CTGCA↓G
<i>PvuI</i>	CGAT↓CG
<i>SalI</i>	G↓TCGAC
<i>SmaI</i>	CCC↓GGG
<i>XmaI</i>	C↓CCGGG
<i>XbaI</i>	GC↓GGCCGC

28. Jane Tokiwa wants to use the conventional Sanger method to verify whether a gene has the following sequence: 5'GCAGCAGCTGGCTTAAGCTTGCGTTACGTA3' (note that only one of the two strands of a DNA is shown). Unfortunately, Jane found that only one of her four sequencing reactions turned out to be good enough to produce a readable sequence. The readable reaction was from a test tube that contains the following nucleotides: dATP, dCTP, dGTP, dTTP, ddTTP, Tris pH 7.0, MgCl, and DNA polymerase. What DNA sequences should Jane read from her sequencing gel of this good reaction?

- A). 3'ATGCATTG5'
- B). 5'GCAGCAGCT3'
- C). 5'TTTTTTTT3'
- D). 5'AAAAAA3'
- E). 5'TTTTAAA3'

29. James Muhammad wants to clone a DNA into a plasmid vector. To prevent interference of self-ligations for his experiment, he decides to clone the DNA by the directional cloning method discussed in LS3. He used a plasmid vector that contains in its MCS the restriction recognition sites of all the enzymes listed in the table given for

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question #27. Which of the following pairs of enzymes is the least desirable choice for his experiment?

- A) EcoRI and BamHI.
- B) AluI and HindIII.
- C) SmaI and AluI
- D) PstI and SmaI
- E) XmaI and BglII

30. Joanne Singh is an undergraduate student researcher working in the MCDB department at UCLA. She wants to clone a gene encoding lycopene cyclase that is required to synthesize β -carotene, and use the gene to engineer a GM rice with high vitamin A content in the rice grain. β -carotene is the precursor of vitamin A, which is synthesized in green tissues of rice but not in the endosperm (the starch-rich tissue) of the rice grain. Joanne hypothesizes that because carrot lycopene cyclase is highly expressed in the endosperm, introducing the carrot lycopene cyclase gene to rice may increase the β -carotene content of rice seeds. Carrot lycopene cyclase is a larger-than-usual protein with more-than-usual arginine and lysine residues. Joanne wants to first purify the carrot lycopene cyclase and use it to prepare a specific antibody. Based on the conditions given, which of the following methods should Joanne select to purify the carrot lycopene cyclase?

- A) Anion exchange chromatography
- B) Gel filtration followed by immunoaffinity chromatography
- C) Gel filtration followed by cation exchange chromatography
- D) Nickel affinity chromatography
- E) Differential centrifugation followed by Immunoprecipitation

31. Joanne successfully purified the carrot lycopene cyclase. She used the purified protein to prepare a rabbit antibody (IgG) against the enzyme. She wants to test whether this antibody recognizes the same enzyme from rice. She decides to use the conventional immunoprecipitation method to do this experiment. Based on the conditions given, which of the following is not needed for her experiment?

- A) The primary antibody Joanne prepared against the carrot lycopene cyclase
- B) The protein A-conjugated agarose beads
- C) SDS-PAGE electrophoresis apparatus
- D) The protein A-conjugated to horseradish peroxidase that catalyzes a chemiluminescence (light emission) reaction
- E) A fluorescence microscope

32. Joanne found that the antibody can recognize carrot lycopene cyclase but not the rice lycopene cyclase, so she cannot use the antibody to clone the rice lycopene cyclase gene. However, Joanne learned another method from LS3, and she wants to try the new method to clone the rice lycopene cyclase gene. Joanne knew the DNA sequence of the carrot lycopene cyclase gene. Joanne also has access to the complete rice genome database and

the DNA sequence of all rice genes online. Based on the conditions given, which of the following reasoning would make the most sense for Joanne to clone the rice lycopene cyclase gene.

- A). Joanne reasons that immunological method is more sensitive than Coomassie Blue stain, so she can prepare a rice cDNA expression library and to clone the rice lycopene cyclase by an immunological method.
- B). Joanne reasons that proteins have similar primary structure should have similar function, the proteins have similar primary structure must have similar DNA sequence of the corresponding genes, so she can use DNA sequence of the carrot lycopene cyclase gene to identify possible rice lycopene cyclase genes in the rice genome database, design the PCR primers to clone those sequences from rice mRNA or cDNA, clone them by PCR and test them further.
- C). Joanne reasons that a rice cDNA expression library must express rice lycopene cyclase in *E. coli* with the native structure and all possible modifications, so she can use the lycopene cyclase enzymatic activity assay to identify the clones from the rice cDNA expression library and test them further.
- D). Joanne reasons that a rice genomic library must contain all the genes including those that encode lycopene cyclases, so she can isolate the rice lycopene cyclase genes from the rice by Northern blot analysis from the rice genomic library.
- E). Joanne reasons that carrot and rice lycopene cyclase genes must have sequence homology, so she can use DNA finger printing method with carrot lycopene cyclase gene as the probe to isolate the rice lycopene cyclase, and further study it.

33. After a few more experiments, Joanne isolated the complete rice gene encoding lycopene cyclase, including the promoter region that may cause high expression in the endosperm. She also found that the carrot lycopene cyclase is a more stable protein than its rice counterpart. So Joanne prepared transgenic rice lines transformed to express the carrot lycopene cyclase cDNA under the control of the promoter of the rice lycopene cyclase gene, and she wanted to test which line expresses the highest amount of the carrot lycopene cyclase protein. Based on the conditions given, which of the following would be the best method for her experiment?

- A). SDS-PAGE and silver stain
- B). Two dimensional gel electrophoresis and Coomassie Blue stain
- C). SDS-PAGE and immunoblot
- D). Western blot probed with a non-radioactive PCR probe
- E). Quantitative RT-PCR

34. Joanne successfully identified a few transgenic rice lines expressing the carrot lycopene cyclase gene at high levels. She wants to know whether the carrot lycopene cyclase transgene is specifically expressed in the endosperm tissue of the seeds in any of her transgenic rice lines. Based on the conditions given here, which of the following methods should she use for this experiment?

- A). A Northern blot analysis to compare RNA samples prepared from whole plants of the wild type (untransformed) rice and the transgenic rice plants
- B). A quantitative RT-PCR analysis to compare RNA samples of the leaf tissue of wild type rice and the transgenic rice lines.

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- C). A SDS-PAGE analysis to compare protein samples of seed homogenates of wild type rice and the transgenic rice lines.
- D). In situ hybridization to compare sections of the seed grains prepared from the wild type rice and the transgenic rice.
- E). A Immunoprecipitation method to compare samples prepared from the wild type rice and the transgenic rice plants.

35. Which of the following about stem cell is incorrect?

- A). Stem cells are cells from stems of plants
- B). Animal stem cells are found in both fertilized eggs and other organs
- C). Plant stem cells are found in both shoot and root.
- D). Stem cells can be cultured *in vitro*.
- E). Stem cells are defined as undifferentiated eukaryotic cells that can reproduce themselves and differentiate into other type of cells.

36. Which of the following best explains the ESC transformation and the microinjection transformation methods for the production of transgenic mice?

- A). Different types of stem cells are often used in the two methods
- B). Different methods are often used to introduce the foreign DNA into stem cells in the two methods
- C). Different post-transformation selection procedures are used in the two methods
- D). The two methods are usually used for different purposes
- E). All of above

37. The US is one of the world's largest producers and exporters of soybean and corn. In 2012, ~95% soybeans cultivated in the US farms were HT (herbicide tolerant) soybeans, and ~68% corns grown in the US farms were Bt (*Bacillus thuringiensis*) corns. HT crops are transformed to express an agrobacterial gene encoding 5-enolpyruvyl-shikimate-3-phosphate synthetase (EPSPS) that is resistant to herbicide glyphosate. Which of the following correctly describes the issues associated with this type of GM crops?

- A). Weeds treated with glyphosate cannot synthesize aromatic amino acids because glyphosate inhibits the EPSPS enzyme of non-transgenic plants.
- B). The major benefit for farmers who adopted HT crops was the reduction of crop production cost, because removing weeds from the crop field is labor-intensive and expensive.
- C). The EPSPS-dependent shikimate pathway produces the type of amino acids that are essential to human, because human do not possess shikimate metabolism. The shikimate metabolic pathway operates well in the HT crops in the presence of glyphosate.

D). After a prolonged use of glyphosate to GM crops, glyphosate-resistant weeds may emerge, so farmers are required to plant a small amount of non-transgenic crops along with the transgenic crops.

E). All of above

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38. Knockout mouse is a useful model system to study human disease. Which of the following about the knockout mouse is *incorrect*?

- A). A knockout mouse is a transgenic animal that has a gene replaced by an exogenous antibiotics-resistance gene via homologous recombination.
- B). The embryonic stem cells are not used to produce a knockout mouse.
- C). The transformed ES cells need to be cultured on antibiotics-containing medium to select the transformed cells
- D). The selected mouse cells need to be injected into blastocyst.
- E). None of above

39. Which of the following descriptions about plant transformation is *correct*?

- A). In plant transformation, the foreign DNA is usually introduced to plant cells by electroporation.
- B). *Agrobacterium tumefaciens* integrates its genome into the plant genome during transformation
- C). Plant cells usually replicate a plasmid with its own replication origin
- D). The modified agrobacterial plasmid called Ti plasmid is often used in most plant transformation.
- E). Plant cells are usually very large so that it is easier to transform plants by the microinjection method.

40. Which of the following descriptions about human cloning is *incorrect*?

- A). Reproductive cloning does not have the danger of producing defective progenies.
- B). There are many types of stem cells in the human body, some can be used for therapeutic cloning.
- C). Therapeutic cloning is a promising method to more effectively treat diseases in the future, which may or may not need to use human embryos.
- D). The epidermal cells of mice are not pluripotent, but it can be used in therapeutic cloning by the SCNT method.
- E). The current iPS method has its technical limitations, so we have not been able to produce clinically safe organ transplant products by this technology.