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請將所有答案寫於「答案本」上，否則不予計分。

I. Multiple choice questions: 50 points (1 point for each question)

1. The atomic number of Oxygen is 8, which answer shown below is wrong?
 (1) Oxygen atom has 8 electrons (2) Oxygen atom has 8 protons
 (3) Oxygen atom has 8 neutrons (4) the molecular weight of Oxygen is 15.
2. Which of the following condition cannot form the hydrogen bond?
 (1) -O-H ----- O-; (2) -N-H ----- O-; (3) -C-H ----- O-; (4) -N-H ----- N-
3. Which of the following material is not belonging to the natural biomaterials?
 (1) proteins (2) nucleic acids (3) quantum dots (4) fatty acids
4. Proteins are composing of the amino acids, the description about the grouping of the amino acids is wrong at the neutral condition pH=7?
 (1) hydrophilic (2) hydrophobic (3) charged (4) hydrophobic charged
5. What kind of force to pull the two strands of DNA together?
 (1) Hydrogen bonds (2) hydrophobic interactions (3) ionic bonds (4) covalent bonds
6. Which component is not required for making the nucleic acids?
 (1) riboses (2) phosphates (3) bases (4) amino acids
7. What do you think why DNA can be used as the nanomaterials?
 (1) the interaction of the two strands is specific (2) only has 2 nm in its diameter
 (3) can be used as the materials for designing a biosensor (4) all of above
8. If you are going to remove bacteria from the solution; what is the pore size of the filter fitting this purpose?
 (1) 0.2 μm (2) 2 μm (3) 20 μm (4) all of above
9. What type of the cells could be infected by a phage?
 (1) Yeast (2) human cell (3) pea cell (4) bacteria
10. Which one shown below is not one of the life cycles of a phage in general?
 (1) Lysogenic life cycle (2) Lytic life cycle
 (3) Semi-persistent infection (4) Chronic infection life cycle
11. The enzyme encoded by RNA phage such as MS2 for replication belongs to which category shown below?
 (1) RNA-dependent DNA polymerase (2) RNA-dependent RNA polymerase
 (3) DNA-dependent RNA polymerase (4) all of above
12. Which phage has been used as tool in molecular biology allows us to transfer gene from one bacterium to another?
 (1) Phage P1 (2) Phage MS2 (3) Phage T2 (4) Phage M13
13. Which one shown below about retrovirus is correct?
 (1) use reverse transcriptase in their life cycle
 (2) use DNA as an intermediate during the infection cycle
 (3) dsDNA genome integrates into host genome
 (4) all of above
14. Reverse transcriptase belongs to which category shown below?
 (1) RNA-dependent DNA polymerase (2) RNA-dependent RNA polymerase
 (3) DNA-dependent RNA polymerase (4) all of above
15. Which one shown below is the right model for DNA replication?
 (1) Conservative (2) semi-conservative (3) dispersive (4) totally random
16. Which one shown below is the right category for DNA polymerase III for DNA replication?
 (1) DNA-dependent DNA polymerase (2) DNA-dependent RNA polymerase
 (3) RNA-dependent DNA polymerase (4) RNA-dependent RNA polymerase

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17. Which one shown below is right for the naturally isolated plasmid?
 (1) Positive supercoiled DNA (2) No supercoiled DNA
 (3) Negative supercoiled DNA (4) none of above
18. If the double-stranded sequence of a gene was 18% G, what must its %T be?
 (1) 18% (2) 82% (3) 32% (4) 41%
19. Which is NOT the function of DNA polymerase I?
 (1) 3'→5' exonuclease (2) 5'→3' exonuclease
 (3) Removes RNA primers used in DNA replication
 (4) Makes RNA oligonucleotides that are used in DNA replication
20. When telomerase binds to the 3' end of telomeric DNA, what enzyme activity is used for DNA elongation?
 (1) DNA-dependent DNA polymerase (2) DNA-dependent RNA polymerase
 (3) RNA-dependent DNA polymerase (4) RNA-dependent RNA polymerase
21. If you take the double-stranded DNA into an alkaline condition, what will be happened on this DNA?
 (1) Denatured (2) degraded (3) remain the same (4) none of above
22. What is the function of DNA ligase?
 (1) seal the gap (2) polymerization (3) seal the nick (4) degrade the RNA
23. The replisome catalyzes coordinated leading and lagging strand DNA synthesis was proposed to be what model?
 (1) Trombone (2) trumpet (3) drum (4) none of above
24. What is the function of topoisomerase involved in DNA replication?
 (1) introduce the negative supercoil ahead of the replication fork
 (2) introduce the positive supercoil behind the replication bubble
 (3) separate the newly formed sister chromosomes
 (4) all of above
25. High energy electromagnetic radiation includes which of the following?
 (1) ultraviolet light (2) x-rays (3) gamma rays (4) all of the above
26. An example of an environmental agent that must be modified by cell metabolism to become an active alkylating agent?
 (1) Dimethylsulfate (2) dimethylnitrosamine (3) glutathione (4) aflatoxins
27. The _____ test involves determining whether a chemical to be tested causes a histidine-requiring mutant of *Salmonella typhimurium* that has a base substitution or frameshift mutation in a *his* gene to revert to the His⁺ phenotype.
 (1) Reiger (2) Watson (3) Ames (4) Barnett
28. Proteins such as O⁶-alkyl-guanine DNA alkyltransferase I, which lose activity after acting only one time, are called _____.
 (1) mortality enzymes (2) suicide enzymes (3) necrosis enzymes (4) zombie enzymes
29. In *E. coli*, which DNA polymerase is primarily responsible for filling in the gaps in the DNA generated during nucleotide excision repair?
 (1) DNA polymerase I (2) DNA polymerase II (3) DNA polymerase IV
 (4) DNA polymerase V
30. In eukaryotes, which DNA polymerase is primarily responsible for filling in the gaps in the DNA generated during base excision repair?
 (1) DNA polymerase α (2) DNA polymerase β (3) DNA polymerase γ
 (4) DNA polymerase μ

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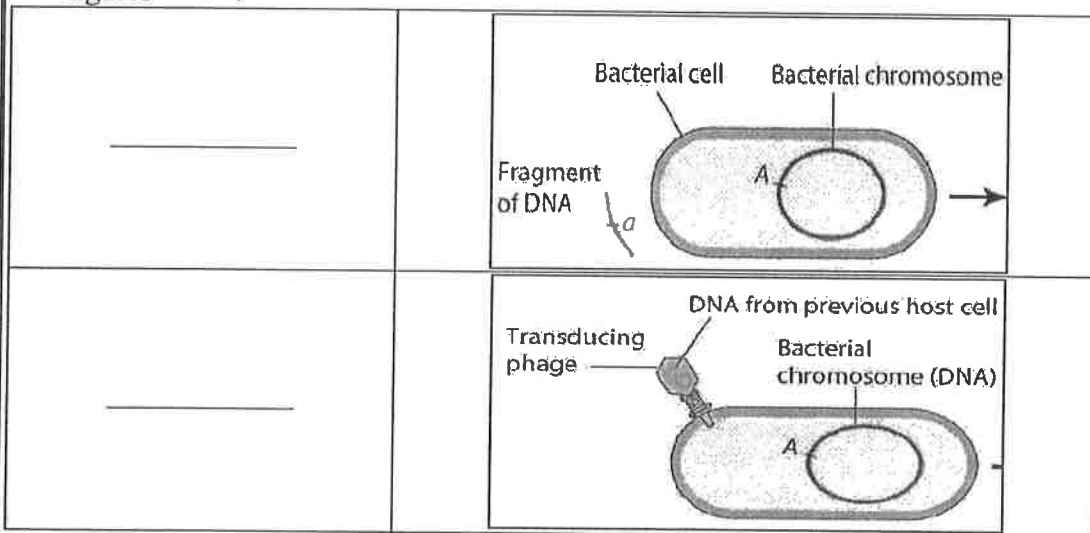
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31. _____ repair system removes mismatches and short insertions or deletions that are present in DNA.
 (1) Base excision (2) Mismatch (3) Nucleotide excision (4) SOS response
32. _____ and LexA regulate the *E. coli* SOS response.
 (1) DNA polymerase I (2) RecA (3) A primase (4) ARS
33. In bacteria, mismatch repair involves:
 (1) DNA glycosylase/lyase (2) AP endonuclease (3) RecA and LexA proteins
 (4) MutS, MutL and MutH proteins
34. _____ involves an exchange of DNA between two interacting DNA molecules.
 (1) Transference (2) Transposition (3) Crossing over (4) Induction
35. Nonhomologous end-joining in animal cells is used to make a mature _____ gene from separated modular parts.
 (1) Immunoglobulin (2) Enzyme (3) Receptor (4) DNA repair protein
36. Mutations in the _____ gene are associated with familial breast and ovarian cancer.
 (1) RAD51 (2) RAD52 (3) BRAC2 (4) MUS81
37. In eukaryotes, rRNA splicing occurs in _____.
 (1) Cytoplasm (2) RER (3) Nucleolus (4) Mitochondria
38. An exon within a coding region of a gene contains the following sequence: 5'-ATTGCACCTG-3'. Exposure of cells to a mutagen results in this sequence changing to 5'-ATTCGCACCTG-3'. Which of the following is true?
 (1) This gene has experienced a transition.
 (2) This gene has experienced a deletion.
 (3) This gene has experienced a frameshift.
 (4) This gene has experienced a transversion.
 (5) This gene has experienced an inversion.
39. Please rearrange the four steps of transcription
 a initiation of RNA synthesis
 b binding of RNA polymerase to promoter
 c elongation of the RNA chain
 d termination
 (1) abcd (2) bacd (3) acbd (4) cabd
40. The 5' cap and poly-A tail of eukaryotic mRNAs _____.
 (1) explain why hnRNA is so much larger than mRNA
 (2) are involved in termination of transcription
 (3) are the result of mRNA splicing (4) are added in the cytoplasm
 (5) have no template DNA sequence
41. According to the "wobble hypothesis," what is the identity of the tRNA that can recognize the following codons: CAU, CAC, and CAA?
 (1) 3'-GTI-5' (2) 3'-IUG-5' (3) 3'-III-5' (4) 3'-GUI-5' (5) 3'-UGI-5'
42. The mRNA is read in the _____ direction, and the corresponding polypeptide is synthesized in the _____ direction.
 (1) 5' to 3'; N-terminal to C-terminal (2) 3' to 5'; C-terminal to N-terminal
 (3) 5' to 3'; C-terminal to N-terminal (4) 3' to 5'; N-terminal to C-terminal
 (5) either; either

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43. When double-stranded RNA exists, which enzyme will cleave it into siRNA?
 (1) DICER (2) Slicer (3) Argonaute (4) RISC
44. Which of the following is NOT an example of genomic control of gene regulation?
 (1) DNA rearrangement (2) Gene amplification (3) Gene deletion
 (4) DNA methylation (5) Alternative RNA splicing
45. A method for examining a cellular process occurring over time by successively exposing the cells to a labeled compound and then to the same compound in an unlabeled form is called
 (1) DNA microarray (2) DNA fingerprinting (3) Pulse-chase experiment
 (4) Hershey-Chase experiment
46. Which one shown below is not one of the characteristics of histone protein?
 (1) Positive charge (2) Lysine-rich (3) Alanine-rich (4) Arginine-rich
47. Homologous recombination also takes place when DNA is transferred into bacterial cells by transformation (A), transduction (B), and conjugation (C). Please match these three mechanisms to the figures below.



- (1) A and B (2) A and C (3) B and C (4) A and A
48. Hershey and Chase were able to demonstrate that DNA is the genetic material of T2 phages because radioactive phosphorus labels _____ and radioactive sulfur labels _____.
 (1) lipids; proteins (2) DNA; proteins (3) proteins; lipids (4) proteins; DNA (5) DNA; DNA
49. One strand of a region of DNA has the sequence 5'-ATTCCG-3'. The complementary strand for this one is _____.
 (1) 5'-ACCTTA-3' (2) 5'-TAAGGC-3' (3) 5'-CGGAAT-3'
 (4) 5'-GCCTTA-3' (5) 5'-ATTCCG-3'
50. The sequence 5'-ATTCCG-3' is NOT a likely recognition sequence for a restriction enzyme because _____.
 (1) when properly base-paired, the sequence is not a palindrome
 (2) when properly base-paired, the sequence does not have the same number of purines as pyrimidines
 (3) it is not antiparallel
 (4) recognition sequences can only be read 3' to 5'
 (5) it is too short

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II. Short-answer questions: 50 points (10 point each question)

1. A plasmid isolated from *E. coli* is subjected to the restriction enzyme digestion for a mapping. There are 2 kb and 5 kb fragments after digestion with *EcoRI*; a 7 kb fragment after digestion with *XbaI*; and a 3.5 kb fragment after digestion with *BamHI*. If you go for the double digest with *EcoRI* and *BamHI* generate 3.5, 2, 1, and 0.5 kb fragments; with *EcoRI* and *XbaI* generate 2 and 3 kb fragments; and with *XbaI* and *BamHI* generate 3.5, 2.5, and 1 kb fragments. Could you draw the restriction map? (10 points)
2. Given the following sequence for an RNA molecule, find a secondary structure that will be maximally stable. (10 point)

GUCCAGCCAUUGCGUUCGCAAUGGC
3. A 340-nm-long duplex DNA molecule in the B-conformation adopts an A-conformation upon dehydration. How long is it now (nm)? What is the length of the molecule (bp)? (A form: 2.9Å/rise per bp, B form: 3.4Å/rise per bp) (10 point)
4. Please translate the following abstract into Chinese. (10 point)
(note: for those specific terms such as "metabolomics" you don't need to translate in Chinese)

Metabolomics is the scientific study of chemical processes involving metabolites. Specifically, metabolomics is the "systematic study of the unique chemical fingerprints that specific cellular processes leave behind", the study of their small-molecule metabolite profiles. The metabolome represents the collection of all metabolites in a biological cell, tissue, organ or organism, which are the end products of cellular processes. mRNA gene expression data and proteomic analyses reveal the set of gene products being produced in the cell, data that represents one aspect of cellular function. Conversely, metabolic profiling can give an instantaneous snapshot of the physiology of that cell. One of the challenges of systems biology and functional genomics is to integrate proteomic, transcriptomic, and metabolomic information to provide a better understanding of cellular biology

5. Please use five sentences to introduce yourself in English. (10 points)