Part I. In the following 30 questions, please choose a CORRECT answer. (60 points, 2 points per question)

1. Which of the following mechanisms are responsible to generate a large group of antibody recognizes different antigen (antibody diversity)?

(1) Somatic hypermutation
(2) Alternative splicing
(3) V(D)J joining
(4) Alternative transcription termination

A. (1), (2);
B. (1), (3);
C. (2), (3);
D. (2), (4);
E. (1), (2), (3)

2. Which of the following statements concerning the constitutive heterochromatin is true?

(1) centromeric location
(2) telomeric location
(3) high Cot value
(4) early replicating

A. (4)
B. (1), (2)
C. (1), (3)
D. (1) (2), (3)
E. (1), (2), (4)

3. Which of the following statements concerning the telomeres is not true?

(1) Hairpin DNA configurations
(2) Repeated sequence
(3) Template-free sequence additions
(4) G:G base pairs

A. (1)
B. (3)
C. (4)
D. (2), (4)
E. (3), (4)

4. Which of the following enzyme uses RNA to replicate DNA?

(1) DNA polymerase IV
(2) RNA polymerase III
(3) Telomerase
(4) Reverse transcriptase
(5) RNA replicase

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

5. If DNA polymerase III could add bases in the 3' to 5' direction in *Escheria coli*, there would be no need for

A. DNA ligase.
B. Okazaki fragments.
C. Helicase.
D. Gyrase (topoisomerase).
E. DNA polymerase II.

6. Eukaryotic mRNA transcription modifications include

A. intron assembly.
B. 5' capping on a terminal 7-methylguanosine residue.
C. polyadenylation on 5' end.
D. exon splicing.
E. none of above.

7. Most of the histones are well conserved from one organism to another, which histone shows the greatest variation among tissues and species?

A. H1
B. H2A
C. H2B
D. H3
E. H4

8. One of the reasons for histone heterogeneity is due to phosphorylation of

A. methionine.
B. leucine and isoleucine.
C. cysteine.
D. serine.

9. Histone acetylation in eukaryotes occurs in
A. cytoplasm.
B. nucleus.
C. both cytoplasm and nucleus.
D. cell membrane.

10. The major difference between the splicing mechanisms of spliceosomal introns and group I introns in the first step of splicing is that
A. the former (spliceosomal introns) uses an exogenous nucleotide.
B. the former uses an exon nucleotide in the last step of splicing.
C. the latter uses a nucleotide that is integral to the intron itself.
D. the latter (group I introns) uses an exogenous nucleotide.

11. The secondary structures of the splicing complexes involving spliceosomal systems are strikingly similar to
A. t-RNA introns.
B. group I introns.
C. group II introns.
D. group III introns.

12. Group I introns from *Tetrahymena* (Protozoa) 26 rRNA precursor can be removed in vitro with
A. no help from protein
B. no help from extra nucleotide
C. extra ATP energy
D. no help from MgCl2.

13. RNA-induced silencing complex (RISC) does not include
A. Dicer.
B. Argonaute.
C. nuclease.
D. RNA polymerase.
E. none of above.

14. The splicing signals in nuclear mRNA are commonly similar. The first two bases of the intron on 5′ end are always
A. AA.
B. AG.
C. GU.
D. GG.
E. UU.

15. The splicing signals of intron on the last two on 3′ end are always

A. AA.
B. AG.
C. GU.
D. GG.
E. UU.

16. *Trypanosome* (Parasitic flagellated protozoa) mRNAs are formed by what kind of splicing between a short leader exon and any one of many independent coding exons.

A. cis-splicing
B. trans-splicing
C. self-splicing
D. lariat-splicing

17. dsRNA has to include what kind of sequences to cause RNA interference (RNAi).

A. exon regions
B. introns
C. promoter sequences
D. introns and promoter sequences

18. Which of the following is not part of the 30S initiation complex?

A. amino-acyl tRNA
B. IF1, IF2, and IF3
C. mRNA
D. 5S rRNA

19. Arrange the following steps of prokaryotic translation initiation in correct order.

I. Binding of IF1, IF2, and GTP to the 30S subunit.
II. Binding of IF3 to the 30S subunit.
III. Binding of the 50S subunit and loss of IF1 and IF3.
IV. Dissociation of the 70S ribosome.
V. Formation of the 70S initiation complex by dissociation of IF2 and GTP hydrolysis.
VI. Formation of the 30S initiation complex.

A. II → VI → III → IV → V → I
B. I → II → III → IV → V → VI
C. IV → II → I → VI → III → V
D. III → I → II → IV → VI → V

20. Which of the following eukaryotic transcription factors is homologous to the prokaryotic transcription factor IF2?

A. eIF2B
B. eIF3
C. eIF4G
D. eIF5

21. Which of the following statements about translation is correct?

A. The secondary RNA structure inhibits translation.
B. Anti SD sequences appears at the 5′ end of 16S rRNA.
C. SD sequences locate downstream of the initiation codon.
D. Formylation takes place before tRNA charges with Met to form $tRNAf^{Met}$

22. Which of the following statements about antibiotics is NOT correct?

A. Chloraphenicol inhibits prokaryotic peptidyl transferase
B. Fudic acid blocks the release of EF-T from the ribosome
C. Streptomycin increases error rate of translation
D. Viomycin inhibits translocation

23. Which of the following molecules does not resemble a tRNA molecule?

A. tmRNA
B. puromycin
C. suppressor tRNA
D. EF-Tu

24. Which of the following characteristics is NOT a characteristic of a G protein?

A. It binds GMP for activation.
B. It has intrinsic GTPase activity.
C. Cleavage of bound GTP to GDP inactivates it.
D. It cycles among three conformational states.

25. Which of the following molecules recognizes the stop codon(s)?

I. RF1 II. RF2 III. RF3 IV. Suppressor tRNA

A. I, II
B. I, II, III
C. I, II, IV
D. I, II, III, IV

26. Which of the following parts of tRNA are important for recognition by its cognate aminotransferase-tRNA synthetase?

A. variable loop and D loop
B. T loop and variable loop
C. anticodon loop and T loop
D. acceptor stem and anticodon loop

27. Which of the following modified nucleotides is fluorescent?

A. Inosine
B. Dihydrouridine
C. Pseudo-uridine
D. Wyosine

28. Which of the following methods can be used to prove the existence of A site and P site in a prokaryotic ribosome?

I. Fragment assay
II. NMR spectroscopy
III. X-Ray crystallography
IV. DNase footprinting

A. I, II
B. I, III
C. I, IV
D. II, III

29. Which statement about the Wobble base pairing is NOT correct?

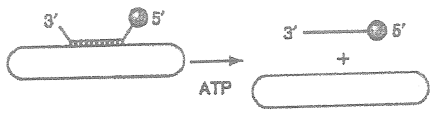
A. Allows one anticodon to recognize two or more codons
B. Occurs between the 1st base of an anticodon and the 3rd base of a codon
C. Occurs between the 3rd base of an anticodon and the 1st base of a codon
D. Reduces the number of tRNAs required to translate the genetic code

30. Which of the following enzymes does NOT simply process reaction from 5' to 3'?

A. Taq DNA polymerase
B. *E. coli* DNA polymerase
C. Reverse transcriptase
D. *E. coli* RNA polymerase

Part II. Please fill in the blanks (10 points)

1. Which enzyme can catalyze the following reaction? _____ (2 points)



2. A bacterial transposable element has two open reading frames, ORFA and ORFR. The sequence of ORFA displays significant similarities to the transposases of other transposable elements. A mutation in the ORFR does not affect transposition; however it affects the resolution of donor and target DNA. Thus, a cointegrate containing two replicons is formed. Which type of the transposition mechanism is used for transposition? _____ (3 points)

3. _____ repair system is responsible for maintaining the stability of microsatellite. Failure of this repair in eukaryotes increases the chance of cancer in human. (2 points)

4. A protein X is known to recognize the following DNA sequences. Please derive a consensus sequence of this protein X. _____ (3 points)

```
5′  TTAATTGCGT  3′
    CGCTTTGCAG
    AGGTTTCCCG
    CCGATTCATT
    CGTATTGGGC
    CCGATTCATT
    CTGATTCTGT
    TTCTTTCCTG
```

Part III. Please answer the following questions. (30 points)

1. Give an example to describe how researchers took advantage of *Saccharomyces cerevisiae* as a tool to clone and identify key cell cycle regulatory genes. (7 points)
2. With their multiple origins, how does the eukaryotic cell know which origins have been already replicated and which still await replication? (7 points)
3. What is a "bacterial artificial chromosome"? Give an example to explain its application in the biomedical field. (6 points)
4. Explain the theory of Cre-loxP system. (5 points)
5. What is microRNA? How may these RNAs participate in the regulation of eukaryotic gene expression? (5 points)