**Part I: Eukaryotic genomes**

A. Choose correct answer from following questions (2% each)

1. Which of following statements is true for eukaryotic genomes?
   - (1) The genome size of eukaryotes is the same as that of prokaryotes.
   - (2) Eukaryotic genomes contain mainly repetitive DNA sequences.
   - (3) The morphological complexity of lower eukaryotes is proportional to their genome size.
   - (4) The genome size of human is larger than that of tobacco.
   - (5) None of above.

2. Our sense of the relative complexity of the organisms accords better with
   - (1) Total DNA content of genome
   - (2) Non-repetitive DNA content of genome
   - (3) Moderately repetitive DNA content of genome
   - (4) Highly repetitive DNA content of genome
   - (5) Number of genes in the genome.

3. The size of eukaryotic genomes is usually several orders in magnitude larger than that of *E. coli* genome. It is because eukaryotic genomes contain
   - (1) Many repeated DNA sequences
   - (2) Non-coding DNA sequences
   - (3) Introns
   - (4) Multiple copies of ribosomal genes
   - (5) All previous answers are correct.

4. Which of following statements is true for tandemly repeated DNA sequences?
   - (1) It accounts for 10-15% of a typical mammalian genome.
   - (2) This type of DNA sequence scattered around the genome.
   - (3) *Alu* family belongs to this type of repeated DNA sequences.
   - (4) Human genome contains mainly this type of repeated DNA sequences.
   - (5) None of above.

5. Which of following components is not found in DNA replication machinery of eukaryotic cells?
   - (1) DNA polymerase δ
   - (2) Primase
   - (3) Helicase
   - (4) DNA gyrase
   - (5) DNA topoisomerase.

6. Telomere is
   - (1) a long non-repetitive DNA sequence at the ends of each chromosome.
   - (2) composed of 100 to 1500 copies of the TTAGGG sequence in human chromosome.
   - (3) synthesized by the RNA-based DNA polymerase.
   - (4) important to facilitate the DNA replication.
   - (5) all previous answers are correct.

7. Nucleosome, the basic unit of chromatin structure, is composed of following components except
   - (1) Histone H1
   - (2) Histone H2A
   - (3) Histone H3B
   - (4) 200 bp DNA
   - (5) Histone H4.
8. In eukaryotes mitochondrion or chloroplast contains its own genome (mtDNA or ctDNA). What is true about the mtDNA or ctDNA?
   (1) It exists as a linear form.
   (2) It encodes all the proteins needed for its own functions.
   (3) The mtDNA or ctDNA follows the rules of Mendelian inheritance.
   (4) Mitochondrial genes are synthesized in mitochondrial matrix.
   (5) None of above.

9. Several sub-structures of protein/DNA complex are formed during nuclear DNA packaging. Which of following sub-structures is not seen in this process?
   (1) Nucleosome
   (2) Heterochromatin
   (3) Chromosome
   (4) Looped domains
   (5) Spindle forms.

10. Most promoters of mammalian genes contain an initiative site for the binding of RNA polymerase II complex. What is this site?
   (1) Shine-Delgarno sequence
   (2) SEB responding element
   (3) UBF1 binding site
   (4) TATA box
   (5) GATA box.

B. Please answer following questions about human genome project. (15 %)

a. What is human genome project? (3 %)

b. Please give reasons why human will be benefited by the completion of human genome project? (6 %)

c. Both Celera and the public human genome project consortium have predicted that humans have roughly 32,000 genes, which is far less than what we known about the number of proteins needed to run an organism as complicated as a person. Please explain why this paradox might be happened? (6 %)
PART II

Multiple choices: (at least one of the answers provided is correct) 2 point each

1. EcoRI restriction enzyme recognizes the sequence GAATTC and after digestion, creates 5' protruding ends. Which of the following is (are) the result(s) of an EcoRI digestion?
   A. G 3'p 5'p AATTC  B. GAA 3'OH 5'p TTC  C. GAATT 3'OH 5'pC  D. G 3'OH 5'p AATTC CTTAA 5'p 3'p G  TT 5'p 3'OH AAG  C 5'p 3'OH TTAAG  CTTAA 5'p 3'OH G

2. During a cloning experiment, it was necessary to perform ligation procedure to put two DNA fragment together. Which of the following are the DNA fragments that you can use for a ligation reaction using T4 DNA ligase?
   A. ...GAATTC 3'OH ...TTAAG 5'p 5'p 3'OH ATAGTT... B. ...GAATTC 3'OH ...CTTAAG 5'p 3'OH ATAGTT... C. ...GAATTC 3'OH ...TTAAG 5'p 3'OH ATAGTT... D. ...GAATTC 3'OH ...CTTAAG 5'p 3'OH ATAGTT...

3. Enhancer is a cis-element that can stimulate the expression of a gene. It can be found at the following location(s) relating to the gene it stimulates.
   A. 5'.  B. 3'.  C. middle of the gene.  D. none of the above

4. Which of the following can be used in gene transfer in bacteria?
   A. Transformation, B. Transfection, C. Transduction, D. Conjugation

5. Chose the right primers for amplifying the following DNA fragment by PCR:
   5'GATCGTTCAATGCCAATCTGTAGCCTGACC...GATGTTACGTACGTCATGCAACGTGCCGG3'
   3'CTAGCAAGCTTGGCAGACTGGG...CTAATGCAATGCATACGTGGTACGTGCC5'
   A. 5'GATCGTTCAATGCCAATCTGTAG  B. 5'CTAGCAAGCTTGGCAGACTGGG  
   C. 5'GATGTTACGTACGTCATGCAAC  D. 5'CCGTACGTGGTACGTGCCGG  
   E. 5'GGCGATCGCAACGTAGCTGGC5'  F. 5'GATCGTTCAATGACGTGCCGGGC

6. To detect the expression of a gene, we can use the following method(s):
   A. Eastern Blot.  B. Southern Blot  C. Western Blot  D. Northern Blot
7. Blue-white screen with x-gal is a very common method for determining whether an
insert DNA fragment has been ligated with the vector DNA, which indicates the
success of the ligation. The principle of blue-white screen is to monitor the
activity of an enzyme called β-galactosidase. When its activity is expressed in
cells, it will hydrolyze the x-gal in the plate and turns the cells blue. If there is no
activity, then the cells will be white. For our purpose, the cloning site is inside the
coding region of β-galactosidase. Thus, when the ligation is successful, the
coding region of β-galactosidase will have an insertion due to the sequence from
the insert. If the ligation is successful, after transformation of the ligation mixture
into E. coli, we can find the colonies formed may have the following color(s):
A. White, B. Blue, C. Green, D. Orange

8. Which one of the following sequences will happen in gene expression in
mammalian cells?
A. Transcription – Translation – Protein degradation – Splicing
B. Transcription – Splicing – Protein degradation – Translation
C. Transcription – Splicing – Translation – Protein Degradation
D. Splicing – Translation – Translation – Protein Degradation

9. To detect the existence of a protein, we can use the following methods:
A. Northern Blot, B. Western Blot, C. Southern blot, D. Immunoblotting

10. The primer that initiates synthesis of a new DNA strand is:
A. RNA, B. DNA, C. an Okazaki fragment D. a thymine dimer

11. The elongation of the leading strand during DNA synthesis
A. Progress away from the replication fork.
B. Occurs in the 3'→5' direction.
C. Depends on the action of DNA polymerase.
D. Does not require a template strand.

Answer the next question:
12. In a typical eucaryotic gene, we can find several features in the DNA that control
gene expression on the transcription level, for example, promoter. Please list 3 other
features.(13 points)
Part III
A. Please choose the correct answer(s) for each of the questions. (2% each)

1. A reciprocal exchange in which a pair of homologous sequences break and
rejoin in a crossover is called
a. replicative transposition
b. general recombination
c. specialized transduction
d. conjugation

2. A conserved DNA sequences centered around positions -10 and -35 upstream
to the transcriptional start in bacteria. The sequences is
a. sigma factor
b. promoter
c. operator
d. attenuator

3. Catabolite repression, a control mechanism of gene expression in bacteria,
a. prevents expression of lac and gal operons
b. is mediated by the level of cAMP in the cell
c. is controlled by the LacI repressor
d. is regulated by the level of glucose in the cell

4. RNA viruses require their own supply of certain enzymes because
a. the viruses are rapidly destroyed by host cell defenses
b. host cells do not have RNA->RNA or RNA->DNA enzymes
c. the enzymes translate viral RNA into proteins
d. the viruses use these enzymes to penetrate host cell membranes

5. Which of the properties are characteristics of an SOS response in bacteria?
a. is a mutation prone reaction
b. is triggered by RecA protein
c. is regulated by LexA repressor
d. allows the cell to replicate past the DNA damage

6. Which of the following is not true about transposable elements?
a. They reproduce independently like plasmids
b. A direct repeats flanking the insertion sites is generated in the transposition process
c. They perform either a replicative transposition or direct cut-and-paste transposition
d. The simple transposons are called insertion sequences
7. Select the correct description(s) of prokaryotic transcriptional regulation
   a. What type of promoter is used depends upon the type of sigma factor bound to
      RNA polymerase.
   b. The regulation of transcription of bacterial operons is often achieved through
      small molecules called effectors.
   c. The regulation of operon transcription can only be negative or positive.
   d. The coordinate regulation of a large number of genes is called global regulation.

8. Which enzymes are required for excision repair in *E. coli*?
   a. DNA ligase
   b. UvrABCD
   c. DNA polymerase I
   d. DNA polymerase III

9. DNA replication in *E. coli* involves
   a. DNA polymerase I
   b. DNA helicase
   c. DNA ligase
   d. primase

10. F' plasmid results when
    a. an F' and F mating is interrupted before completion
    b. an Hfr and F mating is interrupted before completion
    c. an integrated F plasmid is incorrectly excised, bringing host genes with it
    d. an F' and F mating

B. Please describe the characteristics of a sensor-response regulator two-component system in bacteria. (10%)