Part (1) (25%)

1. In prokaryotes, environmental sensing frequently involves regulatory proteins (two-component system) that sense and respond to changes in surroundings. These two-component systems may involve which of the following? (2%)
   I. Protein phosphorylation
   II. Transcriptional regulation
   III. Membrane proteins
   (A) I only
   (B) II only
   (C) III only
   (D) II and III only
   (E) I, II, and III

2. Which of the following is most likely to lead to a loss of gene function? (2%)
   (A) A missense mutation in the open reading frame
   (B) A change from a TAA codon to a TAG codon in the coding region
   (C) A change from a T to C in the promoter region
   (D) A frameshift mutation in the coding region
   (E) A sequence change in the 3’ untranslated region

3. Which one of the following is not used during Western blotting? (2%)
   (A) Secondary antibody with a conjugated detection system
   (B) Agarose gel electrophoresis
   (C) Non-fat dry milk
   (D) Primary antibody that recognizes the protein
   (E) Nitrocellulose membrane

4. Which of the following nucleotides is not normally occurring? (2%)
   (A) 3’-dAMP
   (B) 2’-dAMP
   (C) 3’,5’-cyclic AMP
   (D) 5’-AMP

5. The genetic code is said to be degenerate. This means that (2%)
   (A) each codon codes for more than one amino acid
   (B) each anticodon can interact with many different triplet sequences in the mRNA
   (C) many of the amino acids are coded for by different codons
   (D) the code is universally used by virtually all species

6. The figure at the right shows part of a RNA from a region near the beginning of ORF101. What is the significance of this structure? Point to two specific features that help you identify its function. (5%)

   G C
   G C
   G C
   G C
   C C C G A T G A C C C U U U U G C U C U U U U U U
7. Fill in the blank (10%)
   A. The enzymes that join amino acids to their cognate tRNA are called _l_o_.
   B. Of the three DNA polymerases in _E. coli_, _2_ is the actual replicating enzyme; _3_ is responsible for the removing of RNA primer while simultaneously replacing it with DNA.
   C. The short stretches of sequence produced during discontinuous replication are called _4_, which are initiated with _5_.

**Part (2) (25%)**

1. How do you use alkaline phosphatase in DNA cloning, and why? (4 pts)

2. List the 3' splice site, 5' splice site, and the polyadenylation sequences in eukaryotic mRNA. (9 pts)

3. List the -35, -10, and Shine-Dalgarno sequences of prokaryotics, and their biological roles (12 pts).

**Part (3) (25%)**

1. What steps and enzymes are needed to create a _cDNA library_ from mRNA? (10 pts)

2. How can you create an _artificial life form_ from laboratory chemicals by synthesizing DNAs or chromosomes? In the answer, lease point out approximately the number of genes and types of genes are needed to maintain a life. (8 pts)

3. What is _telomere_? How can _telomerase_ be used to fix the end of chromosome? (7 pts)

**Part (4) (25%)**

Please select the best answer to each question (1 to 5). (3 points each)

1. In eukaryotes, processes that require denaturation of double stranded DNA, such as DNA replication, are facilitated by what kind of supercoiling that pre-exists in DNA?
   a) Neutral
   b) Positive
   c) Negative
   d) Helical
   e) None of the above

2. The sequences (5'-acctgggaattcaagcttgggatcctc-3') can be digested orderly from 5' end by
   a) Hind III - BamHI - EcoRI
   b) EcoRI - Sma I - BamH I
   c) BamH I - Sma I - EcoR I
   d) EcoR I - Hind III - BamH I
   e) BamHI - Hind III – EcoRI
3. Which chemical reaction of the following does NOT happen to proteins in a eukaryotic cell?
   a) Monoubiquitination
   b) Polysomoylation
   c) Deubiquitination
   d) Deneddylation
   e) None of the above

4. In terms of the structural hierarchy of DNA, what is the next, higher-order chromatin structure after the 10-nm fiber (which is also called “beads-on-a-string”)?
   a) The DNA loop
   b) The 30-nm fiber
   c) The mitotic chromosome
   d) Supercoiled DNA
   e) None of the above

5. How is the structure of chromatin regulated in eukaryotic cells?
   a) By post-translational modifications of histone tails
   b) By incorporating different histone variants
   c) By the actions of nucleosome-remodeling complexes
   d) By ubiquitination
   e) All of the above

6. Please answer the following questions regarding a eukaryotic cell. (10 points)
   a. Name two post-translational modifications for histone H3 favoring gene activation. (4 points)
   b. Describe the mechanism of how heterochromatin forms. (2 points)
   c. Explain what epigenetic code and ChIP-Sequencing assay are? (4 points)