1. Please circle the letter(s) corresponding to the most appropriate answer(s); more than one of the choices provided may be correct. (30%)

(1). RNA composes all or part of

a. aminoacyl-tRNA synthetases.

b. telomerases.

c. ribosomes.

d. ribozymes.

e. RNA polymerases.

(2). Cellular DNA replication

a. requires a primer.

b. is known as transcription.

c. requires helicase to unwind the DNA double helix.

d. employs an enzyme called DNA ligase.

e. occurs in the 5' to 3' or 3' to 5' direction.

(3). Which of the following are proteins that are involved in translation?

a. ribosomal RNA.

b. initiation factor.

c. TFIID.

d. aminoacyl-tRNA synthetase.

e. TFIIIC.

(4). A typical prokaryotic gene encoding an enzyme

a. is located in an regulon containing a single gene.

b. may be transcribed into the same mRNA as the genes for other enzymes in the same pathway.

c. may or may not contain introns.

d. may undergo polyadenylation.

e. is transcribed by RNA polymerase.

(5). To be useful in the preparation of recombinant DNA, a plasmid must have

a. a reporter gene.

b. a regulatable promoter.

c. a gene conferring antibiotic resistance.

d. the ability to alternate in the cell between linear and circular forms.

e. a polyA tail.

(6). The unusual property of *Taq* polymerase that is critical to the PCR is its

a. ability to amplify DNA *in vitro*.

b. ability to use dNTP as substrate.

c. thermostability.

d. ability to synthesize DNA in the 5' to 3' direction.

e. ability to use RNA as template.

(7). Hybridization of single stranded RNA or DNA is facilitated by

a. high temperature and high salt.

b. high temperature and low salt.

c. low temperature and high salt.

d. low temperature and low salt.

e. the presence of glycogen.

(8). The Maxam-Gilbert method of determining a DNA sequence involves the use of

a. dimethyl sulfate.

b. electrophoresis.

c. T7 DNA polymerase.

d. formic acid.

e. 5' end labeling.

(9). Correlation of the physical and genetic maps of a chromosomal region permits localization of the specific DNA segment containing a particular mutation. This procedure

a. cannot be accomplished by polymerase chain reaction.

b. is only helpful for the isolation of prokaryotic genes.

c. is more precise, the more markers that comprise the physical map.

d. has been achieved for *Escherichia coli*.

e. takes advantage of recombination between genes.

(10). Gene-knockout experiments

a. involve replacement of wild-type genes with mutant genes.

b. cannot be carried out across species boundaries.

c. are most interesting when they show no effect.

d. may be helpful in determining whether open reading frames with no homology to other known genes encode functional important proteins.

e. may require the deliberate mutation of cloned genes.

(11). The DNA that encodes protein or RNA accounts for approximately what percentage of the total DNA in eukaryotic cells?

a. 0.5 percent.

b. 1 percent.

c. 5 percent.

d. 50 percent.

e. 75 percent.

(12). The ends of chromosomes are replicated by

a. telomerase.

b. DNA polymerase III.

c. DNA polymerase I.

d. telomerase reverse transcriptase.

e. DNA ligase.

(13). Which of the properties are characteristics of sigma factors?

a. *bind to transcription start point.*

b. sigma factor 70kD can bind to different consensus promoter sequences.

c. can bind to enhancers.

d. may require phosphorylation for activity.

e. are transiently associated with RNA polymerase.

(14). Addition of inducer would not greatly affect the synthesis of ß-galactosidase in bacteria having the genotype

a. $Z^- Y^+ A^+$.

b. $I^+ O^c Z^+$.

c. $I^- O^c Z^+$.

d. $I^+ O^+ Z^-$.

e. $I^- O^c Z^-/I^- O^+ Z^+$.

(15). Components of the spliceosome include

a. a single snRNP containing several different snRNAs.

b. U1 snRNP and U2AF.

c. U1 snRNA, which interacts with the 5' splice site in pre-mRNA.

d. U2 snRNA, which interacts with the branch point in pre-mRNA.

e. U6 snRNA, which interacts with U4 snRNA.

2. Please fill in the blanks. (10%)

(1). To initiate transcription in eukaryotes, RNA polymerase II, a multimeric protein, binds through general transcription factor __(a)__, whose __(b)__ component interacts with the TATA sequence.

(2). A measure of repetitiveness of a DNA species based on its reassociation rate is the __(c)__ value.

(3). The duration of the DNA synthesis in human cells is 10 h. Human cells replicate DNA at about 100 bp/s/fork. The minimum number of bidirectional forks required to replicate human genome during the DNA synthetic period is __(d)__.

(4). *E. coli* can restrict __(e)__ and destroy it.

(5). The unique properties of *Escherichia coli* DNA Pol I that make this enzyme essential to replication of the lagging strand is __(f)__.

(6). Termination of transcription at many sites in prokaryotes is dependent on __(g)__.

(7). In higher eukaryotes, the mRNA encoding __(h)__ lacks a poly-A tail.

(8). Splicing of __(i)__ does not involve spliceosome.

(9). __(j)__ plays a role in determining the stability of an mRNA.

3. A set of DNA fragments are obtained by digestion a genomic clone from lambda EMBL3 with restriction enzymes and the length of the fragments are as indicated in the table below. To locate the initiation and termination sites for its transcript, the restriction fragments are hybridized to a population of nascently labeled RNA chains and the results are also shown in the table. Please (10%)

(1). diagram the order of restriction sites in the 11-kb DNA clone.

(2). indicate the initiation and termination sites for the transcription unit.

(3). estimate the maximum length of the transcript.

(4). design an experiment for determining the transcription start point.

(5). design an experiment for determining the transcription termination site.

Restriction fragment		Length (bp)	Hybridization
A.	*Sal*I-*Xho*I	8000	+
B.	*Sal*I-*Bgl*II	2200	-
C.	*Eco*RI-*Bgl*II	700	-
D.	*Eco*RI-*Xho*I	5100	+
E.	*Eco*RI-*Hind*III	400	-
F.	*Xho*I-*Sal*I	3000	-
G.	*Hind*III-*Bgl*II	300	-
H.	XbaI-XhoI	4000	+

4. Define the following terms adequately. (15%)

(1). Ectopic expression.

(2). Homeodomain.

(3). Intercistronic region.

(4). Shine-Dalgarno sequence.

(5). Scaffold.

5. Design an experiment to demonstrate that two proteins interact to each other *in vivo*. (7%)

6. T-cell receptors and antibodies have similar structures and both interact with antigens. What two properties not only distinguish the interaction between the T-cell receptor and antigen from the antibody-antigen interaction but also have complicated study of the reaction of antigens with the T-cell receptor? (6%)

7. Compare the structures and functions between the receptors for EGF and steroid. (8%)

8. Which maternal genes function as anterior and posterior determinants during *Drosophila* embryogenesis and how do their encoded proteins act to establish the early anterioposterior patterning of the embryo? (6%)

9. Compare the functions between RB and p53 in cell-cycle control. (8%)