Answer the following questions. (60%)

1. Please define the following biological terms: (20%, 4% each)
   (1) Next generation sequencing techniques
   (2) Linkage disequilibrium
   (3) Bottleneck effects
   (4) Comparative genomics
   (5) Epistasis

2. What is meant by the term **pseudogene** and how are **pseudogenes** formed? (5%)

3. Please describe in details on the **transposition** of a **retrotransposon**? (5%)

4. What is meant by the term **suppressor mutation** and please list the types of suppressor mutations. (5%)

5. What is an **allele-specific** oligonucleotide and briefly describe its use? (5%)

6. In a cross between a heterozygous tall pea plant and a dwarf plant, predict the ratios of the offspring's genotypes and phenotypes. (6%)

7. What are "Genetic Model Organisms"? List three examples (species) and describe the characteristics that made them especially suitable for genetic research. (8%)

8. Why do mutations in non-coding regions of a gene still have major effects on phenotypic expression? (6%)

9. Choose the correct answer (only one answer) for each of the questions. (40%, 2% each)

(1) If an X-linked disease results from a rare recessive allele
   A. there will be more females exhibiting the trait than males
   B. there will be more males exhibiting the trait than females
   C. the frequency of affected males and females will be equal
   D. among females there will be more affected than carriers
   E. all sons of affected males will be affected

(2) Mitochondrial DNA
   A. carries all of the cell genes necessary for respiration
   B. is a linear molecule
   C. utilizes slightly different genetic code than nuclear genome
   D. carries genes for all components necessary for its function
   E. evolves slower than nuclear DNA

(3) Loss of function of p53
A. activates apoptosis
B. eliminates the DNA damage checkpoint
C. increases contact inhibition
D. blocks activation of the anaphase promoting complex
E. suppresses assembly of the spindle

(4) Ultraviolet light primarily damages DNA by
A. pyrimidine dimers
B. forming purine dimers
C. alkylating DNA
D. depurinating DNA
E. none of the above

(5) A test for carcinogens and mutagens that looks for an increased reversion frequency in a His- strain of bacteria is called the
A. carcinogen test
B. mutagen test
C. Ames test
D. *Salmonella* reversion test.
E. auxotrophic reversion test.

(6) A homeobox is a
A. DNA binding site
B. sequence that codes for DNA binding motif
C. transcriptional activator of other genes
D. protein involved in the control of meiosis
E. protein involved in the control of replication

(7) The nucleotide sequence of the attenuator region
A. contains features of a termination site
B. triggers degradation of RNA transcripts containing homologous sequences
C. interacts with the Polycomb group of transcriptional silencer protein
D. regulates *lac* operon transcription
E. is the binding site of the cAMP-CRP complex

(8) Which of the following is true regarding RNA processing?
A. spliceosomes are present in organelles and nuclei
B. it involves removal of exons
C. it may be autocatalytic
D. it occurs in prokaryotes
E. none of the above

(9) The genetic code is degenerate because
A. mRNA is rapidly degraded
B. the code is not universal among organisms
C. some amino acids have more than one codon
D. frameshift mutations are tolerated
E. stop codons may have corresponding tRNA molecules

(10) Which of the following mutations is more likely to produce a severe rather than mild phenotypic consequence(s)?
A. synonymous mutations
B. nonsense mutations
C. missense mutations
D. none of the above
E. all of the above

(11) If mature eukaryotic mRNA is hybridized with its corresponding DNA coding strand (heteroduplex analysis) and visualized by electron microscopy, looping strands of nucleic acid are seen. What do these structures represent?
A. lariat structures
B. inverted repeats
C. introns
D. exons
E. overlapping genes

(12) Which of the following is unique to prokaryotes?
A. coupled transcription-translation
B. removal of introns
C. 3' polyadenylation
D. mRNA capping
E. promoter sequences

(13) The presence of a bacteriophage can be visualized on a lawn of *E. coli* cells by the formation of lytic foci called

A. plaques
B. lysates
C. prophages
D. cistrons
E. lysogens

(14) Some XY individuals are phenotypically females. What chromosomal abnormality could account for this?

A. mosaicism
B. dosage compensation
C. a deletion of the portion of the Y chromosome containing the testis-determining factor
D. mitotic segregation
E. fragile X syndrome

(15) In *Drosophila* the recessive alleles for brown and scarlet eyes (of two independent genes) interact so that bw/bw; st/st is white. If a pure-breeding brown is crossed to a pure--breeding scarlet, what proportion of the F_2 will be white?

A. 1/16
B. 1/4
C. 7/16
D. 3/4
E. 13/16

(16) If an individual has 10 gene pairs, how many different gametes can be formed if five of the gene pairs are homozygous and the remaining 5 gene pairs are heterozygous?

A. 42
B. 109
C. 32
D. 1024
E. cannot be determined

(17) How many telomeres are there in a nondividing human liver cell?

A. 1
B. 2
C. 23
D. 46
E. 92

(18) A wild type chromosome can be represented as ABC * DEFGH, and from this a chromosomal aberration arises that can be represented ABC * DEGFH. This is known as (* = centromere)

A. deletion
B. translocation
C. duplication
D. pericentric inversion
E.paracentric inversion

(19) An enhancer is best described as a:

A. specialized DNA sequence that acts to promote expression of specific genes
B. a transcription factor that acts to promote expression of specific genes
C. a binding site for RNA polymerase
D. a protein that binds to RNA polymerase, thereby modulating the rate at which RNA polymerase transcribes a given gene
E. TATA box-containing DNA element

(20) In eukaryotes, translation usually begins:

A. at the first set of three nucleotides adjacent to the methyl guanine cap
B. at the first codon downstream of the methyl guanine cap
C. at the first AUG downstream of the methyl guanine cap
D. at the first AAG downstream of the methyl guanine cap
E. at the first anticodon