MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) DNA methylation may be a significant mode of genetic regulation in eukaryotes. Methylation refers to
   A) altering translational activity especially of highly methylated tRNAs.
   B) altering RNA polymerase activity by methylation.
   C) addition of methyl groups to the cytosine of CG doublets.
   D) changes in DNA-DNA hydrogen binding.
   E) alteration of DNA polymerase activity by addition of methyl groups to glycine residues.

2) When considering the initiation of transcription, one often finds consensus sequences located in
   the region of the DNA where RNA polymerase(s) bind. Which are common consensus
   sequences?
   A) any trinucleotide repeat
   B) CAAT, TATA
   C) GGTT, TTAT
   D) TTTTAAA, GGGGCC
   E) satellite DNAs

3) Which of the following clusters of terms applies when addressing enhancers or silencers as
   elements associated with eukaryotic genetic regulation?
   A) cis-acting, fixed position, fixed orientation
   B) trans- and cis-acting, variable position
   C) cis-acting, variable orientation, variable position
   D) cis-acting, variable position, fixed orientation
   E) trans-acting, fixed position, fixed orientation

4) Transcription in eukaryotes requires which of the following in addition to RNA polymerase?
   A) aminoacyl synthetase
   B) start and stop codons
   C) the protein product of the promoter
   D) ribosomes and tRNA
   E) several transcription factors (TFs)

5) The phenomenon in which RNA molecules in a cell are destroyed if they have a sequence
   complementary to an introduced double-stranded RNA is called
   A) RNA obstruction.
   B) RNA blocking.
   C) RNA interference.
   D) RNA disposal.
   E) RNA targeting.
6) Genomic imprinting, DNA methylation, and histone acetylation are all examples of
   A) translocation.
   B) epigenetic phenomena.
   C) karyotypes.
   D) chromosomal rearrangements.
   E) genetic mutation.

7) An intron is a section of
   A) transfer RNA that binds to the anticodon.
   B) carbohydrate that serves as a signal for RNA transport.
   C) DNA that is removed during DNA processing.
   D) RNA that is removed during RNA processing.
   E) protein that is clipped out post-translationally.

8) A region of chromatin has recently become DNAse I hypersensitive. Which enzyme has been
   activated to cause this change in chromatin structure?
   A) histone deacetylase
   B) phosphatase
   C) histone acetylase
   D) kinase
   E) histone methyltransferase

9) You have identified a mutation in a gene which also seems to decrease transcription of another
   gene 2000 bp away from the mutation site. What regulatory sequence, which may be found
   within another gene, has likely been mutated in this instance?
   A) upstream activator sequence
   B) core promoter
   C) homeodomain motif
   D) enhancer sequence
   E) proximal elements

10) Which of the following mechanisms is (are) used to coordinate the expression of multiple,
    related genes in eukaryotic cells?
    A) The genes are organized into large operons, allowing them to be transcribed as a single
        unit.
    B) A single repressor is able to turn off several related genes.
    C) Environmental signals enter the cell and bind directly to promoters.
    D) Genes are organized into clusters, with local chromatin structures influencing the
        expression of all the genes at once.
    E) The genes share a common intragenic sequence, and allow several activators to turn on
        their transcription, regardless of location.

11) If you were to observe the activity of methylated DNA, you would expect it to
    A) be replicating nearly continuously.
    B) have turned off or slowed down the process of transcription.
    C) induce protein synthesis by not allowing repressors to bind to it.
    D) be unwinding in preparation for protein synthesis.
    E) be very actively transcribed and translated.
12) If you want to affect chromatin packaging, which amino acid could you mutate to affect both histone acetylation and methylation patterns?
   A) asparagine
   B) lysine
   C) arginine
   D) methionine
   E) histidine

13) When CpG islands are unmethylated,
   A) chromatin in the promoter region is open, allowing access by transcription factors and RNA polymerase.
   B) genes downstream of the CpG islands cannot be expressed, because the promoter region is blocked by histones.
   C) chromatin in the enhancer region is closed, so they are unable to bind regulatory proteins to initiate transcription.
   D) chromatin in the promoter region is closed, preventing transcription factors and RNA polymerase from binding.
   E) DNase hypersensitivity in that region of the chromosome is lost.

14) Regulatory regions of a eukaryotic gene all contain which of the following sequences, which act only on one copy of the chromosome?
   A) cis-acting regulatory sequences
   B) zinc fingers
   C) leucine zippers
   D) homeodomains
   E) trans-acting regulatory sequences

15) Two potential devices that eukaryotic cells use to regulate transcription are
   A) DNA methylation and histone amplification.
   B) DNA methylation and histone modification.
   C) DNA amplification and histone methylation.
   D) histone amplification and DNA acetylation.
   E) DNA acetylation and methylation.

16) The relationship between a gene and a messenger RNA is that
   A) mRNAs make proteins, which then code for genes.
   B) messenger RNA is directly responsible for making Okazaki fragments.
   C) genes are made from mRNAs.
   D) all genes are made from mRNAs.
   E) mRNAs are made from genes.

17) It has been recently determined that the gene for Duchenne muscular dystrophy (DMD) is over 2000 kb (kilobases) in length; however, the mRNA produced by this gene is only about 14 kb long. What is a likely cause of this discrepancy?
   A) When the mRNA is produced, it is highly folded and therefore less long.
   B) The introns have been spliced out during mRNA processing.
   C) There are more amino acids coded for by the DNA than the mRNA.
   D) The DNA represents a double-stranded structure, while the RNA is single stranded.
   E) The exons have been spliced out during mRNA processing.
18) Which of the following is a function of a poly-A signal sequence?
   A) It is a sequence that codes for the hydrolysis of the RNA polymerase.
   B) It allows the 3' end of the mRNA to attach to the ribosome.
   C) It codes for a sequence in eukaryotic transcripts that signals enzymatic cleavage ~10–35 nucleotides away.
   D) It adds the poly-A tail to the 3' end of the mRNA.
   E) It adds a 7-methylguanosine cap to the 3' end of the mRNA.

19) Molecular biologists can determine experimentally whether a region of DNA contains closed chromatin or open chromatin by assessing the sensitivity of the region to
   A) histone deacetylase.
   B) RNA polymerase II.
   C) DNase.
   D) nucleosomes.
   E) methyltransferase.

20) During RNAi, what do miRNAs target for destruction?
   A) mRNAs
   B) heterochromatic regions of DNA
   C) ribosomes
   D) CpG islands
   E) histones

21) Select three posttranscriptional modifications often seen in the maturation of mRNA in eukaryotes.
   A) 5'-capping, 3'-poly(A) tail addition, splicing
   B) heteroduplex formation, base modification, capping
   C) 5'-poly(A) tail addition, insertion of introns, capping
   D) removal of exons, insertion of introns, capping
   E) 3'-capping, 5'-poly(A) tail addition, splicing

22) Which of the following experimental procedures is most likely to hasten mRNA degradation in a eukaryotic cell?
   A) methylation of C nucleotides
   B) methylation of histones
   C) removal of one or more exons
   D) removal of the 5' cap
   E) enzymatic shortening of the poly-A tail

23) What is the general position of the consensus sequence called the GC box? What is its sequence?
   A) promoter; GGGCGG
   B) terminator; GGGCGG
   C) terminator; CAAT
   D) attenuator; GGGCGG
   E) promoter; CAAT
24) In eukaryotes there are several different types of RNA polymerase. Which type is involved in transcription of mRNA for a globin protein?
   A) ligase
   B) RNA polymerase III
   C) RNA polymerase I
   D) RNA polymerase II
   E) primase

25) Which of the following two terms relates most closely to split genes?
   A) heteroduplex, homoduplex
   B) introns, exons
   C) transcription, translation
   D) elongation, termination
   E) 5'-cap, 3'-poly-A tail

26) Three posttranscriptional modifications often seen in the maturation of mRNA in eukaryotes occur in which cellular organelle?
   A) cytoplasm
   B) lysosome
   C) nucleus
   D) Golgi
   E) mitochondrion

27) Which region(s) of a gene are not found within the mRNA transcript?
   A) termination region
   B) stop codon
   C) promoter and termination regions
   D) promoter and stop codon
   E) promoter region

28) If one compares the base sequences of related genes from different species, one is likely to find that corresponding ________ are usually conserved, but the sequences of ________ are much less well conserved.
   A) introns; proteins
   B) exons; introns
   C) introns; exons
   D) introns; chaperons
   E) chaperons; exons

29) In humans, the embryonic and fetal forms of hemoglobin have a higher affinity for oxygen than that of adults. This is due to
   A) the attachment of methyl groups to cytosine following birth, which changes the type of hemoglobin produced.
   B) identical genes that generate many copies of the ribosomes needed for fetal globin production.
   C) pseudogenes, which interfere with gene expression in adults.
   D) nonidentical genes that produce different versions of globins during development.
   E) histone proteins changing shape during embryonic development.
30) Galactose is absent, but you find active transcription of the GAL genes. Which protein is likely mutated or absent to allow for constitutive transcription of the GAL genes?  
A) Mig1  B) Gal4  C) Gal10  D) Gal80  E) Gal2

31) Alternative RNA splicing  
A) is due to the presence or absence of particular snRNPs.  
B) increases the rate of transcription.  
C) can allow the production of proteins of different sizes from a single mRNA.  
D) is a mechanism for increasing the rate of transcription.  
E) can allow the production of similar proteins from different RNAs.

32) Nucleoli contain many tandem repeat copies of which genes, transcribed by RNA polymerase I?  
A) mRNA  B) siRNA  C) tRNA  D) rRNA  E) all of the above

33) Which of the following best describes siRNA?  
A) a single-stranded RNA that can, where it has internal complementary base pairs, fold into cloverleaf patterns  
B) a portion of rRNA that allows it to bind to several ribosomal proteins in forming large or small subunits  
C) a short double-stranded RNA, one of whose strands can complement and inactivate a sequence of mRNA  
D) a double-stranded RNA that is formed by cleavage of hairpin loops in a larger precursor  
E) a molecule, known as Dicer, that can degrade other mRNA sequences

34) Which protein binds to the silencer sequence and promotes transcriptional silencing in the presence of glucose?  
A) Gal80  B) Gal4  C) Mig1  D) Gal10  E) Gal2

35) You want to design a drug that prevents transcription of mRNAs but does not affect transcription of other RNAs. What enzyme would you target?  
A) methyl transferase  
B) RNA polymerase I  
C) RNA polymerase III  
D) RNA polymerase II  
E) ribozyme

36) What is a ribozyme?  
A) an enzyme that synthesizes RNA primers during DNA replication  
B) an enzyme that catalyzes the association between the large and small ribosomal subunits  
C) an enzyme that uses RNA as a substrate  
D) an enzyme that synthesizes RNA as part of the transcription process  
E) an RNA with enzymatic activity
37) During DNA replication,
   A) DNA polymerase is blocked by methyl groups, and methylated regions of the genome are therefore left uncopied.
   B) methylation of the DNA is maintained because methylation enzymes act at DNA sites where one strand is already methylated and thus correctly methylates daughter strands after replication.
   C) all methylation of the DNA is lost at the first round of replication.
   D) methylated DNA is copied in the cytoplasm, and unmethylated DNA is copied in the nucleus.
   E) methylation of the DNA is maintained because DNA polymerase directly incorporates methylated nucleotides into the new strand opposite any methylated nucleotides in the template.

38) A cell exhibits specific defects in the alternative intron splicing pathway. Which proteins are likely mutated in this cell?
   A) transmembrane proteins
   B) transcription factors
   C) histone proteins
   D) DNA binding proteins
   E) SR proteins

39) Prader–Willi syndrome is a genetic disorder involving a partial deletion of chromosome 15q on the paternal chromosome. When both copies of a gene (or chromosome) are functional but only one is expressed, this is an example of
   A) chromatin modifications.
   B) histone acetylation.
   C) genomic imprinting.
   D) position effect variegation.
   E) X inactivation.

40) The genetic code is said to be triplet, meaning that
   A) there are three "nonsense" triplets.
   B) there are three bases in mRNA that code for an amino acid.
   C) there are three amino acids per base in mRNA.
   D) there may be three ways in which an amino acid may terminate a chain.
   E) none of the above

41) Which sequences would likely have both a nucleosome-depleted region (NDR) and a poly A/T tract to attract transcriptional activators to a transcription start sequence?
   A) open promoters
   B) enhancers
   C) insulators
   D) chromatin modifiers
   E) closed promoters
Use the following model of a eukaryotic transcript to answer the next few questions.

5' UTR E₁ I₁ E₂ I₂ E₃ I₃ E₄ UTR 3'

42) Suppose that exposure to a chemical mutagen results in a change in the sequence that alters the 5’ end of intron 1 (I₁). What might occur?
   A) loss of E₁
   B) premature stop to the mRNA
   C) inclusion of I₁ in the mRNA
   D) exclusion of E₂
   E) loss of the gene product

43) Which components of the previous molecule will also be found in mRNA in the cytosol?
   A) 5' UTR E₁ E₂ E₃ E₄ UTR 3'
   B) 5' UTR I₁ I₂ I₃ UTR 3'
   C) 5' E₁ E₂ E₃ E₄ 3'
   D) 5' E₁ I₁ E₂ I₂ E₃ I₃ E₄ 3'
   E) 5' I₁ I₂ I₃ 3'

TRUE/FALSE. Write 'T' if the statement is true and 'F' if the statement is false.

44) Alternative RNA processing generates different mRNAs, which can direct the synthesis of different polypeptides.

45) Transcription factors are proteins with at least two functional domains—one that binds to DNA and one that binds to RNA polymerase or to other transcription factors.

46) RNA processing occurs when amino acids are removed from nascent proteins.

47) The CAAT (CAAT box) sequence appears to be critical to the ability of many eukaryotic promoters to facilitate transcription.

48) Transcription factors function to help move ribosomes along the mRNA.

49) Alternative RNA processing can result in different mRNAs that start with different exons.

50) When one speaks of a 5’-cap, one is describing the addition of a base, usually thymine, to the 5’ end of a completed peptide.