

Please choose the most appropriate terms/phrases/statements that complete or answer the questions.

Attention: More than one of the choices provided may be correct.

(2.5 points for each question)

1. Regarding to the genetic material of bacteria and viruses, which statements is/are **CORRECT**?
  - (A) Bacterial transformation provided the first evidence that DNA is the genetic material of bacteria.
  - (B) The discovery of bacterial transformation was from the study of *Streptococcus pneumonia* of which the virulence is determined by its polysaccharide capsule.
  - (C) *Streptococcus pneumonia* without capsule (rough appearance) can kill mice by causing pneumonia.
  - (D) The genetic material of viruses can be DNA or RNA.
  - (E) RNA is the genetic material of some viruses that infect human.
2. Regarding to the structure of DNA, which statements is/are **CORRECT**?
  - (A) In the Watson-Crick model, two polynucleotide chains running in opposite directions, called antiparallel.
  - (B) The two strands of DNA are wound around each other to form a regular A-form double helical structure.
  - (C) Supercoiling can occur only if the DNA has no free ends.
  - (D) Eukaryotic chromatin consists of nucleosome. A nucleosome contains DNA associated with a histone octamer.
  - (E) Nucleosomal DNA is divided into core DNA and linker DNA. The core DNA has length approximately 200 bp.
3. Which statements is/are **CORRECT** in regard to the synthesis and expression of genetic information?
  - (A) DNA acts as the template to synthesize RNA by transcription.
  - (B) RNA can act as the template to synthesize DNA by reverse transcription.
  - (C) Both transcription and reverse transcription are accomplished by RNA polymerase.
  - (D) DNA replication requires DNA polymerase to copy DNA from DNA.
  - (E) Translation uses mRNA to synthesize polypeptide (protein), this process is irreversible.
4. Which statements is/are **CORRECT** in regard to DNA replication in bacteria?
  - (A) Bacterial genome is usually a single circular replicon.
  - (B) DNA replication is conservative.
  - (C) Multi-forked chromosomes are often generated in fast-growing bacterial cells.
  - (D) Multi-forked chromosomes are often generated in slow-growing bacterial cells.
  - (E) Hemi-methylated DNA cannot undergo replication initiation.
5. Which statements is/are **CORRECT** in regard to DNA replication in eukaryotes?
  - (A) A eukaryotic chromosome contains many replicons.
  - (B) All the replicons in a chromosome are simultaneously active.
  - (C) Different DNA polymerases are responsible for the synthesis of leading strand and lagging strand.
  - (D) Linear chromosomal DNA has the problem of incomplete replication at the 5'-end.
  - (E) Cyclin-dependent kinase (CDK) is inactivated in the S phase of cell cycle for replication to occur.
6. Which statements is/are **CORRECT** in regard to telomere?
  - (A) A typical telomere has a simple repeating structure.
  - (B) Telomere length is controlled by the activity of telomerase.
  - (C) Telomerase has RNA polymerase activity to extend the telomere.
  - (D) Telomeres are essential for cell survival.
  - (E) Telomeric protein complex marks the location of telomere for DNA damage repair.

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7. Which statements is/are **CORRECT** in regard to the generation of mRNA in eukaryotes?
- (A) Eukaryotic mRNAs are transcribed by RNA polymerase I.
  - (B) Eukaryotic mRNAs are transcribed by RNA polymerase II.
  - (C) The primary transcript of the gene is a pre-mRNA that requires splicing to generate the mature mRNA.
  - (D) Splicing removes exons and retains introns.
  - (E) The length of a gene is often determined by its exons.
8. Which statements is/are **CORRECT** in regard to transcription?
- (A) In *Escherichia coli*, sigma factor associated with core enzyme to determine a set of promoters where transcription is initiated.
  - (B) In eukaryotes, TATA box is a common component of RNA polymerase II promoters.
  - (C) TATA box may determine the location of the transcription start point.
  - (D) Enhancers are short DNA sequence elements.
  - (E) Enhancers have to be located upstream of a promoter to stimulate the promoter activity.
9. Which statements is/are **CORRECT** in regard to the transcription regulation in eukaryotes?
- (A) Expression of eukaryotic gene is controlled at the transcription initiation that requires the opening of chromatin.
  - (B) Histone acetylation is associated with the activation of gene expression.
  - (C) Histone acetylation is associated with the repression of gene expression.
  - (D) DNA methylation is associated with transcription activation.
  - (E) DNA methylation is associated with inactivation of transcription.
10. Which statements is/are **CORRECT** in regard to ribosome and translation in bacteria?
- (A) Ribosomes contain RNA and protein and are the major translation apparatus.
  - (B) Ribosome has two tRNA-binding sites, A site and P site.
  - (C) Translation and transcription take place in the same compartment in bacteria.
  - (D) Bacterial mRNA has Shine-Dalgarno sequence approximately 10 bases upstream of the AUG initiation codon.
  - (E) Shine-Dalgarno is a polypyrimidine sequence important for translation initiation.
11. Which statements is/are **CORRECT** in regard to translation in eukaryotes?
- (A) Eukaryotic ribosomal subunits contain two major rRNAs, 18S and 28S.
  - (B) Eukaryotic ribosomal subunits contain two major rRNAs, 16S and 23S.
  - (C) Eukaryotic 40S ribosomal subunit binds to the 5' end of mRNA and locates the initiation site by scanning.
  - (D) A cap-binding complex binds to the 5' end of mRNA after the association of 40S subunit with the mRNA.
  - (E) A cap-binding complex binds to the 5' end of mRNA before the association of 40S subunit with the mRNA for translation initiation.
12. Which statements is/are **CORRECT** in regard to the operon of prokaryotes?
- (A) A repressor protein can bind to an operator to prevent a gene from being expressed.
  - (B) Polycistronic mRNA transcribed from an operon contains several coding regions.
  - (C) Polycistronic mRNA encode proteins that usually function in different metabolic pathways.
  - (D) The *lac* repressor acts only on a specific operon.
  - (E) The *trp* repressor can regulate more than one set of genes.
13. Which statements is/are **CORRECT** in regard to the noncoding RNA?
- (A) RNA can function as a regulator to turn off the expression of a target gene.
  - (B) A regulator RNA (such as antisense RNA) may form a duplex with the target RNA to block translation.

- (C) A regulator RNA may interfere with transcription.
- (D) Long noncoding RNA (lncRNA) can also control the overall structure of the eukaryotic nucleus.
- (E) Ribozyme represents a RNA sequence with catalytic enzyme activity.
14. What are involved to facilitate a correct chromosome segregation and proper cell division in prokaryotes?
- (A) Site-specific recombination to recreate monomers if the chromosome is in a dimer form at the end of replication.
- (B) Non-homologous recombination.
- (C) Septum formation.
- (D) Z-ring assembly at mid-cell.
- (E) Low MinE/MinCD ratio.
15. Regarding to genome sequences, which statements is/are **CORRECT**?
- (A) Point mutations include transition and transversion.
- (B) Transition results from the substitution of a purine with a pyrimidine, or vice versa.
- (C) Transversion results from the substitution of a purine with a pyrimidine, or vice versa.
- (D) When alleles of the same locus are compared, difference in a single nucleotide is called a single nucleotide polymorphism (SNP).
- (E) SNPs can be found in patients with a specific disorder.
16. Regarding to DNA repair, which statements is/are **CORRECT**?
- (A) DNA polymerase I is the major repair enzyme of *E. coli*.
- (B) DNA polymerase III is the major repair enzyme of *E. coli*.
- (C) DNA polymerase I participates in DNA replication to remove RNA primer and replace it with DNA.
- (D) Mismatches between the two strands of DNA can be repaired by excision repair system.
- (E) Photo-reactivation is a non-mutagenic repair system that acts specifically on purine dimers.
17. Regarding to recombination, which statements is/are **CORRECT**?
- (A) DNA double-strand breaks may be repaired by homologous recombination.
- (B) DNA double-strand breaks may be repaired by non-homologous end joining.
- (C) Homologous recombination can occur between synapsed chromosomes in meiosis.
- (D) Recombination can recover DNA from replication errors.
- (E) Recombinases catalyze specialized recombination involving specific sites that have a long stretch of sequence homology.
18. Regarding to the techniques used in molecular cloning and gene expression, which statements is/are **CORRECT**?
- (A) Restriction endonucleases that recognize and cut DNA at specific sequences are often used in molecular cloning.
- (B) Plasmids with low copy numbers are often used as cloning vectors.
- (C) Expression vectors contain promoters that allow transcription of the cloned gene.
- (D) Cloned DNA can be introduced into *E. coli* by transformation.
- (E) CRISPR-Cas system is a gene editing technique.
19. Regarding to the techniques used to detect nucleic acids and protein expression, which statements is/are **CORRECT**?
- (A) Quantitative (real-time) polymerase chain reaction (qPCR) allows the detection of an exponentially amplified DNA fragment during synthesis.
- (B) Northern blotting can be used to detect DNA.

- (C) Southern blotting can be used to detect DNA.  
(D) Southern blotting can be used to detect RNA.  
(E) Western blotting can be used to detect protein.
20. Regarding to the techniques used in molecular biology, which statements is/are **CORRECT**?
- (A) Chromatin-immunoprecipitation can be used to detect DNA-protein interactions.  
(B) Chromatin-immunoprecipitation are often used to detect interactions between DNA sequences.  
(C) Chromatin-immunoprecipitation are often used to detect protein-protein interactions.  
(D) Immunoprecipitation is often used to detect protein-protein interactions.  
(E) Transgenic mice can be obtained by injecting recipient blastocysts with embryonic stem cells that carry transfected DNA.
21. Which of the following evidence is indicative of the presence of a gene in an unknown DNA sequence?
- (A) alignment to a partial cDNA sequence  
(B) sequence similarity to genes of other organisms  
(C) open reading frame consistent with the rules for exon and intron sequences  
(D) finding the presence of promoters  
(E) identifying the poly(A) sites
22. Which of the following statement(s) is/are **TRUE** of an eukaryotic chromosome?
- (A) It contains heterochromatin, which is transcriptionally inactive and more susceptible to DNase digestion.  
(B) It consists of a single DNA molecule.  
(C) The centromeric sequences are important for proper chromosome segregation during replication.  
(D) The ends of eukaryotic chromosomes are called telomeres, and contain special repeat sequences, called telomeric sequences.  
(E) Kinetochores assemble at the centrosome.
23. For the DNA replication in *E. coli*, which of the following(s) is/are **CORRECT**?
- (A) The strands become separated during synthesis.  
(B) It synthesizes each strand in the opposite direction (one 5'→3', one 3'→5'), so they can be synthesized at once.  
(C) DNA polymerase I adds nucleotides to the primer strand  
(D) The leading strand is synthesized continuously  
(E) The DNA polymerases in bacteria have similar functions to those found in eukaryotes, but they are not identical.
24. Which property of DNA is/are crucial for the conservation of genetic information?
- (A) the amount of C is the same as the amount of G  
(B) base-pair complementarity  
(C) the ability to form a circular DNA  
(D) semiconservative replication  
(E) antiparallelism
25. Okazaki fragments are
- (A) short DNA pieces that explain how DNA is synthesized on the lagging strand.  
(B) short DNA pieces that are only found in prokaryotes.  
(C) short DNA pieces that are ligated by ligase to form continuous DNA strands.  
(D) the remnants of the original strands that are dispersed in the new double stranded DNA molecules.  
(E) RNA primers used for DNA replication.

26. The ability of DNA to denature is important for which process?
- (A) DNA synthesis
  - (B) Nucleic acid hybridization experiments
  - (C) RNA synthesis
  - (D) PCR reaction
  - (E) DNA separation by agarose gel electrophoresis
27. Which of the following statements is/are **TRUE** about DNA repair and proofreading?
- (A) DNA repair mechanisms usually require an endonuclease to nick the duplex, so the repair enzymes can access to the end of a DNA strand.
  - (B) Since DNA Polymerase II has endonuclease activity, it is able to proofread its product when it is used in DNA repair.
  - (C) The newly synthesized strand of DNA lacks methylated bases and other modifications allow repair enzymes to distinguish in correct bases in DNA
  - (D) The proofreading of DNA is especially good because "the identity of each base pair is checked after the enzyme moves on to the next base pair."
  - (E) Nucleotide excision has an intermediate where in a region of single stranded DNA is temporarily created.
28. Which one of the following statements comparing the human and mouse genomes is/are **FALSE**?
- (A) Human and mouse have about the same number of genes.
  - (B) The human genome shares 99% of its genes with the mouse.
  - (C) A comparison of genomes confirms that mouse and humans shared a common ancestor more recently than humans and pufferfish.
  - (D) Mitochondrial DNA is paternally inherited in both human and mouse.
  - (E) Little rearrangement of genes has occurred in the two genomes.
29. When a segment of DNA duplicates, causing two or more copies of a gene to be present in the chromosome, the most unlikely fate of the duplicate(s) would be
- (A) to lose function in subsequent mutation.
  - (B) to become part of a gene family.
  - (C) to gain a new function in subsequent mutation.
  - (D) to become a pseudogene.
  - (E) to improve function in subsequent mutation.
30. Here are two pieces of DNA, one with an adenine plus thymine content of 40%, and the other with a cytosine plus guanine content of 50%. If both are heated under the same experimental conditions, which of the following statement(s) about  $T_m$  of these DNAs is/are **CORRECT**?
- (A) The DNA with 40% adenine plus thymine will have the higher  $T_m$ .
  - (B) The DNA with 50% adenine plus thymine will have the lower  $T_m$ .
  - (C) The DNA with 50% cytosine plus guanine will have the higher  $T_m$ .
  - (D) Their  $T_m$ 's will be the same.
  - (E) There's no way to predict for this information.
31. A class of mutations that results in multiple contiguous (side-by-side) amino acid changes in proteins is/are probably caused by which the following types of mutations?
- (A) recombinant
  - (B) base analog
  - (C) transversion

- (D) frameshift  
(E) transition
32. Which of the following transcription factors is/are utilized by all three eukaryotic RNA polymerases?  
(A) TFIID  
(B) TBP  
(C) DNA helicase  
(D) THIIIC  
(E) THIIF
33. Which of following statements concerning RNA transcription is/are **TRUE**?  
(A) The DNA strands become separated during synthesis.  
(B) Synthesis of RNA is a very accurate process.  
(C) The template strand is read in the 3' → 5' direction.  
(D) Transcription requires the use of a primer.  
(E) DNA to RNA base pairing includes A to U and G to C.
34. Which of the following statements about prokaryotic transcription is/are **TRUE**?  
(A) The enzyme principally responsible for RNA synthesis in *E. coli* is a multisubunit enzyme.  
(B) The first nucleotide incorporated into the RNA chain retains its 5'-triphosphate.  
(C) The sigma ( $\sigma$ ) subunit stays with the RNA Polymerase throughout synthesis.  
(D) Inverted-repeat sequences in the DNA being transcribed can lead to termination  
(E) The end of the new mRNA molecule in *E. coli* usually terminates in a string of A's.
35. Which of the following statements about the various RNA Polymerases in eukaryotes is/are **FALSE**?  
(A) Permanent RNAs, such as tRNA and rRNA use different RNA Polymerases.  
(B) The different RNA Polymerases share some subunits.  
(C) Eukaryotic RNA Polymerases are generally monomeric.  
(D) The RNA Polymerase for mRNA is designated RNA Pol II.  
(E) Binding of TBP to the DNA is a key step in the activation of mRNA synthesis in eukaryotes.
36. Which of the following statements is/are **FALSE**?  
(A) The majority of protein synthesis occurs in the cytoplasm.  
(B) Stop and his amino acids have unique codons.  
(C) All 64 of the codons code for an amino acid.  
(D) rRNA carries amino acids for the process of translation.  
(E) Wobble allows each codon to interact with more than one tRNA.
37. Which of the following is/are **FALSE** about protein synthesis?  
(A) In bacteria, translation of the mRNA begins during the synthesis of the mRNA.  
(B) A Shine-Dalgarno Sequence is a sequence of nucleotides in an mRNA that functions to terminate translation.  
(C) Protein synthesis in prokaryotes always starts with a methionine residue.  
(D) Eukaryotic ribosomes recognize the Kozak sequence, surrounding the start codon in eukaryotes, to prevent false starts at inappropriate parts of the mRNA.  
(E) Both eukaryotic ribosomes and the protein factors used during the process of eukaryotic translation are very different from those in prokaryotic translation.

38. Which of the following is/are **TRUE** about operons?
- (A) A single operon usually contains all the enzymes which are specific for the synthesis of a special biomolecule.
  - (B) The effector for the Lac repressor protein is  $\beta$ -galactosidase.
  - (C) Cyclic AMP affects transcription by phosphorylating a transcription factor.
  - (D) Regarding regulation of the *trp* operon, the amino acid tryptophan acts as a corepressor.
  - (E) Regarding the lactose utilization system in *E. coli*, a constitutive mutant is one in which the three enzymes are produced regardless of the presence or absence of lactose.
39. Which of the following is/are **TRUE** of miRNA processing?
- (A) Drosha processes primary miRNA transcripts to precursor miRNAs.
  - (B) RISC binds to pre-miRNA in the cytoplasm.
  - (C) RNA helicase is necessary for unwinding the miRNA duplex.
  - (D) Dicer completes the processing by cleaving the single-stranded form of the miRNA.
  - (E) Precursor miRNAs are approximately 60-70 nucleotides long.
40. Which of the following is/are a common nucleosomal protein covalent modification that affects gene expression?
- (A) Phosphorylation
  - (B) Acetylation
  - (C) Glycosylation
  - (D) Methylation
  - (E) Polyadenylation

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