

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. What is Shine-Dalgarno sequence?
 - (A) A ribosomal binding site in eukaryotic RNA
 - (B) A ribosomal binding site in bacterial and archaeal RNA
 - (C) A ribosomal binding site in eukaryotic DNA
 - (D) A ribosomal binding site in bacterial and archaeal DNA
 - (E) A transcription regulator binding site in eukaryotic DNA
2. Which physical or chemical factor can cause DNA mutation?
 - (A) Heat
 - (B) Cold
 - (C) Ultra-violet light
 - (D) Ethidium bromide
 - (E) Nitrous acid
3. Which restriction enzyme will generate blunt end after reaction? (* marks the cutting site)
 - (A) XmaI (C*CCGGG)
 - (B) FseI (GGCCGG*CC)
 - (C) EcoRI (G*AATTC)
 - (D) SmaI (CCC*GGG)
 - (E) EcoRV (GAT*ATC)
4. Which material is necessary for Polymerase Chain Reaction when you want to amplify a DNA sequence?
 - (A) Primers
 - (B) Oligo dT
 - (C) DNA polymerase
 - (D) dNTP
 - (E) DNA template
5. If adenosine makes up 27% of the bases in a DNA helix, what statement is (are) **CORRECT**?
 - (A) It should have 27% cytosine
 - (B) It should have 27% guanine
 - (C) It should have 27% thymine
 - (D) It should have 23% guanine
 - (E) It should have 23% thymine
6. Which type of mutation changes a codon to indicate a different amino acid during protein synthesis?
 - (A) Missense mutation
 - (B) Nonsense mutation
 - (C) Frameshift mutation
 - (D) Silent mutation
 - (E) Duplicate mutation
7. What is organelle?
 - (A) A group of cells with similar structure and function
 - (B) A chain of 20 amino acids jointed by peptide bonds

見背面

- (C) A helix-shape molecule carrying genetic information
(D) A constricted region of a chromosome that separates it into a short arm (p) and a long arm
(E) A small compartment inside the cell with a specific function.
8. Which of following structures is found in bacteria?
(A) Chromosome
(B) Nucleus
(C) Golgi apparatus
(D) Ribosome
(E) Endoplasmic reticulum
9. The process of transferring genetic information from DNA to RNA is called _____.
(A) Replication
(B) Transcription
(C) Reverse transcription
(D) Translation
(E) Substitution
10. Which type of molecular bond holds the DNA double helix together?
(A) Hydrogen bond
(B) Peptide bond
(C) Phosphodiester bond
(D) Ionic bond
(E) $\pi - \pi$ interaction
11. Identify the correct order of organization of genetic material, from largest to smallest.
(A) Genome, chromosome, gene, nucleotide
(B) Gene, chromosome, nucleotide, genome
(C) Chromosome, gene, genome, nucleotide
(D) Chromosome, gene, transcript, nucleotide
(E) Genome, nucleotide, gene, chromosome
12. Which of the following statements is (are) **TURE**?
(A) Hydrogen bonds can form between bases in a single RNA molecule
(B) Phosphodiester bonds link bases together in DNA molecules
(C) tRNA transfers proteins to the cell membrane
(D) The central dogma states that the DNA molecule is the most important nucleic acid.
(E) cRNA is the copy created when DNA is transcribed to RNA.
13. The replication of DNA is a complex process; all of the following statements are correct, **EXCEPT**?
(A) DNA replication is considered to be a semiconservative process.
(B) DNA replication occurs during telophase in mitosis
(C) There is one replication fork in one replication bubble.
(D) On the lagging strand, one RNA primer is required for the beginning of every Okazaki fragment.
(E) In order to complete replication, the replication bubbles grow and merge together.
14. Which statements about amino acid is(are) **NOT TURE**?
(A) The essential amino acids mean that they cannot be made by the body.
(B) There are 10 essential amino acids for human body.

- (C) Amino acids are used as a source of energy by the body and building block of proteins.
(D) Amino acids are inorganic compounds that contain both amino and carboxylic acid functional groups.
(E) All chiral proteogenic amino acids have the D configuration.
15. Which of the following macromolecule that has catalytic activity in the biological system?
(A) DNA
(B) RNA
(C) Protein
(D) Lipid
(E) Carbohydrate
16. Which experiments can be used to evaluate the RNA expression level?
(A) Southern blotting
(B) Northern blotting
(C) Western blotting
(D) Reverse transcription polymerase chain reaction (RT-PCR)
(E) High-throughput sequencing of messenger RNA (RNA-seq)
17. Which of the following occurs in prokaryotic cells but not in eukaryotic cells?
(A) DNA transcription
(B) Post-transcriptional splicing
(C) TATA box prompting gene expression
(D) Concurrent transcription and translation
(E) Operon system
18. Regarding to the DNA and protein denaturation, which statement is (are) **CORRECT**?
(A) All of them are reversible
(B) Both can be denatured by heat
(C) Heat is the only way to denature them
(D) Denaturing them makes the conformation change
(E) Denaturing them makes the composition change
19. Which of the following statement about CRIPSR-Cas9 is(are) **NOT TURE**?
(A) A unique technology enables to edit gene by removing, adding or altering sections of the DNA sequence
(B) A naturally occurred system in yeast
(C) A guide RNA is needed.
(D) Though it is extremely efficient, it is not site-specific gene editing.
(E) Its discovery makes Emmanuelle Charpentier and Jennifer Doudna are awarded the 2020 Nobel Prize in Chemistry.
20. Who developed the effective mRNA vaccine against COVID-19 and earned 2023 Nobel Prize?
(A) Barbara McClintock
(B) Drew Weissman
(C) Victor Ambros
(D) Katalin Karikó
(E) David Baker
21. Which of the following descriptions of RNA is (are) **CORRECT**?
(A) The major RNA species in a cell are ribosomal RNA (rRNA) and transfer RNA (tRNA).

見背面

- (B) The poly(A) tail is a characteristic feature of coding RNAs; all noncoding RNAs lack a poly(A) tail.
- (C) Charged tRNAs are essential for protein synthesis. Although there are more than 40 different tRNA sequences in the cell, they all fold into the same general shape.
- (D) RNA can fold into various structures, allowing some RNAs to perform enzymatic functions.
- (E) Ribosomal RNA (rRNA) is the major component of ribosomes.
22. The 2020 Nobel Prize in Chemistry was awarded for the discovery of CRISPR. Which of the following descriptions of CRISPR is (are) **CORRECT**?
- (A) CRISPR is a bacterial immune system used to defend against bacteriophages.
- (B) The targeted DNA cleavage of CRISPR systems from different bacteria involves one RNA and one Cas protein.
- (C) The major breakthrough in CRISPR research was its efficient targeted DNA cleavage at any given position, provided a PAM sequence is present.
- (D) CRISPR can only be used for targeted DNA cleavage.
- (E) The CRISPR system in bacteria recognizes bacteriophages by incorporating parts of their DNA sequences into the bacterial genome.
23. For the following statements related to epigenetics, which is (are) **CORRECT**?
- (A) Both DNA and histone methylation are considered epigenetic modifications.
- (B) Decreased target gene expression via DNA methylation is due to the target DNA breakage.
- (C) Histone acetylation generally results in degradation of histones.
- (D) The function of non-coding RNAs (ncRNAs) in epigenetics is to directly alter DNA sequences.
- (E) Histone methylation can result in either target gene activation or silencing, depending on the specific methylation site on the histone.
24. Which of the following descriptions regarding proteins is (are) **CORRECT**?
- (A) Proteins are made up of amino acids.
- (B) Due to the polar and nonpolar properties of amino acid side chains, both hydrophilic and hydrophobic patches can form within a single protein.
- (C) Alpha-helix and beta-sheet are secondary structures of a protein; in addition to peptide bonds, covalent linkages are required to form both alpha-helices and beta-sheets.
- (D) The majority of enzymes are proteins.
- (E) Due to differences in the properties of amino acids, proteins can be positively or negatively charged.
25. This year's Nobel Prize in Physiology or Medicine was awarded for the discovery of microRNAs. Which of the following descriptions about microRNAs is (are) **CORRECT**?
- (A) MicroRNAs were first discovered in human cells.
- (B) The sequences of microRNAs are encoded in the genome.
- (C) MicroRNAs are important for modulating the RNA population in a cell; however, they are not required during embryonic development.
- (D) The amount of microRNAs in the cell can be regulated by circular RNAs, known as microRNA sponges.
- (E) The essential cytoplasmic ribonuclease for microRNA maturation is Drosha.
26. Which of the following descriptions is (are) **CORRECT**?
- (A) Since the bases are mostly the same between DNA and RNA, the melting temperature (T_m) value is identical for DNA-DNA and RNA-RNA hybrids if the sequences are identical.
- (B) The transcription start site in eukaryotic cells is identical to the translation start site.
- (C) A single transcript encoding multiple coding sequences is observed only in prokaryotes.

- (D) RNA polymerase II is the only RNA polymerase used for eukaryotic mRNA biogenesis.
(E) There are two RNA polymerases in eukaryotes: one for coding genes and another for noncoding genes.
27. Which of the following descriptions regarding transcription is (are) **CORRECT**?
- (A) The TATA box sequence is present in the promoter region in eukaryotes and is important for transcription initiation.
(B) The phosphorylation status of the CTD (C-terminal domain) of RNA polymerase II distinguishes the stages of transcription, including initiation, elongation, and termination.
(C) Most eukaryotic coding genes end with a poly(A) sequence in their genomic DNA.
(D) At the end of eukaryotic RNA polymerase II transcription, a ribonuclease cleaves the newly synthesized RNA downstream of the polyadenylation signal, initiating RNA processing and transcription termination.
(E) The mRNA 5' methylated cap is 7-methylguanylate linked to the first nucleotide of the RNA via a regular phosphodiester bond as in other regions of the RNA backbone.
28. Which of the following descriptions is (are) **CORRECT**?
- (A) The phosphodiester bonds are identical between DNA and RNA.
(B) RNA is less stable than DNA because it uses uracil (U) instead of thymine (T).
(C) Pyrimidines in DNA refer to adenosine (A) and guanine (G).
(D) Cytosine (C) and guanine (G) form three hydrogen bonds in double-stranded DNA.
(E) For the DNA sequence 5'-CGATTATACC-3', the complementary DNA sequence is 5'-GCTAATATGG-3'.
29. Which of the following statements regarding DNA is (are) **CORRECT**?
- (A) DNA replication in cells uses the original double-stranded DNA (dsDNA) as a template. Regardless of direction, the choice of which strand is used as the template for leading strand or Okazaki fragment synthesis is by chance.
(B) The dsDNA duplex adopts the B-form structure, which features two different sizes of grooves known as the major and minor grooves.
(C) Due to hydrogen bonds formed between base pairs, the DNA double helix is flexible along its long axis, allowing it to bend when complexed with DNA-binding proteins.
(D) In *E. coli*, the structure of dsDNA is supercoiled.
(E) DNA concentration is commonly measured by absorbance at 260 nm, as the absorbance value reflects the amount of phosphodiester bonds.
30. For the following post-translational modification statements, which is (are) **CORRECT**?
- (A) Ubiquitin modifies proteins at their arginine residues.
(B) There are several specific types of ubiquitin linkages; among them, the linkage at the 48th position (K48) for polyubiquitination is a well-known protein degradation signal.
(C) Phosphorylation on proteins is found on three amino acid residues: serine, threonine, and tyrosine.
(D) Lysine often serves as a phosphomimic residue to mimic a constitutive phosphorylation condition.
(E) Ubiquitination requires three enzymes—E1, E2, and E3—to achieve.
31. Regarding to interaction between atoms, which of the following is (are) **covalent interaction**?
- (A) Hydrogen bond
(B) Disulfide bond
(C) Van der Waals interaction
(D) Ionic bond
(E) Salt bridge

32. Protein function is dependent on protein structure. Methods that are commonly used to investigate the three-dimensional models of proteins are:
- (A) Mass Spectrometry
 - (B) X-ray Crystallography
 - (C) Nuclear Magnetic Resonance (NMR) Spectroscopy
 - (D) Cryoelectron Microscopy
 - (E) Next Generation Sequence
33. Regarding to biomembranes which statement is (are) **CORRECT**?
- (A) Biomembranes in eukaryotes contain three principal classes of lipids: phosphoglycerides, sphingolipids, and sterols.
 - (B) Most lipids and many proteins are laterally mobile in biomembranes.
 - (C) Lipids frequently undergo flip-flop movement within lipid bilayers.
 - (D) Lipid composition influences the physical properties of membranes.
 - (E) Cholesterol and sphingolipids cluster with specific proteins in membrane microdomains.
34. Regarding to epigenetics which statement is (are) **CORRECT**?
- (A) Epigenetics refers to the study of inherited changes in the phenotype of a cell that results from changes in DNA sequence.
 - (B) Epigenetic changes could be due to the consequences of the expression of master transcription factors.
 - (C) Epigenetic changes could be due to the consequences of the expression of post-translational modification of histones.
 - (D) Epigenetic changes could be due to the consequences of the expression of repressive complexes composed of long noncoding RNAs.
 - (E) Both X-chromosome inactivation and heterochromatin repression belong to epigenetic regulation.
35. Regarding to RNA processing which statement is (are) **CORRECT**?
- (A) Transcription and processing of pre-rRNA occur in the nucleolus by RNA polymerase I.
 - (B) Pre-tRNAs are synthesized by RNA polymerase III in the nucleoplasm and undergo extensive modification in the nucleus.
 - (C) Nuclear bodies are functionally specialized regions in the nucleus where interacting proteins form self-organized structures, responsible for assembly of ribonucleoprotein (RNP) complexes.
 - (D) mRNAs never occur as free RNA molecules in the cell, but are always associated with proteins as RNP complexes.
 - (E) Different mRNAs may be expressed from the same gene in different cell types or at different developmental stages because of alternative splicing of primary transcripts, the use of alternative promoters, and cleavage at different poly(A) sites.
36. Regarding to ion channels and membrane potential which statement is (are) **CORRECT**?
- (A) Most biomolecules cannot diffuse across pure phospholipid bilayer; however, cellular membranes facilitate the traffic of molecules and ions into and out of cells and their organelles through transport proteins.
 - (B) Three classes of transmembrane proteins mediate transport of ions, sugars, amino acids, and other metabolites across membranes: channels, transporters, and ATP-powered pumps.
 - (C) An inside-negative electric potential of about 60 mV exists across the plasma membrane of all cells.
 - (D) In plants and fungi, the membrane potential is maintained by the ATP-driven pumping of protons from the cytosol to the exterior of the cell.

- (E) The resting membrane potential in animal cells is the results of the combined action of the ATP-powered Ca^{2+} pump and Na^+ channel.

37.Regarding to cellular energetics which statement is (are) **CORRECT**?

- (A) Cells convert external sources of energy, sunlight or chemical nutrients, into a biologically universal intracellular chemical energy carrier, adenosine triphosphate (ATP), through aerobic oxidation or photosynthesis.
- (B) In the process of aerobic oxidation, cells convert the energy released by the oxidation of glucose or fatty acids into ATP, which is regulated by the demands of cells.
- (C) Most eukaryotes can generate a small amount of ATP when oxygen is scarce, a process called fermentation.
- (D) In most eukaryotic cells, oxidation of very long-chain fatty acids occurs in mitochondria with production of ATP.
- (E) Reactive oxygen species (ROS) are toxic by-products of glycolysis that can modify and damage proteins, DNAs and lipids.

38.Regarding to eukaryotic cell cycle which statement is (are) **CORRECT**?

- (A) The molecular events promoting entry into the cell cycle are conserved across species, and are regulated by extracellular signals such as nutritional states and the presence of mitogens.
- (B) Activation of mitotic CDKs (cyclin-dependent kinases) initiates mitosis via promoting nuclear envelope and mitotic spindle formation.
- (C) Mitotic CDKs inactivation triggers exit from mitosis.
- (D) Cytokinesis must be coordinated with the site of nuclear division, which is particularly important in cells undergoing asymmetric division.
- (E) There is a surveillance mechanism in cell cycle regulation consist of sensors that monitor a particular cellular event, a signaling pathway, and an effector that halts cell cycle progression and activates repair system when needed.

39.Which of the following is correct regarding to telomeres?

- (A) Serving as an attachment site for the proteins of the kinetochore.
- (B) They are sequences at the ends of the linear eukaryotic chromosome that protect the ends from proteases.
- (C) They are sequences of the eukaryotic chromosome that ensure proper distribution during mitosis.
- (D) In most eukaryotes, telomeres are protected from shortening by a protein-RNA complex called telomere terminal transferase.
- (E) Any eukaryotic chromosome must contain three functional elements in order to replicate and segregate correctly: replication origins, centromere, and the telomeres.

40.mRNA stability modulates the dynamics of the mRNA population in the cell. Which of the following descriptions is (are) **CORRECT**?

- (A) The most common mRNA decay pathways are initiated by either deadenylation or decapping.
- (B) Both RNA interference (RNAi) and microRNAs (miRNAs) decrease the stability of their targeted mRNAs.
- (C) Since transcripts are formed prior to translation, mutations that change the stop codon position do not affect mRNA stability.
- (D) MicroRNAs are known to affect only the stability of their targeted mRNAs without impacting translation efficiency.
- (E) MicroRNAs recognize their target mRNAs by fully base-pairing to their target sequences.