**Please choose the most appropriate terms/phrases/statements that complete or answer the questions. Attention: <u>More than one</u> of the choices provided may be correct. (2.5 points for each question)**

1. Which of the following statements regarding "Cell Cycle" are CORRECT?
   (A) Cyclin D/Cdk4 functions during M phase
   (B) Cyclins are destructed by proteasomes
   (C) Kinetochores assemble at the telomere
   (D) Separase, a cysteine protease, initiates sister chromatid segregation at anaphase by cleaving APC
   (E) Cyclin A/Cdk2 activity can be inhibited by $p21^{CIP}$

2. Which of the following statements regarding "Cancer Genetics" are CORRECT?
   (A) Hereditary tumors usually possess loss-of-heterozygosity in proto-oncogenes
   (B) All the cells in a female tumor have the same inactive X chromosome, which is because that all the tumor cells are derived from a single progenitor cell
   (C) A gain of function mutation in Rb will bypass the restriction point controls
   (D) Micro-RNAs are a new class of oncogenic factors because they function to induce errors during DNA replication
   (E) Some viruses can via integrating into the human genome to activate the cellular proto-oncogenes and contribute to tumor formation.

3. Which of the following statements regarding "Stem Cells" are CORRECT?
   (A) The Dolly sheep was cloned using somatic cell nuclear transfer
   (B) Myeloid stem cells are in the cell lineage which can give rise to T cells
   (C) The stem cells can be induced to divide asymmetrically in responsive to the external cue from the niche
   (D) Stem cells are only found in the embryonic tissues but not in the adult tissues
   (E) The differentiated mouse fibroblasts can be reprogrammed to pluripotent stem cells when transfected with vectors expressing *KLF4, OCT4, and TERT*

4. Which of the following statements "Biochemical Interaction" are CORRECT?
   (A) Ionic bond is stronger than the Van der Waals interaction
   (B) Glutamine is a negatively charged amino acid
   (C) The sulfhydryl group in two adjacent cysteine can oxidize to form a covalent disulfide bond
   (D) The less of $K_d$ (the dissociation constant) indicates a weaker binding affinity between two molecules
   (E) Three hydrogen bonds form between T and A in a Watson-Crick base pair interactions

5. Which of the following are enzyme pairs that catalyze opposite reactions?
   (A) JAK kinases and STATs
   (B) PI-3 kinase and PTEN phosphatase
   (C) NF-κB and I-κB
   (D) MEK and MAP kinase
   (E) Insulin receptor and PTP1B

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6. Which of the following statements regarding "Immunoglobulins" are CORRECT?
   (A) IgM is a pentamer, which is involved in early primary immune response
   (B) Class switch recombination generates antibodies with different light-chain constant regions
   (C) Anti-PD-1 antibody has been developed with potential to restore the latent anti-tumor immunity for several types of tumors
   (D) Monoclonal antibodies are produced by fusing mouse spleen cells with primary B cells
   (E) IgG can cross placenta and provide passive immunity to new born

7. Which of the following statements regarding "Cytoskeleton" are CORRECT?
   (A) Membrane extension during cell locomotion is driven by actin polymerization
   (B) The plasma membrane of eukaryotic cells is mainly supported by microtubules
   (C) Chromosome movement during cell division is regulated by microfilaments
   (D) Cilia and flagella of eukaryotic cells are made up of tubulin
   (E) The drug colchicine acts to stabilize microtubule against depolymerization

8. Which of the following statements regarding "DNA/RNA Synthesis" are CORRECT?
   (A) UAG is one of the target codons to be recognized by elongation factors
   (B) DNA replication begins at sequences called initiators
   (C) The RNA cap structure are removed from mRNAs during processing
   (D) The base in the wobble position of a codon is the 3′ (third) base
   (E) The RNA primer is removed from the Okazaki fragment by DNA Pol I

9. Which of the following methods can separate proteins based on their mass?
   (A) SDS polyacrylamide gel electrophoresis
   (B) Isoelectric focusing electrophoresis
   (C) Ion exchange chromatography
   (D) Gel filtration chromatography
   (E) Centrifugation

10. Which of the following statements regarding "Signaling Pathways" are CORRECT?
   (A) Most genes regulated by PKA contain a cis-acting DNA sequence that binds to the phosphorylated CREB
   (B) Phosphorylation of β-catenin by GSK3 kinase can increase the β-catenin protein level and stimulate the Wnt pathway activity
   (C) Protein kinase B is activated at the plasma membrane, by the activating kinase PDK1
   (D) Ras is a guanine nucleotide exchange factor, which is inactive when bound with GDP
   (E) The nuclear hormone receptor can be activated by binding with the lipid soluble hormone, and then move from cytosol to nucleus for transcription

11. Which of the following statements regarding "Cell and Matrix Interaction" are CORRECT?
   (A) Integrins are heterodimers composed of α and β subunits, which is expressed in a cell-specific manner and binds to the tripeptide sequence of Arg-Gly-Asp
   (B) EDTA can induce the dissociation of cadherin cell-cell interactions by chelating the $Ca^{2+}$
   (C) The desmosomes contain integrins and associate with actin filaments on the

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cytoplasmic side

(D) The gap junctions are protein lined channels connecting the cytoplasms of adjacent cells, which allow passage of ions and small molecules between the cells

(E) Polymerization of collagen into large collagen fibers occurs in the endoplasmic reticulum

12. Which of the following statements regarding "Organelles" are CORRECT?

(A) The smooth endoplasmic reticulum synthesizes the phospholipids that form the plasma membrane

(B) The pH of lysosomes is higher than that of the cytosol because of the action of $H^+$ and $Cl^-$ transport proteins in the lysosomal membrane

(C) The presence of clathrin mediates vesicular transport from ER to *cis*-Golgi

(D) A double-membraned vesicle known as autophagosome can fuse with lysosome and the contents are degraded and recycled

(E) Nucleolus is the site of ribosomal subunit synthesis

13. What method can be used to functionally inactivate a gene without changing its sequence?

(A) RNA interference

(B) Gene knockout

(C) Dominant negative mutation

(D) Site directed mutagenesis

(E) CRISPR/Cas9 editing

14. Which of the following statements regarding "Molecular Technology" are CORRECT?

(A) A double-stranded piece of DNA containing the sequence GGCACGGCTCACTACGC has a higher Tm than one containing the sequence TAGATGGTAACGAACTA

(B) Northern blotting is used to detect a specific point mutation in a RNA molecule

(C) 5' GAGTTC 3' is a typical recognition sequence for a restriction enzyme

(D) Actinomycin D is an inhibitor for transcription

(E) A catalase monoclonal antibody and scanning electron microscopy can help localize catalase in peroxisomes

15. Which of the following statements regarding "Genetic Mapping" are CORRECT?

(A) Crossing of a homozygous wild type with a mutant that is heterozygous for a dominant mutation will result in $F_1$ progeny of which three-fourths show the mutant phenotype

(B) A genetic change from GAA to GAT in the noncoding region is an example of single nucleotide polymorphism (SNP)

(C) Microsatellite DNA consists of a repeat length of 1–13 base pairs, which only occur in the noncoding region but not within the transcription units

(D) A haplotype is a set of closely linked genetic markers on a particular chromosome that tend to be inherited together

(E) In linkage analysis, when the recombination frequency between the gene of interest and a marker is very high, then the gene is likely located near of that marker

16. Which of the following statements regarding "Genome Structure" are CORRECT?

(A) DNA that is transcriptionally active contains unacetylated histones, and is more

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susceptible to DNase I digestion
(B) Heterochromatin stains more darkly with DNA dyes than does euchromatin and is usually transcriptionally inactive
(C) Most of mitochondrial DNA is maternally inherited, which contains exons and introns
(D) Fly β-tubulin and human β-tubulin proteins are considered to be paralogs
(E) Telomeres consist of repetitive sequences with high G content

17. Which of the following statements regarding "Transcription Control" are CORRECT?
(A) An enhancer binds to RNA polymerase and stimulates transcription
(B) The TATA box acts to position RNA polymerase II for transcription initiation, is present in all eukaryotic genes
(C) CpG islands at the promoter usually serve as a control region for genes transcribed at relatively low rates
(D) RNA editing is post-transcriptional alteration of sequences in mRNAs
(E) snRNA (small nuclear RNA) functions in the removal of introns from pre-RNAs

18. What method can be used to identify DNA-protein interactions?
(A) Electrophoretic mobility shift assay (EMSA)
(B) Nuclear run on analysis
(C) DNase I footprinting
(D) Pulse field gel electrophoresis
(E) Chromatin Immunoprecipitation (ChIP)

19. Which of the following statements regarding "Biomembrane" are CORRECT?
(A) The two leaflets of a biomembrane may contain different phospholipids
(B) Phospholipids are the major biomolecule responsible for selective uptake of materials across plasma membrane
(C) Phospholipids with short or unsaturated fatty acyl chains decrease membrane fluidity
(D) The major ATP-powered pump responsible for maintaining ion gradients across the plasma membrane of mammalian cells is the plasma-membrane $Na^+/K^+$ ATPase
(E) In cell membrane, carbohydrates in glycoproteins or glycolipids are oriented towards inside

20. Which of the following statements regarding "Carbohydrate Metabolism" are CORRECT?
(A) Gluconeogenesis is activated by insulin and helps to reduce blood glucose after a carbohydrate-rich meal
(B) The Warburg effect is the observation that most cancer cells predominantly produce energy by a high rate of glycolysis followed by lactic acid fermentation in the cytosol
(C) Pyruvate is the major carbon-containing compound produced by glycolysis
(D) A high ratio of insulin to glucagon occurs during fasting state can promote the synthesis of glycogen
(E) Glucose enters muscle cells mostly by simple diffusion

21. The sigma factor (σ) of procaryotic RNA polymerase is part of the core enzyme. Which of the following statement is NOT TRUE for sigma factor.
(A) it is associated with the core enzyme during transcription.

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(B) it is inhibited by -amanitin
(C) it is required for transcription initiation
(D) it is dispensable for RNA polymerization reaction
(E) it is a component of RNA polymerase holoenzyme

22. Which of the following factor is involved in termination of mRNA transcription in prokaryotes.
(A) σ factor
(B) ρ factor
(C) β subunit
(D) α subunit
(E) ATP.

23. The initiation complex of eukaryotic mRNA transcription usually forms at the position relative to the start site (+1) around
(A) -200
(B) +100
(C) +30
(D) -30
(E) -1

24. IPTG-induction of β-galactosidase activity is the result of
(A) stimulation of Lac repressor function
(B) IPTG binding to the *lac* operon and inducing transcription.
(C) IPTG binding to the *lac*I gene product and inhibiting its activity.
(D) inhibition of β-galactosidase degradation.
(E) IPTG stimulates enzymatic function of β-galactosidase

25. E. coli does not express β-galactosidase when its growth medium containing both lactose and glucose, because
(A) CAP is not activated for DNA binding to promote transcription initiation.
(B) Glucose activates the expression of lac repressor.
(C) Lac repressor can still bind to the *lac* operator sequence.
(D) Glucose interferes with lactose binding with the *lac* repressor.
(E) Glucose inhibits lac operon

26. Which of the following factors is essential for mRNA maturation in eukaryotes
(A) 5'Capping complex
(B) polyA addition to 3' tail
(C) Splicesome
(D) TATA-box binding protein
(E) Carboxyl-terminal domain of pol II largest subunit

27. Which of following double-strand DNA sequences has highest melting temperature?
(A) gga tta cct agc
(B) ggc tta cct agc

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(C) ggc cta cct agc
(D) ggc cca cct agc
(E) ggc ccc cct agc

28. In Watson-Crick model of double-helical DNA, how many bases form one turn of helix?
(A) 8
(B) 9
(C) 10
(D) 14
(E) 16

29. Exonuclease activity is important for DNA polymerase function because
(A) It randomly removes the newly incorporated nucleotide.
(B) It removes oxidized base.
(C) It removes mismatched nucleotide in the exonuclease site for proofreading.
(D) It removes primers present in the lagging strand during DNA replication
(E) It increases DNA polymerization reaction

30. Which of the following RNA has the highest percentage of modified bases
(A) mRNA
(B) HnRNA
(C) rRNA
(D) tRNA
(E) Micro-RNA

31. Which of following bonds do not belong to covalent bonds:
(A) disulfide bond.
(B) hydrogen bond.
(C) phosphodiester bond.
(D) peptide bond
(E) van der Waals

32. Which of following statement(s) for nucleic acid is/are True:
(A) C, T are Purines
(B) There are two hydrogen bonds between CG pairing
(C) During the process of free nucleotides becoming RNA, every single nucleotide added, two phosphate groups are released.
(D) The higher the GC content, the lower the Tm value is.
(E) RNA at neutral pH buffer (pH=7) has no charge

33. Which of the following statements about RNA are True:
(A) There are primary, secondary and tertiary structure in RNA
(B) The difference between the basic unit of DNA and RNA are at 3' hydrogen atom in the ribose ring
(C) RNA can function as an enzyme
(D) Majority of RNAs in the cell are coded for protein sequence.

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(E) RNA is a highly negatively charged molecule at a neutral pH environment

34. Which of following statements are TRUE:
(A) Structure of nucleotides are composed of five-member ring sugar, base and phosphate group.
(B) Amino acids are composed of amino group, carboxyl group and side chains
(C) The bond which connects two amino acids together is called peptide bond
(D) The bond which connects two nucleotides together is called glycosidic bond
(E) The 1st amino acid is usually named as the 5' most amino acid

35. CRISPR is a famous genome-editing tool. Which of following statements are TRUE:
(A) CRISPR is discovered as a bacterial immune system
(B) There is only one type of CRISPR
(C) Two major components that introduced into mammalian cell for genome editing are cas-9 protein and guide DNA
(D) Creating gene deletion using CRISPR rely on the mistake of DNA repairing system in the host cell
(E) The recognition sequence for the cas-9 system are three nucleotide PAM sequence

36. Which of the following statements are True:
(A) tRNA are transcribed by RNA polymerase I
(B) Pre r-RNA are transcribed by RNA polymerase II
(C) mRNA are transcribed by RNA polymerase II
(D) long noncoding RNA are transcribed by RNA polymerase II
(E) microRNA precursors are transcribed by RNA polymerase II

37. Which of the following statements for mRNA are True:
(A) Prior to 5' mRNA capping, there are three phosphate at 5' end of mRNA
(B) Cap structure is critical for protein translation initiation.
(C) Poly(A) tail of the mRNA is encoded in the DNA sequence
(D) Maturation of intron containing pre-mRNA requires splicing process
(E) RNA splicing is one of the first discovered enzymatic reaction that can be catalyzed by Ribozyme.

38. For the statements of various biological processes in different cell compartments, which statements are TRUE
(A) Nucleolus is located in the nucleus
(B) rRNA are accumulated in the nucleolus
(C) RNA synthesis takes place in the cytoplasm
(D) DNA replication takes place in nucleolus
(E) Mitochondria has its own DNA

39. Which of the following statements for RNA interference are TRUE:
(A) RNA interference is a prototype of immune system in lower eukaryotes
(B) Argonaute protein is the enzyme cleaves target RNA
(C) microRNA and RNA interference adopt very similar mechanism in generating the

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small RNA

(D) Long double strand RNA can initiate RNA interference in any organism

(E) One of the nature function of RNA interference in mammals are virus clearance

40. Which of following statements are TRUE:

(A) Hydrophobic means it is water-like

(B) Nucleic acid dissolved in water is because it is a negatively charged molecule.

(C) Sodium acetate solution can not neutralize the charge of nucleic acid

(D) The principle of ethanol precipitation is based on nucleic acid is not able to dissolved in ethanol

(E) Glycogen can be precipitated with nucleic acid during ethanol precipitation

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