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 behaviors is/are **NOT** allowed in biological laboratory?
   (A) Keeping foods in lab's refrigerator
   (B) Wearing lab coats to perform experiments
   (C) Wearing experimental gloves to pick up the phone
   (D) Drinking and eating in the lab
   (E) Throwing away the experimental gloves in general trash can

2. Which of the following diseases is/are related to immune responses?
   (A) Allergy
   (B) Prion disease.
   (C) Psoriasis
   (D) *Rheumatoid arthritis*
   (E) Graft versus host diseases

3. Which of the following organs is/are **NOT** lymphoid organs?
   (A) Tonsil
   (B) Brain
   (C) Thymus
   (D) Spleen
   (E) Liver

4. Which of the following techniques is/are using monoclonal antibodies?
   (A) Northern blotting
   (B) High performance liquid chromatography
   (C) Quantitative real time polymerase chain reaction
   (D) Immunoprecipitation
   (E) Flow cytometry

5. Which of the following cells is/are **NOT** immune cells?
   (A) Neutrophil
   (B) Nature killer cell
   (C) B cell
   (D) Cardiomyocyte
   (E) Adipocyte

6. Dr. Cow asked his student to detect the nucleic acid expression of X gene in cell samples. Which of the following techniques can be used?
   (A) Hematoxylin and eosin (H&E) staining
   (B) Migration assay
   (C) Polymerase chain reaction
   (D) Southern blotting
   (E) Immunohistochemistry

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7. Which of the following strategies can reduce the risk of getting COVID-19 infection?
   (A) Receiving COVID-19 vaccine
   (B) Wearing mask
   (C) Traveling
   (D) Keeping social distance
   (E) Washing hands

8. Which of the following techniques can be used to detect the coat proteins of COVID-19?
   (A) Enzyme-linked immunosorbent assay
   (B) New generation sequencing
   (C) Western blotting
   (D) Polymerase chain reaction
   (E) Polyacrylamide gel electrophoresis followed by silver staining

9. Which of following strategies is/are cancer immunotherapy?
   (A) Chemotherapy
   (B) Immune checkpoint blockade
   (C) CAR-T
   (D) Radiation therapy
   (E) Dendritic cell vaccine

10. The Nobel Prize Laureate Sydney Brenner once said that "Progress in science depends on new techniques, new discoveries and new ideas, probably in that order". The development of which new techniques led to winning of the Nobel Prize.
   (A) Vaccine
   (B) PCR
   (C) CRISPR-Cas9
   (D) ELISA
   (E) Monoclonal antibody

11. Mice are important tools in basic research and drug development. Concerning transgenic mice and knockout mice (using CRISPR-Cas9) which statements is/are **CORRECT**?
   (A) The method for injection of the construct into mouse embryos to generate these two mice are similar
   (B) The time required for generation of these two mice are similar
   (C) Transgenic mice are expressing exogenous gene of interest in vivo
   (D) The exogenous proteins expressed in transgenic mice are always higher than endogenous proteins
   (E) CRISPR-Cas9-mediated deletion but not insertion is the principle for the generation of knockout mice

12. Real-time polymerase chain reaction (RT-PCR) is a very sensitive method, allowing the detection of extremely low amounts of nucleic acid present in the samples. Which statements concerning RT-qPCR is/are **CORRECT**?
   (A) The method relies on the use of fluorescent dye that incorporates into DNA for quantification
   (B) This method can be used to detect COVID-19 virus a nasal swab
   (C) This method is only applicable for quantifying RNA which is reversibly transcribed into DNA but not DNA per se
   (D) Like regular PCR, RT-PCR detect end-point PCR products
   (E) Like regular PCR, the polymerase for RT-PCR is isolated from bacteria of hot spring

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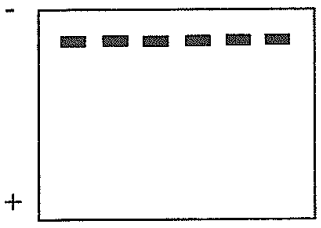
13.Gel electrophoresis is often used in separating nucleic acid or proteins. The following is the set up of an agarose gel. The "–" and "+" signs indicate the orientation of the electrodes. The black solid rectangles are the wells for loading samples. Which descriptions for the setting is/are **CORRECT**?



(A) Smaller DNA will move faster toward the end of the gel
(B) Larger DNA will move slower toward the end of the gel
(C) The DNA will move upward
(D) The higher the percentage of the gel, the slower the DNA will move
(E) RNA cannot be separated in the gel

14.Post-translational modifications of proteins regulate signal transduction in cells in response to different stimuli. Among different modifications, phosphorylation is one of the well characterized events. Please indicate which amino acids can be phosphorylated upon stimulation.
(A) Proline
(B) Serine
(C) Tyrosine
(D) Threonine
(E) Glutamine

15.All the enzymes check DNA errors except
(A) RNA polymerase
(B) RNA primase
(C) DNA ligase
(D) DNA helicase
(E) DNA polymerase

16.Toll-like receptor (TLR) is an evolutionarily conserved innate immune receptor that recognizes pathogen-associated molecular patterns (PAMPs) of pathogens. Regarding TLRs, which descriptions is/are **CORRECT**?
(A) Since the structure of mRNAs of viruses and mammalian cells are the same, there is no TLR that recognizes viral mRNA
(B) All of the TLRs are located on the cell surface to serve as a frontline defense against pathogens
(C) TLR2 recognizes flagellin, a structural protein of flagella of bacteria
(D) TLR4 recognizes lipopolysaccharides of gram-negative bacteria
(E) TLR9 recognizes dsDNA of viruses or bacteria

17.COVID-19 (COVID), a once-in-a-century pandemic, in 2020 has so far resulted in over 80 million infection cases and close to 2 million mortality world-wide. The vaccine developed by Pfizer for COVID was approved by USA, UK and many other countries. Which statements concerning the Pfizer vaccine for COVID is/are **CORRECT**?
(A) The vaccine developed by Pfizer is an RNA vaccine
(B) The administration of the vaccine is through intravascular injection route

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(C) The RNA encodes spike protein, the receptor of COVID virus
(D) The principle of the RNA vaccine is to induce antibody against the RNA of COVID virus
(E) The Pfizer vaccine is not working for the new variant of COVID virus found in UK

18. Concerning the statements of RNA and DNA which is/are **CORRECT**?
(A) The molecular weight of a single-stranded (ss) RNA is lighter than that of ssDNA with the same length
(B) mRNA is more stable than double-stranded DNA
(C) The sugar in DNA and RNA is a pentose
(D) Compare to dsDNA, mRNA tends to form secondary structure
(E) mRNA is more abundant than rRNA and tRNA in a cell

19. Concerning biomembrane which statements is/are **CORRECT**?
(A) ER, lysosome, Golgi apparatus and cytoskeleton are all membrane-bound organelles
(B) Mitochondria have double membrane, consisting of outer and inner membrane
(C) Plasma membrane is composed of lipid bilayer and the components of different lipids in the membrane are completely symmetrical between outer and inner leaflet
(D) Autophagosomes formed during autophagy also consist of double membranes
(E) Phosphatidylserine (PS) exposure to outer leaflet of plasma membrane is a signature of apoptotic cells

20. Which of the following biomolecules have reducing function?
(A) Glutathione
(B) NAD^+
(C) $NADP^+$
(D) FADH2
(E) Vit C

21. Which of the following chemical bonds can contribute to the stabilization of 3-dimensional structure of a polypeptide?
(A) Ionic bond
(B) Van der Waals
(C) H-bond
(D) Salt bridge
(E) Disulfide formation

22. Which of the following macromolecules have the catalytic function in the biological system?
(A) DNA
(B) Protein
(C) Lipid
(D) Carbohydrate
(E) RNA

23. Zinc finger is an important motif in many proteins. Which of the following amino acids is/are involved in zinc finger formation?
(A) Cysteine
(B) Histidine
(C) Methionine
(D) Serine
(E) Threonine

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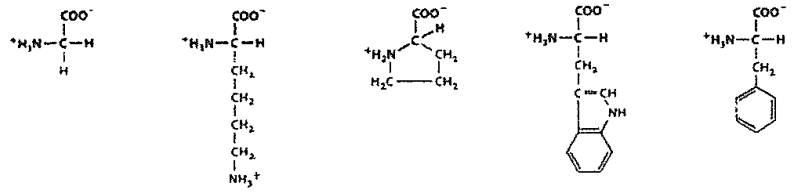
24. Which of the following amino acids can absorb UV light?

(A) (B) (C) (D) (E)



25. Which of the following restriction enzymes can digest an E. coli genomic DNA sample to generate DNA fragments with average size of 256 bp. (/ indicates cutting site)
(A) Not I : GC/GGCCGC
(B) Hind III : A/AGCTT
(C) Hpa II : C/CGG
(D) Hpa I : GTT/AAC
(E) Alu I: AG/CT

26. Protein degradation by ubiquitination requires
(A) Protease
(B) Ubiquitin ligase
(C) ATP
(D) Proteasome
(E) Ubiquitin

27. Choose the **CORRECT** statements describing the induction of β-galactosidase activity by isopropyl thiogalactoside (IPTG) in *E coli.*
(A) IPTG stimulates the *lac* repressor function
(B) IPTG induces the transcription of β-galactosidase.
(C) IPTG binds to the *lac* repressor and inhibits its activity.
(D) IPTG inhibits β-galactosidase degradation.
(E) The binding of *lac* repressor to the *lac* operator is suppressed by IPTG.

28. DNA is more stable than RNA in alkaline hydrolysis. Which of the followings contributes most to this difference?
(A) DNA is double stranded, whereas RNA is single stranded.
(B) DNA has 2' hydrogen atoms, whereas RNA has 2' hydroxyl groups.
(C) DNA includes thymine bases, whereas RNA includes uracil bases.
(D) DNA seldom forms non–Watson-Crick base pairs, whereas RNA does so more readily.
(E) DNA seldom adopts stable tertiary structure folds, whereas RNA does so more readily.

29. Which of the following statements is/are **CORRECT** in describing transcription and translation in prokaryotes?
(A) All mRNAs are monocistronic to encode one single protein
(B) RNA transcription is coupled with the translation event.
(C) One RNA polymerase catalyzes rRNA, mRNA and tRNA.
(D) Genetic code is universal
(E) RNA translation is not initiated until full-length RNA transcription is completed.

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30. Which of the following molecules is/are charged amino acid?
(A) Aspartic acid
(B) Tryptophan
(C) Glutamic acid
(D) Glutamine
(E) Lysine

31. Human microbiota, the microorganisms that residue in and on a single human being, consists of:
(A) Bacteriophages
(B) Archaea
(C) Fungi
(D) Protists
(E) Bacteria

32. Which of the following organelles is/are likely to have evolved as a result of endosymbiosis?
(A) Endoplasmic reticulum
(B) Golgi apparatus
(C) Mitochondria
(D) Nucleus
(E) Chloroplasts

33. Which of the following statements about the lipid bilayer membrane of cells is/are **CORRECT**?
(A) Biomembranes are composed of three principle classes of lipids: phosphoglycerides, sphingolipids and sterols.
(B) Lipid composition influences the physical properties of membrane.
(C) Cholesterol will increase membrane fluidity and facilitates planar diffusion of proteins.
(D) Most lipids and many proteins are laterally mobile in biomembranes.
(E) Lipid bilayers are permeable to small gas molecules and ions.

34. Which of the following statements about mitosis and stem cells is/are **CORRECT**?
(A) Most tissues contain various numbers of stem cells as a source of cell renewal, including the nervous system.
(B) iPSCs (induced pluripotent stem cells) can be formed from somatic cells by expression of combinations of key transcription factors, including KLF4, Sox2, Oct4 and Myc.
(C) Animal cloning establishes that cell differentiation can be reversed.
(D) Symmetric cell division increases cell diversity, and asymmetric cell division expands cell number.
(E) Positioning of mitotic spindle, which determines the plane of cell division, could be regulated by extrinsic factors

35. Which of the following statements about forming and storing memory is/are **CORRECT**?
(A) Memories are formed by changing the number or strength of synapses between neurons.
(B) The hippocampus is a region of the brain that is required for the formation of long-lasting memories.
(C) Changes in synaptic strength can be mediated by presynaptic, trans-synaptic, or postsynaptic mechanisms.
(D) Synaptic plasticity is the process of changing synaptic strength, and it needs to be accomplished with *de novo* protein synthesis.
(E) Formation of long-term memories requires gene expression.

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36. Which of the following statements about autophagy, a self-degradative process that is important for balancing sources of energy, is/are **CORRECT**?
(A) Autophagy plays a housekeeping role in removing aggregated proteins, clearing damaged organelles and eliminating intracellular pathogens.
(B) Autophagy, a self-eating process, is thought of as a survival mechanism for an organism.
(C) The autophagic pathway begins with the formation of a cup-shaped structure that envelops a region of the cytosol or an entire organelle, forming an autophagosome.
(D) The autophagosome has double membranes, and fusion of the outer membrane with the lysosome delivers the enveloped contents to the interior of lysosome for degradation.
(E) Autophagy can be either non-selective or selective in the removal of specific organelles, ribosomes and protein aggregates.

37. Which of the following is regularly an epigenetic phenomenon?
(A) X-chromosome inactivation.
(B) Establishment of heterochromatin at a centromere.
(C) Imprinting.
(D) A position effect in which a gene is silenced by an inversion where both breakpoints occur within a euchromatic environment.
(E) Long noncoding RNAs-mediated genes repression.

38. Which of the following statements about messengers RNA (mRNAs) and micro-RNAs (miRNAs) is/are **CORRECT**?
(A) Many mRNA are transported to specific subcellular locations by sequence-specific RNA binding proteins that bind localization sequences usually found in the 3' untranslated region (UTR).
(B) Nonsense-mediated decay and other mRNA surveillance mechanisms prevent the translation of mRNA with pre-existing, high amount of protein production.
(C) Both miRNAs and short interfering RNAs (siRNAs) contain 21-23 nucleotides and are assembled into a multiprotein RNA-induced silencing complex.
(D) Approximately 1900 different human miRNAs have been observed, and most of them are expressed only in specific cell types at particular times during embryogenesis and after birth.
(E) Translation of mRNA can be repressed by miRNAs which form imperfect hybrids with sequence in the 3'UTR of specific target mRNAs.

39. Which of the following statements about Severe acute respiratory syndrome-Coronavirus 2 (SARS-CoV-2) and its host cells is/are **CORRECT**?
(A) SARS-CoV-2 causes coronavirus 19 disease (COVID-19) which presents a large spectrum of manifestations with fatal outcomes in vulnerable people.
(B) SARS-CoV-2 is highly transmissible which is probably due to the high binding affinity between the viral spike protein and human cell surface receptor, Angiotensin converting enzyme 2 (ACE2).
(C) ACE2 is highly expressed in human epithelia.
(D) SARS-CoV-2 only infects airway epithelial cells.
(E) SARS-CoV-2 can be inactivated by freezing.

40. Which of the following descriptions about second messengers is/are **CORRECT**?
(A) Activation of G-protein coupled receptors results in the production of cyclic GMP
(B) Diacyl glycerol and phosphatidylinositol 4,5-bisphosphate are catalytic products of inositol 1,4,5-triphosphate
(C) Adenylyl cyclase produces cyclic AMP from ATP

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