請用 2B 鉛筆作答於答案卡，並先詳閱答案卡上之「畫記說明」。

**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 enzymes is/are required for DNA replication in E. *coli*?
   (A) DNA polymerase I
   (B) DNA ligase
   (C) RNA polymerase II
   (D) Helicase
   (E) Primase

2. Regarding the structure of DNA and RNA, which of the following statements is/are **CORRECT**?
   (A) DNA contains a 2'-hydroxyl group on the pentose sugar.
   (B) Uracil is found in RNA but usually not in DNA.
   (C) The two strands of B-form DNA run in an antiparallel direction.
   (D) A-DNA is the most common form under physiological conditions.
   (E) Phosphodiester bonds link the nucleotides in both DNA and RNA.

3. Which of the following is/are involved in the processing of eukaryotic pre-mRNA?
   (A) 5' capping (7-methylguanosine)
   (B) Polyadenylation at the 3' end
   (C) Removal of exons by the spliceosome
   (D) Removal of introns by the spliceosome
   (E) Binding of the Shine-Dalgarno sequence

4. Regarding protein synthesis (translation), which of the following statements is/are **CORRECT**?
   (A) In bacteria, the 16S rRNA allows the ribosome to bind to the Shine-Dalgarno sequence.
   (B) The start codon is typically AUG, which codes for Methionine.
   (C) Eukaryotic translation usually involves the ribosome scanning from the 5' cap.
   (D) The "Wobble" hypothesis explains why there are fewer tRNAs than codons.
   (E) Peptide bonds are formed by the peptidyl transferase activity of the rRNA (ribozyme).

5. Which of the following techniques can be used to detect specific proteins in a sample?
   (A) Southern blot
   (B) Northern blot
   (C) Western blot
   (D) ELISA
   (E) RT-PCR

6. Regarding CRISPR-Cas9, which of the following statements is/are **CORRECT**?
   (A) It was originally discovered as an adaptive immune system in bacteria.
   (B) Cas9 is an RNA-guided DNA endonuclease.
   (C) It requires a guide RNA (gRNA) to target specific DNA sequences.
   (D) It introduces double-strand breaks (DSBs) in the DNA.
   (E) It requires a PAM (Protospacer Adjacent Motif) sequence for cleavage.

7. Telomeres are important structures at the ends of linear eukaryotic chromosomes. Which statement(s) is/are **NOT** ture?
   (A) They protect chromosome ends from degradation and fusion.

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(B) They consist of repetitive DNA sequences.
(C) Telomerase is a reverse transcriptase that carries its own RNA template.
(D) Telomerase activity is typically high in somatic cells but low in cancer cells.
(E) They solve the "end-replication problem" of the lagging strand.

8. Which are the characteristics of genetic analysis?
(A) Some of alleles can exhibit both recessive and dominant properties.
(B) Dominant alleles are often the consequence of a mutation that causes some kind of gain of function.
(C) Dominant mutations in certain genes are associated with a loss of function.
(D) Dominant negative produces a phenotype similar to that obtained from a loss-of function mutation.
(E) Recessive and dominant mutant alleles generally have opposite effects on gene function.

9. Which of the following statements about the cell cycle is/are **TRUE**?
(A) DNA replication occurs during the G1 phase.
(B) Cyclins and Cyclin-Dependent Kinases (CDKs) regulate cell cycle progression.
(C) The p53 protein acts as a tumor suppressor and can induce cell cycle arrest.
(D) Mitosis results in two genetically identical daughter cells.
(E) The G0 phase is a resting state where cells are not actively dividing.

10. Which of the following organelles contain(s) its own DNA?
(A) Ribosome
(B) Mitochondria
(C) Golgi apparatus
(D) Chloroplast
(E) Nucleus

11. In the context of signal transduction, which molecules act as "second messengers"?
(A) cAMP (cyclic AMP)
(B) Calcium ions ($Ca^{2+}$)
(C) Insulin
(D) IP3 (Inositol trisphosphate)
(E) DNA polymerase

12. Polymerase Chain Reaction (PCR) is a fundamental technique. Which components are **NOT** essential for a standard PCR reaction?
(A) DNA template
(B) Primers (Oligonucleotides)
(C) Thermostable DNA polymerase
(D) dNTPs (deoxynucleotide triphosphates)
(E) RNA polymerase

13. Regarding topoisomerase, which of the following statements is/are **CORRECT**?
(A) Type I topoisomerase cleaves only one strand of DNA
(B) Type II topoisomerase causes double-strand breaks and requires ATP
(C) One of the functions of topoisomerase is to relieve the supercoiling tension (torsional stress) caused by replication or transcription
(D) DNA gyrase can introduce negative supercoils in bacteria
(E) Topoisomerase only functions during transcription and is unrelated to replication

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14.Which of the following common methods is/are **CORRECT** for detecting protein–protein interactions?
(A) Yeast two-hybrid
(B) Co-immunoprecipitation
(C) FRET / BiFC
(D) GST pull-down assay
(E) EMSA (electrophoretic mobility shift assay)

15.Regarding statements about chromatin and epigenetics, which of the following is/are **CORRECT**?
(A) H3K9me3 is often associated with heterochromatin
(B) Histone acetylation is usually associated with transcriptional activation
(C) DNA methylation near promoters is often associated with gene silencing
(D) The nucleosome core consists of two of each H2A, H2B, H3, and H4 (histone octamer)
(E) Heterochromatin is usually looser and more easily digested by DNase.

16.Regarding the differences in translation between prokaryotes and eukaryotes, which of the following is/are **CORRECT**?
(A) Prokaryotic cells can perform transcription and translation simultaneously (coupling)
(B) The Shine–Dalgarno sequence binds to the small ribosomal subunit to position the start site
(C) The Kozak sequence is mainly found near the initiation site of eukaryotic mRNA
(D) Eukaryotic translation must first be completed inside the nucleus
(E) Prokaryotic translation initiation usually begins with Met-tRNAi entering the A site.

17.Regarding disulfide bonds, which of the following is/are **CORRECT**?
(A) They are formed by two cysteine residues
(B) They are more easily formed in oxidative environments (such as the ER lumen or bacterial periplasm)
(C) Protein disulfide isomerase (PDI) can assist in the formation/rearrangement of disulfide bonds
(D) Disulfide bonds are considered non-covalent interactions
(E) Disulfide bonds can affect protein stability and folding

18.Regarding membrane fluidity, which of the following is/are **CORRECT**?
(A) Increased temperature usually increases fluidity
(B) An increased proportion of unsaturated fatty acids usually increases fluidity
(C) Longer fatty acid carbon chains usually increase fluidity
(D) Cholesterol can "buffer" fluidity (affecting it differently at different temperatures)
(E) The content and composition of membrane proteins can also affect fluidity.

19.Which of the following regarding restriction enzyme cleavage patterns is/are **CORRECT**?
(A) EcoRI produces 5' protruding (sticky) ends.
(B) EcoRV produces blunt ends
(C) Whether sticky or blunt ends are produced depends on the position of the cleavage site relative to the center of the symmetry sequence
(D) All restriction enzymes produce only blunt ends
(E) Sticky ends facilitate ligation efficiency when they are complementary to each other

20.Regarding ribozymes, which of the following is/are **CORRECT**?
(A) They are essentially RNA and possess catalytic activity
(B) They absolutely require proteins to catalyze reactions
(C) They serve as partial evidence supporting the "RNA World" hypothesis
(D) The catalytic core of the ribosome is primarily contributed by rRNA

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(E) A ribozyme is equivalent to a DNA polymerase.

21.Components that are **NOT** found in RNA include.
(A) Thymine
(B) 2'-hydroxyl group
(C) Ribose
(D) Deoxyribose
(E) Uracil

22.Proteins required for eukaryotic DNA replication include.
(A) PCNA
(B) TFIIA
(C) DNA polymerase α
(D) EIF4A
(E) MCM complex

23.Which statements about leading and lagging strand synthesis is/are **CORRECT**?
(A) The leading strand is synthesized continuously.
(B) The lagging strand requires RNA primers.
(C) Okazaki fragments are longer in eukaryotes than in prokaryotes.
(D) DNA polymerase δ extends lagging-strand DNA in eukaryotes.
(E) The lagging strand is produced by 3'→5' synthesis.

24.Which molecular processes can generate double-strand DNA breaks?
(A) Replication fork collapse
(B) Ionizing radiation
(C) Base excision repair
(D) V(D)J recombination
(E) Telomerase-mediated extension

25.Which statements accurately describe eukaryotic transcription initiation?
(A) TFIID binds the TATA box
(B) RNA polymerase II requires general transcription factors
(C) Enhancers must be located immediately upstream of promoters
(D) Mediator integrates signals from activators
(E) Promoter melting requires helicase activity in TFIIH

26.Which techniques are commonly used to quantify global changes in gene expression?
(A) RNA-seq
(B) Northern blot
(C) Microarrays
(D) Whole-genome shotgun sequencing
(E) qRT-PCR

27.Which statements about signal transduction pathways is/are **TRUE**?
(A) GPCRs activate heterotrimeric G-proteins
(B) RTKs autophosphorylate on tyrosine residues
(C) Second messengers can freely diffuse in the cytosol
(D) SH2 domains bind phosphorylated serine

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(E) MAP kinase cascades often rely on sequential phosphorylation events to amplify signals.

28. Which amino acids are most likely to be located in the interior of a soluble, globular protein?
(A) Leucine
(B) Isoleucine
(C) Valine
(D) Aspartate
(E) Lysine

29. Which events occur during NHEJ (non-homologous end joining)?
(A) DNA end recognition by Ku70/80
(B) Template-directed repair
(C) End processing by nucleases
(D) Activity of DNA ligase IV
(E) Use of homologous chromosome as template

30. Which amino acid side chains can form hydrogen bonds via their functional groups?
(A) Serine
(B) Lysine
(C) Phenylalanine
(D) Asparagine
(E) Valine

31. Which of the following statements is/are **TRUE**?
(A) Interactions with the cytoskeleton enhance the mobility of integral membrane proteins.
(B) Lipid-binding motif in peripheral proteins interact with polar head groups of membrane phospholipids.
(C) Most lipids and a few proteins are laterally mobile in the plasma membrane.
(D) Membrane-embedded b sheets are the primary secondary structures in most trans-membrane proteins.
(E) All trans-membrane proteins are asymmetrically oriented in the bilayer.

32. The results of pulse-chase experiments
(A) can be used to estimate the time required to synthesize a cellular constituent.
(B) can be influenced by the pool size.
(C) can be used to determine the direction in which macromolecules are synthesized.
(D) can depend on the nature of the precursor used.
(E) can not be used to determine the location in the cell where a particular cellular constituent is synthesized.

33. Which of the following statements about tRNA is/are **TRUE**?
(A) The first and second bases of a codon in tRNA almost always form standard Watson-Crick base pairs with the third and second bases, respectively, of the corresponding anticodon.
(B) Four of the six codons for leucine (CUA, CUC, CUU, and UUA) are all recognized by the same tRNA with the anticodon 3'-GAI-5'.
(C) The G:U base pair can structurally fit almost as well as the standard G:C pair.
(D) Some 20-30 different tRNA have been identified in bacterial cells and as many as 30-40 in animal and plant cells.
(E) The un-folded structure of tRNA promotes its decoding functions.

34. Vesicle trafficking
(A) uses small membrane-bound sacs (vesicles) to move proteins.

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(B) moves lipids, and other cargo between organelles (like ER to Golgi)
(C) moves proteins, lipids, and other cargo to cell's exterior.
(D) is crucial for nutrient uptake, but not cell communication.
(E) involves in budding, cytoskeletal tracks, and fusion with target membranes.

35.Epigenetic modifications of the genome
(A) only one Y chromosome is active in female mammals.
(B) heterochromatin sciences nearby genes.
(C) one of the two X chromosomes in female mammals is accurately inactivated to achieve proper gene dosage.
(D) DNA methylation is a heritable mark on the DNA.
(E) DNA methylation decreases the rate of mutation.

36.Which of the following statements is/are **TRUE**?
(A) Monomeric actin and tubulin subunits assemble into microfilaments.
(B) There are more than five types of filaments compose the cytoskeleton.
(C) Dimeric subunits composed of a- and b-tubulin polymerize into microtubules.
(D) Intermediate filaments are assembled from a large of diverse family of proteins.
(E) Microtubules radiate from microsomes and organize certain subcellular structures.

37.Eukaryotic Non-coding RNA transcripts
(A) are functional RNA molecules that don't code for proteins.
(B) play crucial roles in regulating gene expression and other cellular processes.
(C) act as key players in everything from protein synthesis (rRNA, tRNA) to gene silencing (miRNA, siRNA) and complex regulation.
(D) Genes specifying long non-coding RNAs (lncRNAs) occupy a large fraction of the genomes of complex organisms.
(E) The term 'lncRNAs' encompasses RNA polymerase I (Pol I), Pol II and Pol III transcribed RNAs, and RNAs from processed introns.

38.Which are the characteristics of the ER or the Golgi?
(A) protein oligomerization occurs in the ER.
(B) protein folding occurs in the Golgi.
(C) protein quality control occurs in the ER.
(D) oligosaccharide is added to many proteins in the ER.
(E) N-terminal acetylation usually occurs in the ER.

39.Which of the following statements is/are **TRUE**?
(A) Mitosis distributes exact copies of genetic material so the daughter nuclei are genetically identical to each other and identical to the mother nucleus from which they came.
(B) The phenotypic ratio of 1:2:1 is characteristic of the F-2 of a monohybrid cross where dominance is lacking.
(C) Crossing over involves the exchange of parts between homologous chromosomes.
(D) Meiosis is often called "reduction division" because the genetic material is reduced by half.
(E) Most genes are probably pleiotropic.

40.Which of the following statements is/are **TRUE**?
(A) Peroxisomes synthesize fatty acids and degrade toxic compounds.

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(B) Mitochondria have their own unique circular DNA "chromosomes" distinct from nuclear DNA.
(C) The synthesis of fatty acids and phospholipids takes place in the rough endoplasmic reticulum.
(D) The nucleus contains the DNA genome, RNA synthetic apparatus, and a fibrous matrix.
(E) Lysosomes vary in size and shape, and several hundred may be present in a typical animal cell.

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