一、單選題 (共 30 題，請作答於『答案卡』，每題 2 分，共 60 分)

1. DNA replication is semiconservative, means that:
(A) one of the two daughter duplexes consists of both original parental strands.
(B) for each daughter duplex, only one of the parental strands is used as a template for both daughter strands.
(C) each daughter duplex consists of one parental strand and one newly synthesized daughter strand.
(D) each daughter duplex may differ in sequence from the parental duplex.
(E) each daughter duplex has sections of original parental duplex and sections of newly synthesized daughter duplex.

2. Which of the following molecules is hydrolyzed for each elongation cycle during protein synthesis by ribosomes?
(A) ATP
(B) TTP
(C) CTP
(D) GTP
(E) UTP

3. A functional gene must:
(A) share an exon with another functional gene.
(B) result in a mutant phenotype if its sequence is mutated.
(C) have an open reading frame.
(D) be expressed in all cell types of the organism.
(E) have a functional ortholog in another species.

4. In a eukaryotic cell, the packing ratio of DNA is greatest:
(A) at the peak of gene expression.
(B) immediately following DNA replication.
(C) during mitosis.
(D) in euchromatin.
(E) during DNA replication.

5. Which of the following is NOT a usual feature of a plasmid vector:
(A) Multiple cloning site
(B) Antibiotic resistance gene
(C) Origin of replication
(D) Centromere
(E) Telomere

6. A single, circular molecule of DNA can be main genetic materials of which kind of cells?
(A) yeasts
(B) bacteria
(C) flies
(D) mice
(E) flowering plants

7. What is the processivity of DNA polymerases?
(A) the enzyme's ability to advance continuously when it synthesizes the leading strand.

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(B) the tendency to remain on a single template rather than to dissociate and reassociate.
(C) the 3'-5' exonuclease activity that is used to excise incorrectly paired bases.
(D) the 5'-3' exonuclease activity that can be combined with DNA synthesis to perform nick translation.
(E) the constrained active site that favors binding of Watson-Crick base pairs.

8. The polymerase chain reaction (PCR) technique can be used for:
(A) direct isolation of a specific segment of genomic DNA.
(B) transcription of a specific segment of RNA based on the given gene.
(C) amplification of a specific protein by using a pair of specific short peptides.
(D) options of (A) and (B).
(E) all of the above.

9. The lagging strand is replicated with stretches of Okazaki fragments and that is why its synthesis is considered to be:
(A) discontinuous.
(B) primed.
(C) never stopping.
(D) semiconservative.
(E) transcriptionally coupled.

10. In E. coli, which of the following descriptions is **NOT true** about Okazaki fragments?
(A) A stretch of single-stranded parental DNA must be exposed.
(B) DNA synthesis proceeds continuously in the 5' to 3' direction as the parental duplex is unwound.
(C) Each Okazaki fragment has an RNA sequence at the 5' end and a free 3'-OH end adjacent to the 5' end of the next fragment.
(D) DNA polymerase I replaces the RNA primer with DNA using nick translation.
(E) The nicks between fragments are resolved by the enzyme DNA ligase.

11. What role does DNA methylation serve in E. coli DNA replication?
(A) Hemimethylated DNA is inhibited from initiating replication.
(B) DNA must be fully methylated for replication to be initiated.
(C) DNA must be unmethylated for replication to be initiated.
(D) DNA must be either hemimethylated or fully methylated for replication to be initiated.
(E) DNA methylation has no effect on DNA replication.

12. Which of the following is true about eukaryotic replicons?
(A) They are activated in linear order across a chromosome.
(B) They are generally over 2 Mb in length.
(C) Generally, replicons in heterochromatin replicate last.
(D) They are all replicated at the same time during S phase.
(E) They have distinct, conserved termination regions.

13. Which of the following is **NOT** a function of homologous recombination?
(A) Ensuring chromosome segregation.
(B) Integrating phage genomes into bacterial chromosomes.
(C) In mitosis, restarting replication that has stalled at lesions.
(D) Generating genetic diversity.

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(E) In mitosis, repairing lesions at replication forks.

14. The TATA box is a common component of promoters for:
(A) RNA polymerases I, II, and III.
(B) RNA polymerases I and III.
(C) RNA polymerase II.
(D) RNA polymerase III.
(E) RNA polymerase I.

15. Which of the following is correct about the location of an enhancer relative to the gene it affects:
(A) must be upstream from
(B) can be very distant from
(C) cannot be within an intron of
(D) must be in the same orientation as
(E) must be downstream from

16. Several features of gene expressions are varied between prokaryotes and eukaryotes, which of the following is correct:
(A) Repressors recognize the operators of introns in a typical bacterial gene to inhibit their transcription.
(B) Polycistronic mRNAs in eukaryotes make polypeptide sizes of eukaryotes greater than those of prokaryotes.
(C) In eukaryotes, a gene can contain introns that are not represented in the polypeptide product.
(D) Most events of intron retention found in eukaryotes are caused by inactive repressions of intron transcription.
(E) None of above is correct.

17. Which of the following may prevent the initiation of transcription by RNA polymerase II in a eukaryotic cell?
(A) TATA-binding protein binds to the TATA box in the minor groove of DNA.
(B) Nucleosomes form by placing A-T-rich sequences with the minor grooves facing inward.
(C) A failure in releasing the sigma factor for the transition to elongation.
(D) A promoter does not contain a TATA box.
(E) All of above may prevent.

18. Which of the following is correct for 5' capping of eukaryotic mRNA:
(A) The capping process takes place during translation and is important for release from pausing of translation.
(B) A 5' cap is formed by adding a G to the terminal base of the transcript via 5'-5' link.
(C) Addition of the 5' terminal G is catalyzed by a RNA ligase with an additional enzymatic activity functioning as the triphosphatase.
(D) The 5' cap of every mRNA or small noncoding RNA molecule is monomethylated and influences RNA stability, splicing, export, and transcription.
(E) Enzymatic decapping represents one of the major mechanisms to release mRNAs into ribosomes for triggering translation in eukaryotic cells.

19. Which of the following is not potential mode of alternative splicing?
(A) Alternative 3' splice sites
(B) Alternative branch points
(C) Mutually exclusive exons
(D) Alternative 5' splice sites

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(E) Exon inclusion/skipping

20. How many of the 64 possible triplets together encode 20 amino acids:
(A) 20
(B) 21
(C) 60
(D) 61
(E) 63

21. The wobble hypothesis states that:
(A) Codon-anticodon pairing must only follow the standard base-pairing rules at the first two codon positions.
(B) Some mutations introduce termination codons.
(C) Most amino acids have more than one codon representing them.
(D) An mRNA may encode more than one polypeptide, and the ribosome may "wobble" or begin at alternate start codons.
(E) Mutations are less likely to occur at the third base of the codon.

22. Which of the following is correct for the translation of a polycistronic mRNA:
(A) The translation relies on one ribosome-binding site for all cistrons (coding regions).
(B) A downstream cistron is initiated only after the upstream translation is terminated.
(C) All cistrons are translated into a polyprotein and consequently processed into polypeptides corresponding to each of cistrons.
(D) Cistrons coding proteins may function in the same pathway and be coordinately controlled.
(E) All of the above.

23. Which of the following types of structures does **NOT** sustain epigenetic effect?
(A) A covalent modification of DNA.
(B) An intermediate structure of DNA called Holliday junction.
(C) A proteinaceous structure that assembles on DNA.
(D) A protein aggregate that controls the conformation of new subunits as they are synthesized.
(E) None of the above.

24. Agrobacteria naturally transfer and insert DNA into the genome of higher plants. The transferred DNA is named T-DNA, what is transferred?
(A) The original double-stranded T-DNA, displaced by synthesis of a new double-stranded copy.
(B) A newly synthesized double-stranded copy of the original T-DNA.
(C) A single pre-existing DNA strand displaced by the synthesis of a new strand.
(D) The entire Ti plasmid, and all but the T-DNA is degraded by the plant cell.
(E) A newly synthesized single strand according to the T-DNA sequence.

25. Which of the following techniques is generally used to detect DNA-protein interactions?
(A) Yeast two-hybrid
(B) SDS-PAGE
(C) Electroporation
(D) Electrophoretic mobility shift assay
(E) Co-immunoprecipitation

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26. Imprinting is a change in a gene that occurs during passage through the sperm or egg with the result that the paternal and maternal alleles have different properties in the very early embryo. This is caused by:
(A) insertion of a transposon
(B) methylation of DNA
(C) homologous recombination
(D) RNA interference
(E) ribosome stalling

27. What is the direct role of the nucleolus in the cell?
(A) ATP synthesis
(B) Membrane synthesis
(C) rRNA synthesis
(D) protein synthesis
(E) DNA synthesis

28. Besides nucleus, which of the organelles contains genetic materials in animal cells?
(A) Endoplasmic reticulum
(B) Golgi apparatus
(C) Mitochondria
(D) Chloroplasts
(E) Amyloplasts

29. Which of the following correctly describes chromatin?
(A) The complex of DNA and protein from which chromosomes are composed.
(B) The total genetic content of a cell.
(C) The proteins that give structural support to a chromosome.
(D) Unpacked DNA; the form in which DNA exists when it is not tightly packed into chromosomes.
(E) All of the above.

30. Which of the following descriptions about telomeres is correct?
(A) Telomeres seal the chromosome ends and function in mitotic chromosome pairing.
(B) Telomeres provide sites of origins for DNA replication and therefore stabilize chromosome ends.
(C) Telomeres are synthesized by an extraordinary DNA polymerase that can initiate replication at the very end.
(D) Loss of telomeres results in senescence.
(E) All of the above.

**二、問答題 (共 5 題，請於試卷【非選擇題作答區】依題號以中或英文作答，共 40 分)**

1. In the late 1940s, the Austrian biochemist Erwin Chargaff discovered that DNA contains equal amounts of adenine and thymine, also those of guanine and cytosine. Such base proportions of DNA helped lead to the discovery of the double helix structure of DNA. Nevertheless, the DNA as the genetic material in a particular virus contains 15% A, 30% T, 20% G, and 35% C. How would you explain these values (3 分)?

2. Please list and explain three essential features of a plasmid vector used in molecular cloning (6 分).

3. Please briefly explain the functions of following factors in DNA replication: (a) helicase, (b) primase, (c) ligase, (d) exonuclease, (e) single-stranded DNA-binding proteins (10 分).

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4. Bacteria generally translate protein coupling to transcription, an mRNA can be used for translation while it is being synthesized. However, these two reactions (transcription and translation) are well separated in eukaryotes. (a) What is the structural feature in a eukaryotic cell that separates these two reactions (3 分)? (b) Describe **two** problems the cell may have if these two reactions are coupled in eukaryotes (6 分).

5. You need to prepare the listed reagents below in a laboratory, please give your recipes about how you calculate the weight or the volume of the given stocks (in parentheses) you need and how you prepare each of them (12 分):
   (1) 100 mL of 1N HCl in H2O (36.5% HCl stock, density 1.2, FW 36.5)
   (2) 100 mL of 0.1M glucose in H2O (anhydrous D-Glucose, FW 180)
   (3) 100 μL of 2.5 pmol/μL DNA oligo in H2O (DNA oligo molecular weight: 16,000; 32 μg in 100 μL H2O)
   (4) 50 mL of 50 mM FeSO4•7H2O in H2O (FeSO4•7H2O, FW 278; H2O molecular weight: 18)

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