※單選題 每題2分 ※ 注意：請用 2B 鉛筆作答於答案卡，並先詳閱答案卡上之「畫記說明」。

1. Transcription of the lactose operon in *E. coli* is stimulated by:
   A) a mutation in the repressor gene that strengthens the affinity of the repressor for the operator.
   B) a mutation in the repressor gene that weakens the affinity of the repressor for the operator.
   C) a mutation in the repressor gene that weakens the affinity of the repressor for the inducer.
   D) the presence of glucose in the growth medium.
   E) binding of the repressor to the operator.

2. *E. coli* DNA polymerase III:
   A) represents over 90% of the DNA polymerase activity in *E. coli* cells.
   B) is the principal DNA polymerase in chromosomal DNA replication.
   C) requires a free 5′-hydroxyl group as a primer.
   D) can initiate replication without a primer.
   E) is efficient at nick translation.

3. The function of the eukaryotic DNA replication factor PCNA (*p*roliferating *c*ell *n*uclear *a*ntigen) is similar to that of the β-subunit of bacterial DNA polymerase III in that it:
   A) forms a circular sliding clamp to increase the processivity of replication.
   B) increases the speed but not the processivity of the replication complex.
   C) has a $3' \rightarrow 5'$ proofreading activity.
   D) facilitates replication of telomeres.
   E) participates in DNA repair.

4. In base-excision repair, the first enzyme to act is:
   A) AP endonuclease.
   B) DNA glycosylase.
   C) DNA polymerase.
   D) Dam methylase.
   E) DNA ligase.

5. In homologous recombination in *E. coli,* the protein that moves along a double-stranded DNA, unwinding the strands ahead of it and degrading them, is:
   A) RuvC protein (resolvase).
   B) RecBCD enzyme.
   C) RecA protein.
   D) DNA ligase.
   E) *chi.*

6. Which enzyme in the urea cycle catalyzes the reaction that provides a direct metabolic link to the TCA (Citric Acid) cycle through the production of fumarate?
   A) Ornithine transcarbamoylase (OTC).
   B) Argininosuccinate synthase (ASS).
   C) Argininosuccinate lyase (ASL).
   D) Carbamoyl phosphate synthetase I (CPS1).
   E) Arginase-1 (ARG1).

見背面

7. An enzyme requires an organic non-protein component to facilitate its catalytic mechanism. If this organic molecule is very tightly or even covalently bound to the enzyme's structure and remains associated with it throughout the reaction cycle, it is most specifically classified as a:
   A) Apoenzyme.
   B) Prosthetic group.
   C) Coenzyme.
   D) Holoenzyme.
   E) Metalloenzyme.

8. In the context of cellular physiology, which of the following transport mechanisms is specifically characterized by the use of a pre-existing electrochemical gradient (such as a sodium gradient) to drive the movement of a solute against its own concentration gradient?
   A) Primary active transport.
   B) Simple diffusion.
   C) Osmosis.
   D) Facilitated diffusion.
   E) Secondary active transport.

9. Phospholipids are the primary structural components of the cell membrane bilayer. Which of the following descriptions regarding the function of phospholipids in the membrane bilayer is the most accurate?
   A) Phospholipids, through their amphipathic nature, spontaneously form a barrier that prevents the free movement of water-soluble substances in and out of the cell.
   B) The primary function of phospholipids is to act as active transport pumps, directly consuming ATP to move ions across the membrane.
   C) Phospholipids remain in a fixed, static state within the membrane to provide mechanical rigidity and replace the need for a cytoskeleton.
   D) The main function of phospholipids is to act as enzymes that catalyze the translation and modification of membrane proteins.
   E) Phospholipids use their hydrophilic tails to create channels in the membrane core to facilitate the simple diffusion of large polar molecules.

10. Pyridoxal phosphate (PLP) is one of the most versatile cofactors in human metabolism. Which of the following catalytic processes is PLP-dependent and involves the formation of a Schiff base intermediate with a lysine residue in the enzyme's active site?
   A) The carboxylation of pyruvate to form oxaloacetate.
   B) The oxidative deamination of glutamate to release free ammonia.
   C) The transamination of amino acids to generate α-keto acids.
   D) The activation of fatty acids for β-oxidation.
   E) The conversion of methyl malonyl-CoA to succinyl-CoA.

接次頁

11. In biochemistry, amino acids are classified as glucogenic or ketogenic based on their degradation products. Which of the following pairs of amino acids are classified as "purely ketogenic," meaning their carbon skeletons can only be converted into acetyl-CoA or acetoacetyl-CoA and cannot be used for gluconeogenesis?
    A) Alanine and Glycine.
    B) Phenylalanine and Tyrosine.
    C) Isoleucine and Threonine.
    D) Leucine and Lysine.
    E) Valine and Histidine.

12. Which of the following best describes the hydrogen bonding pattern in an α-helix?
    A) Between adjacent side chains.
    B) Between carbonyl oxygen of residue i and amide hydrogen of residue i+4.
    C) Between carbonyl oxygen of residue i and amide hydrogen of residue i+1.
    D) Between backbone atoms of adjacent β-strands.
    E) Between backbone atoms and water molecules.

13. In the folding process of globular proteins, hydrophobic side chains tend to:
    A) Expose themselves to water for hydrogen bonding.
    B) Cluster on the protein surface.
    C) Remain randomly distributed.
    D) Be buried in the protein core.
    E) Be post-translationally modified.

14. Which of the following amino acid substitutions is most likely to disrupt protein function by destabilizing a protein's hydrophobic core?
    A) Leucine to Isoleucine.
    B) Isoleucine to Leucine.
    C) Leucine to Methionine.
    D) Leucine to Valine.
    E) Leucine to Arginine.

15. Which of the following would **increase** V_{max} in an enzyme-catalyzed reaction?
    A) Increasing substrate concentration.
    B) Decreasing product concentration.
    C) Increasing enzyme concentration.
    D) Decreasing K_m.
    E) Decreasing k_{cat}.

16. Which of the following statements best describes a competitive inhibitor?
    A) It binds to the enzyme-substrate complex and increases K_m without affecting V_{max}.
    B) It binds to the enzyme-substrate complex and decreases both K_m and V_{max}.
    C) It binds to the active site and increases K_m without affecting V_{max}.
    D) It binds to the active site and decreases both K_m and V_{max}.
    E) It reacts with an active site residue and binds irreversibly to the enzyme.

見背面

17. An enzyme-catalyzed reaction has the following parameters:
K_m = 10 mM
V_{max} = 200 μmol/min
What is the initial rate (Vo) of this reaction when substrate concentration [S] = 10 mM
A) 50 μmol/min
B) 100 μmol/min
C) 133 μmol/min
D) 200 μmol/min
E) 10 μmol/min

18. An enzyme shows **sigmoidal kinetics**, meaning that the plot of initial velocity (Vo) versus substrate concentration ([S]) displays an S-shaped curve. What does this suggest about the enzyme?
A) It binds a single substrate molecule and follows first-order kinetics.
B) It undergoes irreversible inactivation during catalysis.
C) It exhibits cooperative binding, often due to allosteric interactions between subunits.
D) It becomes saturated with substrate only at very high temperatures.
E) It is competitively inhibited at high substrate concentrations.

19. Which of the following amino acid substitutions is most likely to disrupt the formation of a 'heptad repeat' motif in a leucine zipper protein, assuming the substitution occurs at the 'a' or 'd' position of the (abcdefg)n sequence?
A) Leucine to Isoleucine.
B) Leucine to Valine.
C) Leucine to Aspartate.
D) Leucine to Methionine.
E) Leucine to Alanine.

20. A purified peptide was treated with Cyanogen Bromide (CNBr), resulting in two fragments. Treatment of the original peptide with Trypsin yielded three fragments. Chymotrypsin treatment resulted in no cleavage. Recall the specific cleavage sites for Trypsin (positively charged side chains) and Chymotrypsin (aromatic side chains).

Which sequence is consistent with these findings?
A) Met-Gly-Phe-Lys-Ala-Gly
B) Ala-Met-Lys-Arg-Gly-Gly
C) Arg-Lys-Met-Tyr-Ser-Gly
D) Gly-Met-Arg-Lys-Trp-Gly
E) Lys-Met-Phe-Arg-Ala-Gly

21. In the context of Hemoglobin (Hb) allostery, the 'Perutz Mechanism' describes the transition from the T-state to the R-state. Which molecular event triggers the movement of the F-helix?
A) The formation of salt bridges between carbamylated N-termini.
B) The release of 2,3-BPG from the central cavity.
C)The dissociation of the alpha-beta dimers into monomers.
D) The transition of the heme iron from high-spin to low-spin state upon oxygen binding.
E) The expulsion of water molecules from the distal heme pocket.

接次頁

22. G-protein coupled receptors (GPCRs) utilize different mechanisms for desensitization. What is the specific role of beta-arrestin in the termination of GPCR signaling?
A) It hydrolyzes cAMP to 5'-AMP to reduce second messenger levels.
B) It acts as a Guanine Nucleotide Exchange Factor (GEF) for the alpha-subunit.
C) It dephosphorylates the receptor to restore its basal state.
D) It sterically delays G-protein coupling and facilitates clathrin-mediated endocytosis.
E) It phosphorylates the Gα subunit to accelerate GTP hydrolysis.

23. Steroidogenesis involves the conversion of cholesterol into various hormones. Which intermediate serves as the universal precursor for all classes of steroid hormones?
A) Mevalonate (C6H12O4).
B) Squalene (C30H50).
C) Pregnenolone (C21H32O2).
D) Lanosterol (C30H50O).
E) Progesterone (C21H30O2).

24. Which of the following statements regarding purine nucleotide biosynthesis is **INCORRECT?**
A) Phosphoribosylation of hypoxanthine leads to the formation of IMP.
B) Phosphorylation of purine nucleotides, catalyzed by adenosine phosphoribosyltransferase, converts deoxyadenosine to dAMP.
C) IMP can be converted into both AMP and GMP.
D) Salvage pathways require significantly less energy than de novo synthesis.
E) None of the above.

25. Which of the following statements about sphingomyelins is **INCORRECT?**
A) They are present in high concentrations in the myelin sheath surrounding nerve fibers.
B) Sphingomyelins contain glycerol and, upon hydrolysis, yield a fatty acid, phosphoric acid, choline, and sphingosine.
C) They are believed to play a role in apoptosis.
D) All of the above are correct.
E) None of the above.

26. Which of the following statements about histones is **CORRECT?**
A) Histone H1 is the most tightly bound histone in chromatin.
B) Histones H2A, H2B, H3, and H4 form a tetramer.
C) Acetylation of histones H2A and H2B is associated with regulation of gene transcription.
D) Acetylation of core histones is associated with chromosomal assembly during DNA replication.
E) All of the above are incorrect.

見背面

5'-ACTGTATCGGAT-3' (coding)
3'-TGACATAGCCTA-5'

27. The RNA transcript complementary to the coding sequence above is:
A) 5′-ACTGTATCGGAT-3′
B) 5′-ACUGUAUCGGAU-3′
C) 5′-ATCCGATACAGT-3′
D) 5′-AUCCGAUACAGU-3′
E) None of the above.

28. In leucine zipper motifs, leucine residues occur at every:
A) 5th position.
B) 6th position.
C) 7th position.
D) 8th position.
E) 9th position.

29. Which reaction of the citric acid cycle directly produces GTP (or ATP)?
A) Citrate → Isocitrate
B) Isocitrate → α-Ketoglutarate
C) α-Ketoglutarate → Succinyl-CoA
D) Succinyl-CoA → Succinate
E) Malate → Oxaloacetate

30. Which enzyme of the citric acid cycle is strongly inhibited by NADH?
A) Citrate synthase.
B) Aconitase.
C) Isocitrate dehydrogenase.
D) Succinate dehydrogenase.
E) Fumarase.

31. Which step of glycolysis is considered the primary rate-limiting and regulatory step?
A) Glucose → Glucose-6-phosphate
B) Fructose-6-phosphate → Fructose-1,6-bisphosphate
C) Glyceraldehyde-3-phosphate → 1,3-bisphosphoglycerate
D) Phosphoenolpyruvate → Pyruvate
E) Pyruvate → Lactate

32. Which of the following statements regarding glycogen is **CORRECT**?
A) Glycogen is primarily stored in adipose tissue.
B) Glycogen contains β(1→4) glycosidic bonds.
C) Glycogen is more highly branched than amylopectin.
D) Glycogen is composed of fructose units.
E) Glycogen cannot be rapidly mobilized.

接次頁

33. Which monosaccharide is a ketohexose?
A) Glucose.
B) Galactose.
C) Mannose.
D) Ribose.
E) Fructose.

34. Which enzyme is responsible for specifically attaching an amino acid to its corresponding tRNA molecule?
A) Peptidyl transferase.
B) Aminoacyl-tRNA synthetase.
C) RNA polymerase II.
D) Elongation Factor Tu.
E) Elongation Factor Ts.

35. Which component of the ribosome is responsible for the peptidyl transferase activity (catalyzing peptide bond formation)?
A) A protein in the small ribosomal subunit.
B) A protein in the large ribosomal subunit.
C) The 5S rRNA.
D) The 23S rRNA (in prokaryotes) or 28S rRNA (in eukaryotes).
E) The mRNA template itself.

36. Which molecule provides the energy required for the translocation of the ribosome (movement of the ribosome relative to the mRNA) during elongation?
A) ATP.
B) cAMP.
C) CTP.
D) UTP.
E) GTP.

37. The "Wobble Hypothesis" explains which of the following phenomena in protein synthesis?
A) The ability of the ribosome to pause during synthesis of hydrophobic regions.
B) The flexibility of the ribosome to translate different mRNA start codons.
C) The ability of a single tRNA anticodon to base pair with more than one mRNA codon.
D) The error-prone nature of the peptidyl transferase center.
E) The sliding of RNA polymerase backward during transcription proofreading.

38. During the co-translational targeting of secretory proteins to the endoplasmic reticulum (ER), which factor recognizes the hydrophobic signal sequence emerging from the ribosome and temporarily halts translation?
A) Sec61 translocon.
B) Signal Peptidase.
C) Binding Protein (BiP).
D) Signal Recognition Particle (SRP).
E) Protein Disulfide Isomerase (PDI).

見背面

39. Which description below about "The Central Dogma of Molecular Biology" is **WRONG**?
   A) Use RNA as a template to translate protein.
   B) Use DNA as a template to translate RNA.
   C) Use DNA as a template to transcribe RNA.
   D) Use DNA as a template to replicate DNA.
   E) RNA can serve as a template for reverse transcription to DNA.

40. Which RNA below is the most abundant in cells?
   A) mRNA.
   B) tRNA.
   C) rRNA.
   D) snRNA.
   E) siRNA.

41. Which subunit below is **NOT** composed of the subunits for *E. coli* polymerases?
   A) α
   B) β
   C) β'
   D) σ
   E) ν

42. Which description below is **NOT** a trans-acting factor in transcriptional regulation?
   A) TATA box.
   B) TBP.
   C) HSF.
   D) Jun.
   E) Sp1.

43. Which of the descriptions below about RNA transcripts between prokaryotes and eukaryotes is **INCORRECT**?
   A) The mRNA in prokaryotes is processed to produce mature RNA.
   B) In eukaryotes, the mRNA will add a cap at the 5' end and poly(A) tail at the 3' end.
   C) In prokaryotes, RNA transcription occurs in the cytoplasm.
   D) In eukaryotes, RNA transcription occurs in the nucleus.
   E) In prokaryotes, the 23S, 16S, and 5S rRNAs are formed from a single primary transcript.

44. Which of the descriptions below about the spliceosome is **WRONG**?
   A) Spliceosome is an RNA.
   B) Spliceosome is a protein.
   C) The spliceosome catalyzes the removal of DNA.
   D) The spliceosome catalyzes the removal of protein.
   E) None of all.

接次頁

45. The secondary structure of proteins such as α-helices and β-sheets is primarily stabilized by:
A) Disulfide bonds between cysteine residues.
B) Hydrophobic interactions among side chains.
C) Hydrogen bonds between backbone amide and carbonyl groups.
D) Ionic interactions between charged residues.
E) Van der Waals forces between aromatic rings.

46. Aspartate residues frequently participate in acid–base catalysis because they:
A) Are permanently negatively charged.
B) Cannot accept protons.
C) Can act as both proton donors and acceptors.
D) Are hydrophobic at physiological pH.
E) Form covalent enzyme–substrate bonds.

47. Which metabolite serves as an obligate activator of pyruvate carboxylase?
A) ATP.
B) NADH.
C) Citrate.
D) Acetyl-CoA.
E) Oxaloacetate.

48. Reduced LCAT activity most directly impairs:
A) VLDL secretion.
B) LDL receptor binding.
C) HDL maturation and cholesterol esterification.
D) Fatty acid β-oxidation.
E) Bile acid synthesis.

49. Oxygen binding to hemoglobin is an example of:
A) Negative heterotropic regulation.
B) Positive homotropic regulation.
C) Competitive inhibition.
D) Irreversible activation.
E) Noncompetitive inhibition.

50. When estimating protein concentration by UV absorbance at 280 nm, which amino acid contributes most strongly?
A) Phenylalanine.
B) Tyrosine.
C) Histidine.
D) Tryptophan.
E) Arginine.

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