115學年度 學士後醫學系招生考試

普通生物及生化概論試題封面

考試開始鈴響前，請勿翻閱本試題！

★考試開始鈴響前，請注意：

一、除准考證、應考文具及一般手錶外；行動電話、穿戴式裝置及其他物品均須放在臨時置物區。

二、請務必確認行動電話已取出電池或關機，行動電話及手錶的鬧鈴功能必須關閉。

三、就座後，不可擅自離開座位或與其他考生交談。

四、坐定後，雙手離開桌面，確認座位號碼、答案卡號碼與准考證號碼相同，以及抽屜中、桌椅下或座位旁均無非考試必需用品。如有任何問題，請立即舉手反應。

五、考試開始鈴響前，不得翻閱試題本或作答。

六、考試全程不得吃東西、喝水及嚼食口香糖。

七、違反上述規定，依「筆試規則及違規處理辦法」議處。

★作答說明：

一、考試時間：100 分鐘。

二、本試題（含封面）共 **18** 頁，如有缺頁或毀損，應立即舉手請監試人員補發。

三、本試題共 90 題，皆為單選題，共計 150 分；每題答錯倒扣，不作答不計分。

四、答題依題號順序劃記在答案卡上，寫在試題本上無效；答案卡限用 2B 鉛筆劃記，若未按規定劃記，致電腦無法讀取者，考生自行負責。

五、試題本必須與答案卡一併繳回，不得攜出試場。

115 學年度學士後醫學系招生考試
普通生物及生化概論試題

Choose one best answer for the following questions

【單選題】每題 1 分，共計 30 分，答錯 1 題倒扣 0.25 分，倒扣至本大題零分為止，未作答，不給分亦不扣分。1~15 題為普通生物，16~30 題為生化概論。

1. In the cell reproduction, which checkpoint ensures that DNA replication is complete before mitosis proceeds?
   (A) G_2 checkpoint (B) G_1 checkpoint
   (C) S checkpoint (D) Metaphase checkpoint
   (E) Cytokinesis checkpoint

2. An individual whose genitalia and internal ducts are male but whose testes are underdeveloped and do not produce sperms is most likely a victim of _____.
   (A) Down syndrome (B) Turner syndrome (C) Patau syndrome
   (D) Klinefelter syndrome (E) Edwards syndrome

3. In vascular plants, lateral meristems are primarily responsible for _____.
   (A) primary growth in length (B) secondary growth in thickness
   (C) leaf development (D) flower formation
   (E) seed germination

4. Bryophytes differ from vascular plants primarily because bryophytes _____.
   (A) produce seeds (B) possess lignified vascular tissue
   (C) require water for fertilization (D) have dominant sporophyte generations
   (E) produce pollen

5. Double fertilization in angiosperms results in the formation of _____.
   (A) one diploid embryo and one triploid endosperm
   (B) two diploid embryos
   (C) two triploid embryos
   (D) one haploid embryo
   (E) one diploid embryo only

6. In vertebrates relying on extracellular digestion, which intestinal feature most directly enhances the rate of nutrient uptake across the epithelial barrier?
   (A) Slowness of intestinal transit time
   (B) Maintenance of low luminal pH levels
   (C) Increased thickness of intestinal muscle layers
   (D) Emulsifying action of luminal bile salts
   (E) Expansion of epithelial surface area

7. Which characteristic is correct between the cell walls of bacteria and archaea?
   (A) Archaea cell walls are primarily made of polysaccharide, while bacteria use lipopolysaccharide.
   (B) Bacterial cell walls contain peptidoglycan, which is lacking in the cell walls of archaea.
   (C) Archaea lack a cell wall.
   (D) Both domains use peptidoglycan as the primary structural component of their walls.
   (E) Cell walls of archaea are structurally similar to eukaryotic cell walls.

8. Which of the following statements about immune responses is correct?
   (A) Phagocytic white blood cells can specifically recognize and destroy particular bacteria or viruses.
   (B) During an allergic reaction, monocytes release histamine, causing skin redness and swelling.
   (C) During inflammation, red blood cells leak out of blood vessels, causing redness, heat, swelling, and pain.
   (D) In the organ transplantation, T cells mediate a cellular immune response leading to rejection.
   (E) Passive immunity typically lasts for several years without diminishing.

9. High-level transcription in eukaryotes relies on the interaction between activators bound to distant enhancers and the transcription machinery at the promoter. Which statement best describes the structural change in DNA that facilitates this interaction?
   (A) The DNA acts as a track for activators to slide toward the promoter.
   (B) The DNA is permanently unwound to reduce distance.
   (C) The DNA loops to connect activators with the promoter.
   (D) The DNA is spliced to remove intervening sequences.
   (E) The DNA is chemically modified with RNA-like caps to signal initiation.

10. Which structures are found exclusively in birds?
   (A) Carina and syrinx
   (B) Cloaca and feathers
   (C) Epidermal scales and beak
   (D) Gizzard and crop
   (E) Wings and hollow bones

11. Which animal possesses an open circulatory system?
   (A) Earthworm (B) Salmon (C) Frog (D) Eagle (E) Mollusk

12. The National Center for Biotechnology Information (NCBI) provides a wide array of bioinformatics tools. What is the primary function of the widely used software BLAST?
    (A) To predict the three-dimensional structure of a protein from its amino acid sequence by comparing it to structures in the Protein Data Bank.
    (B) To assemble short, overlapping DNA fragments from a sequencing project into a single continuous genome sequence.
    (C) To compare a user-submitted DNA or protein sequence against the entire GenBank database to find sequences with a similar local alignment.
    (D) To identify all functional elements in a genome, including enhancers, promoters, and noncoding RNA genes, as was done in the ENCODE project.
    (E) To construct an evolutionary tree by comparing the entire genomes of multiple species and calculating their divergence times.

13. Which of the following statements about signal transduction pathways is correct?
    (A) All signaling molecules can pass directly through the plasma membrane.
    (B) Protein kinases in signaling pathways often amplify the cellular response.
    (C) Receptor proteins always function as ion channels.
    (D) Second messengers are membrane-bound proteins.
    (E) Signal transduction terminates only when the ligand is degraded.

14. Which circulatory feature most directly enables sustained high rates of oxygen delivery to metabolically active tissues in animals?
    (A) Use of an open vascular network
    (B) Reliance on diffusion across tissues
    (C) Maintenance of high-pressure closed vessels
    (D) Circulation of hemolymph as transport fluid
    (E) Absence of oxygen-binding pigments

15. Which regulatory change would most specifically reduce transcription of a eukaryotic gene without altering its DNA sequence?
    (A) Deletion of the gene's promoter region
    (B) Loss of a transcription factor's DNA-binding domain
    (C) A frameshift mutation in the coding region
    (D) DNA methylation of CpG islands near the promoter
    (E) Removal of the poly(A) tail from mature mRNA

16. Activation of a Gs protein in response to hormone binding requires binding of _____ to the _____ subunit.
    (A) GTP; α (B) GDP; β (C) GDP; γ (D) GTP; β (E) GDP; α

17. The α cells of the pancreatic islets secrete _____ in response to _____ glucose levels.
(A) insulin; high (B) insulin; low (C) glucagon; high
(D) glucagon; low (E) epinephrine; low

18. Which of the following is an omega-3 fatty acid?
(A) 9,12-Octadecadienoic acid (B) 9,12,15-Octadecatrienoic acid
(C) 6,9,12-Octadecatrienoic acid (D) 8,11,14-Eicosatrienoic acid
(E) 5,8,11,14-Eicosatetraenoic acid

19. A protein is observed to bind its ligand with higher affinity at low pH. What is the most likely explanation for this pH-dependent increase in binding?
(A) Protonation of binding site residues, altering their net charge
(B) Rearrangement of the hydrophobic core
(C) Change in the number of peptide bonds
(D) Differences in codon usage
(E) Involvement of disulfide bond formation

20. Glucocorticoids exert anti-inflammatory effects because they promote the production of _____.
(A) Tumor necrosis factor (TNF)
(B) Platelet derived growth factor (PDGF)
(C) Transforming growth factor-beta (TGF-β)
(D) Nuclear factor kappa B (NF-κB)
(E) Inhibitor of kappa B alpha (IκBα)

21. RNA vaccine technology relies on delivery of mRNA into host cells so that the cells can _____.
(A) degrade all ribosomes
(B) synthesize the encoded antigen protein
(C) convert the mRNA into genomic DNA automatically
(D) digest plasma membrane
(E) inhibit all immune signaling

22. Which of the following occurs during the post-translational processing of insulin?
(A) Glycosylation (B) Phosphorylation
(C) Formation of disulfide bonds (D) Acetylation of lysine residues
(E) Amidation of the C-terminal amino acid

23. For eukaryotes, where are the complexes of electron transport located?
(A) Cytosol (B) Outer mitochondrial membrane
(C) Mitochondrial intermembrane space (D) Inner mitochondrial membrane
(E) Mitochondrial matrix

24. Which combination of cofactors is involved in the conversion of pyruvate to acetyl-CoA?
(A) TPP, lipoic acid, and NAD^+
(B) Biotin, NAD^+, and FAD
(C) Biotin, FAD, and TPP
(D) Pyridoxal phosphate, FAD, and lipoic acid
(E) NAD^+, biotin, and TPP

25. Which ligand can bind to a receptor tyrosine kinase (RTK)?
(A) Thyroxine (B) Epinephrine (C) Glucagon
(D) Insulin (E) Cortisol

26. The flow of electrons through the electron transport chain and the synthesis of ATP are normally tightly connected in mitochondria. Which of the following disconnects these two processes?
(A) Cyanide (B) Oligomycin
(C) Uncoupling protein 1 (D) Carbon monoxide
(E) Hydrogen sulfide

27. A patient with type 2 diabetes is treated with a GLP-1 receptor agonist. Which of the following is the most likely metabolic effect of this drug?
(A) Increased gastric emptying
(B) Enhanced insulin release by the pancreas
(C) Decreased glucose-dependent insulin secretion
(D) Increased glucagon secretion during hyperglycemia
(E) Increased hepatic gluconeogenesis

28. An HIV-positive person asks why their immune system is weakened. You explain that this is most likely because HIV primarily infects and depletes which type of immune cells?
(A) B cells (B) Neutrophils (C) Erythrocytes
(D) Cytotoxic T cells (E) Helper T cells

29. Which of the following vitamins is correctly paired with the disease that is caused by its deficiency?
(A) Biotin: scurvy (B) Folic acid: rickets (C) Nicotinamide: pellagra
(D) Thiamine: anemia (E) Pantothenic acid: beriberi

30. Amphetamine and mescaline act as agonists of which neurotransmitter, often called the "pleasure" chemical?
(A) Serotonin (B) Gamma-aminobutyric acid
(C) *N*-methyl-D-aspartate (D) Glutamate
(E) Dopamine

Choose one best answer for the following questions

【單選題】每題 2 分，共計 120 分，答錯 1 題倒扣 0.5 分，倒扣至本大題零分為止，未作答，不給分亦不扣分。31~60 題為普通生物，61~90 題為生化概論。

31. Which organelle is primarily responsible for detoxification of drugs and poisons in liver cells?
    (A) Lysosome
    (B) Mitochondria
    (C) Golgi apparatus
    (D) Smooth endoplasmic reticulum
    (E) Rough endoplasmic reticulum

32. Which of the following statements about hormones and carbohydrate metabolism is **NOT** correct?
    (A) Thyroxine promotes cellular oxidation of glucose; parathyroid hormone inhibits glucose oxidation.
    (B) Thyroxine secretion can be regulated by the hypothalamus and the pituitary gland.
    (C) Insulin and glucagon act antagonistically to maintain blood glucose homeostasis.
    (D) Starvation leads to an increase in glucagon secretion.
    (E) Hypothyroidism (low thyroid function) can lead to carbohydrate accumulation in tissues.

33. Which of the following statements about human excretion is correct?
    (A) The nephron is the structural unit of the kidney, composed of Bowman's capsule, the renal tubule, the glomerulus, and the collecting duct.
    (B) Antidiuretic hormone (ADH) increases urine volume by promoting sodium excretion in the collecting duct.
    (C) The filtrate that passes from the glomerulus into Bowman's capsule consists entirely of waste products with no useful substances.
    (D) The primary function of the renal tubule is reabsorption; it plays no role in the secretion of waste substances into the filtrate.
    (E) Kidney function is regulated by secretions from the parathyroid glands, the posterior pituitary gland, and the adrenal glands.

34. In the nitrogen cycle, various microbial processes transform nitrogen between its different chemical forms. When decomposers, such as bacteria and fungi, break down the proteins and nucleic acids found in dead organic matter, they release inorganic nitrogen in the form of ammonium (NH_4^+). What is this specific process called?
    (A) Nitrogen fixation
    (B) Ammonification
    (C) Nitrification
    (D) Denitrification
    (E) Assimilation

35. A plant growing in magnesium-deficient soil would most directly exhibit _____.
    (A) reduced chlorophyll production
    (B) decreased xylem transport
    (C) increased transpiration rate
    (D) enhanced nitrogen fixation
    (E) increased stomatal density

36. A plant stem is girdled so that phloem transport is disrupted but xylem remains intact. Which of the following processes would continue normally immediately after girdling?
    (A) Downward movement of sugars from leaves
    (B) Pressure-flow-driven sucrose movement
    (C) Distribution of amino acids to roots
    (D) Translocation of photosynthates to fruits
    (E) Long-distance transport of water to leaves

37. In a temperate forest ecosystem, a mutation spreads through fungal populations that prevents the formation of multicellular hyphae, restricting fungi to unicellular growth forms. Although metabolic pathways for enzyme production remain intact, the organisms cannot form extensive filamentous networks in soil or woody substrates. Which ecosystem-level process would most likely experience the greatest decline as a direct consequence?
    (A) Net primary productivity by autotrophs
    (B) Atmospheric nitrogen fixation rates
    (C) Oxygenic photosynthesis in the canopy
    (D) Breakdown of lignin-rich plant biomass
    (E) Carbon fixation by soil microbes

38. In chloroplasts, inhibition of photosystem II would most directly reduce the production of _____.
    (A) NADPH and the proton gradient across the thylakoid membrane
    (B) ATP generated by substrate-level phosphorylation
    (C) glucose during the Calvin cycle
    (D) RuBP regeneration
    (E) oxygen consumption by mitochondria

39. Which characteristic represents a synapomorphy uniting ecdysozoans (e.g., arthropods and nematodes) and most clearly distinguishes them from other bilaterian invertebrates?
    (A) Presence of a fluid-filled body cavity
    (B) Expression of radial body symmetry
    (C) Periodic molting of an external cuticle
    (D) Development of repeated body segments
    (E) Possession of an open circulatory system

40. Which population characteristic is most directly regulated by density-dependent factors?
    (A) Carrying capacity (K)
    (B) Birth rate during a catastrophic event
    (C) Intrinsic rate of increase (r)
    (D) Dispersal ability
    (E) Age at sexual maturity

41. According to the pressure-flow model of phloem transport, long-distance movement of sucrose depends primarily on _____.
    (A) active transport of water into sieve-tube elements at the source
    (B) capillary forces within sieve plates
    (C) a pressure difference established between source and sink tissues
    (D) diffusion of sucrose through plasmodesmata over long distances
    (E) bulk flow driven by transpiration in xylem vessels

42. A population of 10,000 diploid organisms shows genotype frequencies that initially conform to Hardy–Weinberg expectations. Over the next generation, which of the following scenarios would be expected to produce the largest deviation from Hardy–Weinberg genotype proportions in a single generation?
    (A) A 1% migration rate from a genetically similar neighboring population
    (B) Mild inbreeding with an inbreeding coefficient F = 0.05
    (C) Occasional mutation at a rate of 10^{-6} per allele per generation
    (D) A temporary reduction of population size to 5,000 individuals
    (E) Heterozygote disadvantage reducing heterozygote fitness by 50%

43. Which statement best distinguishes inductive reasoning from deductive reasoning in biological research?
    (A) Deductive reasoning is only applicable to molecular biology.
    (B) Inductive reasoning always produces falsifiable conclusions.
    (C) Inductive reasoning tests hypotheses using controlled experiments.
    (D) Inductive reasoning generates hypotheses based on observed patterns.
    (E) Deductive reasoning derives general principles from specific observations.

44. Which characteristic represents a derived feature that most clearly distinguishes extant birds from other living reptiles?
    (A) Presence of keratinized epidermal structures
    (B) Production of shelled amniotic eggs
    (C) Maintenance of elevated metabolic temperature
    (D) Use of internal fertilization mechanisms
    (E) Modification of forelimbs into feathered wings

45. Which two proteins form the extracellular fibers found in all connective tissues?
    (A) Collagen and elastin
    (B) Actin and myosin
    (C) Keratin and collagen
    (D) Fibrin and fibrinogen
    (E) Tubulin and elastin

46. The inactivation of p53 is a near-universal feature of human cancers. What is the most crucial consequence of p53 inactivation for cancer development?
    (A) It directly activates oncogenes, such as Ras and Myc, leading to uncontrolled cell proliferation.
    (B) It allows cells to bypass the G_1/S checkpoint, leading to a shortened call cycle and faster tumor growth.
    (C) It prevents the repair of DNA damage, leading to a mutator phenotype and the rapid accumulation of further mutations.
    (D) It allows cells to survive and proliferate despite cellular stress and DNA damage, conditions that would normally trigger apoptosis or cell-cycle arrest.
    (E) It promotes angiogenesis and the recruitment of stromal cells to the tumor microenvironment.

47. A diploid organism (2n = 8) undergoes meiosis. During meiosis I, a single pair of homologous chromosomes fails to separate, while all other chromosomes segregate normally and crossing over has already occurred during prophase I. Assuming meiosis II proceeds normally, which of the following outcomes is most accurate?
    (A) All resulting gametes will be polyploid.
    (B) Two gametes will be n + 1 and two will be n − 1.
    (C) Two gametes will be normal, and two will be aneuploid.
    (D) Genetic recombination will not occur for the affected chromosome pair.
    (E) Sister chromatids of the affected chromosome will remain genetically identical.

48. RNA viruses accumulate nucleotide substitutions at rates several orders of magnitude higher than most DNA viruses. Experimental measurements show that the RNA-dependent RNA polymerase of many RNA viruses lacks 3'→5' exonuclease proofreading activity, whereas DNA polymerases typically possess such activity. Which description directly represents the elevated evolutionary rates observed in RNA viruses?
    (A) RNA viruses encode more genes involved in host interaction.
    (B) RNA viruses are universally subject to stronger positive selection.
    (C) RNA viruses consistently infect larger host populations.
    (D) The absence of proofreading during genome replication increases mutation rates.
    (E) RNA genomes are more likely to integrate into host chromosomes.

49. The "chicken pox" disease is caused by virus which is _____.
    ① the same virus causes shingles ② a virus with envelope
    ③ dsDNA virus belongs to the same family of smallpox and cowpox virus
    ④ an animal virus
    (A) ①③ (B) ②④ (C) ①④ (D) ①②③ (E) ①②④

50. How are fats converted into energy through cellular respiration pathways?
    (A) Fatty acids are converted to pyruvate in the cytosol and then enter the mitochondria.
    (B) Fatty acids undergo beta-oxidation to produce acetyl-CoA, which enters citric acid cycle.
    (C) The entire fat molecule is converted into an intermediate of glycolysis.
    (D) Glycerol enters the citric acid cycle directly, while fatty acids are converted to glucose.
    (E) Fats are converted to NADH and $FADH_2$ without entering glycolysis or citric acid cycle.

51. Which evolutionary innovation directly removed the primary physiological constraint to prevent early vertebrates from sustained terrestrial activity?
    (A) Development of air-breathing pulmonary organs
    (B) Formation of keratinized epidermal coverings
    (C) Evolution of amniotic reproductive structures
    (D) Expansion of forebrain neural regions
    (E) Emergence of metabolic heat regulation

52. Chylomicrons are transported from intestinal epithelial cells into the lymphatic system. Which of the following best describes their composition and initial transport pathway?
    (A) Composed of triglycerides, phospholipids, and proteins, chylomicrons are formed in the lumen of the small intestine and enter the lacteals by active transport.
    (B) Composed of re-formed triglycerides coated with phospholipids, cholesterol, and proteins, chylomicrons exit epithelial cells via exocytosis and first enter a lacteal.
    (C) Composed of fatty acids and monoglycerides coated with cholesterol and proteins, chylomicrons exit epithelial cells and are directly absorbed into the capillaries of the villus.
    (D) Composed of re-formed triglycerides and bile salts, chylomicrons are formed in epithelial cells and actively transported into the hepatic portal vein.
    (E) Composed of triglycerides, cholesterol, and amino acids, chylomicrons exit epithelial cells via diffusion and first enter a lymphatic vessel called a capillary.

53. Protein import into peroxisomes exhibits unique characteristics compared to mitochondrial import. Which statement accurately contrasts these two processes?
    (A) Both require proteins to be fully unfolded by cytosolic chaperones before translocation.
    (B) Mitochondrial import requires a membrane potential, while peroxisomal import is driven by a proton gradient across the single membrane.
    (C) The import signal for both organelles is a cleavable N-terminal amphipathic helix recognized by the same class of cytosolic receptors.
    (D) Both processes utilize the same family of translocator proteins (TOM/TIM and Pex) that are evolutionarily conserved.
    (E) Peroxisomes can import fully folded and even oligomeric proteins, whereas mitochondria require proteins to be unfolded to pass through translocators.

54. In guinea pigs, black fur (B) is dominant to brown fur (b). If two heterozygous black guinea pigs are crossed and produce exactly two offspring, what is the probability that the first offspring is black and the second is brown?
(A) 1/16 (B) 1/8 (C) 3/16 (D) 1/4 (E) 3/8

55. The initial creation of induced pluripotent stem (iPS) cells by Dr. Shinya Yamanaka (2012 Nobel Prize) from fully differentiated cells involves which specific molecular technique?
(A) Introducing four master regulatory genes into a differentiated cell using a modified adenovirus.
(B) Utilizing a modified retrovirus to insert cloned copies of four specific stem cell master regulatory genes into the genome of a differentiated cell.
(C) Fusing a differentiated cell with an embryonic stem cell to induce reprogramming through cytoplasmic factors.
(D) Directly injecting mRNA transcripts of four key transcription factors into a differentiated cell.
(E) Exposing differentiated cells to a specific cocktail of growth factors and small molecules that reverse the epigenetic landscape to a pluripotent state.

56. A widespread terrestrial species becomes divided when rising sea levels isolate a portion of the population on a newly formed island. Genetic analyses show rapid divergence in allele frequencies between mainland and island populations, and after several thousand generations, individuals from the two populations produce inviable hybrids when brought back into contact. Throughout the isolation period, there was no evidence of gene flow between populations. Which evolutionary process is best supported by this scenario?
(A) Introgressive hybridization maintaining genetic connectivity
(B) Behavioral isolation evolving within a continuous population
(C) Instantaneous reproductive isolation caused by genome duplication
(D) Divergence following geographic isolation with interrupted gene flow
(E) Ecological speciation driven by niche differentiation within the same habitat

57. Epinephrine signaling, which stimulates glycogen breakdown in liver cells, relies on a G protein-coupled receptor (GPCR) pathway. If a mutation renders the G protein's α-subunit unable to hydrolyze GTP to GDP, how will the cellular response be affected?
(A) The signaling pathway will fail to initiate.
(B) Adenylyl cyclase will remain permanently inhibited.
(C) Glycogen breakdown will occur continuously.
(D) The receptor will become desensitized to epinephrine immediately.
(E) The cell will require higher concentrations of epinephrine to initiate a response.

58. A patient is diagnosed with a hereditary form of colon cancer caused by a defect in a mismatch repair enzyme. How does this specific enzymatic failure contribute to the development of cancer?
    (A) It prevents the repair of DNA double-strand breaks, leading to large-scale chromosomal abnormalities.
    (B) It allows incorrectly paired nucleotides introduced during DNA replication to persist, increasing the overall mutation rate.
    (C) It causes the DNA to become more tightly wound into heterochromatin, silencing tumor suppressor genes.
    (D) It fails to remove thymine dimers caused by environmental mutagens like UV light.
    (E) It enhances the activity of telomerase, leading to cellular immortality.

59. Researchers are reconstructing a phylogeny for five vertebrate taxa. Two distantly related desert species exhibit nearly identical limb morphology adapted for burrowing, yet multilocus genomic analyses reveal thousands of shared derived nucleotide substitutions between one of these desert species and a forest-dwelling taxon. Which line of evidence provides the strongest support for inferring true common ancestry among these taxa?
    (A) Overlapping geographic distributions
    (B) Occupation of comparable ecological niches
    (C) Similar limb morphology associated with burrowing behavior
    (D) Convergent morphological traits shaped by environmental pressure
    (E) Shared derived DNA sequence substitutions across multiple independent loci

60. The photosynthesis of CAM plants is considered an adaptation to arid environments primarily because it _____.
    (A) eliminates the need for Rubisco
    (B) performs the Calvin cycle at night
    (C) reduces water loss by temporally separating CO_2 uptake and fixation
    (D) increases ATP production efficiency
    (E) prevents all photorespiration

61. Statins are widely used medications that effectively treat high blood cholesterol, a primary risk factor for atherosclerosis and cardiovascular diseases. What is the primary mechanism by which these drugs lower cholesterol levels in the blood?
    (A) Blocking the intestine from absorbing dietary cholesterol
    (B) Promoting the conversion of body cholesterol into bile acids for elimination
    (C) Blocking the HMG-CoA reductase enzyme from turning 3-hydroxy-3-methylglutaryl-CoA into mevalonate during cholesterol production
    (D) Accelerating the breakdown and clearance of the HMG-CoA reductase enzyme
    (E) Directly boosting the activity of LDL receptors in the liver

62. Which statement about ketone bodies is correct?
(A) During prolonged starvation, the brain cannot use ketone bodies and relies exclusively on glucose.
(B) In ketoacidosis, excess acetone is exhaled through the lung.
(C) Ketone bodies are produced primarily when the insulin-to-glucagon ratio is high after a carbohydrate-rich meal.
(D) Ketone bodies are produced mainly in the cytosol of extrahepatic tissues such as muscle.
(E) During ketosis, ketone bodies are readily converted into glucose in the liver.

63. How does glucokinase (hexokinase IV) differ from hexokinase I?
(A) It has a higher affinity for glucose and is not inhibited by high glucose levels.
(B) It enables the liver to export free glucose into the bloodstream when blood glucose drops.
(C) It needs a higher glucose concentration to reach maximal activity.
(D) It helps prevent the liver from competing with other tissues for glucose when glucose levels are high.
(E) It allows the pancreas to trigger insulin release when blood glucose levels are low.

64. Which advantage(s) explain why organisms often store energy as triacylglycerols rather than polysaccharides?
(A) The carbon atoms in triacylglycerols are more reduced and they are hydrophobic, so little water needs to be stored with them.
(B) The carbon atoms in triacylglycerols are more reduced.
(C) Because triacylglycerols are hydrophobic, they do not require storage with large amounts of water.
(D) Triacylglycerols contain more oxygen than polysaccharides, making them more efficient to oxidize.
(E) Triacylglycerols contain more oxygen than polysaccharides, making them more efficient to oxidize, and they are hydrophobic, so little water needs to be stored with them.

65. During the first half of the chymotrypsin mechanism where the acyl-enzyme intermediate is formed, what role does His play?
(A) general acid only
(B) general base only
(C) general acid then general base
(D) general base then general acid
(E) nucleophile

66. Which of the following ligands or stimuli can activate G protein-coupled receptor (GPCR) signaling pathways?
① Insulin ② Vasopressin ③ Epinephrine ④ Light ⑤ Epidermal growth factor
(A) ①②③ (B) ②③④ (C) ③④⑤ (D) ①③④ (E) ①②⑤

67. In bacterial cells, _____ is an activator of phosphofructokinase while _____ is an inhibitor.
(A) ADP; phosphoenolpyruvate (B) glucose-6-phosphate; ATP
(C) AMP; glyceraldehyde-3-phosphate (D) citrate; ADP
(E) fructose-2,6-bisphosphate; fructose-6-phosphate

68. Which statement about membrane lipids is correct?
(A) Glycerophospholipids occur only in plant cell membranes.
(B) In glycerophospholipids, fatty acids are attached to glycerol by amide bond.
(C) Lecithin used as an emulsifier in margarine and chocolate, is a sphingolipid.
(D) Triacylglycerols are the main lipid components of erythrocyte membrane.
(E) Sphingolipids contain ceramide as part of their structure.

69. Which of the following intracellular signaling molecules is responsible for inducing the gene expression of phosphoenolpyruvate carboxykinase during hepatic gluconeogenesis?
(A) Insulin (B) cGMP (C) cAMP (D) ATP (E) Estrogen

70. Which of the following G proteins decrease the concentration of their respective second messengers upon stimulation?
① G_i protein ② G_s protein ③ transducin ④ G_{olf} protein ⑤ G_{gust} protein
(A) ①② (B) ①③ (C) ①⑤ (D) ①④ (E) ②④⑤

71. Which of following are not mediated by ABC transporters?
(A) Anticancer drugs out of cancer cells (B) Antibiotics out of bacteria
(C) Transports bile salts out of hepatocytes (D) Vitamin E into fat cells (lipocytes)
(E) Chloride ions in the lung

72. What type of bond connects the tRNA with its amino acid (AA)?
(A) Ester between AA carboxylate and tRNA 3′ hydroxyl
(B) Mixed anhydride of AA carboxylate and tRNA 3′ phosphate
(C) Phosphoramide of AA amine and tRNA 3′ phosphate
(D) Mixed anhydride of AA carboxylate and tRNA 5′ phosphate
(E) Phosphoramide of AA amine and tRNA 5′ phosphate

73. Some restriction enzymes generate cohesive (sticky) ends, meaning they _____.
(A) cut both DNA strands at the same position in the same base pair
(B) cut GC-rich regions, producing ends that form more hydrogen bonds than AT-rich ends
(C) remain tightly bound to the DNA ends after cutting
(D) produce ends that can anneal with sticky ends made by *any* restriction enzyme
(E) make staggered cuts in the two strands, leaving short single-stranded overhangs

74. Which of the following steps in the TCA cycle may produce NADH?
① Acetyl-CoA and oxaloacetate to citrate ② Citrate to isocitrate
③ Isocitrate to α-ketoglutarate ④ α-Ketoglutarate to succinyl-CoA
(A) ①② (B) ②③ (C) ②④ (D) ③④ (E) ①③④

75. If a cell cannot synthesize or obtain tetrahydrofolate (H_4 folate), it will most likely be impaired in the biosynthesis of which amino acid?
(A) Isoleucine (B) Leucine (C) Lysine (D) Serine (E) Methionine

76. Which one of the following statements is **NOT** correct?
(A) Δ^1-Pyrroline-5-carboxylate serves as a key intermediate in both L-proline synthesis and breakdown pathways.
(B) Human cells synthesize non-essential amino acids using intermediates from central metabolic pathways or by converting essential amino acids.
(C) Phenylalanine hydroxylase catalyzes the interconversion between phenylalanine and tyrosine.
(D) Liver cells produce serine starting from the glycolysis product 3-phosphoglycerate.
(E) NADPH provides the ultimate source of reducing equivalents for tetrahydrobiopterin regeneration.

77. Which enzyme–effector pair is matched correctly?
(A) Phosphofructokinase-2 (PFK-2) / fructose-2,6-bisphosphate
(B) Phosphofructokinase-1 (PFK-1) / fructose-1,6-bisphosphate
(C) Fructose-1,6-bisphosphatase (FBPase-1) / fructose-1,6-bisphosphate
(D) Fructose-2,6-bisphosphatase (FBPase-2) / fructose-2,6-bisphosphate
(E) Fructose-1,6-bisphosphatase (FBPase-1) / fructose-2,6-bisphosphate

78. Which second messenger is produced after nitrogen monoxide (NO) stimulation?
(A) cAMP (B) cGMP
(C) Phosphatidylinositol 4,5-bisphosphate (D) Inositol 1,4,5-trisphosphate
(E) Diacylglycerol

79. Tamoxifen is used as adjuvant therapy for breast cancer. Which statement about tamoxifen is correct?
(A) It blocks male hormones.
(B) It works better in estrogen receptor negative tumors.
(C) It enters cells via surface receptors.
(D) It binds estrogen receptors.
(E) It inhibits estrogen production.

80. An open reading frame is defined by _____.
(A) a start and stop codon
(B) homology with other species
(C) placement on a genome map
(D) presence of transposable elements
(E) absence of highly repetitive sequences

81. TFIIH is a transcription factor that is responsible for forming the transcription bubble. For this reason, TFIIH is best described as a _____.
(A) gyrase
(B) ligase
(C) helicase
(D) endonuclease
(E) single-strand binding protein

82. Which one of the following statements is **NOT** correct?
(A) A major objective of proteomics is to identify all of the proteins present in a cell under different conditions.
(B) Tandem mass spectrometry has largely replaced the Edman method for the identification of peptides and proteins.
(C) In electrospray ionization mass spectrometry, molecules of a single protein produce a family of peaks, with each successive peak corresponding to a protein ion with one additional charge and a correspondingly lower m/z value.
(D) Since mass is a universal property of all atoms and molecules, mass spectrometry is ideally suited to the detection of posttranslational modifications in peptides/proteins.
(E) Time-of-flight mass is a method to make molecules bear electric charges.

83. To determine an enzyme's turnover number (k_{cat}), you need to know:
(A) Both the enzyme concentration and the initial reaction rate measured when [S] is much greater than K_m
(B) The initial reaction rate when [S] is much greater than K_m
(C) The initial reaction rate at low substrate concentration
(D) The substrate's K_m
(E) The enzyme concentration

84. Two proteins have similar molecular masses (protein A: isoelectric point 5.8, 50 kDa; protein B: isoelectric point 8.5, 50.5 kDa). Which technique would most effectively separate them?
(A) Size-exclusion chromatography
(B) Ion exchange chromatography
(C) SDS-PAGE
(D) Ultracentrifugation
(E) X-ray crystallography

85. In the process of nitrification, nitrate reductase converts _____ into _____.
(A) nitrate; nitrogen
(B) nitrate; ammonia
(C) nitrate; nitrite
(D) nitrate; nitric oxide
(E) nitrogen; nitrate

86. Chaperonins such as the GroEL/ES system function _____.
(A) in an ATP-dependent manner
(B) only when heat shock proteins are activated
(C) in a non-aqueous environment
(D) only at low pH
(E) only when bound to the ER membrane

87. Which of the following best describes the origin of orthologous proteins?
(A) Gene duplication occurring within a single species
(B) Divergence from a common ancestral gene in different species
(C) Evolution from completely unrelated genetic sources
(D) Modification through RNA editing
(E) Changes arising from post-translational modifications (PTMs)

88. Which of the following is an anaplerotic reaction that is often used in the cell?
(A) Conversion of pyruvate to acetyl-CoA
(B) Conversion of α-ketoglutarate to glutamic acid
(C) Conversion of citrate to oxaloacetate and acetyl-CoA
(D) Conversion of pyruvate to oxaloacetate
(E) Conversion of succinyl-CoA to heme

89. Which of the following correctly relates the order of intermediates during the synthesis of glycogen?
(A) glucose → glucose-1-phosphate → glucose-6-phosphate → UDP-glucose → glycogen
(B) glucose → glucose-6-phosphate → glucose-1-phosphate → UDP-glucose → glycogen
(C) glucose → glucose-6-phosphate → UDP-glucose → glucose-1-phosphate → glycogen
(D) glucose → UDP-glucose → glucose-1-phosphate → glucose-6-phosphate → glycogen
(E) glucose → UDP-glucose → glucose-6-phosphate → glucose-1-phosphate → glycogen

90. In its active state, Ras binds _____; after hydrolysis, it becomes _____ and becomes inactive.
(A) GMP; cGMP (B) GTP; GMP (C) GTP; GDP
(D) cGMP; GMP (E) cGMP; GDP