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. What is a key adaptation that allows plants to colonize land?
   (A) Ability to live in water
   (B) Protection of embryos
   (C) Ability to perform photosynthesis
   (D) Development of vascular tissue for transport
   (E) Ability to attract pollinators

2. Natural selection changes allele frequencies because some _____ survive and reproduce better than others.
   (A) alleles (B) loci (C) species
   (D) individuals (E) ecosystems

3. In an ecosystem, if an insect that consumes plant seeds containing 100 J, using 30 J for respiration and excreting 50 J in its feces, what is the insect's net secondary production, and what is its production efficiency?
   (A) 20 J; 20% (B) 50 J; 50% (C) 30 J; 30%
   (D) 70 J; 70% (E) 80 J; 80%

4. How do insects exchange gases?
   (A) Using lungs (B) Through skin diffusion (C) Via tracheal system
   (D) Through hemoglobin (E) With gills

5. Heartwood and sapwood consist of _____.
   (A) bark (B) periderm (C) secondary phloem
   (D) secondary xylem (E) vascular cambium

6. What is the primary function of the plant hormone auxin?
   (A) Inhibit seed germination
   (B) Promote cell elongation and phototropism
   (C) Stimulate stomatal closure
   (D) Reduce transpiration
   (E) Activate pathogen defense mechanisms

7. In angosperm, what does double fertilization mean?
   (A) One sperm is needed to fertilize the egg, and a second sperm fuses with the two nuclei in the large central cell of the female gametophyte.
   (B) Every egg must receive two sperm to produce an embryo.
   (C) Flowers must be pollinated twice to yield fruits and seeds.
   (D) The pollen grain must germinate twice to produce a pollen tube.
   (E) Fertilization must occur both in the spring and in the fall.

8. What is a defining feature of ascomycetes that distinguishes them from other fungal groups?
   (A) The production of non-flagellated spores in sporangia
   (B) The presence of zygosporangia in sexual reproduction
   (C) The formation of spores in sac-like structures
   (D) The presence of flagellated spores in their life cycle
   (E) The development of fruiting bodies called basidiocarps

9. Which one is **NOT** involved in long-term potentiation of the brain?
   (A) Glutamate (B) Mg^{2+}, Na^{+}, Ca^{2+} (C) NMDA receptor
   (D) AMPA receptor (E) P granules

10. A mutation changes a codon from GAC to UAC in the mRNA coding region. Which of the following best describes this mutation?
   (A) A missense mutation (B) A nonsense mutation
   (C) A silent mutation (D) A frameshift mutation
   (E) A neutral mutation that enhances protein function

11. Which of the following statements best describes the process of hermaphroditism in animals?
   (A) An individual produces only male gametes during its lifetime.
   (B) An individual produces only female gametes during its lifetime.
   (C) An individual produces both male and female gametes.
   (D) An individual alternates between producing male and female gametes at different times.
   (E) An individual reproduces asexually via fragmentation.

12. Which one is **NOT** produced during gastrulation?
   (A) Ectoderm (B) Germ layers (C) Blastopore
   (D) Archenteron (E) Blastomeres

13. Which plant-derived medicine and their usage is **NOT** matched?
   (A) Digitalin — heart medication (B) Atropine — throat soother
   (C) Vinblastine — cancer therapy (D) Quinine — malaria prevention
   (E) Taxol — cancer therapy

14. During prophase I of meiosis, what is the primary function of the synaptonemal complex?
(A) It cleaves cohesins to allow sister chromatids to separate.
(B) It attaches kinetochores to the spindle fibers.
(C) It prevents crossing over between sister chromatids.
(D) It holds homologous chromosomes tightly together to facilitate crossing over.
(E) It condenses the chromosomes before metaphase.

15. Proto-oncogenes can be over-activated by following conditions EXCEPT _____.
(A) epigenetic changes (B) chromosome translocation (C) gene amplification
(D) point mutation (E) transduction

16. What is the primary source of one-carbon units for tetrahydrofolate?
(A) Conversion of glycine to serine
(B) Conversion of serine to glycine
(C) Conversion of methionine to homocysteine
(D) Conversion of histidine to glutamate
(E) Conversion of succinyl-CoA to methylmalonyl-CoA

17. Which of the following statements correctly describes the role of pyridoxal phosphate (PLP) in aminotransferase reactions?
(A) PLP is the coenzyme form of vitamin B12.
(B) PLP cannot accept an amino group.
(C) PLP is generally covalently bound to the enzyme's active site through a peptide bond.
(D) PLP is only involved in the metabolism of carbohydrates.
(E) PLP functions as an intermediate carrier of amino groups at the active site of aminotransferases.

18. Which of the following statements about amino acid residues is correct?
① Phenylalanine has UV absorption at 260 nm.
② Glycine has a positive net charge at acidic solutions.
③ The side chain of serine cannot be ionized.
④ Isoleucine and leucine have the same molecular weight.
⑤ Cysteine can be oxidized to form cystine.
(A) ①②③ (B) ①③④ (C) ①④⑤ (D) ②④⑤ (E) ③④⑤

19. Which intermediate is formed during the carboxylation of propionyl-CoA by propionyl-CoA carboxylase?
(A) Acetyl-CoA (B) Citrate (C) Succinyl-CoA
(D) Pyruvate (E) Carboxybiotin

20. Which of the following statements correctly describes the role of hormones in the coordinated regulation of glycolysis and gluconeogenesis in liver?
(A) Glucagon stimulates glycolysis and inhibits gluconeogenesis.
(B) Insulin stimulates gluconeogenesis and inhibits glycolysis.
(C) Glucagon decreases the levels of fructose-2,6-bisphosphate and inhibits glycolysis.
(D) Insulin increases the levels of fructose-2,6-bisphosphate and inhibits glycolysis.
(E) Epinephrine inhibits both glycolysis and gluconeogenesis.

21. Which of the following substances is necessary for the synthesis of palmitate?
① $FADH_2$ ② Malonyl-CoA ③ NADPH ④ NADH ⑤ Acetyl-CoA
(A) ①②③ (B) ①②④ (C) ①④⑤ (D) ②③⑤ (E) ①②⑤

22. Which of the following enzyme-catalyzed steps in glycolysis is performed by different enzymes in gluconeogenesis?
① Hexokinase ② Pyruvate kinase ③ Aldolase ④ Phosphofructokinase
⑤ Phosphoglycerate kinase
(A) ①②③ (B) ②③④ (C) ①②④ (D) ②③⑤ (E) ①②⑤

23. Which of the following cofactors is essential for the activity of several key enzymes in glycolysis, primarily by forming a complex with ATP?
(A) Zinc ion (Zn^{2+})
(B) Cobalamin (Vitamin B_{12})
(C) Thiamine pyrophosphate (TPP)
(D) Pyridoxal phosphate (PLP)
(E) Magnesium ion (Mg^{2+})

24. Which protein complex in the mitochondrial electron transport chain has the largest molecular weight and is also inhibited by rotenone?
(A) Complex I (NADH: ubiquinone oxidoreductase)
(B) Complex II (Succinate dehydrogenase)
(C) Complex III (Cytochrome bc_1 complex)
(D) Complex IV (Cytochrome oxidase)
(E) Complex V (ATP synthase)

25. Which molecule plays a key regulatory role in glycolysis, fat metabolism, and the pentose phosphate pathway (PPP)?
(A) Fructose 6-bisphosphate
(B) Xylulose 5-phosphate
(C) Citrate
(D) Phosphoenolpyruvate (PEP)
(E) NADPH

26. RNA is more susceptible to hydrolytic cleavage than DNA due to structural differences. Which of the following best explains its increased instability?
(A) RNA lacks complementary base pairing, reducing structural stability.
(B) RNA contains uracil instead of thymine, making it more susceptible to degradation.
(C) RNA lacks the double-helix structure of DNA, reducing protection from external damage.
(D) RNA is more chemically reactive than DNA due to its ribose sugar.
(E) The 2'-hydroxyl (-OH) group in RNA facilitates self-cleavage under alkaline conditions.

27. Which statement about histones is correct?
① Histones are negatively charged proteins that stabilize the DNA double helix.
② Lysine and arginine residues of histones can be methylated.
③ Histone octamer contains H2A, H2B, H3, and H4.
④ Deacetylation of histones is not involved in epigenetic regulation.
⑤ H1 is involved in linking nucleosomes.
(A) ①②③ (B) ①③④ (C) ②③④ (D) ②③⑤ (E) ③④⑤

28. What is the primary function of reverse transcriptases in retroviruses?
(A) To synthesize RNA from a DNA template
(B) To convert RNA genomes into double-stranded DNA
(C) To degrade viral RNA
(D) To synthesize telomere ends of chromosomes
(E) To insert RNA introns into DNA genes

29. Which kinase in MAPK cascade is responsible for phosphorylating both Thr and Tyr residues on its substrate?
(A) Raf-1 (B) ERK (C) MEK (D) IRS1 (E) Grb2

30. An enzymatic reaction has a maximum velocity (V_{max}) of 30 μM/min and a Michaelis constant (K_m) of 50 μM. If the substrate concentration ([S]) is 25 μM, what is the reaction velocity (v)?
(A) 7.5 μM/min (B) 10 μM/min (C) 15 μM/min
(D) 20 μM/min (E) 25 μM/min

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31. Which virus and its class/family is **NOT** matched?
(A) Zika virus — Flavivirus (B) Ebola virus — Filovirus
(C) Epstein-Barr virus — Herpesvirus (D) Measles virus — Parvovirus
(E) Hepatitis A virus — Picornavirus

32. Which of the following is an adaptation that enhances the uptake of water and minerals by roots?
(A) Large leaves
(B) Pumping through plasmodesmata
(C) Active uptake by vessel elements
(D) Rhythmic contractions by cells in the root cortex
(E) Mycorrhizae

33. Which of the following is present in angiosperms but **NOT** in gymnosperms?
(A) Seeds (B) Pollen (C) Ovaries
(D) Ovules (E) Vascular tissue

34. In plant vascular system, what primary characteristic enables phloem sap to move bidirectionally?
(A) Positive pressure gradient (B) Living sieve-tube elements
(C) Proton pump mechanisms (D) Symplastic communication
(E) Companion cell interactions

35. In the genetic self-incompatibility (SI) system of angiosperms, which molecular mechanism most commonly prevents self-fertilization?
(A) RNA-directed DNA methylation blocking pollen tube growth.
(B) Ubiquitin-mediated degradation of incompatible pollen proteins.
(C) CRISPR-like genome editing in the pollen grain before fertilization.
(D) Epigenetic silencing of self-recognition genes in the ovule.
(E) Caspase-dependent apoptosis of self-pollen after stigma contact.

36. How do C3, C4, and CAM plants differ in their carbon fixation strategies?
(A) C3 plants use the Calvin cycle only, while C4 and CAM plants have additional mechanisms to reduce photorespiration.
(B) C4 plants keep stomata open at night for CO_2 intake, while CAM plants do so during the daytime for photosynthesis.
(C) CAM plants directly convert fixed carbon into glucose.
(D) C3 plants store CO_2 as malate in their cells before using it for photosynthesis.
(E) C4 and CAM plants rely only on rubisco for carbon fixation.

37. If a plant chloroplast is observed to have a damaged stroma, which of the following processes would be most immediately affected?
(A) Light absorption (B) ATP synthesis in the thylakoid
(C) Sugar synthesis (D) Oxygen production
(E) Electron transport within the thylakoid membrane

38. How might the duplication, rearrangement, and mutation of DNA contribute to genome evolution?
    (A) They prevent the formation of new genes.
    (B) They always lead to harmful mutations and diseases.
    (C) They stabilize the genome and prevent any changes over time.
    (D) They ensure that all genes are expressed at the same level.
    (E) They provide the raw material for natural selection to act upon, potentially leading to new functions and adaptations.

39. Which statement best describes the difference between genotype and phenotype?
    (A) Genotype is the observable trait, but phenotype is the genetic makeup.
    (B) Genotype is inherited, but phenotype is influenced by the environment.
    (C) Phenotype determines genotype.
    (D) They are identical in all individuals.
    (E) Phenotype is unrelated to genes.

40. The ENCODE project revealed that a large portion of the genome is transcribed into RNAs, far more than can be accounted for by protein-coding genes. What is a likely role that these RNAs might play?
    (A) Serve as templates for protein synthesis
    (B) Catalyze metabolic reactions in the cytoplasm
    (C) Act as structural components of ribosomes
    (D) Transport amino acids to the ribosome
    (E) Regulate gene expression by blocking translation or causing degradation of mRNA

41. Which of the following best describes the significance of the Ediacaran biota?
    (A) They are the first multicellular organisms.
    (B) They represent a major increase in marine predation.
    (C) They mark the beginning of complex animal life.
    (D) They are the dominant life forms during the Cambrian explosion.
    (E) They are primarily unicellular organisms.

42. During vertebrate embryonic development, which of the following is a key function of the organizer region?
    (A) It determines the fate of individual cells by direct contact only.
    (B) It initiates gastrulation by forming the primitive streak in all vertebrates.
    (C) It provides nutrients to developing cells, similar to the placenta.
    (D) It exclusively controls limb formation and patterning.
    (E) It directs the formation of body axes through signaling molecules.

43. Scientists studying the SNPs (single nucleotide polymorphisms) in the human genome have found that groups of SNPs tend to be inherited together in blocks known as haplotypes. What explains this observation?
    (A) Independent assortment during meiosis.
    (B) Crossing over is a random event, and the chance of it occurring between two loci increases with distance; SNPs located very close to each other are genetically linked and rarely separated by crossing over.
    (C) The presence of many protein-coding genes located in these regions.
    (D) Random mutations occurring at the same rate across the genome.
    (E) Natural selection favoring the inheritance of specific SNP combinations.

44. One characteristic that distinguishes a population in an extinction vortex from most other populations is that _____.
    (A) its members are rare, top-level predators
    (B) its number on chromosome is fixed
    (C) it is not well-adapted to its current environment
    (D) its effective population size is lower than its total population size
    (E) it lives in a fragmented habitat

45. Mosquitoes resistant to the pesticide DDT first appeared in India in 1959 and are now found worldwide. What is the most likely explanation for the global spread of DDT resistance?
    (A) Mosquitoes in different regions learned to avoid DDT independently.
    (B) DDT directly caused mutations in mosquitoes, making them resistant.
    (C) Resistant mosquitoes migrated from India to other parts of the world.
    (D) All mosquitoes gradually developed resistance over time due to exposure to DDT.
    (E) DDT resistance was present in all mosquito populations but only became apparent after DDT was widely used.

46. A cell receives a signal that prevents it from passing the G1 checkpoint. What is the most likely outcome for this cell?
    (A) It will exit the cell cycle and enter the G0 phase.
    (B) It will proceed directly to the S phase.
    (C) It will immediately enter the M phase.
    (D) It will undergo uncontrolled cell division.
    (E) It will immediately begin apoptosis.

47. Why do RNA viruses require their own supply of certain enzymes?
    (A) Host cells translate RNA directly into DNA.
    (B) Host cells cannot replicate RNA from an RNA template.
    (C) RNA viruses lack genetic material for protein synthesis.
    (D) Host enzymes destroy viral RNA immediately upon entry.
    (E) RNA viruses only infect non-dividing cells without enzymes.

48. Certain genes in Fungi *Laccaria bicolor* are highly upregulated in mycorrhizae. What can be inferred from this?
    (A) These genes are essential for the symbiotic relationship between the fungus and plant.
    (B) These genes are only expressed when the fungus is not in contact with a plant.
    (C) These genes are related to primary metabolism.
    (D) These genes are related to asexual reproduction.
    (E) These genes are related to decomposition.

49. Why is a closed circulatory system more efficient than an open circulatory system?
    (A) It eliminates the need for a heart to pump blood throughout the body.
    (B) It uses less energy than an open circulatory system, making it more efficient.
    (C) Blood freely bathes organs, increasing nutrient absorption and oxygen delivery.
    (D) It only transports oxygen, not other nutrients or metabolic waste.
    (E) Blood is contained within vessels, allowing for higher pressure and faster circulation.

50. Which of the following best describes a difference between the sympathetic and parasympathetic divisions of the autonomic nervous system?
    (A) The sympathetic division controls only voluntary movements.
    (B) Both divisions activate skeletal muscle contractions during stress.
    (C) The postganglionic neurons of the sympathetic division release acetylcholine, while those of the parasympathetic division release norepinephrine.
    (D) The sympathetic division prepares the body for action, while the parasympathetic division promotes rest and digestion.
    (E) The sympathetic division forms synapses near target organs, while the parasympathetic division synapses close to the spinal cord.

51. What is the role of the Golgi apparatus in the protein secretion pathway?
    (A) Synthesizing proteins
    (B) Packaging and modifying proteins for transport
    (C) Breaking down proteins
    (D) Folding proteins
    (E) Generating ATP for protein transport

52. How does countercurrent exchange in fish gills enhance oxygen absorption?
(A) Blood and water flow oppositely, maximizing oxygen diffusion
(B) Water flows faster, increasing oxygen intake
(C) Blood absorbs oxygen actively, not passively
(D) Gills store oxygen for later use
(E) Oxygen moves from low to high concentration

53. What is the significance of sister chromatid cohesion in meiosis?
(A) It ensures the separation of homologous chromosomes in meiosis II.
(B) It allows for the formation of a tetrad during metaphase I.
(C) It holds sister chromatids together and is essential for proper chromosome alignment during meiosis I.
(D) It is necessary for the pairing of homologous chromosomes.
(E) It is needed for the separation of non-sister chromatids.

54. How is lung volume changed during inhalation in mammals?
(A) By decreasing the volume of the thoracic cavity via muscle contraction.
(B) By the movement of the diaphragm and rib muscles, increasing thoracic volume.
(C) By the elastic recoil of the lungs, which expands them directly.
(D) By the contraction of muscles within the lungs themselves, expanding the volume.
(E) By the increase of pressure within the lung, forcing expansion.

55. Which one about translation in bacteria is correct?
(A) The initiator tRNA is $tRNA^{Formyl\text{-}methioine}$.
(B) Initial binding of mRNA requires a 7-methylguanosine cap.
(C) Selection of a start codon is according to Kozak's sequence.
(D) The termination factor is eRF.
(E) The ribosomes composition are 80S ribosomes.

56. Which one about the oogenesis of human female is **NOT** correct?
(A) Oogenesis begins in the embryonic development.
(B) Oogonia are divided by mitosis to form primary oocytes.
(C) Primary oocytes are arrested at prophase of meiosis I.
(D) Secondary oocytes complete meiosis II at ovulation.
(E) Primary oocytes are diploid, 2N.

57. Which one about the mechanism of medicine is **NOT** correct?
    (A) Aspirin prevents the production of prostaglandin.
    (B) Thalidomide clears cells in human embryos.
    (C) L-dopa is converted to dopamine by Dopa decarboxylase.
    (D) Acetaminophen binds to cyclooxygenase to relieve pain.
    (E) Opiate decreases the sensitivity of chemoreceptors to O_2.

58. Which one about antibiotics is **NOT** correct?
    (A) Penicillin inhibits peptidoglycan cross-linking.
    (B) Penicillin blocks the activate site of enzyme to make cell wall.
    (C) Tetracycline inactivates both bacterial and eukaryotic ribosome.
    (D) Erythromycin kills bacteria by blocking protein synthesis.
    (E) Antibiotic-resistance gene is often carried by R plasmids.

59. Which one about bacteria and their products is **NOT** matched?
    (A) *Thermus aquaticus* produces *Taq* polymerase.
    (B) *Bacillus thuringiensis* produces toxins to kill insects.
    (C) *Bacillus anthracis* causes anthrax and produces endospore.
    (D) *Borrelia burgdorferi* produces filaments and cause syphilis.
    (E) *Vibrio cholera* releases toxin to alter the permeability of salts in the large intestine.

60. Through which of the following mechanisms is IgG most likely to contribute to the activation of the complement system?
    (A) Cooperate with TLR3 (Toll-like receptor 3) to modulate the formation of C5b.
    (B) Facilitate the initiation of the complement cascade through Fc region binding to C1 protein.
    (C) Interact with CD4 to modulate the release of IL-10.
    (D) Deliver viral antigens to the thymus as part of negative selection.
    (E) Indirectly regulate complement activity by inhibiting the release of perforin and granzymes.

61. Hibernating animals (animals that sleep all winter) can survive long periods without drinking water. What is the primary mechanism?
    (A) Gluconeogenesis increases water availability.
    (B) Urea cycle reduces water loss.
    (C) TCA cycle produces water.
    (D) Glycogen breakdown releases water.
    (E) Fatty acid oxidation (β-oxidation) releases water.

62. The enzymes used for the catabolism of GMP to uric acid following the order:
① Deaminase ② Nucleotidase ③ Xanthine dehydrogenase ④ Nucleoside phosphorylase
(A) ①②④③ (B) ②③①④ (C) ②④③① (D) ②④①③ (E) ④①②③

63. Which of the following statements about thymidylate synthase is correct?
① It catalyzes the conversion of dUMP and N^5, N^{10}-methylene-tetrafolate to dTMP and dihydrofolate.
② It catalyzes the conversion of dUDP and N^5, N^{10}-methylene-tetrafolate to dTDP and dihydrofolate.
③ It catalyzes the conversion of dUMP and N^5, N^{10}-methylene-tetrafolate to dTMP and tetrahydrofolate.
④ 5-Fluorodeoxyuridine monophosphate acts as an irreversible inhibitor of thymidylate synthase.
⑤ 5-Fluorouracil is a reversible inhibitor of thymidylate synthase.
(A) ①④ (B) ①⑤ (C) ②④ (D) ②⑤ (E) ③④

64. The degradation of thymine results in the production of _____.
① β-aminoisobutyric acid ② CO_2 ③ uric acid ④ NH_4^+ ⑤ β-alanine
(A) ①②④ (B) ①③④ (C) ①④⑤ (D) ②④⑤ (E) ②③⑤

65. A biochemist used three protein purification techniques to separate a DNA-binding protein (protein X) from other proteins in a solution. The solution contains three other proteins (A, B, and C) with the following properties:

Protein	pI	Size (Mr)	Binds to DNA?
A	7.4	35,000	Yes
B	6.8	21,500	Yes
C	7.9	23,000	No
X	7.8	22,000	Yes

Which sequence of techniques would be the most effective for purifying protein X from the other proteins?
① Size-exclusion chromatography
② Ion-exchange chromatography
③ Affinity chromatography
(A) ①→②→③ (B) ①→③→② (C) ②→①→③
(D) ②→③→① (E) ③→②→①

66. Which one of the following amino acid peaks will **NOT** appear in the HPLC chromatogram for amino acid analysis?
(A) Gln (B) Phe (C) Met (D) Arg (E) Gly

67. Which of the following statements correctly describes the role of type II topoisomerases?
(A) Type II topoisomerases break one DNA strand and change the linking number in increments of 1.
(B) Type II topoisomerases do not require ATP to function.
(C) Type II topoisomerases can introduce negative supercoils and relax both positive and negative supercoils.
(D) Type II topoisomerases are only involved in DNA replication.
(E) Type II topoisomerases cannot untangle catenanes.

68. Which of the following statements about cholesterol biosynthesis is correct?
① NADPH is not required for cholesterol biosynthesis.
② HMG-CoA reductase is the major control points of the overall process.
③ The conversion of one molecule of mevalonate into one molecule of isopentenyl pyrophosphate consumes three molecules of ATP.
④ The conversion of one molecule of HMG-CoA into one molecule of mevalonate consumes two molecules of NADH.
⑤ The addition of geranyl pyrophosphate to isopentenyl pyrophosphate to form farnesyl pyrophosphate is a head-to-tail reaction.
(A) ①②③ (B) ①③⑤ (C) ②③④ (D) ②③⑤ (E) ②④⑤

69. In eukaryotes, which of the following components is used in the catalytic conversion of stearyl-CoA to oleyl-CoA by stearyl-CoA desaturase?
① NADPH ② NADH ③ Cytochrome *c* ④ Cytochrome *b5* ⑤ O_2
(A) ①②④ (B) ①④⑤ (C) ②③④ (D) ③④⑤ (E) ②④⑤

70. Which of the following statements about *E. coli* DNA polymerase is correct?
① DNA polymerase I is involved in DNA repair.
② DNA polymerase III is involved in chromosomal replication.
③ DNA polymerase III shows 3′ exonuclease activity.
④ DNA polymerase II shows 5′ exonuclease activity.
⑤ The Vmax (nucleotides/second) of DNA polymerase III is higher than that of DNA polymerase I and DNA polymerase II.
(A) ①②③ (B) ①②④ (C) ①②⑤ (D) ②③④ (E) ②④⑤

71. Which of the following enzymes is an aspartate protease and exhibits its catalytic mechanism through the general acid-general base mechanism?
① HIV protease ② Chymotrypsin ③ Pepsin ④ Subtilisin ⑤ Elastase
(A) ①② (B) ①③ (C) ①④ (D) ③④ (E) ③⑤

72. In the process of fatty acid synthesis, which of the following sets represents the starting material and the major irreversible enzyme, respectively?
(A) Malonyl-CoA; Fatty acid synthase
(B) Pyruvate; Acetyl-CoA carboxylase
(C) Acetyl-CoA; ATP-citrate lyase
(D) Acetyl-CoA; Acetyl-CoA carboxylase
(E) NADPH; Fatty acid synthase

73. Which of the following enzymes are involved in the catabolism of propionyl-CoA to succinyl-CoA?
① 2,4-Dienoyl-CoA reductase
② Methylmalonyl-CoA epimerase
③ Methylmalonyl-CoA mutase
④ Enoyl-CoA isomerase
⑤ Acyl-CoA dehydrogenase

(A) ①② (B) ②③ (C) ③④ (D) ③⑤ (E) ④⑤

74. Which of the following phospholipids has zwitterionic properties?
① Phosphatidylinositol ② Phosphatidylglycerol ③ Cardiolipin
④ Phosphatidylethanolamine ⑤ Phosphatidylcholine
(A) ①② (B) ②③ (C) ③④ (D) ③⑤ (E) ④⑤

75. Which of the following statements correctly describes the oxidation of linoleate?
(A) Linoleate has a cis-Δ9, cis-Δ12 configuration.
(B) Linoleate is converted to oleoyl-CoA before entering the β-oxidation pathway.
(C) Linoleate does not require any auxiliary enzymes for its oxidation.
(D) Linoleate is converted to nine molecules of acetyl-CoA without any intermediate steps.
(E) Linoleate is oxidized directly to acetyl-CoA by enoyl-CoA hydratase.

76. Which of the following statements about sphingomyelins is **NOT** correct?
(A) Sphingomyelins contain phosphocholine or phosphoethanolamine as their polar head group.
(B) Sphingomyelins are classified along with glycerophospholipids as phospholipids.
(C) Sphingomyelins have a net positive charge on their head groups.
(D) Sphingomyelins are present in the plasma membranes of animal cells.
(E) Sphingomyelins are especially prominent in myelin.

77. Which of the following enzymes is used in gluconeogenesis only but **NOT** in glycolysis?
(A) pyruvate kinase (B) phosphoglycerate kinase
(C) hexokinase (D) fructose 1,6-bisphosphatase
(E) glyceraldehyde 3-phosphate dehydrogenase

78. Which of the following statements about G_s protein is correct?
① The G_s protein has an αβγ trimeric structure.
② The α subunit of the G_s proteins displays GTPase activity.
③ The β subunit of the G_s proteins has a GTP binding site.
④ G_s protein is involved in activating adenylate cyclase.
⑤ Binding of cholera toxin to G_s protein results in inhibition of adenylate cyclase activity.
(A) ①②③ (B) ①②④ (C) ①③⑤ (D) ②③④ (E) ②③⑤

79. Phenylketonuria (PKU) and Maple Syrup Urine Disease (MSUD) are both inherited metabolic disorders affecting amino acid metabolism. Which of the following best describes between these two disorders?
(A) PKU is caused by a defect in the oxidative decarboxylation of branched-chain amino acids, whereas MSUD elevated blood levels of acetoacetate and β-hydroxybutyrate.
(B) PKU affects the metabolism of branched-chain amino acids, while MSUD involves the transamination of an amino acid.
(C) PKU is due to a deficiency in phenylalanine hydroxylase, while MSUD is caused by a defect in the oxidative decarboxylation of branched-chain amino acids.
(D) Both PKU and MSUD result from impaired absorption of amino acids in the intestine.
(E) PKU and MSUD are both caused by defects in the same enzyme pathway but affect different amino acids.

80. Which of the following statements describes P-type ATPases is **NOT** correct?
(A) P-type ATPases are cation transporters that are reversibly phosphorylated by ATP.
(B) Phosphorylation of P-type ATPases forces a conformational change that moves cations across the membrane.
(C) The Na^+K^+ ATPase is a symporter for Na^+ and K^+ ions in animal cells.
(D) P-type ATPases are sensitive to inhibition by vanadate.
(E) P-type ATPases are found only in eukaryotes.

81. Which of the following has the lowest protein content (as a percentage of dry weight)?
(A) Chylomicron (B) VLDL (C) IDL
(D) LDL (E) HDL

82. The following are intermediate products in cholesterol synthesis. Please select the correct order of the synthesis pathway.

① Acetyl-CoA ② Activated isoprene ③ Cholesterol
④ Lanosterol ⑤ Mevalonate ⑥ Squalene

(A) ①→⑤→②→④→⑥→③ (B) ①→②→⑤→⑥→④→③
(C) ①→⑤→⑥→②→④→③ (D) ①→⑤→②→⑥→④→③
(E) ⑤→①→②→⑥→③→④

83. Which of the following statements correctly describes how miRNA degrades target mRNA?

(A) After mature miRNA binds to RISC, it suppresses translation when partially complementary to the mRNA.
(B) miRNA directly binds to the mRNA poly-A tail to promote its degradation.
(C) miRNA functions in the nucleus and promotes mRNA degradation by altering DNA methylation.
(D) miRNA inhibits mRNA transcription by interfering with RNA polymerase II, ultimately leading to mRNA degradation.
(E) Dicer cleaves pri-miRNA in the nucleus, while Drosha processes pre-miRNA in the cytoplasm.

84. ① is one of the enzymes that appears in ②. Which one of the following is **NOT** correct?

(A) ① Arginase; ② urea cycle
(B) ① Pyruvate dehydrogenase; ② TCA cycle
(C) ① Aspartate transcarbamoylase; ② the *de novo* biosynthesis of pyrimidine
(D) ① Glucose-6-phosphate dehydrogenase; ② the pentose phosphate pathway
(E) ① Ribonucleotide reductase; ② the de novo biosynthesis of dNTP

85. Which of the following statements about amylose and cellulose is correct?

① The sugar residue in amylose and cellulose is glucose.
② Amylose is the storage polysaccharide, and cellulose is the structural polysaccharide.
③ Amylose has a regular helical conformation.
④ Sugar residues in cellulose are connected by α(1→4) linkage.
⑤ Sugar residues in amylose are connected by β(1→4) linkage.

(A) ①②③ (B) ①③④ (C) ①④⑤ (D) ②③④ (E) ②④⑤

86. Which of the following enzymes **CANNOT** reduce ubiquinone (Q) to ubiquinol (QH_2) in the mitochondrial electron transport chain?

(A) Dihydroorotate dehydrogenase (B) Succinate dehydrogenase
(C) ETF: ubiquinone oxidoreductase (D) ATP synthase
(E) Glycerol 3-phosphate dehydrogenase

87. Which of the following statements about the pentose phosphate pathway is correct?
① The pentose phosphate pathway produces NADPH and ribose-5-phosphate.
② The pentose phosphate pathway begins with the oxidation of glucose-1-phosphate.
③ The pentose phosphate pathway consists of oxidative and non-oxidative reactions.
④ The pentose phosphate pathway is also known as hexose monophosphate shunt.
⑤ The oxidative phase of the pentose phosphate produces one molecule of NADPH.
(A) ①②③ (B) ①③④ (C) ①③⑤ (D) ①④⑤ (E) ①②④

88. Which of the following statements about glycogenolysis is correct?
① Epinepherine promotes glycogenolysis in muscle.
② Glucagon promotes glycogenolysis in liver.
③ Insulin promotes glycogenolysis in liver.
④ Phosphorylase b catalyzes the breakdown of glycogen into glucose.
⑤ Phosphorylase a catalyzes the breakdown of glycogen into glucose-1-phosphate.
(A) ①②③ (B) ①②④ (C) ①②⑤ (D) ②③④ (E) ②④⑤

89. Which of the following statements is **NOT** correct regarding the interaction of carbon monoxide (CO) with hemoglobin (Hb)?
(A) A Hb with two bound CO molecules releases little oxygen in the tissues.
(B) Fetal Hb has a higher affinity for CO than adult Hb.
(C) Removing CO-poisoned person from CO-polluted site results in slowly dropping of COHb level.
(D) As CO bind to two Hb subunits, the affinity for oxygen is decreased in the remaining substrates.
(E) The CO-oxygen exchange can be accelerated by 100% oxygen at a pressure of 3 atm.

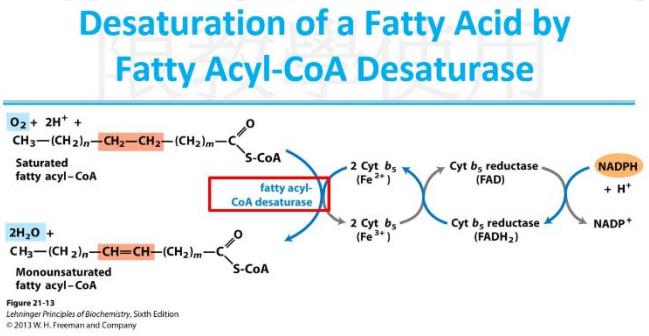
90. Which of the following statements is correct regarding reversible inhibition of enzymes?
① The catalytic efficiency of enzyme is K_{cat}/K_m in the presence of competitive inhibitors.
② Competitive inhibitors are substrate analogs or transtion state analogs.
③ Uncompetitive inhibitors combine only with enzyme-substrate complex.
④ In the presence of inhibitors, the initial rate of enzyme-catalyzed reactions is positively correlated with substrate concentration.
⑤ The binding of noncompetitive inhibitors to enzymes is inhibited by substrate.
(A) ①②③ (B) ②③④ (C) ③④⑤ (D) ①③④ (E) ②④⑤

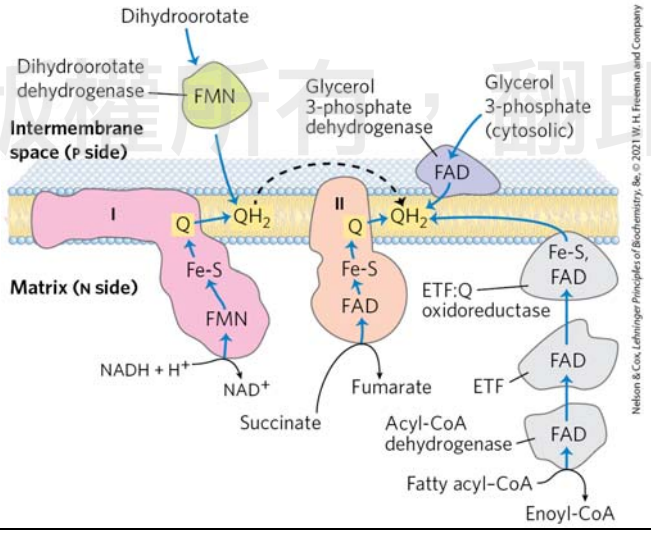
後醫-普通生物及生化概論

題號	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
答案	B	D	A	C	D	B	A	C	E	A	C	E	B	D	E	B	E	C	E	C
題號	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
答案	D	C	E	A	B	E	D	B	C	B	D	E	C	A	B	A	C	E	B	E
題號	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
答案	C	E	B	D	C	A	B	A	E	D	B	A	C	B	A	D	E	C	D	B
題號	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
答案	E	D	A	A	E	A	C	D	E	C	B	D	B	E	A	C	D	B	C	E
題號	81	82	83	84	85	86	87	88	89	90										
答案	A	D	A	B	A	D	B	C	D	B										

高雄醫學大學 114 學年度學士後醫學系招生考試試題參考答案疑義釋疑公告

科目	題號	釋疑答覆	釋疑結果
生化概論	18	根據 Lehninger Principles of Biochemistry, 8ed, Table 3-1: glycine 的等電點(pI)為 5.97，其 carboxyl group (-COOH) pKa ≈ 2.34 與其 amino group (-NH2) pKa ≈ 9.6。本題問 glycine 在**酸性的環境**下是否都帶正電荷，答案應該為帶正電荷或是不帶電，因為其 PI 值也屬於酸性環境之下。	維持原答案(C)
	25	(B)為正解, Lehninger Principles of Biochemistry, 8ed, p1984 (A)Fructose 6-bisphosphate是錯誤選項 (C)Citrate不直接參與在pentose phosphate pathway (PPP) (D)Phosphoenolpyruvate (PEP)是glycolytic intermediate，但不是glycolysis, fat metabolism, and PPP 的重要regulator (E) NADPH是PPP的產物並參與fat metabolism但不是regulator	維持原答案(B)
	26	此題問"best explains" ，選項E為最佳答案。	維持原答案(E)
	29	題目" Which kinase in MAPK cascade is responsible for phosphorylating both Thr and Tyr residues on its substrate "明顯指出同一個受質的Thr and Tyr residues的磷酸化，答案(C) MEK為正確答案，而 ERK 為 Ser/Thr kinase。	維持原答案(C)
	61	根據Lehninger Principles of Biochemistry, 8ed, p2207-2208. Hibernating animals 主要是以儲存fat作為冬眠時主要的能量來源，Fatty acid oxidation (β-oxidation) 雖是經由分解 triglycerides產生acetyl-CoA, 進入 TCA cycle及 electron transport chain (ETC)產生代謝水，但是β-oxidation為冬眠動物最主要產生代謝水的原始重要反應(**primary mechanism**)。因此(E)為正解。	維持原答案(E)
	64	應該是在問65題(錯植?) ，請見65題的回覆。	維持原答案(A)

科目	題號	釋疑答覆	釋疑結果
	65	本題要求"最有效"的技術序列，應著重於針對給定蛋白特性的最佳區分策略，而非遵循常規程序。(1)雖然考生引用文獻指出親和層析法常作為"最後步驟"，但這是一般純化策略而非絕對規則在特定情境下，層析法的順序應根據待分離蛋白質的具體特性來決定。本題中，親和層析法用於第一步驟可立即去除蛋白C(不結合DNA)，這是合理且有效的策略。(2)苛刻洗脫條件的影響被放大:考生強調親和層析法可能需要極端pH條件，但DNA親和層析通常可用鹽度梯度洗脫，不一定需要極端條件即使有苛刻條件，若目標蛋白較穩定，或其他分離方法效果不佳時，仍可考慮先用親和層析。(3)本題情境的特殊性:本題中有4種蛋白，其中只有C不結合DNA，這使得DNA親和層析法在第一步就能有效去除25%的干擾蛋白。剩餘蛋白(X、A、B)的pI和分子量差異可被後續離子交換和尺寸排阻層析有效區分。(5)雖然Lehninger教科書顯示常規純化表中親和層析位於最後，但該表代表一般情況而非所有情境。因此維持原答案:選項E(3→2→1)最具有效率。	維持原答案(E)
	66	本題為根據 Lehninger Principles of Biochemistry, 8ed, 第三章中蛋白質的 6N 酸水解方式，麩醯胺(Gln)：醯胺側鏈(-CO-NH₂)被水解為羧基(-COOH)，轉化為麩胺酸(Glu).(1)考生舉例(https://doi.org/10.1016/j.focha.2023.100415)中 Ninhydrin 幾乎都可以與胺基酸上的 amino group 反應後使用 HPCL 測到所有胺基酸，與本題不符合。(2)考生舉例(DOI: 10.10160261-5614(91)90037-d)其中保存條件為 4~-20 度 C，這為特殊低溫保存方式與本題題意不符。	維持原答案(A)
	67	Type II topoisomerases introduce negative supercoils and relax both positive and negative supercoils. Type II topoisomerases require ATP to function. Type II topoisomerases can untangle catenanes. Topoisomerase IV屬於type II topoisomerase。選項(C)無誤。	維持原答案(C)
	69	根據Lehninger Principles of Biochemistry, 8ed, 第21章 Figure 21-13，NADPH, Cytochrome *b5* & O2 為正解。  **Desaturatoion of Fatty Acids Requires a Mixed-Function Oxidase** fatty acyl-CoA desaturase, a mixed-function oxidase	答案改成(B)

科目	題號	釋疑答覆	釋疑結果
	70	根據 Mathews, et al, 4ed. Biochemistry, p1044, Table 25-1: DNA polymerase III (polC)不含有 3' exonuclease activity，而是由另一個 DnaQ 蛋白負責。	維持原答案(C)
	72	Pyruvate可做為其他反應的starting materials，Acetyl-CoA 為正解(starting materials of fatty acid synthesis)，acetyl-CoA carboxylase為major irreversible enzyme, rate-limiting step in the biosynthesis of fatty acids。	維持原答案(D)
	76	根據Lehninger Principles of Biochemistry, 8ed, p1308: " Sphingomyelins contain phosphocholine or phosphoethanolamine as their polar head group." 選項(A)無誤。	維持原答案(C)
	80	根據 Lehninger Principles of Biochemistry, 8ed, p1465, Figure 11-37: (C) The Na^+-K^+ ATPase is a symporter for Na^+ and K^+ ions in animal cells. 是錯誤的。(E) P-type ATPases are found only in eukaryotes 也是錯誤的。	(C)和(E)皆為正確答案
	83	題幹所問"correctly describes how miRNA degrades target mRNA"與選項A並無衝突。Lehninger Principles of Biochemistry, 8ed, Page 3421& FIGURE 26-26 清楚陳述"After mature miRNA binds to RISC, it suppresses translation when partially complementary to the mRNA. "。	維持原答案(A)
	84	Ribonucleotide reductase確實是 the de novo biosynthesis of dNTP的重要酵素，無誤。	維持原答案(B)
	86	根據 Lehninger Principles of Biochemistry, 8ed 的 Figure 19-15, p2398: (D) ATP synthase 無法還原 Q→QH_2 答案無誤。 (A) Dihydroorotate dehydrogenase (B) Succinate dehydrogenase (C) ETF: ubiquinone oxidoreductase (E) Glycerol 3-phosphate dehydrogenase 皆參與在 mitochondrial electron transport chain 的 ubiquinone (Q) to ubiquinol (QH_2)的電子轉移反應中。  	維持原答案(D)
	89	根據Lehninger Principles of Biochemistry, 8ed, p656: "When an individual is moved from the CO-polluted site to a normal, outdoor atmosphere, O_2 begins to replace the CO in hemoglobin — but the COHb level drops only slowly."	維持原答案(D)

科目	題號	釋疑答覆	釋疑結果
	90	Catalytic efficiency is defined as kcat/Km under uninhibited conditions**.** 根據Lehninger Principles of Biochemistry, 8ed, p813: In the presence of inhibitors, it calls “apparent Km”, is defined as αKm. 以下解釋①&⑤為錯誤之理由： ① In the presence of competitive inhibitors**,** Km increases (apparent affinity decreases), but Kcat remains unchanged. kcat/Km cannot be directly used to define efficiency with inhibition. ⑤Their binding of noncompetitive inhibitors to enzymes is not affected by substrate concentration, so substrate does not inhibit their binding.	維持原答案(B)

高雄醫學大學114學年度學士後醫學系招生考試試題參考答案疑義釋疑公告

科目	題號	釋疑答覆	釋疑結果
普通生物學	1	Vascular system 主要與植物的大小有關，然胚胎的保護機制才是重中之重	答案維持(B)
	11	In animal, hermaphroditism 該單字的創設就是強調"同時"可以存在， 跟可 reverse 性別是不同	答案維持(C)
	15	選項（A）epigenetic changes 是對的，因為 DNA 低甲基化或組蛋白修飾等變化可以增加基因的表達。（資料根據:Campbell, Biology, 12ed, P439） 選項（E）transduction(轉導)並非原癌基因過度活化的主要機制，病毒轉導（病毒引入外來 DNA）可以引入致癌基因，但大多數情況下它並**不是**過度活化現有原癌基因的**直接**機制。它與**引入致癌基因**更相關，而不是修改原癌基因。 →排除其它直接的選項後，只有(E)選項較不合適，因此答案維持(E)選項。	答案維持(E)
	32	吸水及礦物元素，共生菌菌圈是讓根的功能更強大	答案維持(E)
	34	只有壓力勢才是後面讓水分運移的"動力"	答案維持(A)
	35	不親合蛋白質的降解才是避免自花授粉最重要的關鍵	答案維持(B)
	37	ATP 是 Thylakoid 外形成，不是內部。該題主要是探討 stroma 的暗反應	答案維持(C)
	39	該題意相當清楚指出基因型(先天遺傳)與外表型(可由後天環境影響)	答案維持(B)
	41	The chapter describes the Ediacaran biota as soft-bodied organ over 1 m long than lived from 635 to 541 million years ago. Representing an enormous change from the previous microbial world and setting the stage for the Cambrian explosion.	答案維持(C)

<table>
<tr><th>科目</th><th>題號</th><th>釋疑答覆</th><th>釋疑結果</th></tr>
<tr><td></td><td>42</td><td>在胚胎發育過程中，body axes 的決定，是最重要的初始定型</td><td>答案維持(E)</td></tr>
<tr><td></td><td>44</td><td>An extinction vortex is characterized by a small population size that leads to “inbreeding”and loss of genetic variation, which further reduces the population’s to adapt and survive.</td><td>答案維持(D)</td></tr>
<tr><td></td><td>45</td><td>在 Decent with modification: A Darwinian view of life 中明確提到 migration of resistant individuals leads to the “spread” of resistance gene.</td><td>答案維持(C)</td></tr>
<tr><td></td><td>57</td><td>1. 選項 (D) Acetaminophen bind cox to relieve pain. (資料根據:Brooker, Biology, 3rd ed, p99)。

2. Acetaminophen 雖可能並非 bind 在 active, 但有 binding。
Table 2. Interaction of COX-2 with acetaminophen
<table><tr><th>Name</th><th>Distance</th><th>Category</th><th>Types</th><th>From Chemistry</th><th>To Chemistry</th></tr><tr><td>: LIG1: H – A:SER530:OG</td><td>2.72612</td><td>Hydrogen Bond</td><td>Conventional hydrogen bond</td><td>H-Donor</td><td>H-acceptor</td></tr><tr><td>A: GLY526: C, O;ALA527: N -: LIG1</td><td>4.47155</td><td>Hydrophobic</td><td>Amide-Pi Stacked</td><td>Amide</td><td>Pi-Acceptor</td></tr><tr><td>: LIG1 – A:VAL349</td><td>5.16312</td><td>Hydrophobic</td><td>Pi-Alkyl</td><td>Pi-Orbitals</td><td>Alkyl</td></tr><tr><td>: LIG1 – A:LEU352</td><td>5.35157</td><td>Hydrophobic</td><td>Pi-Alkyl</td><td>Pi-Orbitals</td><td>Alkyl</td></tr></table>(資料根據:Interaction of acetaminophen and caffeine towards cyclooxygenase-2 (COX-2) in inhibition of prostaglandin (PGH2) synthesis. G C Krisnamurti and F Fatchiyah 2019 J. Phys.: Conf. Ser. 1146 012004)

3. Opiates decrease the sensitivity of chemoreceptors to CO2 but not O2. (資料根據: Brooker, Biology, 3rd ed, p1003)。

→因此答案維持 (E)選項。</td><td>答案維持(E)</td></tr>
<tr><td></td><td>59</td><td>1. Vibrio cholerae 也會在大腸 (資料根據: Brooker, Biology, 3rd ed, p 940)。

2. The presence of Vibrio cholerae in the blood, bile (in 60 and 70% cases, respectively), small and large intestine (in 100% cases). (資料來源: Ultrastructural evidence of invasive activity of Vibrio cholerae. Kharlanova NG, Lomov YM, Bardykh ID, Monakhova EV, Bardakhch'yan EA. Bull Exp Biol Med. 2004 Apr;137(4):403-6. doi: 10.1023/b:bebm.0000035143.55617.04. PMID: 15452615)

→因此答案維持 (D)選項。</td><td>答案維持(D)</td></tr>
</table>

生化概論

莊老師(施政安)老師提供

16. What is the primary source of one-carbon units for tetrahydrofolate?
(A) Conversion of glycine to serine
(B) Conversion of serine to glycine
(C) Conversion of methionine to homocysteine
(D) Conversion of histidine to glutamate
(E) Conversion of succinyl-CoA to methylmalonyl-CoA

17. Which of the following statements correctly describes the role of pyridoxal phosphate (PLP) in aminotransferase reactions?
(A) PLP is the coenzyme form of vitamin B12.
(B) PLP cannot accept an amino group.
(C) PLP is generally covalently bound to the enzyme's active site through a peptide bond.
(D) PLP is only involved in the metabolism of carbohydrates.
(E) PLP functions as an intermediate carrier of amino groups at the active site of aminotransferases.

Ans: E
[解析] Mechanism of Transaminase: NH_3^+-A → NH_3^+-B
Step 1) E-PLP + NH_3^+-A → *E-PLP-NH_3^+* + R
Step 2) *E-PLP-NH_3^+* + B → E-PLP + NH_3^+-B
故選(E)
(E/transaminase; NH_2-A /amino acid A; NH_2-B /amino acid B; R/α-keto acid)

18. Which of the following statements about amino acid residues is correct?
① Phenylalanine has UV absorption at 260 nm.
② Glycine has a positive net charge at acidic solutions.
③ The side chain of serine cannot be ionized.
④ Isoleucine and leucine have the same molecular weight.
⑤ Cysteine can be oxidized to form cystine.
(A) ①②③ (B) ①③④ (C) ①④⑤ (D) ②④⑤ (E) ③④⑤

19. Which intermediate is formed during the carboxylation of propionyl-CoA by propionyl-CoA carboxylase?
(A) Acetyl-CoA (B) Citrate (C) Succinyl-CoA
(D) Pyruvate (E) Carboxybiotin

Ans: E
[解析] Mechanism of propionyl-CoA carboxylase:
Step 1) E-biotin + CO_2 → *E-biotin-COO^- (carboxybiotin)*
Step 2) *E-biotin-COO^-* + propionyl-CoA
→ E-biotin + D-methyl-malonyl-CoA

故選(E)

(E-biotin/ propionyl-CoA carboxylase)

20. Which of the following statements correctly describes the role of hormones in the coordinated regulation of glycolysis and gluconeogenesis in liver?
(A) Glucagon stimulates glycolysis and inhibits gluconeogenesis.
(B) Insulin stimulates gluconeogenesis and inhibits glycolysis.
(C) Glucagon decreases the levels of fructose-2,6-bisphosphate and inhibits glycolysis.
(D) Insulin increases the levels of fructose-2,6-bisphosphate and inhibits glycolysis.
(E) Epinephrine inhibits both glycolysis and gluconeogenesis.

21. Which of the following substances is necessary for the synthesis of palmitate?
① $FADH_2$ ② Malonyl-CoA ③ NADPH ④ NADH ⑤ Acetyl-CoA
(A) ①②③ (B) ①②④ (C) ①④⑤ (D) ②③⑤ (E) ①②⑤

Ans: D
[解析] *de novo* biosynthesis of fatty acid in cytosol:
Step 1) Acetyl-CoA + CO_2 + ATP → Malonyl-CoA + ADP + Pi
Step 2) *Acetyl-CoA* + 7*Malonyl-CoA* + 7 (2*NADPH* + $2H^+$)
→ Palmitate + 7 ($2NADP^+$)

22. Which of the following enzyme-catalyzed steps in glycolysis is performed by different enzymes in gluconeogenesis?
① Hexokinase ② Pyruvate kinase ③ Aldolase ④ Phosphofructokinase
⑤ Phosphoglycerate kinase
(A) ①②③ (B) ②③④ (C) ①②④ (D) ②③⑤ (E) ①②⑤

23. Which of the following cofactors is essential for the activity of several key enzymes in glycolysis, primarily by forming a complex with ATP?
(A) Zinc ion (Zn^{2+})
(B) Cobalamin (Vitamin B_{12})
(C) Thiamine pyrophosphate (TPP)
(D) Pyridoxal phosphate (PLP)
(E) Magnesium ion (Mg^{2+})

Ans: E
[解析] *Most glycolytic enzymes require Mg^{2+} for activity*.
(Nelson and Cox, Lehninger's Principles of Biochemistry, 8th edition, p.514)

24. Which protein complex in the mitochondrial electron transport chain has the largest molecular weight and is also inhibited by rotenone?
(A) Complex I (NADH: ubiquinone oxidoreductase)
(B) Complex II (Succinate dehydrogenase)
(C) Complex III (Cytochrome bc_1complex)
(D) Complex IV (Cytochrome oxidase)
(E) Complex V (ATP synthase)

25. Which molecule plays a key regulatory role in glycolysis, fat metabolism, and the pentose phosphate pathway (PPP)?
(A) Fructose 6-bisphosphate
(B) Xylulose 5-phosphate
(C) Citrate

(D) Phosphoenolpyruvate (PEP)
(E) NADPH

Ans: B
[解析]

1) 本題考 ChREBP function: ChREBP activated the target genes

(a) Glycolysis: Glucokinase, Pyruvate kinase

(b) PPP: glucose-6-phosphate dehydrogenase, transketolase

(c) Fatty acid biosynthesis: acetyl-CoA carboxylase, FAS

(PPP/pentose phosphate pathway)

(Katsumi Lizuka, The transcription factor carbohydrate-response-element-protein(ChREBP): a possible link between metabolic disease and cancer, *Biochemica et Biophysica Acta,* 2017, 1863: 474)

2) ChREBP activated by xylulose-5-phosphate:

Glucose-6-phosphate
↓ PPP
Xylulose-5-phosphate
↓
PP2A (protein phosphatase 2A)
↓ activates
ChREBP transcription factor
↓ activates
Genes: Glycolytic enzyme genens, Fatty acid biosynthetic genes, and PPP genes

26. RNA is more susceptible to hydrolytic cleavage than DNA due to structural differences. Which of the following best explains its increased instability?
(A) RNA lacks complementary base pairing, reducing structural stability.
(B) RNA contains uracil instead of thymine, making it more susceptible to degradation.
(C) RNA lacks the double-helix structure of DNA, reducing protection from external damage.
(D) RNA is more chemically reactive than DNA due to its ribose sugar.
(E) The 2'-hydroxyl (-OH) group in RNA facilitates self-cleavage under alkaline conditions.

27. Which statement about histones is correct?
① Histones are negatively charged proteins that stabilize the DNA double helix.
② Lysine and arginine residues of histones can be methylated.
③ Histone octamer contains H2A, H2B, H3, and H4.
④ Deacetylation of histones is not involved in epigenetic regulation.
⑤ H1 is involved in linking nucleosomes.
(A) ①②③ (B) ①③④ (C) ②③④ (D) ②③⑤ (E) ③④⑤

Ans: D
[解析]

題 號 修正

① Histones are positively charged proteins.

④ Deacetylation of histones is involved in epigenetic regulation.

28. What is the primary function of reverse transcriptases in retroviruses?
(A) To synthesize RNA from a DNA template
(B) To convert RNA genomes into double-stranded DNA
(C) To degrade viral RNA
(D) To synthesize telomere ends of chromosomes
(E) To insert RNA introns into DNA genes

29. Which kinase in MAPK cascade is responsible for phosphorylating both Thr and Tyr residues on its substrate?
(A) Raf-1 (B) ERK (C) MEK (D) IRS1 (E) Grb2

Ans: C
[解析]
1) MEK is a *dual* kinase.
2) Dual kinase phosphorylates the target protein on a *serine* and a *tyrosine* residue.

30. An enzymatic reaction has a maximum velocity (V_{max}) of 30 μM/min and a Michaelis constant (K_m) of 50 μM. If the substrate concentration ([S]) is 25 μM, what is the reaction velocity (v)?
(A) 7.5 μM/min (B) 10 μM/min (C) 15 μM/min
(D) 20 μM/min (E) 25 μM/min

61. Hibernating animals (animals that sleep all winter) can survive long periods without drinking water. What is the primary mechanism?
(A) Gluconeogenesis increases water availability.
(B) Urea cycle reduces water loss.
(C) TCA cycle produces water.
(D) Glycogen breakdown releases water.
(E) Fatty acid oxidation (β-oxidation) releases water.

Ans: E
[解析] Fatty acid oxidation generates more ATP and H_2O:
1) Fatty acid
↓ β-*oxidation*
Acetyl-CoA + more (NADH and $FADH_2$)
↓ TCA cycle
More NADH and $FADH_2$
2) More NADH and $FADH_2$
↓ electron transfer chair
O_2 → *more* H_2O

62. The enzymes used for the catabolism of GMP to uric acid following the order:
① Deaminase ② Nucleotidase ③ Xanthine dehydrogenase ④ Nucleoside phosphorylase
(A) ①②④③ (B) ②③①④ (C) ②④③① (D) ②④①③ (E) ④①②③

63. Which of the following statements about thymidylate synthase is correct?
① It catalyzes the conversion of dUMP and N^5, N^{10}-methylene-tetrafolate to dTMP and dihydrofolate.
② It catalyzes the conversion of dUDP and N^5, N^{10}-methylene-tetrafolate to dTDP and dihydrofolate.
③ It catalyzes the conversion of dUMP and N^5, N^{10}-methylene-tetrafolate to dTMP and

tetrahydrofolate.
④ 5-Fluorodeoxyuridine monophosphate acts as an irreversible inhibitor of thymidylate synthase.
⑤ 5-Fluorouracil is a reversible inhibitor of thymidylate synthase.
(A) ①④ (B) ①⑤ (C) ②④ (D) ②⑤ (E) ③④

Ans: A
[解析]

題 號	修正
② ③	It catalyzes the conversion of dUMP and N^5, N^{10}-methylene-tetrahydrofolate to *dTMP* and *dihydrofolate*.
⑤	5-Fluorouracile is an *irreversible i*nhibitor of thymidylate synthase.

64. The degradation of thymine results in the production of _____.
① β-aminoisobutyric acid ② CO_2 ③ uric acid ④ NH_4^+ ⑤ β-alanine
(A) ①②④ (B) ①③④ (C) ①④⑤ (D) ②④⑤ (E) ②③⑤

65. A biochemist used three protein purification techniques to separate a DNA-binding protein (protein X) from other proteins in a solution. The solution contains three other proteins (A, B, and C) with the following properties:

Protein	pI	Size (Mr)	Binds to DNA?
A	7.4	35,000	Yes
B	6.8	21,500	Yes
C	7.9	23,000	No
X	7.8	22,000	Yes

Which sequence of techniques would be the most effective for purifying protein X from the other proteins?
① Size-exclusion chromatography
② Ion-exchange chromatography
③ Affinity chromatography
(A) ①→②→③ (B) ①→③→② (C) ②→①→③
(D) ②→③→① (E) ③→②→①

Ans: E
[解析] Purification step:

A, B, C, X
↓ ③ affinity chromatography
A, B, X (DNA-binding) + C release (DNA-unbinding)
↓ ② ion-exchange chromatography
A, X (pI > 7.0) + B release (pI 6.8 < 7.0)
↓ ① size-exclusion chromatography

E*lution sequence:* A (35KD) → *X (22 KD)*
故選(E)

66. Which one of the following amino acid peaks will **NOT** appear in the HPLC chromatogram for amino acid analysis?
(A) Gln (B) Phe (C) Met (D) Arg (E) Gly

67. Which of the following statements correctly describes the role of type II topoisomerases?
(A) Type II topoisomerases break one DNA strand and change the linking number in increments of 1.
(B) Type II topoisomerases do not require ATP to function.
(C) Type II topoisomerases can introduce negative supercoils and relax both positive and negative supercoils.
(D) Type II topoisomerases are only involved in DNA replication.
(E) Type II topoisomerases cannot untangle catenanes.

Ans: C
[解析]

題 號　　修正

(A) Type II topoisomerases break *two DNA* strand and ΔLk increment of *2*.
(B) Type II topoisomerases *need ATP* to function.
(D) Type II topoisomerases involve in *replication and recombination*.
(E) Type II topoisomerases can *resolve* the catenanes of DNA.

68. Which of the following statements about cholesterol biosynthesis is correct?
① NADPH is not required for cholesterol biosynthesis.
② HMG-CoA reductase is the major control points of the overall process.
③ The conversion of one molecule of mevalonate into one molecule of isopentenyl pyrophosphate consumes three molecules of ATP.
④ The conversion of one molecule of HMG-CoA into one molecule of mevalonate consumes two molecules of NADH.
⑤ The addition of geranyl pyrophosphate to isopentenyl pyrophosphate to form farnesyl pyrophosphate is a head-to-tail reaction.
(A) ①②③　(B) ①③⑤　(C) ②③④　(D) ②③⑤　(E) ②④⑤

69. In eukaryotes, which of the following components is used in the catalytic conversion of stearyl-CoA to oleyl-CoA by stearyl-CoA desaturase?
① NADPH ② NADH ③ Cytochrome *c* ④ Cytochrome *b5* ⑤ O_2
(A) ①②④　(B) ①④⑤　(C) ②③④　(D) ③④⑤　(E) ②④⑤

Ans: B
[解析] 釋疑後改為(B)
1) Desaturase system: Lehinger 版
(a) Reaction:
Stearic acid + O_2 + *NADPH* + H^+ → Linoleic acid + $2H_2O$ + $NADP^+$
(b) System enzymes: (desaturase + cytochrome *b5* + cytochrome *b5* reductase)
2) **依現行生化教科書則有 NADH 或 NADPH 兩種寫法:**
(a) Lehinger: *NADPH*
(Nelson and Cox, Lehninger's Principles of Biochemistry, 6th edition, Figure 21-23, p.838)
(b) Garrett and Grisham 版: *NADH*
(Garrett and Grisham, Biochemistry, 8th edition, Figure 25.24, p.514)
3) 釋疑後出題者支持 Lehinger 版
4) 本作者則支持原解(B) NADH 說法: 根據最新報告指出 cytochrome *b5*

reductase 是 NADH-dependent enzyme.
(Elahian et al, Human cytochrome b5 reductase: structure, function,
And potential applications, Critical Reviews in Biotechnology, 2012)

70. Which of the following statements about *E. coli* DNA polymerase is correct?
① DNA polymerase I is involved in DNA repair.
② DNA polymerase III is involved in chromosomal replication.
③ DNA polymerase III shows 3' exonuclease activity.
④ DNA polymerase II shows 5' exonuclease activity.
⑤ The Vmax (nucleotides/second) of DNA polymerase III is higher than that of DNA polymerase I and DNA polymerase II.
(A) ①②③ (B) ①②④ (C) ①②⑤ (D) ②③④ (E) ②④⑤

71. Which of the following enzymes is an aspartate protease and exhibits its catalytic mechanism through the general acid-general base mechanism?
① HIV protease ② Chymotrypsin ③ Pepsin ④ Subtilisin ⑤ Elastase
(A) ①② (B) ①③ (C) ①④ (D) ③④ (E) ③⑤

Ans: B
[解析] Aspartic peptidase: ① HIV-1 protease, ③ Pepsin, and Cathepsin D

72. In the process of fatty acid synthesis, which of the following sets represents the starting material and the major irreversible enzyme, respectively?
(A) Malonyl-CoA; Fatty acid synthase
(B) Pyruvate; Acetyl-CoA carboxylase
(C) Acetyl-CoA; ATP-citrate lyase
(D) Acetyl-CoA; Acetyl-CoA carboxylase
(E) NADPH; Fatty acid synthase

73. Which of the following enzymes are involved in the catabolism of propionyl-CoA to succinyl-CoA?
① 2,4-Dienoyl-CoA reductase
② Methylmalonyl-CoA epimerase
③ Methylmalonyl-CoA mutase
④ Enoyl-CoA isomerase
⑤ Acyl-CoA dehydrogenase
(A) ①② (B) ②③ (C) ③④ (D) ③⑤ (E) ④⑤

Ans: B
[解析] Propionyl-CoA
CO_2 + ATP ↓ propionyl-CoA carboxylase/biotin
D-Methyl-malonyl-CoA
↓ ② D-*Methyl-malonyl-CoA epimerase*
L-Methyl-malonyl-CoA
↓ ③ L-*Methyl-malonyl-CoA mutase*/B_{12}
Succinyl-CoA

74. Which of the following phospholipids has zwitterionic properties?
① Phosphatidylinositol
② Phosphatidylglycerol

③ Cardiolipin
④ Phosphatidylethanolamine
⑤ Phosphatidylcholine
(A) ①② (B) ②③ (C) ③④ (D) ③⑤ (E) ④⑤

75. Which of the following statements correctly describes the oxidation of linoleate?
(A) Linoleate has a cis-Δ9, cis-Δ12 configuration.
(B) Linoleate is converted to oleoyl-CoA before entering the β-oxidation pathway.
(C) Linoleate does not require any auxiliary enzymes for its oxidation.
(D) Linoleate is converted to nine molecules of acetyl-CoA without any intermediate steps.
(E) Linoleate is oxidized directly to acetyl-CoA by enoyl-CoA hydratase.

Ans: A
[解析]
題_號_____修正_____
(B) Linoleate is converted to *linoleoyl-CoA* before entering the β-oxidation.
(C) Linoleate *requires one auxiliary* enzyme (*isomerase*) for its oxidation.
(D) Linoleate is converted to nine acetyl-CoA *with two different intermediate* step than stearate β-oxidation.
(E) Linoleate is converted to acetyl-CoA by the process of β-oxidation.

76. Which of the following statements about sphingomyelins is **NOT** correct?
(A) Sphingomyelins contain phosphocholine or phosphoethanolamine as their polar head group.
(B) Sphingomyelins are classified along with glycerophospholipids as phospholipids.
(C) Sphingomyelins have a net positive charge on their head groups.
(D) Sphingomyelins are present in the plasma membranes of animal cells.
(E) Sphingomyelins are especially prominent in myelin.

77. Which of the following enzymes is used in gluconeogenesis only but NOT in glycolysis?
(A) pyruvate kinase
(B) phosphoglycerate kinase
(C) hexokinase
(D) fructose 1,6-bisphosphatase
(E) glyceraldehyde 3-phosphate dehydrogenase

Ans: D
[解析] Enzymes in gluconeogenesis only:
1) Pyruvate carboxylase
2) PEP carboxykinase
3) *Fructose-1,6-bisphosphatase*-1
4) Glucose-6-phosphatase

78. Which of the following statements about G_s protein is correct?
① The G_s protein has an αβγ trimeric structure.
② The α subunit of the G_s proteins displays GTPase activity.
③ The β subunit of the G_s proteins has a GTP binding site.
④ G_s protein is involved in activating adenylate cyclase.
⑤ Binding of cholera toxin to G_s protein results in inhibition of adenylate cyclase activity.

(A) ①②③ (B) ①②④ (C) ①③⑤ (D) ②③④ (E) ②③⑤

79. Phenylketonuria (PKU) and Maple Syrup Urine Disease (MSUD) are both inherited metabolic disorders affecting amino acid metabolism. Which of the following best describes between these two disorders?
(A) PKU is caused by a defect in the oxidative decarboxylation of branched-chain amino acids, whereas MSUD elevated blood levels of acetoacetate and β-hydroxybutyrate.
(B) PKU affects the metabolism of branched-chain amino acids, while MSUD involves the transamination of an amino acid.
(C) PKU is due to a deficiency in phenylalanine hydroxylase, while MSUD is caused by a defect in the oxidative decarboxylation of branched-chain amino acids.
(D) Both PKU and MSUD result from impaired absorption of amino acids in the intestine.
(E) PKU and MSUD are both caused by defects in the same enzyme pathway but affect different amino acids.

Ans: C
[解析]

Disease	Deficiency	Reaction type
PKU	*Phenylalanine hydroxylase*	Hydroxylation
MSUC	*BCAA α-keto acid dehydrogenase complex*	*Oxidative decarboxylation*

80. Which of the following statements describes P-type ATPases is **NOT** correct?
(A) P-type ATPases are cation transporters that are reversibly phosphorylated by ATP.
(B) Phosphorylation of P-type ATPases forces a conformational change that moves cations across the membrane.
(C) The Na^+K^+ ATPase is a symporter for Na^+ and K^+ ions in animal cells.
(D) P-type ATPases are sensitive to inhibition by vanadate.
(E) P-type ATPases are found only in eukaryotes.

81. Which of the following has the lowest protein content (as a percentage of dry weight)?
(A) Chylomicron (B) VLDL (C) IDL (D) LDL (E) HDL

Ans: A
[解析] [protein] 濃度 ：HDL > LDL > VLDL > *Chylomicron*

82. The following are intermediate products in cholesterol synthesis. Please select the correct order of the synthesis pathway.
① Acetyl-CoA ② Activated isoprene
③ Cholesterol ④ Lanosterol
⑤ Mevalonate ⑥ Squalene
(A) ①→⑤→②→④→⑥→③ (B) ①→②→⑤→⑥→④→③
(C) ①→⑤→⑥→②→④→③ (D) ①→⑤→②→⑥→④→③
(E) ⑤→①→②→⑥→③→④

83. Which of the following statements correctly describes how miRNA degrades target mRNA?
(A) After mature miRNA binds to RISC, it suppresses translation when partially complementary to the mRNA.
(B) miRNA directly binds to the mRNA poly-A tail to promote its degradation.
(C) miRNA functions in the nucleus and promotes mRNA degradation by altering DNA methylation.
(D) miRNA inhibits mRNA transcription by interfering with RNA polymerase II, ultimately

leading to mRNA degradation.
(E) Dicer cleaves pri-miRNA in the nucleus, while Drosha processes pre-miRNA in the cytoplasm.

Ans: A
[解析]
題 號＿＿＿＿＿＿＿＿＿＿＿＿修正＿＿＿＿＿＿＿＿＿＿＿＿

(B) miRNA directly binds to *3'UTR* of mRNA to promote its *degradation*.
(C) miRNA functions in *cytosol* and inhibits the translation.
(D) miRNA *inhibits the translation* of mRNA and *promotes mRNA decay*.
(E) D*rosha processes pri-miRNA in the nucleus*, while *Dicer cleaves the pre-mRNA in cytosol.*

84. ①is one of the enzymes that appears in②. Which one of the following is **NOT** correct?
(A) ① Arginase; ② urea cycle
(B) ① Pyruvate dehydrogenase; ② TCA cycle
(C) ① Aspartate transcarbamoylase; ② the *de novo* biosynthesis of pyrimidine
(D) ① Glucose-6-phosphate dehydrogenase; ② the pentose phosphate pathway
(E) ① Ribonucleotide reductase; ② the de novo biosynthesis of dNTP

85. Which of the following statements about amylose and cellulose is correct?
① The sugar residue in amylose and cellulose is glucose.
② Amylose is the storage polysaccharide, and cellulose is the structural polysaccharide.
③ Amylose has a regular helical conformation.
④ Sugar residues in cellulose are connected by α(1→4) linkage.
⑤ Sugar residues in amylose are connected by β(1→4) linkage.
(A) ①②③ (B) ①③④ (C) ①④⑤ (D) ②③④ (E) ②④⑤

Ans: A
[解析]
題 號＿＿＿＿＿＿＿＿＿＿＿＿修正＿＿＿＿＿＿＿＿＿＿＿＿

④ Sugar residues in cellulose are connected by *β(1→ 4) linkage*.
⑤ Sugar residues in amylose are connected by *α(1→ 4) linkage*.

86. Which of the following enzymes **CANNOT** reduce ubiquinone (Q) to ubiquinol (QH_2) in the mitochondrial electron transport chain?
(A) Dihydroorotate dehydrogenase
(B) Succinate dehydrogenase
(C) ETF: ubiquinone oxidoreductase
(D) ATP synthase
(E) Glycerol 3-phosphate dehydrogenase

87. Which of the following statements about the pentose phosphate pathway is correct?
① The pentose phosphate pathway produces NADPH and ribose-5-phosphate.
② The pentose phosphate pathway begins with the oxidation of glucose-1-phosphate.
③ The pentose phosphate pathway consists of oxidative and non-oxidative reactions.
④ The pentose phosphate pathway is also known as hexose monophosphate shunt.
⑤ The oxidative phase of the pentose phosphate produces one molecule of NADPH.

(A) ①②③ (B) ①③④ (C) ①③⑤ (D) ①④⑤ (E) ①②④

Ans: B

[解析]

題_號＿＿＿＿＿＿＿＿＿＿＿＿修正＿＿＿＿＿＿＿＿＿＿＿＿

② The pentose phosphate pathway (PPP) begins with the oxidation of *glucose-6-phosphat*e.

⑤ The oxidative phase of PPP produces *two molecules of NADPH*.

88. Which of the following statements about glycogenolysis is correct?

① Epinepherine promotes glycogenolysis in muscle.
② Glucagon promotes glycogenolysis in liver.
③ Insulin promotes glycogenolysis in liver.
④ Phosphorylase b catalyzes the breakdown of glycogen into glucose.
⑤ Phosphorylase a catalyzes the breakdown of glycogen into glucose-1-phosphate.

(A) ①②③ (B) ①②④ (C) ①②⑤ (D) ②③④ (E) ②④⑤

89. Which of the following statements is **NOT** correct regarding the interaction of carbon monoxide (CO) with hemoglobin (Hb)?

(A) A Hb with two bound CO molecules releases little oxygen in the tissues.
(B) Fetal Hb has a higher affinity for CO than adult Hb.
(C) Removing CO-poisoned person from CO-polluted site results in slowly dropping of COHb level.
(D) As CO bind to two Hb subunits, the affinity for oxygen is decreased in the remaining substrates.
(E) The CO-oxygen exchange can be accelerated by 100% oxygen at a pressure of 3 atm.

Ans: D

[解析]

題_號＿＿＿＿＿＿＿＿＿＿＿＿修正＿＿＿＿＿＿＿＿＿＿＿＿

(D) As CO binds to two Hb subunits, the affinity for oxygen is *increased* in the remaining substrate.

(Den et al, Carbon monoxide poisoning: from microbes to therapeutics, Annual Reviews Medicine, 2024, 75: 337)

90. Which of the following statements is correct regarding reversible inhibition of enzymes?

① The catalytic efficiency of enzyme is K_{cat}/K_m in the presence of competitive inhibitors.
② Competitive inhibitors are substrate analogs or transtion state analogs.
③ Uncompetitive inhibitors combine only with enzyme-substrate complex.
④ In the presence of inhibitors, the initial rate of enzyme-catalyzed reactions is positively correlated with substrate concentration.
⑤ The binding of noncompetitive inhibitors to enzymes is inhibited by substrate.

(A) ①②③ (B) ②③④ (C) ③④⑤ (D) ①③④ (E) ②④⑤

生物學

張劍鴻(張芸潔)老師提供

高雄醫大 學士後醫 生物學 考題分析

課程大綱	114 高醫	113 高醫	112 高醫	111 高醫	110 高醫	小計	%
Unit 1 細胞生物學	1	3	2	1	1	8	4
Unit 2 動物生理學	9	8	9	7	22	55	24
Unit 3 巨分子及生物化學	0	2	2	3	2	9	4
Unit 4 分子生物學	9	3	4	6	4	26	12
Unit 5 DNA生物科技	2	1	1	2	1	7	3
Unit 6 微生物免疫	5	9	4	5	3	26	12
Unit 7 植物學	11	10	10	10	3	44	20
Unit 8 演化學	5	7	7	9	6	34	15
Unit 9 生態學	3	2	6	2	3	16	7
總計	45	45	45	45	45	225	100