NIPER JEE Pharmacy Subjects

Sample Paper – 1

M.S.(Pharm) / M.Pharm Joint Entrance Examination

Duration: 96 Minutes **Maximum Marks: 80**

Instructions

- This paper contains **160 single-correct Multiple Choice Questions** drawn from the pharmaceutical-sciences syllabus of the **NIPER Joint Entrance Examination** (M.S.(Pharm) / M.Pharm).
- Each correct answer carries **+0.5 marks**. **0.125 mark is deducted** for every wrong answer, and an unattempted question gets **0 marks**. Maximum marks: **80**.
- The paper runs continuously from **Q1 to Q160** across six parts: Pharmaceutics; Pharmacology & Toxicology; Pharmaceutical & Medicinal Chemistry; Pharmaceutical Analysis & QA; Pharmacognosy; and Pharmaceutical Biotechnology & Microbiology.
- Only **one** option is correct. Personal calculators, mobile phones, and other electronic gadgets are strictly prohibited.

Part A: Pharmaceutics

Q1. The solubility of silver chloride (AgCl) in pure water is found to be 1.0×10^{-5} mol/L at 25°C. What is the value of its solubility product, K_{sp}?

(A) 1.0×10^{-5}

(B) 1.0×10^{-10}

(C) 2.0×10^{-5}

(D) 1.0×10^{-15}

Q2. A drug distributes between octanol and water such that 90 mg is in the octanol phase and 10 mg in the equal-volume water phase at equilibrium. The oil/water partition coefficient (P) of the drug is:

(A) 0.11

(B) 0.90

(C) 1.0

(D) 9.0

Q3. A surfactant blend is required to form a stable oil-in-water (o/w) emulsion. Which range of the Hydrophilic-Lipophilic Balance (HLB) value is most appropriate?

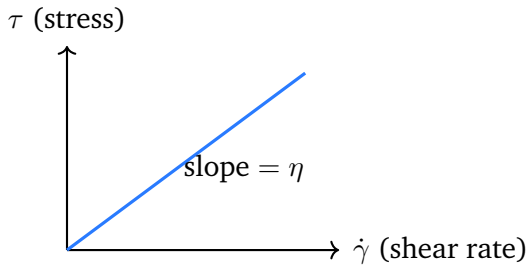
(A) 1.5 – 3 (antifoaming)

(B) 3 – 6 (w/o emulsifier)

(C) 8 – 18 (o/w emulsifier)

(D) 13 – 15 (detergent only)

Q4. The flow curve below (shear stress τ versus shear rate $\dot{\gamma}$) passes through the origin as a straight line. Which type of flow behaviour does it represent?



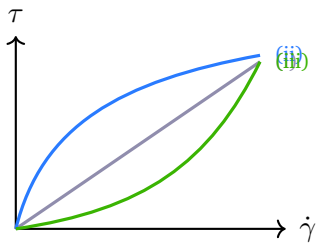
(A) Newtonian flow

(B) Pseudoplastic (shear-thinning) flow

(C) Dilatant (shear-thickening) flow

(D) Plastic flow with yield value

Q5. Three flow curves are shown. Curve (i) is a straight line through the origin; curve (ii) bows toward the stress axis (apparent viscosity falls as shear rate rises); curve (iii) bows toward the shear-rate axis. Curve (ii) represents:



(A) Newtonian flow

(B) Pseudoplastic (shear-thinning) flow

(C) Dilatant (shear-thickening) flow

(D) Bingham plastic flow

Q6. The CGS unit of dynamic (absolute) viscosity is the poise. One poise is equivalent to:

(A) 1 Pa·s

(B) 1 N·s/m^2

(C) 1 centistoke

(D) 0.1 Pa·s

Q7. A granule blend has a bulk density of 0.40 g/mL and a tapped density of 0.50 g/mL. Carr's compressibility index of this powder is:

(A) 10%

(B) 16%

(C) 20%

(D) 25%

Q8. For the same powder (bulk density 0.40 g/mL, tapped density 0.50 g/mL), the Hausner ratio and the corresponding flow character are:

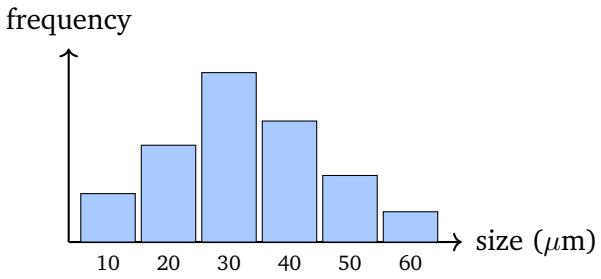
(A) 1.25, passable flow

(B) 0.80, excellent flow

(C) 1.50, very poor flow

(D) 1.05, excellent flow

Q9. The histogram shows a particle-size frequency distribution. The size class with the highest frequency (the mode) lies in which interval (in μm)?



(A) 10 – 20

(B) 20 – 40

(C) 40 – 50

(D) 50 – 60

Q10. An acetate buffer is prepared with 0.1 M acetic acid and 0.1 M sodium acetate (pK_a of acetic acid $= 4.76$). The pH of this buffer is approximately:

(A) 3.76

(B) 5.76

(C) 7.00

(D) 4.76

Q11. The buffer capacity of a buffer system is maximal when:

(A) pH $=$ pK_a (salt/acid ratio $= 1$)

(B) the salt concentration is far higher than the acid

(C) the total buffer concentration is minimised

(D) the pH is two units away from the pK_a

Q12. According to Fick's first law of diffusion, the steady-state flux (J) of a drug across a membrane is directly proportional to:

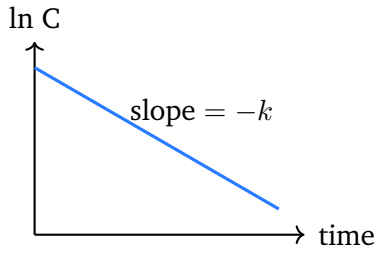
(A) the square of the membrane thickness

(B) the concentration gradient (dC/dx)

(C) the reciprocal of the diffusion coefficient

(D) the membrane surface charge only

Q13. In the plot shown, a straight line is obtained when the natural log of drug concentration (ln C) is plotted against time. This linear relationship indicates the reaction follows:



(A) zero-order kinetics

(B) second-order kinetics

(C) first-order kinetics

(D) pseudo-zero-order kinetics

Q14. A drug solution degrades by zero-order kinetics with a rate constant $k_0 = 0.05$ mg mL^{-1} month^{-1} from an initial concentration of 10 mg/mL. The shelf-life t_{90} (time for 10% loss) is:

(A) 20 months

(B) 2 months

(C) 10 months

(D) 100 months

Q15. Accelerated stability testing relies on the Arrhenius equation. Storing a product at elevated temperature is used to:

(A) change the order of the degradation reaction

(B) eliminate the activation energy of degradation

(C) measure the partition coefficient of the drug

(D) predict shelf-life at normal storage temperature by extrapolation

Q16. The Freundlich adsorption isotherm is expressed as $x/m = k\,C^{1/n}$. A linear plot is obtained when one plots:

(A) x/m versus C

(B) $\log(x/m)$ versus $\log C$

(C) $1/(x/m)$ versus C

(D) x/m versus $1/C$

Q17. Beta-cyclodextrin is widely used in pharmaceutical formulation primarily because it can:

(A) act as a disintegrant in tablets

(B) raise the surface tension of water

(C) form inclusion complexes that improve solubility and stability of poorly soluble drugs

(D) serve as a propellant in aerosols

Q18. According to the Noyes-Whitney equation, the rate of dissolution of a solid drug increases when:

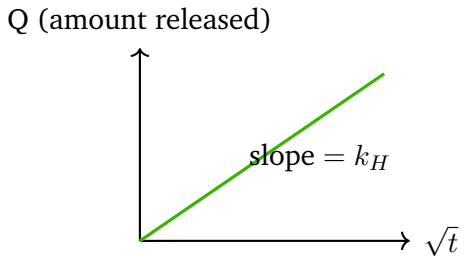
(A) the effective surface area of the drug is increased

(B) the diffusion-layer thickness is increased

(C) the saturation solubility (C_s) is decreased

(D) agitation/stirring is stopped

Q19. For a matrix-type sustained-release tablet, the cumulative amount of drug released is plotted against the square root of time and gives a straight line through the origin (see figure). This obeys:



(A) zero-order release

(B) first-order release

(C) Hixson-Crowell cube-root law

(D) the Higuchi model

Q20. In the Korsmeyer-Peppas model ($M_t/M_\infty = kt^n$) for drug release from a cylindrical/slab matrix, a release exponent of $n = 0.45$ indicates the dominant mechanism is:

(A) zero-order (case-II) transport

(B) Fickian (diffusion-controlled) release

(C) super case-II transport

(D) anomalous (non-Fickian) transport

Q21. In the Biopharmaceutics Classification System (BCS), a drug that has *high solubility* but *low permeability* belongs to:

(A) Class I

(B) Class II

(C) Class III

(D) Class IV

Q22. Two formulations of the same drug are said to be *bioequivalent* when:

(A) their rate and extent of absorption (C_{max}, AUC) do not differ significantly

(B) they contain different active ingredients

(C) one is given orally and the other intravenously

(D) their tablet hardness values are identical

Q23. In a tablet formulation, magnesium stearate is incorporated mainly to function as a:

(A) binder

(B) disintegrant

(C) diluent

(D) lubricant

Q24. As per pharmacopoeial limits, the friability of conventional uncoated tablets, tested in a Roche friabilator, should generally not exceed:

(A) 0.1%

(B) 1.0%

(C) 5.0%

(D) 10.0%

Q25. Which of the following is classified as a *superdisintegrant* in tablet formulation?

(A) Acacia

(B) Talc

(C) Sodium starch glycolate

(D) Lactose

Q26. The Limulus Amebocyte Lysate (LAL) test, used for quality control of parenteral products, specifically detects:

(A) bacterial endotoxins (pyrogens)

(B) particulate matter

(C) drug content uniformity

(D) tablet disintegration time

Q27. The displacement value of a drug in a suppository base is best defined as the:

(A) ratio of base to drug by volume

(B) melting point of the medicated suppository

(C) weight of drug that dissolves in 1 mL of water

(D) number of parts by weight of drug that displaces 1 part by weight of base

Q28. In emulsion technology, the *irreversible* coalescence of dispersed droplets leading to complete phase separation is termed:

(A) creaming

(B) cracking

(C) flocculation

(D) phase inversion

Q29. Compared with a deflocculated suspension, a *flocculated* pharmaceutical suspension typically shows:

(A) a hard, caked sediment that cannot be redispersed

(B) a very slow rate of sedimentation with a clear supernatant only at the end

(C) a loose sediment that is easily redispersed on shaking

(D) the lowest possible sedimentation volume

Q30. White petrolatum (soft paraffin) is an example of which class of ointment base?

(A) Oleaginous (hydrocarbon) base

(B) Absorption base

(C) Water-removable (o/w) base

(D) Water-soluble (PEG) base

Q31. Which size-reduction equipment uses high-velocity compressed air or steam to cause inter-particle collision, producing very fine particles (1–20 μm) with negligible heat build-up?

(A) Ball mill

(B) Fluid energy mill (micronizer)

(C) Edge runner mill

(D) Roller mill

Q32. During lyophilization (freeze-drying), the bulk of the water is removed in the primary drying stage by the process of:

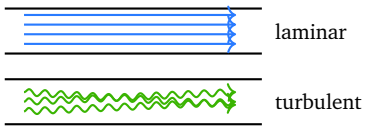
(A) evaporation at high temperature

(B) simple filtration

(C) adsorption onto silica gel

(D) sublimation of ice under reduced pressure

Q33. The two sketches contrast fluid flow in a pipe: the upper streamlines are smooth and parallel, while the lower ones are chaotic and swirling. For flow through a circular pipe, the upper (laminar) regime corresponds to a Reynolds number (Re) of:



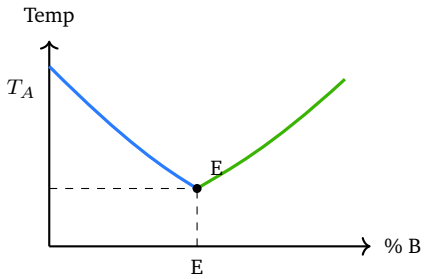
(A) greater than 4000

(B) between 2100 and 4000

(C) less than 2100

(D) exactly 10000

Q34. The binary phase diagram shown is for two components A and B that are completely miscible as liquids but immiscible as solids. Point E, where the two liquidus curves meet at the lowest melting temperature, is called the:



(A) eutectic point

(B) triple point

(C) critical solution point

(D) glass transition point

Part B: Pharmacology & Toxicology

Q35. A drug given as a 500 mg IV bolus yields an initial (extrapolated $t = 0$) plasma concentration of 25 mg/L. Assuming a one-compartment model, the apparent volume of distribution (V_d) is:

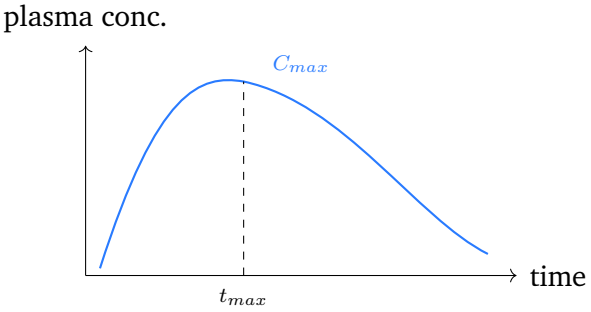
(A) 0.05 L

(B) 20 L

(C) 50 L

(D) 12.5 L

Q36. The plasma drug concentration-time profile after an oral dose is shown (absorption then first-order elimination). For a drug whose concentration falls from 80 mg/L to 10 mg/L over 9 hours, the elimination half-life is:



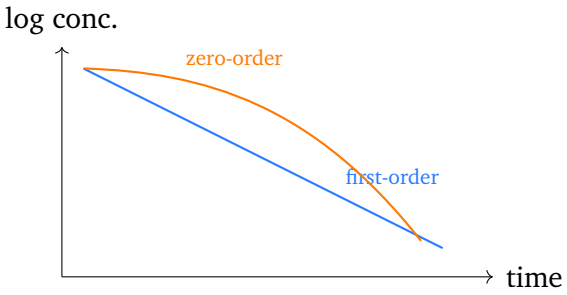
(A) 1.5 h

(B) 3 h

(C) 4.5 h

(D) 9 h

Q37. The semi-log plot (log concentration vs time) below shows a straight line for one drug and a curve for another. The straight line is the hallmark of first-order elimination. Which statement correctly distinguishes zero-order from first-order elimination kinetics?



(A) In first-order kinetics a constant amount of drug is eliminated per unit time

(B) Zero-order elimination has a constant half-life independent of concentration

(C) In zero-order kinetics a constant amount (not fraction) of drug is eliminated per unit time, as the eliminating process is saturated

(D) Ethanol and phenytoin at therapeutic doses follow strict first-order kinetics

Q38. For a drug following first-order elimination, the relationship between

clearance (CL), volume of distribution (V_d) and elimination rate constant (k_e) is:

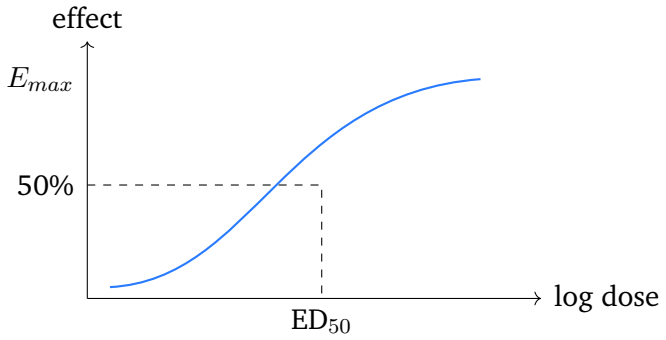
(A) $CL = k_e \times V_d$

(B) $CL = k_e / V_d$

(C) $CL = V_d / k_e$

(D) $CL = k_e \times V_d^2$

Q39. The graded dose-response (effect vs log dose) sigmoid curve below is fundamental to pharmacodynamics. The parameter marked on the y-axis at the plateau and the dose producing 50% of it respectively reflect:



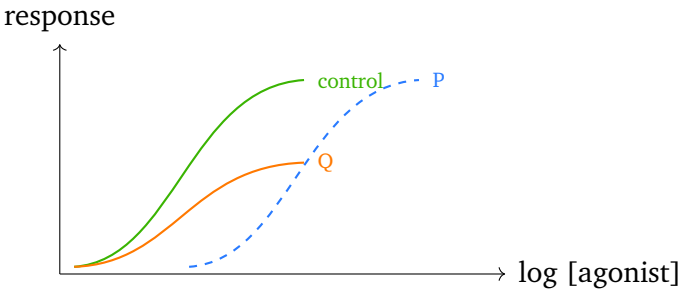
(A) Both reflect potency

(B) Both reflect efficacy

(C) E_{max} reflects potency; ED_{50} reflects efficacy

(D) E_{max} reflects efficacy; ED_{50} (lower value = more potent) reflects potency

Q40. The two log dose-response shifts below are produced by two antagonists. Curve P (parallel rightward shift, same maximum) and curve Q (depressed maximum) respectively indicate:



(A) P = competitive (surmountable) antagonist; Q = non-competitive (insurmountable) antagonist

(B) P = non-competitive antagonist; Q = competitive antagonist

(C) Both are competitive antagonists

(D) P = partial agonist; Q = inverse agonist

Q41. A partial agonist differs from a full agonist in that it:

(A) Has higher affinity but produces a greater maximal response

(B) Produces a sub-maximal response even at full receptor occupancy (lower intrinsic activity) and can antagonise a full agonist

(C) Has no affinity for the receptor

(D) Always produces zero response (intrinsic activity = 0)

Q42. The pA_2 value of a competitive antagonist, derived from a Schild plot, is defined as the:

(A) Concentration of antagonist that abolishes the agonist response completely

(B) Slope of the Schild regression line

(C) Negative logarithm of the molar antagonist concentration that requires a doubling ($2\times$) of the agonist concentration to restore the original response

(D) Negative logarithm of the agonist ED_{50}

Q43. Match the receptor with the fastest signalling timescale. Which receptor type transduces its signal in milliseconds by directly gating an ion flux?

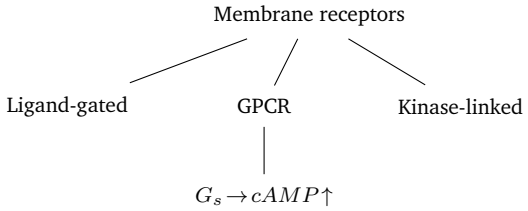
(A) Nuclear (steroid) receptor

(B) GPCR coupled to adenylyl cyclase

(C) Receptor tyrosine kinase (e.g. insulin receptor)

(D) Ligand-gated ion channel (e.g. nicotinic ACh receptor / GABA-A)

Q44. In the receptor classification shown, the branch ending in "$G_s \rightarrow$ adenylyl cyclase $\uparrow\rightarrow$ cAMP" is characteristic of which receptor superfamily?



(A) G-protein-coupled receptors (7-transmembrane), e.g. β-adrenergic receptor

(B) Ligand-gated ion channels

(C) Receptor tyrosine kinases

(D) Intracellular nuclear receptors

Q45. The phenomenon of "spare receptors" (receptor reserve) implies that:

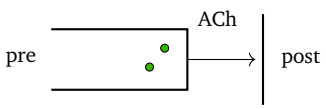
(A) Receptors that are permanently non-functional

(B) A maximal tissue response can be achieved when only a fraction of the total receptors are occupied by agonist, so $EC_{50} < K_d$

(C) There are no receptors left for the agonist

(D) Receptors that bind only antagonists

Q46. At the cholinergic synapse depicted, physostigmine and neostigmine act by inhibiting acetylcholinesterase. The key clinical difference relevant to CNS effects is that:



(A) Both are charged quaternary amines unable to cross the blood-brain barrier

(B) Neostigmine readily enters the CNS whereas physostigmine does not

(C) Physostigmine is a tertiary amine that crosses the blood-brain barrier (used in central anticholinergic toxicity), while neostigmine is a quaternary compound acting peripherally

(D) Both act by irreversibly phosphorylating the enzyme

Q47. Atropine produces all of the following EXCEPT one. The effect that is NOT consistent with muscarinic blockade is:

(A) Miosis and increased lacrimal secretion

(B) Mydriasis and cycloplegia

(C) Tachycardia

(D) Dry mouth and decreased sweating

Q48. A patient with hypertension and asthma is best avoided on a non-selective β-blocker. Which of the following is a β_1-selective (cardioselective) blocker preferred in such a patient?

(A) Propranolol

(B) Timolol

(C) Nadolol

(D) Metoprolol (atenolol/bisoprolol are likewise β_1-selective)

Q49. Succinylcholine differs from non-depolarizing blockers such as vecuronium because succinylcholine:

(A) Is a competitive antagonist at the nicotinic receptor reversed by neostigmine

(B) Is a depolarizing agonist that causes initial fasciculations, is not reversed by (indeed worsened by) AChE inhibitors, and is metabolised by plasma pseudocholinesterase

(C) Has a long duration of several hours

(D) Acts by blocking calcium release from the sarcoplasmic reticulum

Q50. Which adrenergic agonist is a relatively selective β_2-agonist used as a bronchodilator in asthma?

(A) Phenylephrine

(B) Clonidine

(C) Salbutamol (albuterol)

(D) Noradrenaline

Q51. Benzodiazepines potentiate GABAergic inhibition by:

(A) Binding an allosteric site on the GABA-A receptor-chloride channel and increasing the *frequency* of chloride channel opening

(B) Directly opening the chloride channel in the absence of GABA

(C) Increasing the *duration* of channel opening (which is the barbiturate mechanism)

(D) Blocking GABA reuptake

Q52. The therapeutic antipsychotic action of classical (typical) neuroleptics such as haloperidol is attributed mainly to blockade of:

(A) 5-HT_{2A} receptors only

(B) Dopamine D_2 receptors in the mesolimbic pathway

(C) Muscarinic M_1 receptors

(D) Histamine H_1 receptors

Q53. Fluoxetine relieves depression primarily by:

(A) Irreversibly inhibiting monoamine oxidase

(B) Blocking reuptake of both noradrenaline and serotonin equally (TCA-like)

(C) Blocking dopamine D_2 receptors

(D) Selectively inhibiting the serotonin (5-HT) reuptake transporter

Q54. The analgesic, euphoric and respiratory-depressant actions of morphine are mediated predominantly through which opioid receptor subtype?

(A) μ (mu) opioid receptor

(B) κ (kappa) opioid receptor only

(C) δ (delta) opioid receptor only

(D) Nociceptin/ORL-1 receptor

Q55. Phenytoin controls tonic-clonic and partial seizures mainly by:

(A) Enhancing GABA synthesis

(B) Blocking T-type calcium channels (the ethosuximide mechanism for absence seizures)

(C) Use-dependent blockade of voltage-gated sodium channels, prolonging their inactivated state

(D) Antagonising NMDA glutamate receptors

Q56. Local anaesthetics such as lidocaine produce reversible nerve block by:

(A) Opening potassium channels and hyperpolarising the membrane

(B) Blocking voltage-gated sodium channels from the intracellular side, preventing the propagation of the action potential

(C) Activating GABA-A receptors on the nerve

(D) Inhibiting acetylcholinesterase at the neuromuscular junction

Q57. Carbidopa is combined with levodopa in Parkinson's disease therapy because carbidopa:

(A) Crosses the blood-brain barrier and is itself converted to dopamine

(B) Is a dopamine receptor agonist that supplements levodopa

(C) Inhibits central monoamine oxidase-B

(D) Inhibits peripheral DOPA-decarboxylase (does not cross the BBB), reducing peripheral dopamine formation, lowering the levodopa dose and limiting nausea

Q58. Enalapril lowers blood pressure chiefly by:

(A) Inhibiting angiotensin-converting enzyme, reducing angiotensin II formation and aldosterone, and decreasing bradykinin breakdown

(B) Blocking angiotensin II AT_1 receptors directly

(C) Blocking β_1-adrenergic receptors

(D) Blocking L-type calcium channels in vascular smooth muscle

Q59. Glyceryl trinitrate (nitroglycerin) relieves anginal pain mainly by:

(A) Increasing cardiac contractility and heart rate

(B) Releasing nitric oxide, which raises cyclic GMP and relaxes vascular smooth muscle, predominantly venodilation that reduces preload and myocardial oxygen demand

(C) Blocking calcium channels in the SA node

(D) Inhibiting the renin-angiotensin system

Q60. In the Vaughan-Williams classification, amiodarone is placed predominantly in Class III, meaning its dominant electrophysiological action is:

(A) Sodium channel blockade (Class I)

(B) β-adrenergic receptor blockade (Class II)

(C) Potassium channel blockade that prolongs repolarisation and the action-potential duration / effective refractory period

(D) Calcium channel blockade (Class IV)

Q61. The positive inotropic action of digoxin in heart failure results from:

(A) Direct activation of β_1-adrenergic receptors

(B) Opening of cardiac potassium channels

(C) Phosphodiesterase-3 inhibition raising cAMP

(D) Inhibition of the membrane Na^+/K^+-ATPase, raising intracellular Na^+, which reduces Ca^{2+} extrusion via the Na^+/Ca^{2+} exchanger and increases intracellular Ca^{2+}

Q62. Which statement correctly contrasts warfarin and heparin?

(A) Warfarin inhibits vitamin-K-dependent clotting factor synthesis (II, VII, IX, X), acts orally with delayed onset and is monitored by INR/PT; heparin enhances antithrombin, acts immediately by injection and is monitored by aPTT

(B) Heparin is the oral agent monitored by INR

(C) Warfarin acts immediately and is reversed by protamine

(D) Both are reversed by vitamin K

Q63. Ranitidine and cimetidine differ from chlorpheniramine because the former group:

(A) Blocks H_1 receptors and causes sedation

(B) Blocks H_2 receptors and inhibits gastric acid secretion

(C) Are first-generation sedating H_1 antihistamines

(D) Are mast-cell stabilisers

Q64. The anti-inflammatory, analgesic and antipyretic effects of aspirin are due to:

(A) Reversible inhibition of lipoxygenase

(B) Blockade of histamine H_1 receptors

(C) Irreversible acetylation and inhibition of cyclooxygenase (COX-1 and COX-2), reducing prostaglandin and thromboxane synthesis

(D) Selective COX-2 inhibition with platelet sparing

Q65. Allopurinol is used in the long-term management of gout because it:

(A) Inhibits microtubule polymerisation in neutrophils (that is colchicine)

(B) Increases renal uric acid excretion as a uricosuric

(C) Is a selective COX-2 inhibitor

(D) Inhibits xanthine oxidase, decreasing the conversion of hypoxanthine/xanthine to uric acid and lowering urate production

Q66. Which pairing of antibiotic class with mechanism is CORRECT?

(A) β-lactams (penicillins) inhibit bacterial cell-wall (peptidoglycan) synthesis by binding penicillin-binding proteins (transpeptidases)

(B) Aminoglycosides inhibit DNA gyrase

(C) Fluoroquinolones inhibit the 30S ribosomal subunit

(D) Sulfonamides inhibit cell-wall cross-linking

Q67. Streptomycin, gentamicin and other aminoglycosides are bactericidal mainly because they:

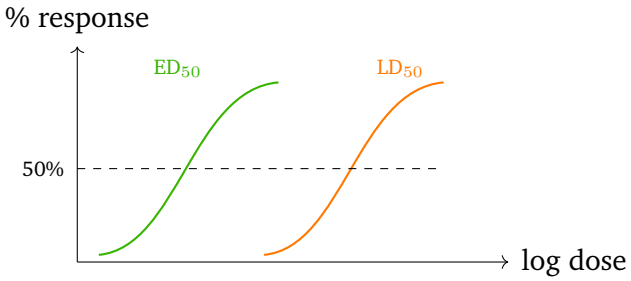
(A) Inhibit DNA-dependent RNA polymerase

(B) Bind the 30S ribosomal subunit, causing misreading of mRNA and inhibition of bacterial protein synthesis

(C) Inhibit dihydrofolate reductase

(D) Inhibit the 50S subunit peptidyl transferase

Q68. The therapeutic-index diagram below relates ED_{50} and LD_{50}; toxicology also relies on specific antidotes. Which antidote-poison pairing is INCORRECT?



(A) Organophosphate poisoning $\rightarrow$ atropine plus pralidoxime

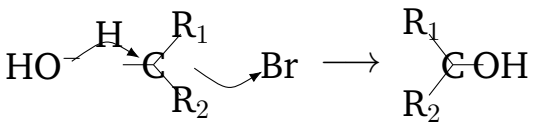
(B) Opioid overdose $\rightarrow$ naloxone

(C) Paracetamol (acetaminophen) overdose $\rightarrow$ flumazenil

(D) Benzodiazepine overdose $\rightarrow$ flumazenil

Part C: Pharmaceutical & Medicinal Chemistry

Q69. The reaction of (*S*)-2-bromobutane with hydroxide ion in acetone gives 2-butanol. The mechanism and the stereochemical outcome at the reacting carbon are best described by the scheme below.



Identify the correct statement.

(A) It is an S_N1 reaction proceeding with racemisation.

(B) It is an S_N2 reaction proceeding with inversion of configuration to give (*R*)-2-butanol.

(C) It is an E2 reaction giving 1-butene.

(D) It is an S_N2 reaction proceeding with retention of configuration.

Q70. Arrange the following carbocations in the correct order of decreasing stability: (i) CH_3^+, (ii) $CH_3CH_2^+$, (iii) $(CH_3)_2CH^+$, (iv) $(CH_3)_3C^+$.

(A) (i) > (ii) > (iii) > (iv)

(B) (ii) > (i) > (iv) > (iii)

(C) (iii) > (iv) > (ii) > (i)

(D) (iv) > (iii) > (ii) > (i)

Q71. In electrophilic aromatic substitution, which one of the following substituents is a *meta*-directing, deactivating group?

(A) $-OCH_3$

(B) –Cl

(C) $-NO_2$

(D) $-NH_2$

Q72. Benzaldehyde, on treatment with concentrated NaOH, undergoes a disproportionation to give benzyl alcohol and sodium benzoate. This reaction is known as the:

(A) Cannizzaro reaction

(B) Aldol condensation

(C) Perkin reaction

(D) Claisen condensation

Q73. For a chiral carbon bearing the four groups –Br, –OH, $–CH_3$ and –H, the correct CIP priority order (highest to lowest) used to assign R/S configuration is:

(A) –OH $>$ –Br $>$ $–CH_3$ $>$ –H

(B) –Br $>$ –OH $>$ $–CH_3$ $>$ –H

(C) $–CH_3$ $>$ –Br $>$ –OH $>$ –H

(D) –Br $>$ $–CH_3$ $>$ –OH $>$ –H

Q74. According to Hückel's rule, a planar, fully conjugated, monocyclic system is aromatic when it contains $(4n+2)$ π electrons. Which of the following species is aromatic?

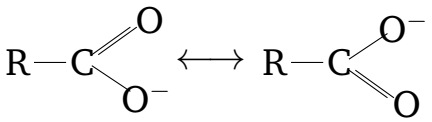
(A) Cyclobutadiene (4 π electrons)

(B) Cyclooctatetraene (8 π electrons, tub-shaped)

(C) Cyclopentadienyl anion (6 π electrons)

(D) Cyclopentadienyl cation (4 π electrons)

Q75. The carboxylate ion is unusually stable because the negative charge is delocalised equally over both oxygen atoms, as shown by the two equivalent resonance structures below.



Which statement about the real carboxylate ion is correct?

(A) The two C–O bonds have different lengths, one being a true double bond.

(B) The negative charge resides permanently on a single oxygen.

(C) It is less stable than an alkoxide ion.

(D) The two C–O bonds are identical (bond order ≈ 1.5) and the ion is resonance stabilised.

Q76. Which of the following is the strongest acid (lowest pK_a)?

(A) Trichloroacetic acid, CCl_3COOH

(B) Acetic acid, CH_3COOH

(C) Phenol, C_6H_5OH

(D) Ethanol, C_2H_5OH

Q77. When propene (CH_3–CH=CH_2) reacts with HBr in the absence of peroxides, the major product follows Markovnikov's rule. The major product is:

(A) 1-bromopropane ($CH_3CH_2CH_2Br$)

(B) 2-bromopropane ($CH_3CHBrCH_3$)

(C) 1,2-dibromopropane

(D) propan-1-ol

Q78. Tartaric acid has two stereocentres. The form that is optically inactive due to an internal plane of symmetry, despite containing stereocentres, is called the:

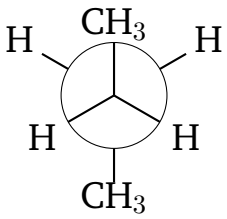
(A) racemic enantiomer

(B) (+)-enantiomer

(C) meso compound

(D) geometric isomer

Q79. The Newman projection below (viewing along the C2–C3 bond of butane) shows the conformation in which the two methyl groups are 180° apart.



This lowest-energy staggered conformation of butane is called the:

(A) anti conformation

(B) gauche conformation

(C) fully eclipsed conformation

(D) totally eclipsed (syn) conformation

Q80. A Grignard reagent CH_3MgBr reacts with formaldehyde (HCHO), followed by aqueous acidic work-up. The product is:

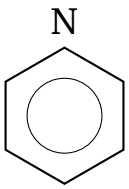
(A) acetic acid

(B) acetone

(C) a tertiary alcohol

(D) ethanol (a primary alcohol)

Q81. The aromatic heterocycle shown below has its nitrogen lone pair located in an sp^2 orbital in the plane of the ring (not part of the aromatic sextet), which makes it a weak base ($pK_{aH} \approx 5$).



Identify this heterocycle.

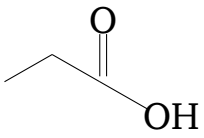
(A) pyrrole

(B) pyridine

(C) furan

(D) benzene

Q82. Identify the functional group present in the skeletal structure drawn below.



(A) ketone

(B) aldehyde

(C) carboxylic acid

(D) ester

Q83. The Diels–Alder reaction between a conjugated diene (1,3-butadiene) and a dienophile (ethene) is a [4+2] cycloaddition. The product is:

(A) cyclohexene

(B) benzene

(C) cyclobutane

(D) 1,3-cyclohexadiene

Q84. In contrast to Zaitsev elimination, the Hofmann elimination of a quaternary ammonium hydroxide preferentially yields:

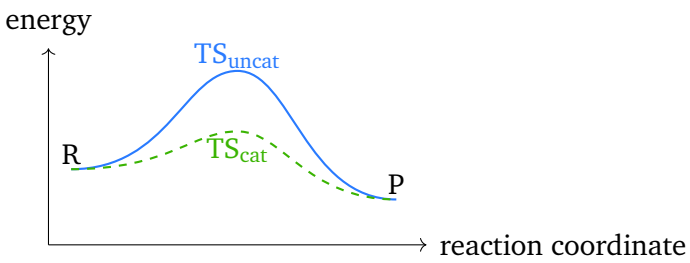
(A) the more substituted (more stable) alkene

(B) the less substituted (least stable) terminal alkene

(C) an alcohol

(D) no alkene at all

Q85. The reaction-coordinate diagram below shows the energy profile of a reaction with and without a catalyst.



What effect does a catalyst have on the reaction, as illustrated?

(A) It increases the activation energy.

(B) It changes the position of equilibrium in favour of products.

(C) It makes ΔH of the reaction more negative.

(D) It lowers the activation energy by providing an alternative pathway, leaving ΔH unchanged.

Q86. Phase I drug metabolism most commonly involves oxidation reactions catalysed by which enzyme system in the liver?

(A) Cytochrome P450 (CYP450) mono-oxygenases

(B) UDP-glucuronosyltransferase

(C) Sulfotransferase

(D) N-acetyltransferase

Q87. Which of the following is a Phase II (conjugation) reaction in drug metabolism?

(A) aromatic hydroxylation

(B) glucuronidation

(C) N-dealkylation

(D) ester hydrolysis

Q88. A prodrug is an inactive derivative that is converted to the active drug in the body. Which of the following is a classic example of a prodrug?

(A) paracetamol

(B) aspirin acting directly

(C) enalapril (hydrolysed to enalaprilat)

(D) diazepam given as is

Q89. In medicinal chemistry, bioisosteric replacement is used to improve a drug's properties while retaining activity. The replacement of a –COOH group by a tetrazole ring is a classic example of:

(A) a prodrug strategy

(B) racemic switching

(C) ring contraction

(D) (non-classical) bioisosterism

Q90. In Hansch analysis (QSAR), the partition coefficient $\log P$ is used as a descriptor primarily for which property of a drug molecule?

(A) lipophilicity (hydrophobic character)

(B) the electronic effect of substituents

(C) the steric bulk of substituents

(D) the number of hydrogen-bond donors only

Q91. In the Hammett equation, the substituent constant σ quantifies the:

(A) lipophilic contribution of a substituent

(B) electronic (electron-withdrawing/donating) effect of a substituent on a reaction

(C) steric size of a substituent

(D) molar refractivity of the molecule

Q92. The antibacterial activity of penicillins and cephalosporins depends critically on the integrity of which structural feature, opened by β-lactamase enzymes?

(A) an aromatic benzene ring

(B) a sulfonamide group

(C) the strained four-membered β-lactam ring

(D) a quaternary ammonium centre

Q93. Sulfonamide antibacterials act as competitive antagonists in folate biosynthesis because they are structural analogues (bioisosteres) of:

(A) dihydrofolate reductase

(B) tetrahydrofolate

(C) thymidine

(D) para-aminobenzoic acid (PABA)

Q94. Local anaesthetics are classified by the linkage joining the aromatic and amine portions. Which of the following is an **amide**-type local anaesthetic (and thus metabolised mainly in the liver rather than by plasma esterases)?

(A) lidocaine (lignocaine)

(B) procaine

(C) benzocaine

(D) tetracaine

Q95. For a chiral drug, the enantiomer that possesses the greater pharmacological activity for the desired target is termed the:

(A) distomer

(B) eutomer

(C) racemate

(D) metabolite

Q96. Which of the following pharmaceutical inorganic compounds is used as an antacid to neutralise gastric hydrochloric acid?

(A) potassium permanganate

(B) silver nitrate

(C) magnesium hydroxide / aluminium hydroxide

(D) ferrous sulfate

Q97. EDTA is used as an antidote in heavy-metal poisoning (e.g. lead). Its mechanism of action is best described as:

(A) oxidation of the metal ion

(B) precipitation as an insoluble sulfide

(C) reduction to the elemental metal

(D) chelation, forming a stable water-soluble metal complex

Q98. Diazepam, lorazepam and alprazolam, which enhance GABA-mediated chloride conductance, all belong to which chemical class of drugs?

(A) benzodiazepines

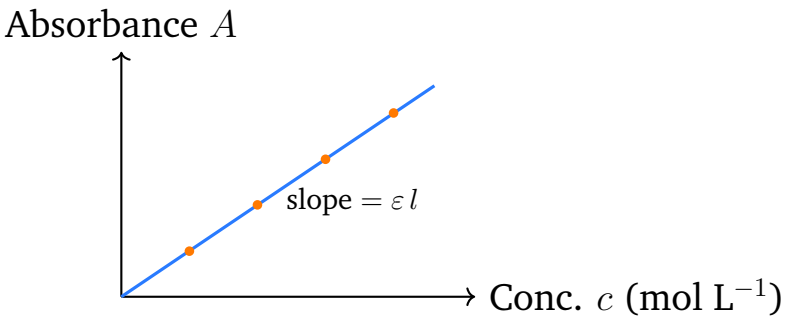
(B) barbiturates

(C) phenothiazines

(D) sulfonamides

Part D: Pharmaceutical Analysis & Quality Assurance

Q99. The figure below shows a Beer–Lambert calibration plot for a drug measured at its λ_{max}. Absorbance is plotted against concentration and the points fall on a straight line passing through the origin. Which quantity does the slope of this line represent?



(A) Product of molar absorptivity and path length, $\varepsilon\, l$

(B) Molar absorptivity ε alone

(C) Path length l alone

(D) Transmittance of the solution

Q100. In the non-aqueous titration of a weakly basic alkaloid drug dissolved in glacial acetic acid, the most commonly used titrant is:

(A) Sodium methoxide in methanol

(B) Perchloric acid in glacial acetic acid

(C) Tetrabutylammonium hydroxide

(D) Aqueous sodium hydroxide

Q101. On a TLC plate developed over a distance of 8.0 cm, a spot travels 3.0 cm from the baseline (point of application). The retardation factor R_f of the compound is:

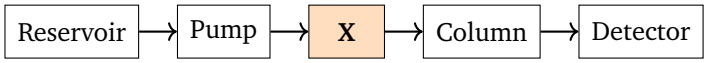
(A) 2.67

(B) 0.27

(C) 0.375

(D) 0.625

Q102. The block diagram of a liquid chromatograph is shown. Identify the component labelled **X**, which sits between the high-pressure pump and the column and introduces the sample into the mobile-phase stream.



(A) Mobile-phase degasser

(B) Fraction collector

(C) Guard cartridge regenerator

(D) Injector (sample-introduction valve)

Q103. Which statement correctly distinguishes iodimetry from iodometry?

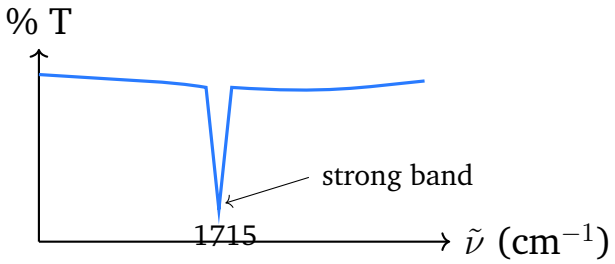
(A) Iodimetry is a direct titration with standard iodine, whereas iodometry liberates iodine that is then titrated with thiosulphate

(B) Iodimetry uses thiosulphate as titrant; iodometry uses standard iodine

(C) Both methods titrate liberated iodine with permanganate

(D) Iodometry is a direct titration of the analyte with iodine

Q104. The schematic IR spectrum below shows transmittance versus wavenumber with a strong, sharp absorption band marked. A band of this intensity appearing near **1715 cm^{-1}** is most characteristic of which functional group?



(A) O–H stretch of an alcohol

(B) C=O stretch of a carbonyl (ketone)

(C) C–H stretch of an alkane

(D) N–H stretch of a primary amine

Q105. In the complexometric titration of Ca^{2+} and Mg^{2+} with EDTA using Eriochrome Black T (EBT) as indicator at pH 10, the colour change at the end point is from:

(A) Yellow to colourless

(B) Colourless to pink

(C) Wine-red to blue

(D) Blue to wine-red

Q106. In the ^{1}H NMR spectrum of ethanol (CH_3CH_2OH), assuming no rapid OH exchange and first-order coupling, how many distinct signals (sets of chemically non-equivalent protons) are observed?

(A) 1

(B) 6

(C) 2

(D) 3

Q107. For a chromatographic column of length L that exhibits N theoretical plates, the height equivalent to a theoretical plate (HETP) is given by:

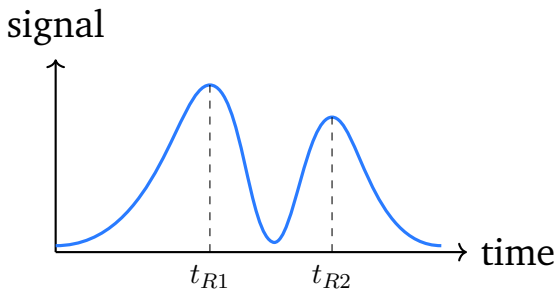
(A) $H = L/N$

(B) $H = N/L$

(C) $H = N \times L$

(D) $H = L \times N^2$

Q108. The chromatogram shows two closely eluting peaks. Their retention times are t_{R1} and t_{R2} and their baseline widths are w_1 and w_2. The resolution R_s between the two peaks is correctly defined as:



(A) $R_s = (t_{R2} + t_{R1})/(w_1 + w_2)$

(B) $R_s = 2(t_{R2} - t_{R1})/(w_1 + w_2)$

(C) $R_s = (w_1 + w_2)/2(t_{R2} - t_{R1})$

(D) $R_s = (t_{R2} - t_{R1})/(w_1 \times w_2)$

Q109. Which of the following correctly pairs an argentometric (silver-nitrate) titration method with its indicator?

(A) Mohr method — ferric alum

(B) Volhard method — potassium chromate

(C) Fajans method — an adsorption indicator (e.g. fluorescein)

(D) Mohr method — an adsorption indicator

Q110. Flame photometry is most suitable for the routine quantitative estimation of which group of elements in pharmaceutical samples?

(A) Transition metals such as Fe and Cu

(B) Halogens such as Cl and Br

(C) Heavy metals such as Pb and Hg

(D) Alkali and alkaline-earth metals such as Na, K, Ca

Q111. A shift of the absorption maximum (λ_{max}) of a chromophore to a *longer* wavelength, typically caused by attaching an auxochrome or by increased conjugation, is called a:

(A) Bathochromic (red) shift

(B) Hypsochromic (blue) shift

(C) Hyperchromic shift

(D) Hypochromic shift

Q112. What is the normality of a H_2SO_4 solution that is 0.50 molar? (Treat sulphuric acid as a diprotic acid that furnishes 2 equivalents of H^+ per mole.)

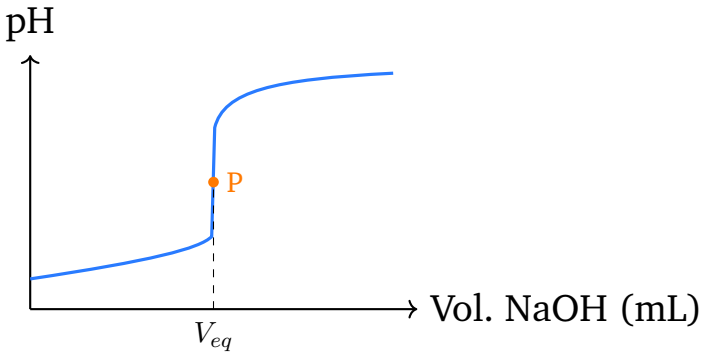
(A) 0.25 N

(B) 1.0 N

(C) 0.50 N

(D) 2.0 N

Q113. The curve shows pH versus volume of NaOH added during the titration of a strong acid with a strong base. The point marked **P**, where the curve is steepest (point of inflection) and the pH changes most rapidly, corresponds to:



(A) The point where all indicator has decomposed

(B) The buffer region of the titration

(C) The equivalence point of the titration

(D) The point of maximum buffering capacity

Q114. In a mass spectrum, the term **base peak** refers to:

(A) The peak corresponding to the intact molecular ion $M^{+\bullet}$

(B) The peak at the lowest mass-to-charge ratio

(C) The peak due to the M+1 isotope

(D) The most intense peak in the spectrum, assigned 100% relative abundance

Q115. In reverse-phase HPLC, the stationary phase is non-polar (e.g. a C18-bonded silica) and the mobile phase is relatively polar. Consequently, the order of elution of analytes is:

(A) More polar compounds elute first; less polar (more non-polar) compounds are retained longer

(B) Less polar compounds elute first; polar compounds are retained longer

(C) Elution order is independent of polarity

(D) All compounds co-elute at the void volume

Q116. In gas chromatography, which detector responds to almost all organic (carbon-containing) compounds by measuring the ions produced when the eluent is burned in a hydrogen flame?

(A) Thermal conductivity detector (TCD)

(B) Flame ionization detector (FID)

(C) Refractive-index detector (RID)

(D) Electrochemical detector

Q117. Potassium permanganate is used as a self-indicating titrant in permanganometry because:

(A) It forms a coloured complex only with starch

(B) It requires an external ferroin indicator to detect the end point

(C) Its own intense violet colour persists at the first slight excess, marking the end point

(D) It is colourless until reduced, then turns violet

Q118. In analytical method validation as per ICH guidelines, the closeness of agreement between a series of measurements obtained from *multiple sampling of the same homogeneous sample* under prescribed conditions is the definition of:

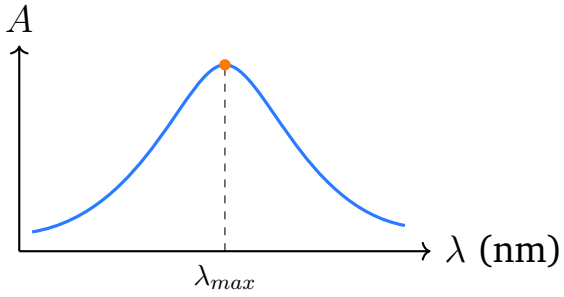
(A) Accuracy

(B) Specificity

(C) Linearity

(D) Precision

Q119. The UV absorption curve below plots absorbance against wavelength. The wavelength at the peak maximum, marked λ_{max}, is the value normally used for quantitative assay because there:



(A) Absorbance is maximal and changes least with small wavelength errors, giving best sensitivity and reproducibility

(B) Absorbance is at a minimum, reducing background

(C) The molar absorptivity is zero

(D) Transmittance equals 100%

Q120. In gravimetric analysis, the analyte is ultimately determined by:

(A) Measuring the volume of a titrant consumed

(B) Isolating it as a pure solid of known composition and weighing it

(C) Measuring its absorbance at λ_{max}

(D) Measuring the potential of an indicator electrode

Q121. Applying the $(n+1)$ multiplicity rule, the methyl (CH_3) protons in pure bromoethane (CH_3CH_2Br) are split by the adjacent methylene protons into a:

(A) Singlet

(B) Doublet

(C) Triplet

(D) Quartet

Q122. In analytical method validation, the lowest amount of analyte that can be reliably *quantified* with acceptable accuracy and precision (commonly taken at a signal-to-noise ratio of about 10:1) is termed the:

(A) Limit of detection (LOD)

(B) Specificity limit

(C) Working range upper limit

(D) Limit of quantitation (LOQ)

Part E: Pharmacognosy & Natural Products

Q123. In pharmacognostical classification, "organized" crude drugs are those having a definite cellular structure, whereas "unorganized" drugs are cell-free direct products of plant metabolism. Which of the following sets contains **only unorganized** crude drugs?

(A) Senna leaf, Cinchona bark, Nux vomica seed

(B) Clove bud, Ginger rhizome, Digitalis leaf

(C) Acacia gum, Aloe, Honey

(D) Ergot, Ipecac root, Liquorice rhizome

Q124. A teacher groups crude drugs as alkaloids, glycosides, volatile oils, tannins and resins, ignoring their botanical relationship or therapeutic use. This basis of grouping crude drugs is called:

(A) Chemical classification

(B) Taxonomical classification

(C) Morphological classification

(D) Pharmacological classification

Q125. Arranging crude drugs according to the therapeutic action of their chief constituent, for example grouping *Digitalis* and *Strophanthus* together as cardiotonics, is best described as which type of classification?

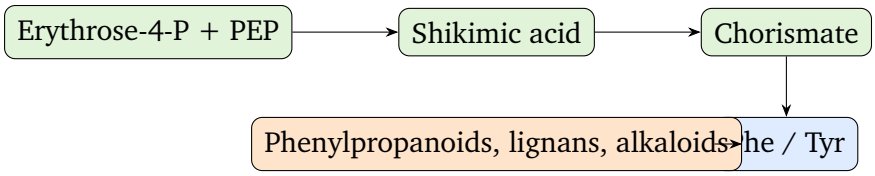
(A) Alphabetical classification

(B) Pharmacological (therapeutic) classification

(C) Chemical classification

(D) Morphological classification

Q126. The biosynthetic scheme below outlines a major secondary-metabolite route in plants. Identify the pathway and the class of compounds it primarily generates.



(A) Acetate–mevalonate pathway giving terpenoids

(B) Acetate–malonate pathway giving fatty acids

(C) Glycolytic pathway giving sugars

(D) Shikimic acid pathway giving aromatic amino acids and phenylpropanoids

Q127. Morphine and codeine are phenanthrene-type isoquinoline alkaloids obtained from the dried latex of unripe capsules of which plant?

(A) *Papaver somniferum*

(B) *Atropa belladonna*

(C) *Rauwolfia serpentina*

(D) *Cinchona officinalis*

Q128. Pseudo-alkaloids are nitrogen-containing basic compounds in which the nitrogen atom is **not** derived from an amino acid. Which of the following is correctly classified as a pseudo-alkaloid?

(A) Morphine (a true alkaloid)

(B) Ephedrine (a protoalkaloid)

(C) Caffeine (a purine pseudo-alkaloid)

(D) Atropine (a true alkaloid)

Q129. A purified plant extract gives a prominent **orange-brown precipitate** when a few drops of a reagent prepared from potassium bismuth iodide are added. This positive colour reaction for alkaloids is the:

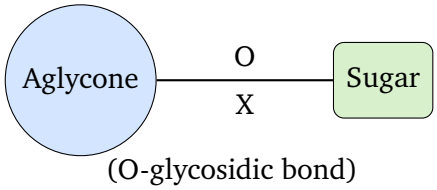
(A) Mayer's test (cream precipitate)

(B) Dragendorff's test

(C) Molisch's test

(D) Bornträger's test

Q130. The schematic shows the general structure of a glycoside, with two structural halves joined by the linkage marked "X".



(O-glycosidic bond)

The non-sugar portion (aglycone or genin) and the linkage "X" are, respectively:

(A) The glycone; an ester bond

(B) The genin; a peptide bond

(C) The sugar moiety; a glycosidic bond

(D) The genin; an O-glycosidic (acetal) bond

Q131. Digitoxin and digoxin are cardiac glycosides whose steroidal aglycone bears a five-membered α,β-unsaturated butenolide (cardenolide) ring. The leaves of which official plant are their source?

(A) *Digitalis purpurea / Digitalis lanata*

(B) *Cassia angustifolia*

(C) *Glycyrrhiza glabra*

(D) *Dioscorea deltoidea*

Q132. Senna leaves and pods owe their purgative action to anthraquinone glycosides called sennosides. The presence of these anthraquinone derivatives is confirmed by a characteristic pink-to-red colour in the ammoniacal layer in which test?

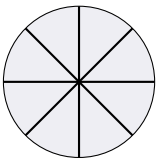
(A) Keller–Kiliani test

(B) Bornträger's test

(C) Legal's test

(D) Baljet test

Q133. The microscopical sketch below shows a cell inclusion frequently used as a diagnostic character in powdered-drug evaluation. A star-shaped cluster of calcium oxalate, as drawn, is called:



calcium oxalate

(A) A prism crystal

(B) A microsphenoidal crystal

(C) A rosette aggregate (cluster crystal / sphaeraphide)

(D) A raphide bundle

Q134. Clove (the dried flower bud of *Syzygium aromaticum*) yields a volatile oil containing 70–90% of a phenolic constituent responsible for its dental-analgesic use. This chief constituent is:

(A) Eugenol

(B) Menthol

(C) Anethole

(D) Cinnamaldehyde

Q135. Peppermint oil, obtained by distillation of *Mentha piperita*, owes its cooling sensation chiefly to which monoterpene alcohol?

(A) Anethole

(B) Thymol

(C) Carvone

(D) Menthol

Q136. Acacia (gum arabic) and tragacanth differ markedly in their behaviour with water. Which statement correctly distinguishes them?

(A) Both dissolve completely to give clear true solutions

(B) Acacia is almost completely soluble in water giving a viscous solution, whereas tragacanth only swells to form a gel

(C) Tragacanth dissolves fully while acacia is insoluble

(D) Both are insoluble and only swell in water

Q137. Which of the following correctly differentiates a fixed (fatty) oil from a volatile oil?

(A) A fixed oil evaporates without residue and a volatile oil leaves a permanent grease spot

(B) Both are chemically glycerides of fatty acids

(C) A fixed oil leaves a permanent translucent grease spot on paper and is non-volatile, whereas a volatile oil evaporates leaving no permanent stain

(D) A volatile oil can be saponified to soap but a fixed oil cannot

Q138. Terpenoids and steroids of plant origin are biosynthesised from a common five-carbon building block. Through which pathway is this isoprene unit (isopentenyl pyrophosphate) classically generated from acetyl-CoA?

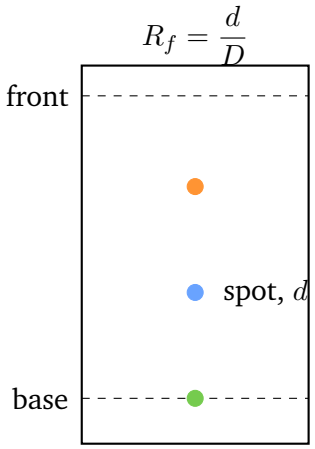
(A) Shikimic acid pathway

(B) Acetate–malonate pathway

(C) Pentose phosphate pathway

(D) Acetate–mevalonate (mevalonic acid) pathway

Q139. The TLC plate below is a chromatographic fingerprint of a herbal extract, showing the baseline (spotting line), three resolved spots, and the solvent front.



If a spot migrates a distance $d = 2.8$ cm while the solvent front D moves 4.0 cm from the baseline, the R_f value of that spot is:

(A) 0.70

(B) 1.43

(C) 0.28

(D) 0.40

Q140. In the standardisation of a crude drug, the residue obtained after incinerating the total ash with dilute hydrochloric acid (the acid-insoluble siliceous matter) is reported as:

(A) Total ash value

(B) Acid-insoluble ash

(C) Water-soluble ash

(D) Sulphated ash

Q141. A continuous hot-extraction technique in which a small quantity of powdered drug is repeatedly percolated by freshly distilled, condensed solvent until exhaustion, using minimum solvent, is best carried out using a:

(A) Simple maceration in a closed vessel

(B) Single-stage percolator at room temperature

(C) Soxhlet apparatus (continuous hot percolation)

(D) Infusion in cold water

Q142. Substitution of a genuine drug with an exhausted (spent) drug from which the active constituents have already been removed by previous extraction is an example of which type of adulteration?

(A) Substitution with superficially similar but inferior natural drugs

(B) Admixture with foreign matter such as sand

(C) Addition of synthetic principles to enhance activity

(D) Use of exhausted (deteriorated/spent) drugs

Part F: Pharmaceutical Biotechnology & Microbiology

Q143. A restriction endonuclease cleaves double-stranded DNA at a recognition site to leave 5′ single-stranded overhangs (“sticky ends”). Which one of the following enzymes produces such cohesive ends rather than blunt ends?

(A) *Eco*RI, which cuts GAATTC between G and A on each strand

(B) *Sma*I, which cuts CCCGGG at the centre

(C) *Alu*I, which cuts AGCT at the centre

(D) *Hae*III, which cuts GGCC at the centre

Q144. In a standard polymerase chain reaction (PCR), the three repeated thermal steps occur in the order:

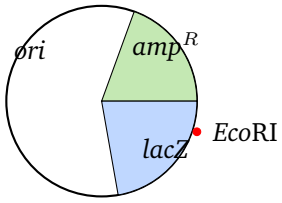
(A) Annealing ($\sim$55°C) $\rightarrow$ denaturation ($\sim$94°C) $\rightarrow$ extension ($\sim$72°C)

(B) Denaturation ($\sim$94°C) $\rightarrow$ annealing ($\sim$55°C) $\rightarrow$ extension ($\sim$72°C)

(C) Extension ($\sim$72°C) $\rightarrow$ denaturation ($\sim$94°C) $\rightarrow$ annealing ($\sim$55°C)

(D) Denaturation ($\sim$72°C) $\rightarrow$ annealing ($\sim$94°C) $\rightarrow$ extension ($\sim$55°C)

Q145. The circular cloning vector shown below carries an origin of replication, an ampicillin-resistance gene, a *lacZ* gene, and a unique *Eco*RI site within *lacZ*. When a foreign DNA fragment is inserted at the *Eco*RI site and the transformants are plated on X-gal, the recombinant colonies will appear:



(A) Blue, because *lacZ* is still functional

(B) Blue, because ampicillin resistance is lost

(C) White, because insertional inactivation disrupts *lacZ*

(D) White, because the origin of replication is destroyed

Q146. Which enzyme is used to covalently join the foreign DNA insert to the vector by forming phosphodiester bonds between adjacent 3′-OH and 5′-phosphate ends?

(A) Reverse transcriptase

(B) DNA polymerase I

(C) Restriction endonuclease

(D) DNA ligase

Q147. In molecular biology, the technique used to detect a **specific protein** from a mixture by separating proteins on a gel, transferring them to a membrane, and probing with a labelled antibody is called:

(A) Western blotting

(B) Southern blotting

(C) Northern blotting

(D) Eastern blotting

Q148. In a conventional stirred-tank aerobic bioreactor, the component whose primary function is to break up air bubbles and improve oxygen transfer while keeping the broth homogeneous is the:

(A) Sparger alone, without agitation

(B) Impeller (agitator) together with baffles

(C) Cooling jacket

(D) Foam breaker (mechanical defoamer)

Q149. Penicillin produced by *Penicillium chrysogenum* is best classified as a:

(A) Primary metabolite formed during the log phase (trophophase)

(B) Structural protein of the fungal cell wall

(C) Secondary metabolite formed mainly in the stationary phase (idiophase)

(D) Storage carbohydrate of the organism

Q150. Fermentation media are most commonly sterilized by moist heat in an autoclave. The standard reference condition for this is:

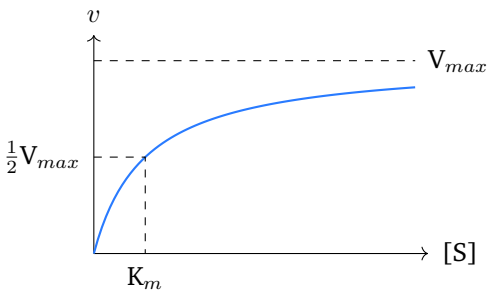
(A) 100°C at atmospheric pressure for 60 min

(B) 160°C dry heat for 2 h

(C) Membrane filtration through a 0.45 μm filter

(D) 121°C at 15 psi (about 103 kPa) for 15–20 min

Q151. The Michaelis–Menten plot of initial velocity v against substrate concentration [S] for an enzyme is shown. The substrate concentration at which v equals one-half of V_{max} is, by definition:



(A) The Michaelis constant K_m

(B) Twice the value of V_{max}

(C) The turnover number k_{cat}

(D) The dissociation constant of the enzyme dimer

Q152. A competitive inhibitor binds reversibly to the active site of an enzyme. Compared with the uninhibited reaction, its effect on the kinetic parameters is:

(A) K_m decreases, V_{max} unchanged

(B) K_m increases (apparent), V_{max} unchanged

(C) K_m unchanged, V_{max} decreases

(D) Both K_m and V_{max} decrease

Q153. Among the following methods of enzyme immobilization, the technique in which the enzyme is physically trapped within the lattice of a polymer gel (such as calcium alginate) without forming covalent bonds is called:

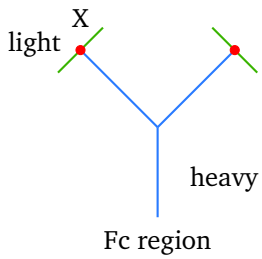
(A) Covalent coupling to an activated support

(B) Adsorption onto an ion-exchange resin

(C) Entrapment in a polymer matrix

(D) Cross-linking with glutaraldehyde

Q154. The basic immunoglobulin (IgG) monomer is shown below as a Y-shaped molecule with two heavy chains and two light chains. The region labelled X, which actually binds the antigen, is the:



(A) Fc region of the heavy chains

(B) Hinge region only

(C) Constant domain C_H2

(D) Variable region of the Fab arm (antigen-binding site)

Q155. Which immunoglobulin class exists predominantly as a pentamer, is the first antibody produced in a primary immune response, and is the most efficient at complement activation and agglutination?

(A) IgM

(B) IgG

(C) IgA

(D) IgE

Q156. Administration of preformed anti-tetanus immunoglobulin (antiserum) to a patient with a contaminated wound is an example of:

(A) Active artificial immunity, with long-lasting memory

(B) Passive artificial immunity, giving immediate but short-lived protection

(C) Active natural immunity following infection

(D) Passive natural immunity through breast milk

Q157. In hybridoma technology for producing monoclonal antibodies, antibody-secreting B-lymphocytes from an immunised animal are fused with myeloma cells. The chief reason for using myeloma (cancer) cell partners is that they:

(A) Secrete a different antibody so the product is polyclonal

(B) Provide the antigen for selection on HAT medium

(C) Confer immortality, allowing the fused hybridoma to divide indefinitely in culture

(D) Supply the gene for the variable antibody region

Q158. Gram-positive and Gram-negative bacteria differ chiefly in their cell-wall composition, which determines retention of the crystal-violet–iodine complex. Gram-positive cells appear **purple** after staining primarily because they possess:

(A) An outer membrane rich in lipopolysaccharide

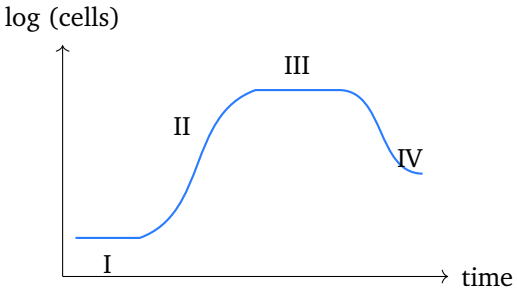
(B) Only a thin peptidoglycan layer between two membranes

(C) No cell wall, decolourising readily with alcohol

(D) A thick multilayered peptidoglycan wall that retains the crystal-violet complex

Q159. The bacterial growth curve below plots the logarithm of viable cell number against time. In which labelled phase is the specific growth rate

maximal and the generation time shortest, with cells dividing exponentially?



(A) Phase II (log / exponential phase)

(B) Phase I (lag phase)

(C) Phase III (stationary phase)

(D) Phase IV (death / decline phase)

Q160. A heat-labile pharmaceutical solution (for example, an enzyme or a thermolabile antibiotic) must be sterilized without exposure to high temperature. The most appropriate method is:

(A) Autoclaving at 121°C for 15 min

(B) Membrane (bacterial) filtration through a 0.22 μm filter

(C) Dry-heat sterilization at 160°C for 2 h

(D) Red-heat flaming in a Bunsen burner

Detailed Solutions

Q1.

Solution

Concept — Solubility product: For a 1:1 salt AgCl $\rightleftharpoons$ $Ag^+ + Cl^-$, $K_{sp} = [Ag^+][Cl^-] = s^2$ where s is the molar solubility. **Reasoning:** $s = 1.0 \times 10^{-5}$ mol/L, so $K_{sp} = (1.0 \times 10^{-5})^2 = 1.0 \times 10^{-10}$. **Why the other options are wrong:**

- (A) 1.0×10^{-5} is the solubility s itself, not s^2.
- (C) 2.0×10^{-5} wrongly multiplies s by 2.
- (D) 1.0×10^{-15} corresponds to s^3, valid only for a 1:2 (e.g. AB_2) salt.

Final Answer: $K_{sp} = s^2 = 1.0 \times 10^{-10} \Rightarrow$ B

Answer: (B) Go Back to Q1

Q2.

Solution

Concept — Partition coefficient: $P = C_{oil}/C_{water}$ at equilibrium; with equal volumes the concentration ratio equals the mass ratio. **Reasoning:** $P = 90/10 = 9.0$. A high P indicates a lipophilic drug favouring the oil (octanol) phase. **Why the other options are wrong:**

- (A) 0.11 is the inverted (water/oil) ratio.
- (B) 0.90 misplaces the decimal.
- (C) 1.0 would mean equal distribution, which is not the case here.

Final Answer: $P = 90/10 = 9.0 \Rightarrow$ D

Answer: (D) Go Back to Q2

Q3.

Solution

Concept — HLB scale: The Griffin HLB scale assigns surfactant function by value; higher HLB means more hydrophilic. **Reasoning:** o/w emulsifiers fall in the HLB range 8–18 (hydrophilic enough to keep the continuous water phase). w/o emulsifiers are 3–6. **Why the other options are wrong:**

- (A) 1.5–3 is the antifoaming range.

- (B) 3–6 is the w/o emulsifier range, opposite to what is needed.
- (D) 13–15 alone is only the detergent sub-range, too narrow a description.

Final Answer: o/w emulsifier ⇒ HLB 8–18 ⇒ C

Answer: (C) Go Back to Q3

Q4.

Solution

Concept — Newtonian flow: A linear τ vs $\dot{\gamma}$ plot passing through the origin means viscosity $\eta = \tau/\dot{\gamma}$ is constant. **Reasoning:** Constant slope $= \eta$ and no yield value is the definition of Newtonian behaviour (e.g. water, glycerin, dilute solutions). **Why the other options are wrong:**

- (B) Pseudoplastic curves bow toward the stress axis (viscosity falls).
- (C) Dilatant curves bow toward the shear-rate axis (viscosity rises).
- (D) Plastic flow has a yield value, so the line does not pass through the origin.

Final Answer: straight line through origin ⇒ Newtonian ⇒ A

Answer: (A) Go Back to Q4

Q5.

Solution

Concept — Non-Newtonian flow: Curve shape reveals how apparent viscosity changes with shear rate. **Reasoning:** Curve (ii) bows toward the stress axis: at higher $\dot{\gamma}$ less extra stress is needed, so apparent viscosity decreases. This is shear-thinning, i.e. pseudoplastic flow (e.g. polymer gels, methylcellulose). **Why the other options are wrong:**

- (A) Newtonian is the straight line (i).
- (C) Dilatant is curve (iii), bowing toward the shear-rate axis.
- (D) Bingham plastic needs a yield intercept on the stress axis, absent here.

Final Answer: curve (ii) is shear-thinning ⇒ pseudoplastic ⇒ B

Answer: (B) Go Back to Q5

Q6.

Solution

Concept — Viscosity units: The poise (P) is CGS; the pascal-second (Pa·s) is SI. 1 Pa·s = 10 poise. **Reasoning:** Therefore 1 poise = 0.1 Pa·s. (Note 1 centipoise = 1 mPa·s, the viscosity of water at 20°C.) **Why the other options are wrong:**

- (A) 1 Pa·s equals 10 poise, not 1.
- (B) N·s/m^2 is identical to Pa·s, again 10 poise.
- (C) The centistoke is a unit of kinematic, not dynamic, viscosity.

Final Answer: 1 poise = 0.1 Pa·s $\Rightarrow$ D

Answer: (D) Go Back to Q6

Q7.

Solution

Concept — Carr's index: Carr's % $= \dfrac{(\rho_{tapped} - \rho_{bulk})}{\rho_{tapped}} \times 100$. **Reasoning:** $= \dfrac{0.50 - 0.40}{0.50} \times 100 = \dfrac{0.10}{0.50} \times 100 = 20\%$. A value of 18–21% indicates fair-to-passable flow. **Why the other options are wrong:**

- (A) 10% would need a smaller density difference.
- (B) 16% wrongly uses bulk density in the denominator-numerator mix.
- (D) 25% over-estimates the difference.

Final Answer: $(0.10/0.50) \times 100 = 20\% \Rightarrow$ C

Answer: (C) Go Back to Q7

Q8.

Solution

Concept — Hausner ratio: HR $= \rho_{tapped}/\rho_{bulk}$; 1.12–1.18 is good, 1.19–1.25 passable. **Reasoning:** HR $= 0.50/0.40 = 1.25$, which corresponds to passable flow (consistent with the 20% Carr's index of the previous question). **Why the other options are wrong:**

- (B) 0.80 is the inverted ratio; HR is always ≥ 1.
- (C) 1.50 over-estimates the ratio.
- (D) 1.05 would imply excellent flow, contradicting the data.

Final Answer: HR $= 0.50/0.40 = 1.25$ (passable) $\Rightarrow$ A

Answer: (A) Go Back to Q8

Q9.

Solution

Concept — Particle-size distribution: The mode is the size class (bar) with the greatest frequency. **Reasoning:** The tallest bar in the histogram is the third one, spanning the 20–40 μm region (peaking at the 30 μm class). Hence the modal interval is 20–40 μm. **Why the other options are wrong:**

- (A) 10–20 is one of the shorter low-size bars.
- (C) 40–50 is a descending bar, lower than the peak.
- (D) 50–60 is the smallest bar.

Final Answer: tallest bar lies in 20–40 μm $\Rightarrow$ B

Answer: (B) Go Back to Q9

Q10.

Solution

Concept — Henderson-Hasselbalch: $\text{pH} = \text{pK}_a + \log \dfrac{[\text{salt}]}{[\text{acid}]}$. **Reasoning:** With equal salt and acid concentrations (0.1 M each), $\log(1) = 0$, so $\text{pH} = \text{pK}_a = 4.76$. **Why the other options are wrong:**

- (A) 3.76 wrongly subtracts 1 from the pK_a.
- (B) 5.76 wrongly adds 1 to the pK_a.
- (C) 7.00 is neutral pH, ignoring the buffer composition.

Final Answer: $\text{pH} = \text{pK}_a = 4.76 \Rightarrow$ D

Answer: (D) Go Back to Q10

Q11.

Solution

Concept — Buffer capacity (β): The resistance of a buffer to pH change is maximal where the buffer can neutralise added acid and base equally. **Reasoning:** This occurs at pH $=$ pK_a, i.e. when the salt/acid ratio is 1. Capacity also rises with total buffer concentration. **Why the other options are wrong:**

- (B) A large salt-to-acid imbalance shifts pH away from pK_a, lowering capacity.
- (C) Minimising total concentration reduces capacity.
- (D) Two pH units from pK_a the buffer is nearly exhausted.

Final Answer: maximal at pH $=$ pK_a $\Rightarrow$ A

Answer: (A) Go Back to Q11

Q12.

Solution

Concept — Fick's first law: $J = -D\dfrac{dC}{dx}$, where D is the diffusion coefficient and dC/dx the concentration gradient. **Reasoning:** Flux is directly proportional to the concentration gradient (and to D and area), and inversely proportional to membrane thickness. **Why the other options are wrong:**

- (A) Flux falls with thickness; it is not proportional to thickness squared.
- (C) Flux is proportional to D, not its reciprocal.
- (D) Surface charge is not a term in Fick's first law.

Final Answer: $J \propto dC/dx \Rightarrow$ B

Answer: (B) Go Back to Q12

Q13.

Solution

Concept — Order of reaction by plot: First-order: $\ln C = \ln C_0 - kt$, so $\ln C$ versus t is linear with slope $-k$. **Reasoning:** The straight ln C vs time plot directly identifies first-order kinetics (e.g. most drug hydrolysis in dilute solution). **Why the other options are wrong:**

- (A) Zero-order gives a linear C (not ln C) vs time plot.
- (B) Second-order gives a linear $1/C$ vs time plot.
- (D) Pseudo-zero-order again gives a linear C vs time plot.

Final Answer: linear ln C vs t $\Rightarrow$ first-order $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q13

Q14.

Solution

Concept — Zero-order shelf-life: $t_{90} = \dfrac{0.1\,C_0}{k_0}$ for zero-order loss of 10%. **Reasoning:** $t_{90} = \dfrac{0.1 \times 10}{0.05} = \dfrac{1.0}{0.05} = 20$ months. **Why the other options are wrong:**

- (B) 2 months ignores the $0.1\,C_0$ factor of 10.
- (C) 10 months uses C_0 instead of $0.1\,C_0$ incorrectly halved.
- (D) 100 months mis-divides by 0.01.

Final Answer: $t_{90} = (0.1 \times 10)/0.05 = 20$ months $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q14

Q15.

Solution

Concept — Arrhenius / accelerated stability: $k = Ae^{-E_a/RT}$; rate constants measured at several elevated temperatures are extrapolated to storage temperature. **Reasoning:** A plot of $\ln k$ vs $1/T$ lets one predict the degradation rate (and hence shelf-life) at 25°C without waiting years. **Why the other options are wrong:**

- (A) The reaction order is assumed constant, not changed.
- (B) Heating cannot eliminate E_a; it is the energy barrier being characterised.
- (C) Partition coefficient is unrelated to Arrhenius kinetics.

Final Answer: extrapolate elevated-T rates to predict normal shelf-life $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q15

Q16.

Solution

Concept — Freundlich isotherm: Taking logs of $x/m = kC^{1/n}$ gives $\log(x/m) = \log k + \frac{1}{n}\log C$. **Reasoning:** Hence a plot of $\log(x/m)$ vs $\log C$ is a straight line with slope $1/n$ and intercept $\log k$. **Why the other options are wrong:**

- (A) x/m vs C is curved for Freundlich.
- (C) $1/(x/m)$ vs C is the Langmuir linearisation, a different model.
- (D) x/m vs $1/C$ does not linearise the Freundlich form.

Final Answer: log-log plot is linear $\Rightarrow$ B

Answer: (B) Go Back to Q16

Q17.

Solution

Concept — Complexation: Cyclodextrins are cyclic oligosaccharides with a hydrophobic cavity and hydrophilic exterior. **Reasoning:** A poorly soluble drug enters the cavity forming an inclusion complex, improving aqueous solubility, dissolution and chemical stability. **Why the other options are wrong:**

- (A) It is not used as a disintegrant.
- (B) It does not raise water surface tension.
- (D) It is not a propellant.

Final Answer: forms inclusion complexes improving solubility/stability $\Rightarrow$ C

Answer: (C) Go Back to Q17

Q18.

Solution

Concept — Noyes-Whitney: $\frac{dC}{dt} = \frac{DA}{h}(C_s - C)$, where A is surface area, h diffusion-layer thickness, C_s saturation solubility. **Reasoning:** Increasing the effective surface area (e.g. by micronization) raises A and so increases the dissolution rate. **Why the other options are wrong:**

- (B) Increasing h (stagnant layer) lowers the rate.
- (C) Decreasing C_s reduces the driving force $(C_s - C)$.

- (D) Stopping agitation thickens h, slowing dissolution.

Final Answer: larger surface area increases dissolution rate $\Rightarrow$ A

Answer: (A) Go Back to Q18

Q19.

Solution

Concept — Higuchi model: $Q = k_H\sqrt{t}$; matrix release is diffusion-controlled so cumulative amount is linear with the square root of time. **Reasoning:** A straight line of Q vs $\sqrt{t}$ through the origin (slope k_H) is the signature of the Higuchi model. **Why the other options are wrong:**

- (A) Zero-order plots Q linearly vs t (not $\sqrt{t}$).
- (B) First-order plots $\log(\%\,\text{remaining})$ linearly vs t.
- (C) Hixson-Crowell plots the cube root of remaining mass vs t.

Final Answer: Q vs $\sqrt{t}$ linear $\Rightarrow$ Higuchi model $\Rightarrow$ D

Answer: (D) Go Back to Q19

Q20.

Solution

Concept — Korsmeyer-Peppas exponent: For a slab/cylinder, $n \leq 0.45$ indicates Fickian diffusion; $0.45 < n < 0.89$ anomalous; $n = 0.89$ case-II. **Reasoning:** $n = 0.45$ marks the boundary of pure Fickian (diffusion-controlled) release. **Why the other options are wrong:**

- (A) Zero-order (case-II) corresponds to $n \approx 0.89$.
- (C) Super case-II is $n > 0.89$.
- (D) Anomalous transport is $0.45 < n < 0.89$.

Final Answer: $n = 0.45 \Rightarrow$ Fickian diffusion $\Rightarrow$ B

Answer: (B) Go Back to Q20

Q21.

Solution

Concept — BCS: Class I high sol/high perm; Class II low sol/high perm; Class III high sol/low perm; Class IV low sol/low perm. **Reasoning:** High solubility with low permeability is by definition Class III (absorption is permeability-limited). **Why the other options are wrong:**

- (A) Class I is high/high.
- (B) Class II is low solubility/high permeability.
- (D) Class IV is low solubility/low permeability.

Final Answer: high solubility + low permeability $\Rightarrow$ Class III $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q21

Q22.

Solution

Concept — Bioequivalence: Two products are bioequivalent when their bioavailability (rate and extent of absorption) is statistically comparable. **Reasoning:** The 90% confidence intervals of the C_{max} and AUC ratios must fall within 80–125%, showing no significant difference. **Why the other options are wrong:**

- (B) Bioequivalents contain the same active ingredient.
- (C) Different routes change absorption and are not compared this way.
- (D) Tablet hardness is a physical test, not a measure of bioequivalence.

Final Answer: comparable C_{max} and AUC $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q22

Q23.

Solution

Concept — Tablet excipients: Lubricants reduce die-wall friction and aid ejection; magnesium stearate is the classic hydrophobic lubricant. **Reasoning:** It coats granules to ease tablet ejection; excess amounts can retard disintegration and dissolution. **Why the other options are wrong:**

- (A) Binders (e.g. PVP, starch paste) impart cohesion.
- (B) Disintegrants (e.g. starch, SSG) break the tablet up.

- (C) Diluents (e.g. lactose) add bulk.

Final Answer: magnesium stearate is a lubricant $\Rightarrow$ D

Answer: (D) Go Back to Q23

Q24.

Solution

Concept — Friability test: Measured in a Roche friabilator; weight loss after 100 revolutions reflects mechanical strength. **Reasoning:** The pharmacopoeial acceptance limit for conventional uncoated tablets is a maximum of 1.0% weight loss. **Why the other options are wrong:**

- (A) 0.1% is unnecessarily strict and not the official limit.
- (C) 5.0% would indicate an unacceptably weak tablet.
- (D) 10.0% is far beyond any acceptable value.

Final Answer: friability limit $\leq 1.0\% \Rightarrow$ B

Answer: (B) Go Back to Q24

Q25.

Solution

Concept — Superdisintegrants: These act at low concentration (2–8%) by rapid swelling/wicking; examples are sodium starch glycolate, croscarmellose sodium, crospovidone. **Reasoning:** Sodium starch glycolate swells many-fold in water, fracturing the tablet quickly. **Why the other options are wrong:**

- (A) Acacia is a binder/suspending agent.
- (B) Talc is a glidant/lubricant.
- (D) Lactose is a diluent.

Final Answer: sodium starch glycolate is a superdisintegrant $\Rightarrow$ C

Answer: (C) Go Back to Q25

Q26.

Solution

Concept — Pyrogen / LAL test: The Limulus Amebocyte Lysate (from horseshoe crab) gels in the presence of bacterial endotoxin (lipopolysaccharide). **Reasoning:**

The LAL test is the standard in-vitro assay for endotoxins (pyrogens) in parenteral products, replacing the rabbit pyrogen test. **Why the other options are wrong:**

- (B) Particulate matter is tested by light-obscuration/microscopy.
- (C) Content uniformity is a separate assay.
- (D) Disintegration time is a tablet test, not for parenterals.

Final Answer: LAL detects bacterial endotoxins $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q26

Q27.

Solution

Concept — Displacement value (DV): It corrects for the volume a drug occupies in a suppository mould relative to the base. **Reasoning:** DV is the number of parts by weight of drug that displaces 1 part by weight of the base (so the correct mass of base can be calculated). **Why the other options are wrong:**

- (A) DV is by weight, not a simple base:drug volume ratio.
- (B) Melting point is unrelated to DV.
- (C) Aqueous solubility is not the definition of DV.

Final Answer: parts of drug displacing 1 part of base $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q27

Q28.

Solution

Concept — Emulsion instability: Cracking (breaking) is the irreversible coalescence of droplets giving two separate phases. **Reasoning:** Unlike creaming, cracking cannot be reversed by shaking because the interfacial film has been destroyed. **Why the other options are wrong:**

- (A) Creaming is reversible upward/downward migration of droplets.
- (C) Flocculation is reversible clumping without coalescence.

- (D) Phase inversion is a change of emulsion type (o/w → w/o), not coalescence to two layers.

Final Answer: irreversible coalescence = cracking ⇒ B

Answer: (B) Go Back to Q28

Q29.

Solution

Concept — Flocculated suspensions: Particles form loose aggregates (flocs) that settle rapidly but as a high-volume, easily redispersed sediment. **Reasoning:** The loose floc network prevents hard caking, so gentle shaking re-suspends the product, a key formulation goal. **Why the other options are wrong:**

- (A) Hard, non-redispersible cake is the deflocculated problem.
- (B) Slow sedimentation with a clear supernatant describes deflocculated systems.
- (D) Flocculated systems have a high (not lowest) sedimentation volume.

Final Answer: loose, easily redispersed sediment ⇒ C

Answer: (C) Go Back to Q29

Q30.

Solution

Concept — Ointment bases: Oleaginous (hydrocarbon) bases are anhydrous, occlusive and emollient; white/yellow petrolatum is the prototype. **Reasoning:** White petrolatum is a purified hydrocarbon mixture, classifying it as an oleaginous base. **Why the other options are wrong:**

- (B) Absorption bases (e.g. wool fat) can take up water.
- (C) Water-removable bases are o/w creams (e.g. hydrophilic ointment).
- (D) Water-soluble bases are PEG-based and contain no hydrocarbon.

Final Answer: white petrolatum is an oleaginous base ⇒ A

Answer: (A) Go Back to Q30

Q31.

Solution

Concept — Size reduction: A fluid energy (jet) mill uses high-velocity air/steam jets; particles collide with one another and shatter. **Reasoning:** It gives ultra-fine micronized powder (1–20 μm) with minimal heat, ideal for thermolabile and inhalation drugs. **Why the other options are wrong:**

- (A) Ball mill grinds by impact/attrition of balls, coarser product, more heat.
- (C) Edge runner mill crushes by heavy rollers, for coarse material.
- (D) Roller mill compresses between rollers, not for micronization.

Final Answer: fluid energy mill micronizes via air-jet collision $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q31

Q32.

Solution

Concept — Lyophilization: Freeze-drying freezes the product, then removes ice directly as vapour under vacuum. **Reasoning:** In primary drying, ice sublimes (solid $\rightarrow$ vapour) under reduced pressure below the triple point, protecting heat-sensitive biologicals. **Why the other options are wrong:**

- (A) High-temperature evaporation would denature labile drugs.
- (B) Filtration removes particles, not bound water.
- (C) Silica gel adsorption is for desiccation of packaged goods, not primary drying.

Final Answer: primary drying removes water by sublimation $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q32

Q33.

Solution

Concept — Reynolds number: $\text{Re} = \dfrac{\rho v d}{\eta}$ classifies flow regime in a pipe. **Reasoning:** $\text{Re} < 2100$ is laminar (smooth, parallel streamlines), 2100–4000 transitional, and > 4000 turbulent (chaotic). The smooth upper sketch is laminar, so $\text{Re} < 2100$. **Why the other options are wrong:**

- (A) Re > 4000 is turbulent (the lower sketch).
- (B) 2100–4000 is the transitional regime.
- (D) Re $= 10000$ is firmly turbulent.

Final Answer: laminar flow $\Rightarrow$ Re $< 2100 \Rightarrow$ C

Answer: (C) Go Back to Q33

Q34.

Solution

Concept — Eutectic point: In a binary system fully miscible as liquid but immiscible as solid, the two liquidus curves meet at the lowest melting temperature. **Reasoning:** That meeting point (E) is the eutectic point, where liquid of fixed composition freezes to a fine mixture of both solids at a single temperature. **Why the other options are wrong:**

- (B) The triple point refers to a single substance (solid-liquid-vapour coexistence).
- (C) The critical solution point is for partially miscible liquids (e.g. phenol-water).
- (D) The glass transition is a property of amorphous solids, not a phase-diagram intersection.

Final Answer: lowest-melting intersection = eutectic point $\Rightarrow$ A

Answer: (A) Go Back to Q34

Q35.

Solution

Concept — Volume of distribution: V_d is the proportionality constant linking the amount of drug in the body to the plasma concentration, $V_d = \text{Dose}/C_0$. **Reasoning:** For an IV bolus in a one-compartment model, C_0 is the concentration extrapolated to $t = 0$. Here $V_d = 500\,\text{mg}/25\,\text{mg/L} = 20$ L. **Why the other options are wrong:**

- (A) 0.05 L inverts the ratio (C_0/Dose).
- (C) 50 L uses 10 mg/L, not the given 25 mg/L.
- (D) 12.5 L halves the dose without basis.

Final Answer: $V_d = 500/25 = 20$ L $\Rightarrow$ B

Answer: (B) Go Back to Q35

Q36.

Solution

Concept — First-order half-life: In first-order kinetics a constant *fraction* is eliminated per unit time; each half-life halves the concentration. **Reasoning:** 80 $\rightarrow$ 40 $\rightarrow$ 20 $\rightarrow$ 10 mg/L is three successive halvings, i.e. 3 half-lives in 9 h. Therefore $t_{1/2} = 9/3 = 3$ h. **Why the other options are wrong:**

- (A) 1.5 h would give 6 half-lives (factor 64), too much.
- (C) 4.5 h gives only 2 half-lives (factor 4), reaching 20 mg/L.
- (D) 9 h is one half-life, reaching only 40 mg/L.

Final Answer: Three halvings over 9 h $\Rightarrow t_{1/2} = 3$ h $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q36

Q37.

Solution

Concept — Zero vs first-order kinetics: Zero-order means a saturated eliminating process removes a fixed amount per unit time; first-order removes a fixed fraction. **Reasoning:** When enzymes/transporters are saturated (e.g. ethanol, phenytoin and aspirin at high doses), elimination becomes zero-order: a constant amount disappears per unit time and the apparent half-life lengthens as concentration rises. Option (C) states this correctly. **Why the other options are wrong:**

- (A) Reverses the definitions; first-order removes a fixed fraction.
- (B) Half-life is constant only in first-order, not zero-order.
- (D) Ethanol and phenytoin at therapeutic levels are zero-order, not first-order.

Final Answer: Zero-order = constant amount eliminated per unit time $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q37

Q38.

Solution

Concept — Clearance relationship: Clearance is the product of the elimination rate constant and the volume of distribution. **Reasoning:** The rate of elimination $= CL \times C = k_e \times (\text{amount}) = k_e \times V_d \times C$. Dividing by C gives $CL = k_e \times V_d$. This is the fundamental link among the three primary pharmacokinetic parameters. **Why the other options are wrong:**

- (B), (C) Have the volume in the wrong place (dimensionally incorrect).
- (D) The squared volume term is dimensionally wrong.

Final Answer: $CL = k_e \times V_d \Rightarrow$ A

Answer: (A) Go Back to Q38

Q39.

Solution

Concept — Potency vs efficacy: On a graded log dose-response curve, the plateau (E_{max}) measures efficacy, while the position along the dose axis (ED_{50}/EC_{50}) measures potency. **Reasoning:** Efficacy is the maximal effect a drug can produce; potency is the dose needed to produce a given effect. A lower ED_{50} (curve shifted left) means greater potency. Thus E_{max} = efficacy and ED_{50} = potency. **Why the other options are wrong:**

- (A), (B) Assign both parameters to one property.
- (C) Reverses the correct assignment.

Final Answer: E_{max} = efficacy; ED_{50} = potency $\Rightarrow$ D

Answer: (D) Go Back to Q39

Q40.

Solution

Concept — Competitive vs non-competitive antagonism: A competitive antagonist shifts the agonist curve to the right in parallel without lowering E_{max} (surmountable); a non-competitive antagonist depresses the maximum (insurmountable). **Reasoning:** Curve P keeps the same plateau but needs more agonist, so it is competitive. Curve Q has a reduced maximum that more agonist cannot

overcome, so it is non-competitive (or irreversible). **Why the other options are wrong:**

- (B) Swaps the two interpretations.
- (C) Only P fits competitive behaviour.
- (D) Partial/inverse agonists are not what these antagonist curves show.

Final Answer: P = competitive, Q = non-competitive $\Rightarrow$ A

Answer: (A) Go Back to Q40

Q41.

Solution

Concept — Partial agonist: A partial agonist has affinity for the receptor but only sub-maximal intrinsic activity (efficacy between 0 and 1). **Reasoning:** Even at full occupancy it cannot reach the full agonist's E_{max}. In the presence of a full agonist it competes for receptors and can therefore behave as an antagonist, capping the response. **Why the other options are wrong:**

- (A) Higher affinity does not raise the maximal response.
- (C) It does bind the receptor.
- (D) Intrinsic activity is between 0 and 1, not exactly 0 (that is a pure antagonist).

Final Answer: Sub-maximal response, can antagonise a full agonist $\Rightarrow$ B

Answer: (B) Go Back to Q41

Q42.

Solution

Concept — pA_2 / Schild analysis: pA_2 quantifies competitive antagonist potency; for a simple competitive antagonist it equals the pK_B. **Reasoning:** pA_2 is the negative logarithm of the molar antagonist concentration that produces a dose ratio of 2, i.e. requires doubling the agonist concentration to restore the control response. The Schild plot (log(dose ratio-1) vs log[antagonist]) gives this as its x-intercept. **Why the other options are wrong:**

- (A) Describes complete blockade, not the $2\times$ definition.
- (B) The Schild slope is ideally 1, not pA_2.

- (D) pA_2 concerns the antagonist, not the agonist ED_{50}.

Final Answer: $-\log$ [antagonist] giving a dose ratio of 2 $\Rightarrow$ C

Answer: (C) Go Back to Q42

Q43.

Solution

Concept — Receptor signalling timescales: Ligand-gated ion channels (ionotropic) act in milliseconds; GPCRs in seconds; kinase-linked in minutes; nuclear receptors in hours. **Reasoning:** The nicotinic ACh receptor and GABA-A receptor are ligand-gated ion channels in which agonist binding directly opens the integral channel, giving the fastest signalling by gating ion flux. **Why the other options are wrong:**

- (A) Nuclear receptors alter gene transcription over hours.
- (B) GPCR signalling via second messengers is on the seconds scale.
- (C) Receptor tyrosine kinases act over minutes via phosphorylation cascades.

Final Answer: Ligand-gated ion channel signals fastest $\Rightarrow$ D

Answer: (D) Go Back to Q43

Q44.

Solution

Concept — GPCR second messengers: Seven-transmembrane GPCRs couple through G proteins; G_s stimulates adenylyl cyclase to raise cAMP. **Reasoning:** The β-adrenergic receptor is a classic G_s-coupled GPCR; agonist binding activates adenylyl cyclase, increases cAMP and activates protein kinase A. This is the branch shown. **Why the other options are wrong:**

- (B) Ligand-gated channels gate ions, not G proteins.
- (C) RTKs autophosphorylate; they do not use G_s/cAMP.
- (D) Nuclear receptors act on DNA, not adenylyl cyclase.

Final Answer: $G_s \rightarrow$ cAMP is a GPCR signal $\Rightarrow$ A

Answer: (A) Go Back to Q44

Q45.

Solution

Concept — Spare receptors: A receptor reserve exists when the maximal response is reached before all receptors are occupied. **Reasoning:** With spare receptors the agonist concentration giving half-maximal response (EC_{50}) is lower than the concentration occupying half the receptors (K_d), so $EC_{50} < K_d$. This amplifies sensitivity and explains why partial occupancy can give a full effect. **Why the other options are wrong:**

- (A), (C) Spare receptors are functional, not absent or non-functional.
- (D) They bind the agonist normally.

Final Answer: Full response at partial occupancy, $EC_{50} < K_d \Rightarrow \boxed{B}$

Answer: (B) Go Back to Q45

Q46.

Solution

Concept — AChE inhibitors: Physostigmine is a lipid-soluble tertiary amine; neostigmine is a charged quaternary amine. **Reasoning:** Because physostigmine is uncharged it crosses the blood-brain barrier and is the antidote for central anticholinergic (e.g. atropine) toxicity. Neostigmine, being quaternary, stays peripheral and is used for myasthenia gravis and to reverse non-depolarizing block. **Why the other options are wrong:**

- (A) Physostigmine is tertiary and does enter the CNS.
- (B) Reverses their CNS penetration.
- (D) Carbamates inhibit reversibly; irreversible phosphorylation is the organophosphate mechanism.

Final Answer: Physostigmine (tertiary) enters CNS; neostigmine (quaternary) is peripheral $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q46

Q47.

Solution

Concept — Atropine (antimuscarinic): Atropine blocks muscarinic receptors, opposing parasympathetic "rest-and-digest" actions. **Reasoning:** Muscarinic blockade gives mydriasis, cycloplegia, tachycardia, dry mouth and reduced secretions. Miosis and *increased* lacrimal secretion are cholinergic (muscarinic-stimulant) effects, so option (A) is NOT produced by atropine. **Why the other options are wrong:**

- (B) Mydriasis/cycloplegia are genuine atropine effects.
- (C) Tachycardia follows vagal blockade.
- (D) Dry mouth and reduced sweating are typical antimuscarinic effects.

Final Answer: Miosis with increased lacrimation is the exception $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q47

Q48.

Solution

Concept — β-blocker selectivity: Cardioselective (β_1-selective) blockers spare bronchial β_2 receptors and are safer in airway disease. **Reasoning:** Metoprolol (like atenolol and bisoprolol) is β_1-selective, so at usual doses it lowers heart rate and blood pressure with less bronchoconstriction, making it preferable when a β-blocker is needed in asthma. **Why the other options are wrong:**

- (A) Propranolol is non-selective.
- (B) Timolol is non-selective.
- (C) Nadolol is non-selective.

Final Answer: Metoprolol is β_1-selective $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q48

Q49.

Solution

Concept — Depolarizing vs non-depolarizing blockers: Succinylcholine is a depolarizing agonist; vecuronium and similar agents are competitive (non-depolarizing) antagonists. **Reasoning:** Succinylcholine binds and persistently de-

polarizes the motor end-plate, producing initial fasciculations then flaccid paralysis (Phase I). AChE inhibitors do not reverse it (they can worsen it), and it is rapidly hydrolysed by plasma pseudocholinesterase, giving a short action. **Why the other options are wrong:**

- (A) Competitive antagonism reversed by neostigmine describes the non-depolarizing class.
- (C) Its action is brief, not hours.
- (D) Blocking SR calcium release is the action of dantrolene.

Final Answer: Depolarizing agonist, hydrolysed by pseudocholinesterase $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q49

Q50.

Solution

Concept — β_2-agonists: Selective β_2-agonists relax bronchial smooth muscle and are first-line bronchodilators. **Reasoning:** Salbutamol (albuterol) is a short-acting selective β_2-agonist that relieves acute bronchospasm in asthma with relatively little cardiac β_1 stimulation. **Why the other options are wrong:**

- (A) Phenylephrine is an α_1-agonist (decongestant/vasopressor).
- (B) Clonidine is a central α_2-agonist antihypertensive.
- (D) Noradrenaline is a non-selective α/β_1 agonist with little β_2 action.

Final Answer: Salbutamol is the selective β_2-agonist $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q50

Q51.

Solution

Concept — Benzodiazepines and GABA-A: Benzodiazepines are positive allosteric modulators of the GABA-A receptor-chloride ionophore. **Reasoning:** They bind a site distinct from GABA and increase the *frequency* of chloride channel opening in response to GABA, enhancing inhibitory hyperpolarisation. They require GABA to act, which underlies their wide safety margin. **Why the other options are wrong:**

- (B) They cannot open the channel without GABA.

- (C) Increasing channel-open *duration* is the barbiturate mechanism.
- (D) They do not block GABA reuptake.

Final Answer: Increase frequency of Cl^- channel opening $\Rightarrow$ A

Answer: (A) Go Back to Q51

Q52.

Solution

Concept — Antipsychotic D_2 blockade: Typical neuroleptics are dopamine D_2 receptor antagonists. **Reasoning:** Blockade of mesolimbic D_2 receptors reduces positive psychotic symptoms. Blockade of nigrostriatal D_2 produces extrapyramidal side effects, and tubero-infundibular blockade raises prolactin. **Why the other options are wrong:**

- (A) Strong 5-HT_{2A} blockade is more typical of atypicals.
- (C) M_1 blockade causes anticholinergic side effects, not antipsychosis.
- (D) H_1 blockade causes sedation and weight gain, not the core effect.

Final Answer: Mesolimbic D_2 blockade $\Rightarrow$ B

Answer: (B) Go Back to Q52

Q53.

Solution

Concept — SSRI mechanism: Selective serotonin reuptake inhibitors block the presynaptic serotonin transporter (SERT). **Reasoning:** Fluoxetine selectively inhibits 5-HT reuptake, raising synaptic serotonin with minimal effect on noradrenaline or dopamine transporters, giving efficacy with fewer anticholinergic and cardiac effects than TCAs. **Why the other options are wrong:**

- (A) Irreversible MAO inhibition describes MAOIs.
- (B) Mixed NA/5-HT reuptake block describes TCAs.
- (C) D_2 blockade is an antipsychotic action.

Final Answer: Selective serotonin reuptake inhibition $\Rightarrow$ D

Answer: (D) Go Back to Q53

Q54.

Solution

Concept — Opioid receptors: The μ (MOP) receptor mediates the principal actions of morphine. **Reasoning:** μ-receptor activation produces supraspinal analgesia, euphoria, respiratory depression, miosis, constipation and physical dependence. These G_i-coupled receptors reduce cAMP, close calcium channels and open potassium channels. **Why the other options are wrong:**

- (B) κ gives spinal analgesia and dysphoria, not morphine's main profile.
- (C) δ contributes modulatory analgesia, not the dominant effects.
- (D) ORL-1 (nociceptin) is a distinct system.

Final Answer: μ (mu) opioid receptor $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q54

Q55.

Solution

Concept — Phenytoin mechanism: Phenytoin acts by use-dependent (state-dependent) blockade of voltage-gated sodium channels. **Reasoning:** By binding preferentially to the inactivated state and prolonging it, phenytoin limits high-frequency repetitive firing of neurons, suppressing seizure spread in tonic-clonic and partial seizures without depressing normal low-frequency activity. **Why the other options are wrong:**

- (A) GABA enhancement is not its primary action.
- (B) T-type calcium channel block is ethosuximide's action in absence seizures.
- (D) It is not an NMDA antagonist.

Final Answer: Use-dependent Na^+ channel blockade $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q55

Q56.

Solution

Concept — Local anaesthetic mechanism: Local anaesthetics block voltage-gated sodium channels from the cytoplasmic side. **Reasoning:** The unionised base crosses the axonal membrane, then the ionised form binds the inner pore, preventing Na^+ influx and so blocking action-potential generation and conduction. Smaller, myelinated and rapidly firing fibres are blocked preferentially. **Why the other options are wrong:**

- (A) They do not open potassium channels.
- (C) They do not activate GABA-A receptors.
- (D) AChE inhibition is unrelated to nerve block.

Final Answer: Block voltage-gated Na^+ channels from inside $\Rightarrow$ B

Answer: (B) Go Back to Q56

Q57.

Solution

Concept — Levodopa/carbidopa: Carbidopa is a peripheral DOPA-decarboxylase inhibitor that does not cross the blood-brain barrier. **Reasoning:** By blocking the peripheral conversion of levodopa to dopamine, carbidopa increases the fraction of levodopa reaching the brain, lowers the required dose, and reduces peripheral side effects such as nausea and hypotension. **Why the other options are wrong:**

- (A) Carbidopa does not enter the CNS and is not converted to dopamine.
- (B) It is not a dopamine receptor agonist.
- (C) Central MAO-B inhibition describes selegiline.

Final Answer: Peripheral DOPA-decarboxylase inhibition $\Rightarrow$ D

Answer: (D) Go Back to Q57

Q58.

Solution

Concept — ACE inhibitors: Enalapril inhibits angiotensin-converting enzyme (ACE). **Reasoning:** Reduced angiotensin II lowers vasoconstriction and aldosterone-driven sodium/water retention, while reduced bradykinin breakdown

adds vasodilation (and explains the dry cough). The net effect is lowered blood pressure and reduced afterload. **Why the other options are wrong:**

- (B) Direct AT_1 blockade describes ARBs (e.g. losartan).
- (C) β_1 blockade is a different class.
- (D) L-type calcium channel block describes dihydropyridine CCBs.

Final Answer: ACE inhibition lowering angiotensin II $\Rightarrow$ A

Answer: (A) Go Back to Q58

Q59.

Solution

Concept — Organic nitrates: Nitroglycerin is a nitric-oxide donor that relaxes vascular smooth muscle. **Reasoning:** NO activates guanylyl cyclase, raising cGMP and relaxing smooth muscle. Predominant venodilation lowers preload (and at higher doses arterial dilation lowers afterload), reducing myocardial wall tension and oxygen demand, which relieves angina. **Why the other options are wrong:**

- (A) It does not increase contractility or rate; that would worsen ischaemia.
- (C) It is not a calcium channel blocker.
- (D) It does not act on the renin-angiotensin system.

Final Answer: NO/cGMP venodilation reducing preload $\Rightarrow$ B

Answer: (B) Go Back to Q59

Q60.

Solution

Concept — Vaughan-Williams Class III: Class III antiarrhythmics block potassium channels and prolong repolarisation. **Reasoning:** Amiodarone's dominant action prolongs the action-potential duration and effective refractory period by blocking K^+ channels, although it also has Class I, II and IV properties. The prolonged repolarisation underlies its broad antiarrhythmic use. **Why the other options are wrong:**

- (A) Na^+ block alone is Class I.
- (B) β-blockade is Class II.
- (D) Ca^{2+} channel block is Class IV.

Final Answer: K^+ channel block prolonging repolarisation $\Rightarrow$ C

Answer: (C) Go Back to Q60

Q61.

Solution

Concept — Digoxin inotropy: Digoxin inhibits the sarcolemmal Na^+/K^+-ATPase. **Reasoning:** Inhibiting the pump raises intracellular Na^+, which slows Ca^{2+} efflux through the Na^+/Ca^{2+} exchanger. The resulting rise in intracellular Ca^{2+} increases the force of contraction (positive inotropy). Digoxin also increases vagal tone, slowing AV conduction. **Why the other options are wrong:**

- (A) It does not directly activate β_1 receptors.
- (B) It does not open potassium channels for inotropy.
- (C) PDE-3 inhibition is the mechanism of inamrinone/milrinone.

Final Answer: Na^+/K^+-ATPase inhibition raising intracellular Ca^{2+} $\Rightarrow$ D

Answer: (D) Go Back to Q61

Q62.

Solution

Concept — Warfarin vs heparin: The two anticoagulants differ in mechanism, route, onset and monitoring. **Reasoning:** Warfarin inhibits vitamin-K epoxide reductase, reducing synthesis of factors II, VII, IX and X; it is oral, slow in onset and monitored by INR/PT, reversed by vitamin K. Heparin potentiates antithrombin, acts immediately by injection, is monitored by aPTT and reversed by protamine. Option (A) captures all of this. **Why the other options are wrong:**

- (B) Heparin is not oral and is not monitored by INR.
- (C) Warfarin has delayed onset and is not reversed by protamine.
- (D) Vitamin K reverses warfarin, not heparin.

Final Answer: Warfarin oral/INR; heparin injected/aPTT $\Rightarrow$ A

Answer: (A) Go Back to Q62

Q63.

Solution

Concept — H_1 vs H_2 antihistamines: H_1 blockers treat allergy; H_2 blockers reduce gastric acid. **Reasoning:** Ranitidine and cimetidine are H_2-receptor antagonists that block histamine-stimulated acid secretion from gastric parietal cells, used in peptic ulcer and reflux. Chlorpheniramine is a sedating H_1 antihistamine for allergy. **Why the other options are wrong:**

- (A) Blocking H_1 with sedation describes chlorpheniramine.
- (C) They are not H_1 antihistamines.
- (D) They are not mast-cell stabilisers (e.g. cromoglicate).

Final Answer: H_2 blockade reducing gastric acid $\Rightarrow$ B

Answer: (B) Go Back to Q63

Q64.

Solution

Concept — Aspirin mechanism: Aspirin irreversibly inhibits cyclooxygenase. **Reasoning:** It acetylates a serine residue in the COX active site, irreversibly inhibiting COX-1 and COX-2 and reducing synthesis of prostaglandins (inflammation, fever, pain) and thromboxane A_2 (platelet aggregation). Platelet inhibition lasts the platelet's lifespan because platelets cannot synthesise new enzyme. **Why the other options are wrong:**

- (A) It does not inhibit lipoxygenase.
- (B) It does not block H_1 receptors.
- (D) It is not COX-2 selective (that describes coxibs).

Final Answer: Irreversible acetylation/inhibition of COX $\Rightarrow$ C

Answer: (C) Go Back to Q64

Q65.

Solution

Concept — Allopurinol in gout: Allopurinol is a xanthine oxidase inhibitor used for urate-lowering therapy. **Reasoning:** By inhibiting xanthine oxidase it blocks conversion of hypoxanthine and xanthine to uric acid, reducing urate production

and serum urate, preventing recurrent gout and tophi. It is not for acute attacks (which use NSAIDs/colchicine). **Why the other options are wrong:**

- (A) Inhibiting neutrophil microtubules is colchicine's action.
- (B) Increasing uric acid excretion describes uricosurics (probenecid).
- (C) It is not a COX-2 inhibitor.

Final Answer: Xanthine oxidase inhibition lowering urate production $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q65

Q66.

Solution

Concept — Antibiotic mechanisms: Antibacterials are grouped by target: cell wall, protein synthesis, nucleic acids and folate metabolism. **Reasoning:** β-lactams (penicillins, cephalosporins) bind penicillin-binding proteins (transpeptidases) and block peptidoglycan cross-linking, inhibiting cell-wall synthesis. Option (A) pairs them correctly. **Why the other options are wrong:**

- (B) Aminoglycosides act on the 30S ribosome, not DNA gyrase.
- (C) Fluoroquinolones inhibit DNA gyrase/topoisomerase, not the 30S subunit.
- (D) Sulfonamides inhibit folate synthesis, not cell-wall cross-linking.

Final Answer: β-lactams inhibit cell-wall synthesis $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q66

Q67.

Solution

Concept — Aminoglycosides: These bactericidal agents target the 30S ribosomal subunit. **Reasoning:** Streptomycin and gentamicin bind 16S rRNA of the 30S subunit, causing misreading of the codon-anticodon and inhibiting initiation and accuracy of protein synthesis; the resulting faulty membrane proteins contribute to their bactericidal effect. **Why the other options are wrong:**

- (A) RNA polymerase inhibition describes rifampicin.
- (C) DHFR inhibition describes trimethoprim.
- (D) 50S peptidyl transferase inhibition describes chloramphenicol.

Final Answer: 30S binding causing mRNA misreading $\Rightarrow$ B

Answer: (B) Go Back to Q67

Q68.

Solution

Concept — Specific antidotes: Each poison has a matched antidote; the therapeutic index (LD_{50}/ED_{50}) frames overdose risk. **Reasoning:** Paracetamol overdose is treated with N-acetylcysteine (which replenishes glutathione), NOT flumazenil. Flumazenil is the benzodiazepine antagonist. So the paracetamol-flumazenil pairing in option (C) is incorrect. **Why the other options are wrong:**

- (A) Organophosphate poisoning is correctly treated with atropine plus pralidoxime.
- (B) Naloxone is the correct opioid antagonist.
- (D) Flumazenil is correctly the benzodiazepine antidote.

Final Answer: Paracetamol antidote is N-acetylcysteine, not flumazenil $\Rightarrow$ C

Answer: (C) Go Back to Q68

Q69.

Solution

Concept — S_N2 mechanism: A secondary alkyl halide with a strong nucleophile in aprotic solvent reacts by a concerted, single-step backside attack. **Reasoning:** The hydroxide attacks the carbon from the side opposite the leaving Br, passing through a trigonal-bipyramidal transition state. This causes Walden inversion, so (*S*)-2-bromobutane gives (*R*)-2-butanol. The rate is second order overall. **Why the other options are wrong:**

- (A) S_N1/racemisation needs a stable carbocation and a polar protic solvent.
- (C) E2 would need a base abstracting a β-hydrogen; here substitution dominates.
- (D) S_N2 always inverts, never retains, configuration.

Final Answer: S_N2 with inversion giving (*R*)-2-butanol $\Rightarrow$ B

Answer: (B) Go Back to Q69

Q70.

Solution

Concept — Carbocation stability: Stability increases with the number of alkyl groups due to hyperconjugation and the inductive (+I) electron-releasing effect. **Reasoning:** Tertiary > secondary > primary > methyl. Thus $(CH_3)_3C^+ > (CH_3)_2CH^+ > CH_3CH_2^+ > CH_3^+$, i.e. (iv) > (iii) > (ii) > (i). **Why the other options are wrong:**

- (A) Reverses the true order; methyl cation is least stable.
- (B) and (C) jumble the tertiary/primary ranking.
- Only the strictly decreasing tert → methyl sequence is correct.

Final Answer: (iv) > (iii) > (ii) > (i) ⇒ D

Answer: (D) Go Back to Q70

Q71.

Solution

Concept — Directing effects in EAS: Substituents are classified as o,p-directing (usually activating) or m-directing (deactivating). **Reasoning:** The nitro group ($–NO_2$) is strongly electron-withdrawing by both resonance and induction. It deactivates the ring and directs incoming electrophiles to the meta position. **Why the other options are wrong:**

- (A) $–OCH_3$ is activating and o,p-directing.
- (B) –Cl is deactivating but o,p-directing (halogen exception).
- (D) $–NH_2$ is strongly activating and o,p-directing.

Final Answer: $–NO_2$ is meta-directing and deactivating ⇒ C

Answer: (C) Go Back to Q71

Q72.

Solution

Concept — Cannizzaro reaction: Aldehydes lacking an α-hydrogen undergo base-induced disproportionation. **Reasoning:** Benzaldehyde has no α-hydrogen, so with concentrated NaOH one molecule is oxidised to benzoate and another reduced to benzyl alcohol. This self redox is the Cannizzaro reaction. **Why the**

other options are wrong:

- (B) Aldol needs an α-hydrogen, which benzaldehyde lacks.
- (C) Perkin uses an aromatic aldehyde with an anhydride.
- (D) Claisen is an ester condensation.

Final Answer: It is the Cannizzaro reaction $\Rightarrow$ A

Answer: (A) Go Back to Q72

Q73.

Solution

Concept — CIP priority rules: Priority is assigned by the atomic number of the atom directly bonded to the stereocentre. **Reasoning:** Br (Z=35) $>$ O of OH (Z=8) $>$ C of CH_3 (Z=6) $>$ H (Z=1). So the order is –Br $>$ –OH $>$ –CH_3 $>$ –H. **Why the other options are wrong:**

- (A) Places OH above Br, but oxygen $<$ bromine.
- (C) Wrongly ranks CH_3 highest.
- (D) Ranks CH_3 above OH, but oxygen $>$ carbon.

Final Answer: –Br $>$ –OH $>$ –CH_3 $>$ –H $\Rightarrow$ B

Answer: (B) Go Back to Q73

Q74.

Solution

Concept — Hückel's rule: A cyclic, planar, fully conjugated system is aromatic with $(4n+2)$ π electrons. **Reasoning:** The cyclopentadienyl anion has 6 π electrons ($n = 1$), is planar and fully conjugated, so it is aromatic. **Why the other options are wrong:**

- (A) Cyclobutadiene has 4 π electrons ($4n$) and is antiaromatic.
- (B) Cyclooctatetraene is non-planar (tub), hence non-aromatic.
- (D) Cyclopentadienyl cation has 4 π electrons, antiaromatic.

Final Answer: Cyclopentadienyl anion (6 π e^-) is aromatic $\Rightarrow$ C

Answer: (C) Go Back to Q74

Q75.

Solution

Concept — Resonance in carboxylate: The two contributing structures are equivalent, so the true ion is their hybrid. **Reasoning:** Because the two resonance forms are identical, the negative charge is shared equally over both oxygens. The two C–O bonds become equivalent with bond order about 1.5, and the delocalisation provides strong resonance stabilisation. **Why the other options are wrong:**

- (A) The bonds are equal, not one single and one double.
- (B) Charge is delocalised, not fixed on one oxygen.
- (C) Carboxylate is far more stable than an alkoxide (no resonance there).

Final Answer: Equal C–O bonds, resonance stabilised $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q75

Q76.

Solution

Concept — Acidity and inductive effects: Electron-withdrawing groups stabilise the conjugate base and increase acidity (lower pK_a). **Reasoning:** The three electronegative chlorines in CCl_3COOH strongly stabilise the carboxylate by induction, giving $pK_a \approx 0.7$, far stronger than acetic acid (4.76), phenol (10) or ethanol (16). **Why the other options are wrong:**

- (B) Acetic acid lacks the electron-withdrawing chlorines.
- (C) Phenol is far weaker than any carboxylic acid.
- (D) Ethanol is the weakest acid of the set.

Final Answer: Trichloroacetic acid is the strongest acid $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q76

Q77.

Solution

Concept — Markovnikov's rule: In HX addition to an unsymmetrical alkene, H adds to the carbon with more hydrogens, so X goes to the more substituted carbon. **Reasoning:** Protonation of propene gives the more stable secondary carbocation at C2, so Br^- attaches at C2, giving 2-bromopropane as the major product. **Why**

the other options are wrong:

- (A) 1-bromopropane is the anti-Markovnikov product (needs peroxides).
- (C) A dibromide would need Br_2, not HBr.
- (D) An alcohol would require water/acid hydration, not HBr.

Final Answer: 2-bromopropane $\Rightarrow$ B

Answer: (B) Go Back to Q77

Q78.

Solution

Concept — Meso compounds: A molecule with stereocentres but an internal mirror plane is achiral overall. **Reasoning:** Meso-tartaric acid has two stereocentres of opposite configuration related by an internal symmetry plane; the optical rotations cancel internally, so it is optically inactive though it has chiral centres. **Why the other options are wrong:**

- (A) A racemate is a 50:50 mix of two enantiomers, not a single compound.
- (B) The (+)-enantiomer is optically active.
- (D) Geometric isomerism applies to double bonds/rings, not this case.

Final Answer: It is the meso compound $\Rightarrow$ C

Answer: (C) Go Back to Q78

Q79.

Solution

Concept — Conformations of butane: Rotation about C2–C3 gives staggered (anti, gauche) and eclipsed forms. **Reasoning:** When the two methyl groups are 180° apart, steric strain is minimal. This staggered arrangement is the anti conformation, the global energy minimum of butane. **Why the other options are wrong:**

- (B) Gauche has the methyls 60° apart (staggered but higher energy).
- (C) Eclipsed forms have dihedral 0°/120°, higher energy.
- (D) Syn (fully eclipsed) methyls is the highest-energy form.

Final Answer: Anti conformation $\Rightarrow$ A

Answer: (A) Go Back to Q79

Q80.

Solution

Concept — Grignard addition: Grignard reagents add to carbonyls; the product class depends on the carbonyl used. **Reasoning:** CH_3MgBr adds to formaldehyde (HCHO) to give, after acidic work-up, CH_3CH_2OH, a primary alcohol (ethanol). Formaldehyde always yields a primary alcohol. **Why the other options are wrong:**

- (A) Acetic acid would need CO_2 as the electrophile.
- (B) Acetone arises from esters/two additions, not formaldehyde.
- (C) A tertiary alcohol needs a ketone, not formaldehyde.

Final Answer: Ethanol, a primary alcohol $\Rightarrow$ $\boxed{D}$

Answer: (D) Go Back to Q80

Q81.

Solution

Concept — Pyridine basicity: The nitrogen lone pair lies in an in-plane sp^2 orbital, not in the aromatic π system. **Reasoning:** Because the lone pair is available (not delocalised into the ring), pyridine acts as a weak base ($pK_{aH} \approx 5$) while remaining aromatic with 6 π electrons. The figure shows a six-membered ring with one nitrogen. **Why the other options are wrong:**

- (A) In pyrrole the N lone pair is part of the aromatic sextet (weakly basic/N–H acidic).
- (C) Furan has oxygen, not nitrogen.
- (D) Benzene has no heteroatom.

Final Answer: The heterocycle is pyridine $\Rightarrow$ $\boxed{B}$

Answer: (B) Go Back to Q81

Q82.

Solution

Concept — Functional-group recognition: A carbon bearing both a double-bonded O and an –OH defines a carboxyl group. **Reasoning:** The structure shows C=O and C–OH on the same carbon, i.e. –COOH, the carboxylic acid functional group. **Why the other options are wrong:**

- (A) A ketone is C=O flanked by two carbons, no OH.
- (B) An aldehyde is C=O with an H, no OH.
- (D) An ester would have –O–C (alkoxy) instead of –OH.

Final Answer: Carboxylic acid (–COOH) $\Rightarrow$ C

Answer: (C) Go Back to Q82

Q83.

Solution

Concept — Diels–Alder [4+2]: A diene and a dienophile combine to form a six-membered ring with one new double bond. **Reasoning:** 1,3-Butadiene (4π) and ethene (2π) cyclise to cyclohexene, which retains one double bond from the diene. **Why the other options are wrong:**

- (B) Benzene would require full aromatisation, not a simple cycloaddition.
- (C) Cyclobutane is a [2+2], thermally forbidden here.
- (D) 1,3-Cyclohexadiene has two double bonds, not the product.

Final Answer: Cyclohexene $\Rightarrow$ A

Answer: (A) Go Back to Q83

Q84.

Solution

Concept — Hofmann elimination: Elimination from a bulky quaternary ammonium hydroxide is anti-Zaitsev. **Reasoning:** The bulky leaving group and base favour abstraction of the least hindered β-hydrogen, giving the less substituted (Hofmann) alkene, usually the terminal one. **Why the other options are wrong:**

- (A) The more substituted alkene is the Zaitsev product, not Hofmann.
- (C) An alcohol is a substitution product, not elimination.

- (D) Elimination does occur and gives an alkene.

Final Answer: The less substituted terminal alkene $\Rightarrow$ B

Answer: (B) Go Back to Q84

Q85.

Solution

Concept — Catalysis and activation energy: A catalyst opens a new lower-energy pathway. **Reasoning:** As the diagram shows, the catalysed curve has a lower transition-state energy (lower E_a) but the same reactant and product energies, so ΔH is unchanged. The equilibrium position is not shifted; only the rate increases. **Why the other options are wrong:**

- (A) A catalyst lowers, not raises, E_a.
- (B) It speeds both forward and reverse rates equally; equilibrium position is unchanged.
- (C) ΔH (R$\rightarrow$P) is fixed by the states, independent of the path.

Final Answer: Lowers E_a via a new pathway, ΔH unchanged $\Rightarrow$ D

Answer: (D) Go Back to Q85

Q86.

Solution

Concept — Phase I metabolism: Phase I introduces or unmasks a functional group, mainly by oxidation. **Reasoning:** The hepatic cytochrome P450 (CYP450) mono-oxygenase system catalyses most Phase I oxidations (hydroxylation, N/O-dealkylation, etc.). **Why the other options are wrong:**

- (B) UDP-glucuronosyltransferase is a Phase II enzyme.
- (C) Sulfotransferase is a Phase II conjugating enzyme.
- (D) N-acetyltransferase performs Phase II acetylation.

Final Answer: Cytochrome P450 mono-oxygenases $\Rightarrow$ A

Answer: (A) Go Back to Q86

Q87.

Solution

Concept — Phase II conjugation: Phase II attaches a polar endogenous molecule to increase water solubility for excretion. **Reasoning:** Glucuronidation (conjugation with glucuronic acid via UGT) is a hallmark Phase II reaction. **Why the other options are wrong:**

- (A) Aromatic hydroxylation is Phase I oxidation.
- (C) N-dealkylation is a Phase I (CYP450) reaction.
- (D) Ester hydrolysis is a Phase I hydrolytic reaction.

Final Answer: Glucuronidation $\Rightarrow$ B

Answer: (B) Go Back to Q87

Q88.

Solution

Concept — Prodrugs: A prodrug is biologically inactive until metabolically converted to the active species. **Reasoning:** Enalapril is an ester prodrug hydrolysed in vivo to the active ACE inhibitor enalaprilat, improving oral absorption. **Why the other options are wrong:**

- (A) Paracetamol is itself the active drug.
- (B) Aspirin is given as the active acetylating agent (not the intended "inactive" choice here).
- (D) Diazepam is administered as the active drug.

Final Answer: Enalapril (to enalaprilat) is the prodrug $\Rightarrow$ C

Answer: (C) Go Back to Q88

Q89.

Solution

Concept — Bioisosterism: Replacing a group with another of similar size/electronic/biological properties to retain activity. **Reasoning:** A tetrazole is a non-classical bioisostere of –COOH; both are acidic and ionise at physiological pH, but tetrazole resists metabolism and improves permeability (e.g. in sartans). **Why the other options are wrong:**

- (A) A prodrug is metabolically activated, a different concept.
- (B) Racemic switching concerns chirality, not group replacement.
- (C) Ring contraction merely changes ring size, not the design rationale here.

Final Answer: Non-classical bioisosterism $\Rightarrow$ D

Answer: (D) Go Back to Q89

Q90.

Solution

Concept — Hansch (QSAR) descriptors: Activity is correlated with hydrophobic, electronic and steric parameters. **Reasoning:** The partition coefficient log$P$ (octanol/water) measures lipophilicity, governing membrane permeation and distribution. **Why the other options are wrong:**

- (B) Electronic effects are captured by Hammett σ.
- (C) Steric bulk is captured by Taft E_s or molar refractivity.
- (D) H-bond donor count is a separate (Lipinski) descriptor, not log$P$.

Final Answer: log$P$ measures lipophilicity $\Rightarrow$ A

Answer: (A) Go Back to Q90

Q91.

Solution

Concept — Hammett equation: $\log(k/k_0) = \rho\sigma$ relates substituent electronic effects to reactivity. **Reasoning:** The substituent constant σ measures the electron-withdrawing (positive σ) or electron-donating (negative σ) effect of a meta/para substituent on a benzene ring. **Why the other options are wrong:**

- (A) Lipophilic contribution is the π (Hansch) constant.
- (C) Steric size is the Taft E_s parameter.
- (D) Molar refractivity (MR) is a separate bulk/polarisability term.

Final Answer: σ quantifies the electronic effect $\Rightarrow$ B

Answer: (B) Go Back to Q91

Q92.

Solution

Concept — β-lactam antibiotics: Penicillins and cephalosporins share a reactive four-membered β-lactam ring. **Reasoning:** The strained β-lactam acylates the bacterial transpeptidase (PBP). β-Lactamases hydrolyse this ring, destroying activity, hence its central importance. **Why the other options are wrong:**

- (A) An aromatic ring is not the pharmacophore here.
- (B) Sulfonamide groups belong to a different drug class.
- (D) No quaternary ammonium centre is involved.

Final Answer: The four-membered β-lactam ring $\Rightarrow$ C

Answer: (C) Go Back to Q92

Q93.

Solution

Concept — Sulfonamide mechanism: They block bacterial folate synthesis by competitive inhibition. **Reasoning:** Sulfonamides are structural bioisosteres of para-aminobenzoic acid (PABA) and competitively inhibit dihydropteroate synthase, blocking folic-acid biosynthesis. **Why the other options are wrong:**

- (A) Dihydrofolate reductase is inhibited by trimethoprim, not sulfonamides.
- (B) Tetrahydrofolate is the downstream product, not the analogue.
- (C) Thymidine is unrelated to the PABA mimicry.

Final Answer: They are analogues of PABA $\Rightarrow$ D

Answer: (D) Go Back to Q93

Q94.

Solution

Concept — Ester vs amide local anaesthetics: The linker type determines metabolism and allergy profile. **Reasoning:** Lidocaine contains an amide linkage (–NHCO–) and is metabolised in the liver. Amide anaesthetics are recognised by two "i"s in the name (lid-o-caine). **Why the other options are wrong:**

- (B) Procaine is an ester, hydrolysed by plasma esterases.
- (C) Benzocaine is an ester-type anaesthetic.

- (D) Tetracaine is also an ester local anaesthetic.

Final Answer: Lidocaine is an amide-type anaesthetic $\Rightarrow$ A

Answer: (A) Go Back to Q94

Q95.

Solution

Concept — Eutomer vs distomer: For chiral drugs the two enantiomers usually differ in potency. **Reasoning:** The more active enantiomer at the target is the eutomer; the less active (or inactive/toxic) one is the distomer. Their potency ratio is the eudismic ratio. **Why the other options are wrong:**

- (A) The distomer is the *less* active enantiomer.
- (C) A racemate is the equimolar mixture, not a single enantiomer.
- (D) A metabolite is a transformation product, not an enantiomer term.

Final Answer: The more active enantiomer is the eutomer $\Rightarrow$ B

Answer: (B) Go Back to Q95

Q96.

Solution

Concept — Pharmaceutical inorganic antacids: Antacids are weak bases that neutralise gastric HCl. **Reasoning:** Magnesium hydroxide and aluminium hydroxide react with HCl to form the chloride salt and water, raising gastric pH. They are classic inorganic antacids. **Why the other options are wrong:**

- (A) Potassium permanganate is an oxidising antiseptic.
- (B) Silver nitrate is an astringent/caustic.
- (D) Ferrous sulfate is a haematinic (iron supplement).

Final Answer: Magnesium/aluminium hydroxide is the antacid $\Rightarrow$ C

Answer: (C) Go Back to Q96

Q97.

Solution

Concept — Chelation therapy: A polydentate ligand binds a metal ion in a ring-shaped complex. **Reasoning:** EDTA is a hexadentate ligand that chelates lead and other heavy-metal ions to form a stable, water-soluble complex that is excreted renally. **Why the other options are wrong:**

- (A) It does not oxidise the metal.
- (B) It does not precipitate the metal as a sulfide.
- (C) It does not reduce the ion to the elemental metal.

Final Answer: Chelation forming a soluble complex $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q97

Q98.

Solution

Concept — Benzodiazepines: A class characterised by a benzene ring fused to a seven-membered diazepine ring. **Reasoning:** Diazepam, lorazepam and alprazolam are benzodiazepines (the "-azepam"/"-azolam" stems). They potentiate $GABA_A$ chloride currents. **Why the other options are wrong:**

- (B) Barbiturates derive from barbituric acid (e.g. phenobarbital).
- (C) Phenothiazines are antipsychotics (e.g. chlorpromazine).
- (D) Sulfonamides are antibacterials.

Final Answer: They are benzodiazepines $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q98

Q99.

Solution

Concept — Beer–Lambert law: $A = \varepsilon c l$, so absorbance is linear in concentration with intercept zero. **Reasoning:** Plotting A (y) against c (x) gives a straight line through the origin whose slope is the coefficient of c, namely εl. Here ε is molar absorptivity and l is the optical path length, both constant for a fixed wavelength and cell. **Why the other options are wrong:**

- (B) ε alone would be the slope only if $l = 1$; the slope is the product εl.

- (C) Path length alone is not the slope; it is one factor of it.
- (D) Transmittance is logarithmically related to A, not the slope of this plot.

Final Answer: The slope equals $\varepsilon l \Rightarrow$ A

Answer: (A) Go Back to Q99

Q100.

Solution

Concept — Non-aqueous titration of weak bases: Weak bases are too weak to titrate in water; dissolving them in glacial acetic acid (an acidic, levelling solvent) enhances their basicity. **Reasoning:** The standard titrant for such weak bases is perchloric acid dissolved in glacial acetic acid, with crystal violet as indicator. The acetic acid medium makes the weak base behave as a strong base, giving a sharp end point. **Why the other options are wrong:**

- (A) Sodium methoxide is used to titrate weak *acids*, not weak bases.
- (C) Tetrabutylammonium hydroxide is also a base titrant, used for weak acids.
- (D) Aqueous NaOH is for acid titration and gives no sharp end point for weak bases.

Final Answer: Perchloric acid in glacial acetic acid $\Rightarrow$ B

Answer: (B) Go Back to Q100

Q101.

Solution

Concept — R_f in TLC: $R_f = \dfrac{\text{distance travelled by solute}}{\text{distance travelled by solvent front}}$. **Reasoning:** The solute moved 3.0 cm and the solvent front moved 8.0 cm, so $R_f = 3.0/8.0 = 0.375$. R_f is dimensionless and always lies between 0 and 1. **Why the other options are wrong:**

- (A) 2.67 is the inverse ratio (8/3); R_f cannot exceed 1.
- (B) 0.27 corresponds to 3/11 and uses a wrong front distance.
- (D) 0.625 is $5/8$, using the wrong solute distance.

Final Answer: $R_f = 3/8 = 0.375 \Rightarrow$ C

Answer: (C) Go Back to Q101

Q102.

Solution

Concept — HPLC flow path: reservoir → pump → injector → column → detector.
Reasoning: The component between the pump and the column that introduces a precise sample volume into the pressurised mobile-phase stream is the injector (typically a fixed-loop or autosampler valve). It is the only point where the analyte enters the flow. **Why the other options are wrong:**

- (A) A degasser sits before/at the reservoir, not between pump and column.
- (B) A fraction collector is placed after the detector, in preparative work.
- (C) A guard cartridge protects the column but does not introduce sample.

Final Answer: X is the injector ⇒ D

Answer: (D) Go Back to Q102

Q103.

Solution

Concept — Iodimetry vs iodometry: both involve iodine but differ in direction.
Reasoning: In iodimetry the analyte (a reducing agent) is titrated *directly* with a standard iodine solution. In iodometry an oxidising analyte liberates iodine from excess iodide, and the liberated iodine is then titrated with standard sodium thiosulphate. **Why the other options are wrong:**

- (B) Reverses the two methods.
- (C) Permanganate is not the titrant in either iodine method.
- (D) Iodometry is indirect, not a direct titration with iodine.

Final Answer: Iodimetry direct with I_2; iodometry titrates liberated I_2 with thiosulphate ⇒ A

Answer: (A) Go Back to Q103

Q104.

Solution

Concept — IR group frequencies: the C=O stretch is a strong band near 1700–1750 cm^{-1}. **Reasoning:** A strong, sharp absorption at about 1715 cm^{-1} is the textbook carbonyl (C=O) stretch of a ketone. The high intensity arises from the large change in dipole moment during the stretch. **Why the other options are wrong:**

- (A) O–H stretch is broad and appears near 3200–3600 cm^{-1}.
- (C) C–H stretch of alkanes is near 2850–2960 cm^{-1}.
- (D) N–H stretch appears around 3300–3500 cm^{-1}.

Final Answer: 1715 $cm^{-1} \Rightarrow$ carbonyl C=O $\Rightarrow$ $\boxed{B}$

Answer: (B) Go Back to Q104

Q105.

Solution

Concept — EBT with EDTA: EBT forms a wine-red complex with metal ions; free EBT at pH 10 is blue. **Reasoning:** Before the end point, metal–EBT complex gives a wine-red solution. As EDTA strips the last metal ions from EBT, the free indicator is released, turning the solution blue. So the end-point colour change is wine-red $\rightarrow$ blue. **Why the other options are wrong:**

- (A) Yellow to colourless is not the EBT change.
- (B) Colourless to pink describes other indicators, not EBT here.
- (D) Reverses the actual direction of the colour change.

Final Answer: Wine-red to blue $\Rightarrow$ $\boxed{C}$

Answer: (C) Go Back to Q105

Q106.

Solution

Concept — NMR equivalent protons: the number of signals equals the number of chemically distinct proton environments. **Reasoning:** Ethanol has three environments: the CH_3 protons, the CH_2 protons, and the OH proton. These are chemically non-equivalent, so three signals appear. **Why the other options are**

wrong:

- (A) 1 would require all protons equivalent, which they are not.
- (B) 6 counts individual protons, not environments.
- (C) 2 ignores the OH proton as a separate environment.

Final Answer: Three distinct environments $\Rightarrow$ D

Answer: (D) Go Back to Q106

Q107.

Solution

Concept — Column efficiency: HETP (H) measures how much column length corresponds to one theoretical plate. **Reasoning:** By definition $H = L/N$, where L is the column length and N the number of theoretical plates. A smaller H (more plates per unit length) means a more efficient column. **Why the other options are wrong:**

- (B) N/L is plates per unit length, the inverse of H.
- (C) $N \times L$ has the wrong dimensions and magnitude.
- (D) $L \times N^2$ is not a defined chromatographic quantity.

Final Answer: $H = L/N \Rightarrow$ A

Answer: (A) Go Back to Q107

Q108.

Solution

Concept — Chromatographic resolution: R_s compares peak separation with average peak width. **Reasoning:** The standard definition is $R_s = \dfrac{2(t_{R2} - t_{R1})}{w_1 + w_2}$, i.e. twice the difference in retention times divided by the sum of the baseline widths. $R_s \geq 1.5$ indicates baseline resolution. **Why the other options are wrong:**

- (A) Uses the sum of retention times in the numerator, which is meaningless.
- (C) Is the reciprocal form, giving the wrong value.
- (D) Divides by the product of widths, not their sum.

Final Answer: $R_s = 2(t_{R2} - t_{R1})/(w_1 + w_2) \Rightarrow$ B

Answer: (B) Go Back to Q108

Q109.

Solution

Concept — Argentometric indicators: Mohr (chromate), Volhard (ferric alum), Fajans (adsorption indicators). **Reasoning:** In the Fajans method an adsorption indicator such as fluorescein or dichlorofluorescein adsorbs onto the precipitate surface near the equivalence point, changing colour. This pairing is correct. **Why the other options are wrong:**

- (A) Mohr uses potassium chromate, not ferric alum.
- (B) Volhard uses ferric alum (Fe^{3+}), not potassium chromate.
- (D) Mohr does not use an adsorption indicator.

Final Answer: Fajans method — adsorption indicator $\Rightarrow$ C

Answer: (C) Go Back to Q109

Q110.

Solution

Concept — Flame photometry (flame emission): easily excited elements emit characteristic light in a flame. **Reasoning:** Alkali and alkaline-earth metals (Na, K, Li, Ca, etc.) have low excitation energies and emit intense, characteristic colours in a flame, making flame photometry ideal for their routine quantitation. **Why the other options are wrong:**

- (A) Transition metals are better suited to AAS than simple flame emission.
- (B) Halogens are non-metals and do not give useful flame emission.
- (C) Heavy metals like Pb and Hg are determined by AAS/ICP, not flame photometry.

Final Answer: Alkali and alkaline-earth metals (Na, K, Ca) $\Rightarrow$ D

Answer: (D) Go Back to Q110

Q111.

Solution

Concept — UV spectral shifts: a move to longer wavelength is a bathochromic (red) shift. **Reasoning:** Adding an auxochrome or extending conjugation lowers the energy gap between ground and excited states, so absorption occurs at longer

wavelength (lower energy). This red shift is termed bathochromic. **Why the other options are wrong:**

- (B) Hypsochromic is a blue shift, to shorter wavelength.
- (C) Hyperchromic refers to increased intensity, not wavelength.
- (D) Hypochromic refers to decreased intensity, not wavelength.

Final Answer: Bathochromic (red) shift $\Rightarrow$ A

Answer: (A) Go Back to Q111

Q112.

Solution

Concept — Normality and equivalents: $N = M\times$ (number of equivalents per mole). **Reasoning:** H_2SO_4 furnishes 2 H^+ per mole, so its equivalence factor is 2. Therefore $N = 0.50 \times 2 = 1.0$ N. **Why the other options are wrong:**

- (A) 0.25 N divides instead of multiplies by 2.
- (C) 0.50 N treats it as monoprotic.
- (D) 2.0 N uses molarity 1.0 by mistake.

Final Answer: $N = 0.50 \times 2 = 1.0$ N $\Rightarrow$ B

Answer: (B) Go Back to Q112

Q113.

Solution

Concept — Titration curve inflection: the steepest part of a pH-vs-volume curve marks the equivalence point. **Reasoning:** For a strong acid–strong base titration, the pH jumps sharply when the moles of base added equal the moles of acid. The inflection point P, where dpH/dV is maximal, locates this equivalence point at V_{eq}. **Why the other options are wrong:**

- (A) Indicators do not decompose; this is not a chemical event on the curve.
- (B) The buffer region is the flat part, not the steep inflection.
- (D) Maximum buffering occurs in the flat region (half-equivalence for weak acids), not at P.

Final Answer: P is the equivalence point $\Rightarrow$ C

Answer: (C) Go Back to Q113

Q114.

Solution

Concept — Mass-spectrum terminology: base peak vs molecular ion. **Reasoning:** The base peak is the most intense peak in the mass spectrum and is conventionally assigned a relative abundance of 100%; all other peaks are scaled to it. It need not be the molecular ion. **Why the other options are wrong:**

- (A) The intact molecular ion is $M^{+\bullet}$, which is sometimes but not always the base peak.
- (B) The lowest m/z peak is just a small fragment.
- (C) The M+1 isotope peak reflects ^{13}C abundance, usually small.

Final Answer: Base peak = most intense peak (100% abundance) $\Rightarrow$ D

Answer: (D) Go Back to Q114

Q115.

Solution

Concept — Reverse-phase HPLC: non-polar stationary phase, polar mobile phase, so retention increases with analyte non-polarity. **Reasoning:** Polar analytes prefer the polar mobile phase and elute early; non-polar analytes partition into the C18 layer and are retained longer. This is the opposite of normal-phase behaviour. **Why the other options are wrong:**

- (B) Describes normal-phase, not reverse-phase, elution.
- (C) Elution order in RP-HPLC is governed by polarity.
- (D) Compounds are separated, not co-eluted at the void volume.

Final Answer: Polar elutes first, non-polar retained longer $\Rightarrow$ A

Answer: (A) Go Back to Q115

Q116.

Solution

Concept — GC detectors: the FID burns eluent in a hydrogen flame and measures resulting ions. **Reasoning:** The flame ionization detector responds to virtually all organic (C–H bearing) compounds, producing a signal proportional to carbon content. It is highly sensitive and has a wide linear range, making it the workhorse GC detector. **Why the other options are wrong:**

- (A) TCD is universal but far less sensitive and does not use a flame.
- (C) RID is a liquid-chromatography detector, not used in GC.
- (D) Electrochemical detection is used in HPLC, not standard GC.

Final Answer: Flame ionization detector (FID) $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q116

Q117.

Solution

Concept — Self-indicating titrant: permanganate is intensely violet, its product Mn^{2+} is almost colourless. **Reasoning:** During the titration each added MnO_4^- is decolourised as it is reduced. At the end point, the first slight excess of permanganate gives a persistent faint pink/violet colour, signalling completion. No external indicator is needed. **Why the other options are wrong:**

- (A) Starch is the indicator for iodine titrations, not permanganate.
- (B) Ferroin is used in cerimetry, not permanganometry.
- (D) Permanganate is coloured (violet) before reduction, not after.

Final Answer: Persistent violet of slight excess marks the end point $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q117

Q118.

Solution

Concept — Validation parameters (ICH Q2): precision vs accuracy. **Reasoning:**

Precision is the closeness of agreement among repeated measurements of the same homogeneous sample (repeatability, intermediate precision, reproducibility). It reflects random error, distinct from accuracy. **Why the other options are wrong:**

- (A) Accuracy is closeness to the true value, not agreement among repeats.
- (B) Specificity is the ability to measure the analyte amid interferents.
- (C) Linearity is the proportionality of response to concentration.

Final Answer: Agreement among repeated measurements = precision $\Rightarrow$ D

Answer: (D) Go Back to Q118

Q119.

Solution

Concept — Why assay at λ_{max}: the curve is flattest at its peak, so small wavelength errors barely change A. **Reasoning:** At λ_{max} absorbance is maximal, giving the highest sensitivity, and $dA/d\lambda \approx 0$, so minor monochromator errors cause minimal absorbance change. This yields the most reproducible quantitative results. **Why the other options are wrong:**

- (B) A minimum gives poor sensitivity, the opposite of what is wanted.
- (C) At λ_{max} the molar absorptivity is maximal, not zero.
- (D) Transmittance is at its minimum (not 100%) where absorbance peaks.

Final Answer: Maximal, flat-topped absorbance gives best sensitivity and reproducibility $\Rightarrow$ A

Answer: (A) Go Back to Q119

Q120.

Solution

Concept — Gravimetric analysis: quantitation by mass of an isolated pure solid. **Reasoning:** In gravimetry the analyte is converted to a sparingly soluble, well-defined solid (precipitate or residue), which is filtered, dried/ignited, and weighed. The analyte amount is calculated from the weighed mass and its stoichiometry. **Why the other options are wrong:**

- (A) Measuring titrant volume is titrimetry, not gravimetry.
- (C) Measuring absorbance is spectrophotometry.
- (D) Measuring electrode potential is potentiometry.

Final Answer: Isolated as a pure solid and weighed $\Rightarrow$ B

Answer: (B) Go Back to Q120

Q121.

Solution

Concept — $(n+1)$ rule: a proton coupled to n equivalent neighbours is split into $n+1$ lines. **Reasoning:** In CH_3CH_2Br the CH_3 protons have two equivalent neighbouring CH_2 protons ($n=2$), so they appear as a $2+1=3$-line pattern: a triplet. **Why the other options are wrong:**

- (A) A singlet would mean no coupling neighbours.
- (B) A doublet implies one neighbour ($n=1$).
- (D) A quartet implies three neighbours ($n=3$); that describes the CH_2 split by CH_3.

Final Answer: $n=2 \Rightarrow$ triplet $\Rightarrow$ C

Answer: (C) Go Back to Q121

Q122.

Solution

Concept — LOD vs LOQ: detection (qualitative) vs quantitation (reliable measurement). **Reasoning:** The limit of quantitation (LOQ) is the lowest analyte amount that can be quantified with acceptable accuracy and precision, commonly taken at a signal-to-noise ratio of about 10:1. LOD (S/N $\approx$ 3:1) only signals presence. **Why the other options are wrong:**

- (A) LOD (S/N $\approx$ 3:1) tells only that analyte is present, not how much.
- (B) Specificity limit is not a defined ICH quantitation parameter.
- (C) The upper limit of the working range is the maximum, not minimum, quantifiable amount.

Final Answer: Lowest reliably quantifiable amount = LOQ $\Rightarrow$ D

Answer: (D) Go Back to Q122

Q123.

Solution

Concept — Organized vs unorganized drugs: Organized drugs are entire plant organs (leaf, bark, root, seed) with a cellular structure; unorganized drugs are cell-free metabolic products such as gums, latex exudates, dried juices and waxes. **Reasoning:** Acacia gum is a dried gummy exudate, aloe is the dried drug juice

of the leaves, and honey is an animal/plant secretory product. None of these has an organized cellular tissue, so the set in option (C) is entirely unorganized. **Why the other options are wrong:**

- (A) Leaf, bark and seed are all organized organs.
- (B) Bud, rhizome and leaf are organized.
- (D) Root and rhizome are organized; ergot is a fungal sclerotium but the set is mixed.

Final Answer: Acacia gum, aloe and honey are all cell-free exudates/secretions $\Rightarrow$ C

Answer: (C) Go Back to Q123

Q124.

Solution

Concept — Chemical classification: Crude drugs may be grouped by the chemical nature of their principal active constituents, independent of botany or therapeutics. **Reasoning:** Sorting drugs into alkaloids, glycosides, volatile oils, tannins and resins is purely by the chemical class of the chief constituent, which is the defining feature of chemical classification. **Why the other options are wrong:**

- (B) Taxonomical grouping is by botanical family/genus.
- (C) Morphological grouping is by the plant part used.
- (D) Pharmacological grouping is by therapeutic action.

Final Answer: Grouping by constituent chemistry is chemical classification $\Rightarrow$ A

Answer: (A) Go Back to Q124

Q125.

Solution

Concept — Pharmacological classification: Crude drugs are arranged according to the pharmacological/therapeutic action of their chief constituent. **Reasoning:** *Digitalis* and *Strophanthus* belong to different families and morphological parts, but both act on the heart as cardiotonics. Grouping them by this common therapeutic action is pharmacological classification. **Why the other options are wrong:**

- (A) Alphabetical is merely by Latin/English name order.
- (C) Chemical is by constituent class.
- (D) Morphological is by plant part.

Final Answer: Grouping by therapeutic action is pharmacological classification $\Rightarrow$ B

Answer: (B) Go Back to Q125

Q126.

Solution

Concept — Shikimic acid pathway: Erythrose-4-phosphate and phosphoenolpyruvate condense and proceed via shikimic acid and chorismate to the aromatic amino acids phenylalanine and tyrosine. **Reasoning:** From Phe/Tyr arise the phenylpropanoid (C6–C3) units that build lignans, coumarins, flavonoids and several aromatic alkaloids. The scheme therefore depicts the shikimic acid pathway generating aromatic amino acids and phenylpropanoids. **Why the other options are wrong:**

- (A) Acetate–mevalonate gives terpenoids, not aromatics.
- (B) Acetate–malonate gives fatty acids and some phenols, but not via shikimate.
- (C) Glycolysis yields sugars/pyruvate, not these aromatics.

Final Answer: It is the shikimic acid pathway $\Rightarrow$ D

Answer: (D) Go Back to Q126

Q127.

Solution

Concept — Opium alkaloids: Opium is the air-dried milky exudate from incised unripe capsules of *Papaver somniferum* (Papaveraceae). **Reasoning:** Morphine and codeine are the major phenanthrene isoquinoline alkaloids of opium, both sourced from the latex of *Papaver somniferum*. **Why the other options are wrong:**

- (B) *Atropa belladonna* yields atropine/hyoscyamine.
- (C) *Rauwolfia serpentina* yields reserpine.
- (D) *Cinchona* yields quinine.

Final Answer: Source is the opium poppy *Papaver somniferum* $\Rightarrow$ A

Answer: (A) Go Back to Q127

Q128.

Solution

Concept — Alkaloid classification: True alkaloids have ring nitrogen derived from an amino acid; protoalkaloids have an amino-acid-derived nitrogen outside a ring; pseudo-alkaloids have nitrogen not arising from an amino acid. **Reasoning:**

Caffeine is a purine derivative whose nitrogen atoms come from the purine ring, not from a precursor amino acid, so it is classed as a (purine) pseudo-alkaloid. **Why the other options are wrong:**

- (A) Morphine is a true alkaloid.
- (B) Ephedrine is a protoalkaloid.
- (D) Atropine is a true alkaloid.

Final Answer: Caffeine is a purine pseudo-alkaloid $\Rightarrow$ C

Answer: (C) Go Back to Q128

Q129.

Solution

Concept — Alkaloid precipitating reagents: Dragendorff's reagent is potassium bismuth iodide; Mayer's reagent is potassium mercuric iodide. **Reasoning:** An orange to orange-brown precipitate with potassium bismuth iodide is the classic positive Dragendorff's test for alkaloids. **Why the other options are wrong:**

- (A) Mayer's gives a cream/white precipitate, not orange-brown.
- (C) Molisch's is a test for carbohydrates.
- (D) Bornträger's detects anthraquinones.

Final Answer: Orange-brown precipitate with $KBiI_4$ is Dragendorff's test $\Rightarrow$ B

Answer: (B) Go Back to Q129

Q130.

Solution

Concept — Glycoside structure: A glycoside has a sugar (glycone) joined to a non-sugar aglycone (genin); the bond is most commonly an O-glycosidic (acetal) linkage. **Reasoning:** In the schematic the non-sugar half is the aglycone/genin and the linkage "X" through oxygen is an O-glycosidic acetal bond formed between the anomeric carbon of the sugar and a hydroxyl of the aglycone. **Why the other options are wrong:**

- (A) The genin is the aglycone, not the glycone; the bond is not an ester.
- (B) It is not a peptide bond.
- (C) The sugar moiety is the glycone, not the aglycone.

Final Answer: Aglycone (genin) joined by an O-glycosidic acetal bond $\Rightarrow$ D

Answer: (D) Go Back to Q130

Q131.

Solution

Concept — Cardiac glycosides: Cardenolides are steroidal glycosides with a five-membered butenolide ring; the official source is *Digitalis*. **Reasoning:** Digitoxin comes mainly from *Digitalis purpurea* and digoxin from *Digitalis lanata*; both are obtained from the dried leaves. **Why the other options are wrong:**

- (B) *Cassia angustifolia* gives anthraquinone (senna) glycosides.
- (C) *Glycyrrhiza glabra* gives the saponin glycyrrhizin.
- (D) *Dioscorea* gives the steroidal saponin diosgenin, not cardenolides.

Final Answer: Source is *Digitalis purpurea/Digitalis lanata* $\Rightarrow$ A

Answer: (A) Go Back to Q131

Q132.

Solution

Concept — Bornträger's test: Free anthraquinones, liberated by hydrolysis and oxidation, give a pink-to-red colour in an ammoniacal (alkaline) organic layer. **Reasoning:** Sennosides are anthraquinone glycosides; on the modified Bornträger's test the freed anthraquinones impart the characteristic pink-red colour

to the ammonia layer, confirming their presence. **Why the other options are wrong:**

- (A) Keller–Kiliani detects deoxy-sugars of cardiac glycosides.
- (C) Legal's (sodium nitroprusside) detects cardenolides.
- (D) Baljet detects cardiac-glycoside lactone rings.

Final Answer: Anthraquinones are confirmed by Bornträger's test $\Rightarrow$ B

Answer: (B) Go Back to Q132

Q133.

Solution

Concept — Calcium oxalate crystals: Calcium oxalate occurs as prisms, microsphenoidal crystals, rosette aggregates (clusters/sphaeraphides) and raphide bundles, each a diagnostic powder character. **Reasoning:** A star-shaped radiating cluster of crystals, as sketched, is a rosette aggregate or cluster crystal (sphaeraphide), seen for example in senna and rhubarb. **Why the other options are wrong:**

- (A) Prisms are single rectangular/monoclinic crystals.
- (B) Microsphenoidal crystals are tiny and individual.
- (D) Raphides are needle-shaped crystals in bundles.

Final Answer: The star-shaped cluster is a rosette aggregate $\Rightarrow$ C

Answer: (C) Go Back to Q133

Q134.

Solution

Concept — Clove oil: The volatile oil of clove (*Syzygium aromaticum*) is dominated by the phenolic constituent eugenol. **Reasoning:** Eugenol forms about 70–90% of clove oil and is responsible for its characteristic odour and local-analgesic (dental) action. **Why the other options are wrong:**

- (B) Menthol is the chief constituent of peppermint oil.
- (C) Anethole is from fennel/anise.
- (D) Cinnamaldehyde is from cinnamon bark.

Final Answer: Chief constituent of clove oil is eugenol $\Rightarrow$ A

Answer: (A) Go Back to Q134

Q135.

Solution

Concept — Peppermint oil: Peppermint oil from *Mentha piperita* is rich in the monoterpene alcohol menthol. **Reasoning:** Menthol produces the cooling sensation by stimulating cold receptors and is the principal constituent of peppermint oil. **Why the other options are wrong:**

- (A) Anethole is from fennel/anise.
- (B) Thymol is from thyme/ajowan.
- (C) Carvone characterises caraway/spearmint, not the cooling of peppermint.

Final Answer: The cooling monoterpene is menthol $\Rightarrow$ D

Answer: (D) Go Back to Q135

Q136.

Solution

Concept — Acacia vs tragacanth: Acacia (gum arabic) is highly water-soluble, while tragacanth largely swells rather than dissolves. **Reasoning:** Acacia dissolves almost completely in water to give a clear, viscous, slightly acidic solution; tragacanth absorbs water and swells into a stiff gel, with only a small soluble fraction (tragacanthin). **Why the other options are wrong:**

- (A) Tragacanth does not form a clear true solution.
- (C) It is acacia, not tragacanth, that is freely soluble.
- (D) Acacia is soluble, so "both insoluble" is incorrect.

Final Answer: Acacia dissolves; tragacanth only swells $\Rightarrow$ B

Answer: (B) Go Back to Q136

Q137.

Solution

Concept — Fixed vs volatile oils: Fixed oils are non-volatile glycerides leaving a permanent grease spot; volatile oils evaporate completely and are not glycerides. **Reasoning:** A drop of fixed oil on paper leaves a permanent translucent grease stain because it does not evaporate, whereas a volatile oil evaporates on warming and leaves no lasting stain. This is the standard distinguishing test. **Why the other options are wrong:**

- (A) The behaviour is reversed.
- (B) Only fixed oils are glycerides; volatile oils are terpene/phenol mixtures.
- (D) Volatile oils are not saponifiable glycerides.

Final Answer: Fixed oil leaves a permanent grease spot; volatile oil evaporates clean $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q137

Q138.

Solution

Concept — Acetate–mevalonate pathway: Three acetyl-CoA units form HMG-CoA, which is reduced to mevalonic acid and then to the C5 isoprene unit IPP. **Reasoning:** IPP and its isomer DMAPP are the universal building blocks of all terpenoids and steroids, classically formed through the mevalonic acid pathway from acetyl-CoA. **Why the other options are wrong:**

- (A) Shikimate gives aromatic compounds.
- (B) Acetate–malonate gives fatty acids and polyketide phenols.
- (C) The pentose phosphate pathway supplies sugars/NADPH, not isoprene units.

Final Answer: Isoprene units arise via the acetate–mevalonate pathway $\Rightarrow \boxed{D}$

Answer: (D) Go Back to Q138

Q139.

Solution

Concept — Retardation factor (R_f): R_f is the ratio of the distance travelled by the solute to the distance travelled by the solvent front, both measured from the baseline. **Reasoning:** Here $R_f = d/D = 2.8/4.0 = 0.70$. The value is dimensionless and lies between 0 and 1, as expected. **Why the other options are wrong:**

- (B) 1.43 is D/d (the inverse) and exceeds 1, impossible.
- (C) 0.28 misplaces the decimal.
- (D) 0.40 ignores the actual distances.

Final Answer: $R_f = 2.8/4.0 = 0.70 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q139

Q140.

Solution

Concept — Ash values: Total ash, acid-insoluble ash, water-soluble ash and sulphated ash are standardisation parameters indicating mineral matter and contamination. **Reasoning:** Boiling the total ash with dilute hydrochloric acid and incinerating the insoluble residue gives the acid-insoluble ash, which chiefly measures siliceous (sand/earth) contamination. **Why the other options are wrong:**

- (A) Total ash is the whole residue before acid treatment.
- (C) Water-soluble ash is the portion dissolved by water.
- (D) Sulphated ash uses sulphuric acid, not the acid-insoluble method.

Final Answer: The acid-insoluble siliceous residue is acid-insoluble ash $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q140

Q141.

Solution

Concept — Soxhlet extraction: The Soxhlet apparatus performs continuous hot extraction, repeatedly bathing the drug in freshly condensed solvent with minimal total solvent use. **Reasoning:** Solvent vapour condenses onto the drug in the thimble, percolates through it, and siphons back to the flask, so the drug is continuously extracted by pure solvent until exhausted. **Why the other options are**

wrong:

- (A) Maceration is a static cold soak, not continuous.
- (B) Single percolation passes solvent through only once.
- (D) Cold infusion gives a single, low-efficiency extract.

Final Answer: Continuous hot percolation uses a Soxhlet apparatus $\Rightarrow$ C

Answer: (C) Go Back to Q141

Q142.

Solution

Concept — Adulteration types: Adulteration may be by inferior natural substitutes, foreign matter, synthetic principles, or use of exhausted/deteriorated drugs. **Reasoning:** Replacing genuine drug with material already exhausted of its actives by prior extraction (for example exhausted ginger or clove) is intentional adulteration with spent/exhausted drug. **Why the other options are wrong:**

- (A) That describes substitution with similar inferior drugs, not spent drug.
- (B) Sand is foreign organic/inorganic matter.
- (C) Adding synthetic principles is a separate category.

Final Answer: Spent drug is use of exhausted/deteriorated drugs $\Rightarrow$ D

Answer: (D) Go Back to Q142

Q143.

Solution

Concept — Restriction enzymes (sticky vs blunt ends): Enzymes that cut the two strands of a palindrome at staggered positions leave single-stranded cohesive (sticky) overhangs; symmetric central cuts give blunt ends. **Reasoning:** *Eco*RI recognises GAATTC and cleaves between G and A on both strands, generating complementary 5′-AATT overhangs. These sticky ends base-pair with any other *Eco*RI-cut fragment, which is why *Eco*RI is a workhorse for cloning. **Why the other options are wrong:**

- (B) *Sma*I cuts CCC|GGG at the centre, giving blunt ends.
- (C) *Alu*I cuts AG|CT centrally, blunt ends.
- (D) *Hae*III cuts GG|CC centrally, blunt ends.

Final Answer: Only *Eco*RI makes a staggered cut producing sticky ends $\Rightarrow$ A

Answer: (A) Go Back to Q143

Q144.

Solution

Concept — PCR thermal cycle: Each PCR cycle has three temperature steps that amplify the target exponentially using a thermostable polymerase. **Reasoning:**

The cycle begins with denaturation ($\sim$94°C) to melt the duplex, then annealing ($\sim$50–60°C) so primers bind their complementary sequences, then extension ($\sim$72°C) where *Taq* polymerase synthesises new strands. The order is therefore denaturation $\rightarrow$ annealing $\rightarrow$ extension. **Why the other options are wrong:**

- (A) Denaturation must come first, not annealing.
- (C) Extension cannot precede denaturation in a cycle.
- (D) The temperatures are mismatched to the steps.

Final Answer: Denaturation $\rightarrow$ annealing $\rightarrow$ extension $\Rightarrow$ B

Answer: (B) Go Back to Q144

Q145.

Solution

Concept — Blue/white screening (insertional inactivation): Inserting DNA into the *Eco*RI site that lies inside *lacZ* disrupts the gene, so functional β-galactosidase is no longer made. **Reasoning:** Non-recombinant plasmids keep *lacZ* intact and cleave X-gal to a blue product. Recombinants have *lacZ* interrupted by the insert, cannot cleave X-gal, and so form **white** colonies. The *ori* and amp^R remain intact, so the cells still replicate and grow on ampicillin. **Why the other options are wrong:**

- (A) Insertion disrupts *lacZ*; it is not functional.
- (B) Ampicillin resistance is unaffected by the *lacZ* insert.
- (D) The origin lies outside the *Eco*RI site and is not destroyed.

Final Answer: Recombinants are white due to insertional inactivation of *lacZ* $\Rightarrow$ C

Answer: (C) Go Back to Q145

Q146.

Solution

Concept — DNA ligase: Ligase seals nicks by catalysing phosphodiester bond formation between a free 3′-OH and an adjacent 5′-phosphate. **Reasoning:** After a restriction enzyme cuts vector and insert, the annealed sticky (or blunt) ends are held only by hydrogen bonds. T4 DNA ligase covalently joins the backbone, producing a stable recombinant molecule. It is the joining (not cutting) enzyme of cloning. **Why the other options are wrong:**

- (A) Reverse transcriptase makes cDNA from RNA.
- (B) DNA polymerase I fills gaps and removes RNA primers, it does not seal ends.
- (C) Restriction endonuclease cuts DNA, the opposite job.

Final Answer: DNA ligase forms the phosphodiester bonds $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q146

Q147.

Solution

Concept — Blotting techniques: Southern detects DNA, Northern detects RNA, and Western detects protein. A useful mnemonic: “SNoW DRoP” (DNA, RNA, Protein). **Reasoning:** The procedure described, separating proteins by electrophoresis, transferring to a membrane, and probing with a labelled **antibody**, is Western blotting. The antibody probe is specific for proteins, distinguishing it from nucleic-acid blots that use labelled DNA/RNA probes. **Why the other options are wrong:**

- (B) Southern blotting detects DNA with a DNA probe.
- (C) Northern blotting detects RNA with a nucleic-acid probe.
- (D) “Eastern blotting” detects post-translational modifications, not the general protein-by-antibody method described.

Final Answer: Protein detected by antibody probe is Western blotting $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q147

Q148.

Solution

Concept — Bioreactor mixing and aeration: In a stirred-tank fermenter the impeller plus baffles shear large air bubbles into small ones and keep the broth uniform, maximising oxygen transfer. **Reasoning:** Air enters through the sparger, but it is the rotating impeller (agitator) that disperses bubbles and circulates the medium; baffles prevent vortexing and improve turbulence. Together they raise the volumetric oxygen-transfer coefficient k_La needed for aerobic growth. **Why the other options are wrong:**

- (A) The sparger alone gives poor mixing without agitation.
- (C) The cooling jacket controls temperature, not bubble break-up.
- (D) The foam breaker only manages surface foam.

Final Answer: Impeller with baffles disperses bubbles and mixes the broth $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q148

Q149.

Solution

Concept — Primary vs secondary metabolites: Primary metabolites (e.g. ethanol, amino acids) form during active growth (trophophase); secondary metabolites form later, in the stationary phase (idiophase), and are not essential for growth. **Reasoning:** Penicillin is a classic secondary metabolite. Its synthesis by *Penicillium chrysogenum* peaks during the stationary phase (idiophase), after the rapid growth phase, when nutrient limitation triggers secondary pathways. **Why the other options are wrong:**

- (A) Primary metabolites form in the log phase; penicillin does not.
- (B) Penicillin is a β-lactam, not a structural protein.
- (D) It is not a storage carbohydrate.

Final Answer: Penicillin is a secondary metabolite of the idiophase $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q149

Q150.

Solution

Concept — Moist-heat sterilization: Saturated steam under pressure kills microbes by denaturing proteins; the autoclave reference cycle is 121°C at 15 psi for 15–20 min. **Reasoning:** At 15 psi above atmospheric pressure water boils at 121°C, and 15–20 min of contact reliably destroys vegetative cells and spores. This is the standard validated condition for sterilising most fermentation media and aqueous solutions. **Why the other options are wrong:**

- (A) 100°C at atmospheric pressure does not kill spores reliably.
- (B) 160°C is dry-heat, for glassware and oils, not aqueous media.
- (C) Filtration removes microbes but is not the "moist-heat" method asked.

Final Answer: 121°C, 15 psi, 15–20 min ⇒ D

Answer: (D) Go Back to Q150

Q151.

Solution

Concept — Michaelis constant K_m: K_m is the substrate concentration at which the reaction velocity is half of V_{max}, and it inversely reflects enzyme–substrate affinity. **Reasoning:** From $v = \dfrac{V_{max}[S]}{K_m + [S]}$, setting $v = \frac{1}{2}V_{max}$ gives $[S] = K_m$. On the hyperbolic plot this is exactly the [S] read off where the curve reaches half the V_{max} asymptote, as marked in the figure. **Why the other options are wrong:**

- (B) K_m has units of concentration, not twice a velocity.
- (C) k_{cat} is the turnover number, a rate constant.
- (D) K_m is not a dimerisation constant.

Final Answer: The [S] giving $\frac{1}{2}V_{max}$ is K_m ⇒ A

Answer: (A) Go Back to Q151

Q152.

Solution

Concept — Competitive inhibition: A competitive inhibitor competes with substrate for the active site; excess substrate can outcompete it, so V_{max} is reachable but apparent K_m rises. **Reasoning:** Because high [S] displaces the inhibitor, the maximum velocity V_{max} is unchanged. However more substrate is needed to reach half-maximal velocity, so the **apparent K_m increases** (affinity appears lower). On a Lineweaver–Burk plot the lines share the same $1/v$ intercept but differ in slope. **Why the other options are wrong:**

- (A) K_m rises, it does not decrease.
- (C) That pattern (V_{max} down, K_m same) is non-competitive inhibition.
- (D) Both falling describes uncompetitive inhibition.

Final Answer: Apparent K_m increases, V_{max} unchanged $\Rightarrow$ $\boxed{B}$

Answer: (B) Go Back to Q152

Q153.

Solution

Concept — Enzyme immobilization by entrapment: The enzyme is caged within the pores of a gel or polymer matrix so it stays put while substrate and product diffuse freely; no bonds form to the enzyme. **Reasoning:** Trapping an enzyme inside calcium-alginate beads is the textbook example of entrapment. The enzyme is held physically within the lattice, preserving its native conformation and activity, unlike methods that chemically modify the protein. **Why the other options are wrong:**

- (A) Covalent coupling forms chemical bonds to a support.
- (B) Adsorption relies on weak surface attachment, not lattice caging.
- (D) Cross-linking uses glutaraldehyde to bond enzyme molecules together.

Final Answer: Trapping in a polymer gel lattice is entrapment $\Rightarrow$ $\boxed{C}$

Answer: (C) Go Back to Q153

Q154.

Solution

Concept — Antibody structure: An IgG monomer has two heavy and two light chains forming two Fab arms (antigen binding) and one Fc stem (effector functions). The antigen-binding site lies in the variable (V) domains at the tips of the Fab arms. **Reasoning:** The labelled region X at the tip of a Fab arm is the variable region (V_H + V_L), which forms the complementarity-determining paratope that recognises antigen. Each IgG monomer therefore has two identical antigen-binding sites. **Why the other options are wrong:**

- (A) The Fc region binds complement and receptors, not antigen.
- (B) The hinge gives flexibility but does not bind antigen.
- (C) C_H2 is a constant effector domain.

Final Answer: X is the variable antigen-binding region of the Fab arm $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q154

Q155.

Solution

Concept — Immunoglobulin classes: IgM is a pentamer (largest Ig), the first antibody made in a primary response, and the strongest activator of complement and agglutinator. **Reasoning:** Its ten antigen-binding sites and J-chain-linked pentameric form make IgM highly efficient at agglutination and classical-pathway complement fixation. It appears early, then class-switching yields IgG later. **Why the other options are wrong:**

- (B) IgG is a monomer, dominant in the secondary response, crosses the placenta.
- (C) IgA (often dimeric) guards mucosal secretions.
- (D) IgE mediates allergy and parasite defence, present in trace amounts.

Final Answer: The pentameric, first-response, complement-fixing antibody is IgM $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q155

Q156.

Solution

Concept — Active vs passive immunity: Active immunity is the host's own antibody production (slow onset, long memory); passive immunity is the transfer of ready-made antibodies (immediate, short-lived, no memory). **Reasoning:** Giving preformed anti-tetanus immunoglobulin supplies antibodies the patient did not make, so protection is immediate but temporary and leaves no memory. Because it is deliberately administered, it is **artificial passive** immunity. **Why the other options are wrong:**

- (A) Active immunity would need the patient to make antibodies (e.g. a vaccine).
- (C) Natural active immunity follows actual infection.
- (D) Passive natural immunity is via placenta or breast milk, not injected antiserum.

Final Answer: Injected preformed antiserum gives artificial passive immunity $\Rightarrow$ B

Answer: (B) Go Back to Q156

Q157.

Solution

Concept — Hybridoma technology: Fusing a short-lived antibody-producing B cell with an immortal myeloma cell yields a hybridoma that both secretes a single (monoclonal) antibody and divides indefinitely. **Reasoning:** Normal B lymphocytes die after a few divisions in culture. The myeloma partner contributes immortality, so the fused hybridoma grows continuously while the B cell supplies the desired antibody specificity. Unfused cells are removed on HAT selection medium. **Why the other options are wrong:**

- (A) The product is monoclonal, from one B-cell specificity, not polyclonal.
- (B) HAT selects fused cells; the myeloma does not provide the antigen.
- (D) The variable-region gene comes from the B cell, not the myeloma.

Final Answer: Myeloma cells confer immortality for continuous antibody production $\Rightarrow$ C

Answer: (C) Go Back to Q157

Q158.

Solution

Concept — Gram stain and cell wall: Gram-positive bacteria have a thick peptidoglycan layer that traps the crystal-violet–iodine complex, staining them purple; Gram-negatives have thin peptidoglycan plus an outer membrane and lose the dye, staining pink with safranin. **Reasoning:** During decolourisation with alcohol, the thick, dehydrated peptidoglycan mesh of Gram-positives shrinks and retains the dye complex, so the cells stay purple. The wall composition is the decisive factor. **Why the other options are wrong:**

- (A) An LPS outer membrane is the Gram-negative feature.
- (B) Thin peptidoglycan between two membranes describes Gram-negatives.
- (C) Gram-positives do possess a cell wall; they do not decolourise easily.

Final Answer: Thick peptidoglycan retains crystal violet, giving purple Gram-positives $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q158

Q159.

Solution

Concept — Bacterial growth curve: The four phases are lag (I), log/exponential (II), stationary (III), and death/decline (IV). Growth rate is highest in the log phase. **Reasoning:** In the log phase (Phase II) nutrients are plentiful and cells divide at a constant maximal specific growth rate, giving the shortest generation (doubling) time and a straight rising line on the log plot. This is why log-phase cells are used for industrial inoculation and assays. **Why the other options are wrong:**

- (B) Phase I (lag) has little or no division while cells adapt.
- (C) Phase III (stationary) has growth balanced by death, net rate ≈ 0.
- (D) Phase IV (death) shows declining viable counts.

Final Answer: Maximal growth rate occurs in the log phase, Phase II $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q159

Q160.

Solution

Concept — Sterilization of heat-labile fluids: Thermolabile solutions are sterilised by passage through a membrane filter of 0.22 μm pore size, which physically removes bacteria without heat. **Reasoning:** A 0.22 μm membrane retains bacteria and is the pharmacopoeial choice for sterilising heat-sensitive solutions such as enzymes, vaccines, and thermolabile antibiotics. No high temperature is involved, so the active ingredient is preserved. **Why the other options are wrong:**

- (A) Autoclaving at 121°C would denature heat-labile material.
- (C) Dry heat at 160°C is even harsher and is for glassware/oils.
- (D) Flaming is for inoculation loops, not solutions.

Final Answer: 0.22 μm membrane filtration sterilises heat-labile fluids $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q160

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	D	3	C	4	A	5	B
6	D	7	C	8	A	9	B	10	D
11	A	12	B	13	C	14	A	15	D
16	B	17	C	18	A	19	D	20	B
21	C	22	A	23	D	24	B	25	C
26	A	27	D	28	B	29	C	30	A
31	B	32	D	33	C	34	A	35	B
36	B	37	C	38	A	39	D	40	A
41	B	42	C	43	D	44	A	45	B
46	C	47	A	48	D	49	B	50	C
51	A	52	B	53	D	54	A	55	C
56	B	57	D	58	A	59	B	60	C
61	D	62	A	63	B	64	C	65	D
66	A	67	B	68	C	69	B	70	D
71	C	72	A	73	B	74	C	75	D
76	A	77	B	78	C	79	A	80	D
81	B	82	C	83	A	84	B	85	D
86	A	87	B	88	C	89	D	90	A
91	B	92	C	93	D	94	A	95	B
96	C	97	D	98	A	99	A	100	B
101	C	102	D	103	A	104	B	105	C
106	D	107	A	108	B	109	C	110	D
111	A	112	B	113	C	114	D	115	A
116	B	117	C	118	D	119	A	120	B
121	C	122	D	123	C	124	A	125	B
126	D	127	A	128	C	129	B	130	D
131	A	132	B	133	C	134	A	135	D
136	B	137	C	138	D	139	A	140	B
141	C	142	D	143	A	144	B	145	C
146	D	147	A	148	B	149	C	150	D
151	A	152	B	153	C	154	D	155	A
156	B	157	C	158	D	159	A	160	B