MCAT BONUS - PRACTICE TEST 8

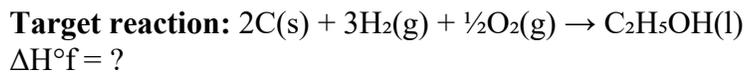## Chemical And Physical Foundations of Biological Systems

Time	Questions
95 minutes	59

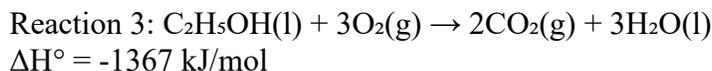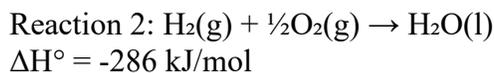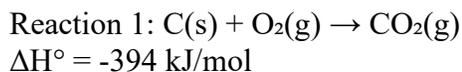## PASSAGE 1: Thermochemistry and Hess's Law

Enthalpy (ΔH) measures heat change at constant pressure. Exothermic reactions ($\Delta H < 0$) release heat; endothermic reactions ($\Delta H > 0$) absorb heat. Hess's law states that total enthalpy change is path-independent—ΔH for a reaction equals the sum of ΔH values for any sequence of steps leading to the same products.

Standard enthalpies of formation ($\Delta H°f$) are measured for forming one mole of compound from elements in standard states. $\Delta H°rxn = \Sigma\Delta H°f(\text{products}) - \Sigma\Delta H°f(\text{reactants})$.

Bond enthalpy estimates: $\Delta H \approx \Sigma(\text{bonds broken}) - \Sigma(\text{bonds formed})$. Energy required to break bonds is positive; energy released forming bonds is negative.

Given thermochemical data:

Reaction 1: $C(s) + O_2(g) \rightarrow CO_2(g)$
$\Delta H° = -394$ kJ/mol

Reaction 2: $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$
$\Delta H° = -286$ kJ/mol

Reaction 3: $C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$
$\Delta H° = -1367$ kJ/mol

Target reaction: $2C(s) + 3H_2(g) + \frac{1}{2}O_2(g) \rightarrow C_2H_5OH(l)$
$\Delta H°f = ?$

Bomb calorimeter experiment:

- Burned 0.500 g glucose ($C_6H_{12}O_6$, MW = 180 g/mol)

- Calorimeter heat capacity: 10.0 kJ/°C
- Temperature increased 1.56°C
- Heat released: 15.6 kJ

Bond energies (kJ/mol):

- C-H: 413
- O=O: 498
- C=O: 799
- O-H: 463

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1. Using Hess's law, the ΔH°f of ethanol is:

A. -1367 kJ/mol

B. +277 kJ/mol

C. -277 kJ/mol

D. +1367 kJ/mol

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2. To calculate ethanol's ΔH°f, the correct manipulation is:

A. Reverse Reaction 3, add 2×(Reaction 1) and 3×(Reaction 2)

B. Add all reactions directly

C. Multiply Reaction 3 by 2

D. Subtract Reaction 2 from Reaction 1

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3. The combustion of glucose releasing 15.6 kJ from 0.500 g means the molar heat of combustion is:

A. 15.6 kJ/mol

B. 31.2 kJ/mol

C. 1560 kJ/mol

D. 5616 kJ/mol

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4. For the reaction CH₄ + 2O₂ → CO₂ + 2H₂O, if breaking 4 C-H bonds and 2 O=O bonds requires 2648 kJ, and forming 2 C=O and 4 O-H bonds releases 3450 kJ, then ΔH is:

A. +802 kJ (endothermic)

B. -802 kJ (exothermic)

C. +2648 kJ

D. -3450 kJ

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5. Bomb calorimetry measures ΔE (constant volume) rather than ΔH (constant pressure), but they are approximately equal when:

A. Temperature changes are large

B. Reactions involve only solids

C. The change in moles of gas is small (ΔH ≈ ΔE when PΔV ≈ 0)

D. Pressure is zero

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6. If a reaction has ΔH° = -50 kJ/mol, the reverse reaction has:

A. ΔH° = +50 kJ/mol

B. ΔH° = -50 kJ/mol

C. ΔH° = -100 kJ/mol

D. ΔH° = 0 kJ/mol

PASSAGE 2: Acids, Bases, and pH

The pH scale measures $[H^+]$: pH = -log$[H^+]$. At 25°C, Kw = $[H^+][OH^-]$ = 1.0×10^{-14}. For water: pH + pOH = 14.

Strong acids (HCl, HNO$_3$, H$_2$SO$_4$) completely dissociate. Weak acids partially dissociate with Ka = [H$^+$][A$^-$]/[HA]. pKa = -log(Ka). Lower pKa = stronger acid.

Titration curves show pH changes during acid-base addition. At equivalence point, moles acid = moles base. For weak acid titrations, pH at half-equivalence point equals pKa.

Experimental data:

Solution A: 0.10 M HCl

- Measured pH: 1.0
- [H$^+$] = 0.10 M

Solution B: 0.10 M acetic acid (CH$_3$COOH, Ka = 1.8 × 10^{-5})

- Measured pH: 2.87
- [H$^+$] = 1.3 × 10^{-3} M

Solution C: 0.10 M NaOH

- Measured pH: 13.0
- [OH$^-$] = 0.10 M

Titration: 25.0 mL of 0.10 M acetic acid titrated with 0.10 M NaOH

- Initial pH: 2.87
- Half-equivalence (12.5 mL added): pH = 4.74 = pKa
- Equivalence point (25.0 mL added): pH = 8.72
- After equivalence (30.0 mL added): pH = 12.0

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7. HCl solution having lower pH than acetic acid at equal concentrations demonstrates:

A. Acetic acid is a stronger acid

B. Strong acids completely dissociate while weak acids partially dissociate

C. HCl has a higher pKa

D. Both are weak acids

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8. At the half-equivalence point, pH = pKa because:

A. $[H^+] = Ka$

B. Solution is neutral

C. All acid is neutralized

D. $[HA] = [A^-]$, so $pH = pKa + log(1) = pKa$

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9. The equivalence point pH being 8.72 (basic) rather than 7.0 occurs because:

A. Acetate ion (conjugate base) hydrolyzes to produce OH^-

B. Excess NaOH was added

C. HCl was used instead of acetic acid

D. The solution is acidic

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10. If $[H^+] = 1.0 \times 10^{-9}$ M, the $[OH^-]$ is:

A. 1.0×10^{-9} M

B. 1.0×10^{-14} M

C. 1.0×10^{-5} M

D. 1.0×10^{-7} M

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11. A buffer system containing equal concentrations of acetic acid and acetate ion would:

A. Have pH far from pKa

B. Resist pH changes when small amounts of acid or base are added

C. Have pH = 0
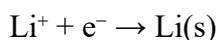
D. Have no buffering capacity

PASSAGE 3: Electrochemistry and Batteries

Electrochemical cells convert chemical energy to electrical energy (galvanic) or electrical energy to chemical energy (electrolytic). Cell potential E°cell = E°cathode - E°anode. Positive E°cell indicates spontaneous reactions.

The relationship between $\Delta G°$ and E°: $\Delta G° = -nFE°$, where n = electrons transferred, F = 96,485 C/mol (Faraday constant). Negative $\Delta G°$ corresponds to positive E° (spontaneous).

The Nernst equation: $E = E° - (RT/nF)\ln(Q)$ or at 25°C: $E = E° - (0.0592/n)\log(Q)$.

Standard reduction potentials:

$Li^+ + e^- \rightarrow Li(s)$
E° = -3.05 V

$Zn^{2+} + 2e^- \rightarrow Zn(s)$
E° = -0.76 V

$Cu^{2+} + 2e^- \rightarrow Cu(s)$
E° = +0.34 V
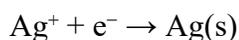
$Ag^+ + e^- \rightarrow Ag(s)$
E° = +0.80 V

Galvanic cell constructed: $Zn \mid Zn^{2+}(1.0 \text{ M}) \parallel Cu^{2+}(1.0 \text{ M}) \mid Cu$

- E°cell = +0.34 - (-0.76) = +1.10 V
- Spontaneous reaction
- Zn oxidized (anode), Cu^{2+} reduced (cathode)

Non-standard conditions: $[Zn^{2+}] = 0.10$ M, $[Cu^{2+}] = 1.0$ M

- E = 1.10 - (0.0592/2)log(0.10/1.0)
- E = 1.10 - (0.0296)(-1) = 1.13 V

Electrolysis: $2H_2O \rightarrow 2H_2 + O_2$ (requires external voltage)

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12. The Zn/Cu cell having E°cell = +1.10 V indicates:

A. Non-spontaneous reaction

B. Equilibrium

C. No current flows

D. Spontaneous oxidation of Zn and reduction of Cu^{2+}

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13. In this cell, electrons flow from:

A. Cu to Zn through external circuit

B. Zn to Cu through external circuit

C. Neither electrode

D. Both directions equally

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14. Decreasing [Zn^{2+}] while keeping [Cu^{2+}] constant increases cell potential because:

A. $E°$ changes

B. Temperature increases

C. Lower [Zn^{2+}] shifts equilibrium toward more Zn oxidation (products), increasing E

D. [Cu^{2+}] decreases

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15. For the spontaneous reaction with $\Delta G° = -nFE°$, if $E° = +1.10$ V and n = 2, $\Delta G°$ equals:

A. -212 kJ/mol

B. +212 kJ/mol

C. -1.10 kJ/mol

D. +1.10 kJ/mol

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16. Electrolysis of water requiring external voltage demonstrates:

A. The reaction is endergonic with positive ΔG

B. Water decomposition is spontaneous

C. No energy is required

D. Water is an acid

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17. Which combination would produce the highest voltage galvanic cell?

A. Li/Li^+ and Zn/Zn^{2+}

B. Li/Li^+ and Ag/Ag^+

C. Zn/Zn^{2+} and Cu/Cu^{2+}

D. Cu/Cu^{2+} and Ag/Ag^+

PASSAGE 4: Kinetics and Enzyme Catalysis

Reaction rate = $k[reactants]^n$. First-order: rate = $k[A]$, half-life $t_{1/2} = 0.693/k$ (concentration-independent). Second-order: rate = $k[A]^2$, $t_{1/2} = 1/(k[A]_0)$.

Activation energy (Ea) is the minimum energy required for reaction. Arrhenius equation: $k = Ae^{(-Ea/RT)}$. Higher Ea = slower reaction. Temperature increases reaction rates exponentially.

Enzymes are biological catalysts lowering Ea without changing ΔG or equilibrium position. Michaelis-Menten kinetics: $v = (V_{max}[S])/(K_m + [S])$. Km is substrate concentration at $v = V_{max}/2$. Lower Km = higher enzyme-substrate affinity.

Competitive inhibitors increase apparent Km (more substrate needed) but don't change Vmax. Noncompetitive inhibitors decrease Vmax but don't affect Km.

Enzyme experiment:

Without inhibitor:

- Vmax = 100 μmol/min
- Km = 10 mM

With Inhibitor A:

- Vmax = 100 μmol/min
- Apparent Km = 30 mM

With Inhibitor B:

- Vmax = 50 µmol/min
- Km = 10 mM

Temperature study:

- At 25°C: reaction rate = 5 µmol/min
- At 35°C: reaction rate = 15 µmol/min
- At 55°C: enzyme denatures, activity = 0

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18. Inhibitor A increasing Km without changing Vmax indicates:

A. Competitive inhibition where inhibitor competes for active site

B. Noncompetitive inhibition

C. Irreversible inhibition

D. Allosteric activation

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19. Inhibitor B decreasing Vmax without changing Km suggests:

A. Competitive inhibition

B. Substrate analogs

C. Noncompetitive inhibition binding at a site other than active site

D. Increased enzyme concentration

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20. At [S] = Km = 10 mM, the reaction velocity equals:

A. Vmax

B. Zero

C. Vmax/4

D. Vmax/2 (by definition of Km)

21. The reaction rate tripling from 25°C to 35°C reflects:

A. Linear temperature dependence

B. Exponential increase in molecules with energy $\geq E_a$ (Arrhenius relationship)

C. Enzyme activation only

D. Decreased Ea

22. Enzyme denaturation at 55°C causing loss of activity demonstrates:

A. Temperature-dependent reaction rates continue increasing indefinitely

B. Optimal temperature exists beyond which protein structure disrupts

C. Ea increases at high temperature

D. Substrates decompose

PASSAGE 5: Organic Chemistry - Stereochemistry

Chirality describes molecules non-superimposable on their mirror images. Chiral centers (stereocenters) are sp^3 carbons with four different substituents. Enantiomers are non-superimposable mirror images with opposite configurations at all chiral centers.

Diastereomers are stereoisomers that aren't enantiomers (differ at some but not all chiral centers). A molecule with n chiral centers has maximum 2^n stereoisomers.

Optical activity: enantiomers rotate plane-polarized light equally but in opposite directions. (+) = dextrorotatory (clockwise), (-) = levorotatory (counterclockwise). Racemic mixtures (1:1 enantiomer ratio) show zero net rotation.

R/S nomenclature (Cahn-Ingold-Prelog): assign priorities (1-4) by atomic number; orient lowest priority away; clockwise $1\rightarrow2\rightarrow3$ = R, counterclockwise = S.

Compounds studied:

Compound A: 2-butanol ($CH_3CH(OH)CH_2CH_3$)

- One chiral center
- Exists as pair of enantiomers: (R)-2-butanol and (S)-2-butanol
- Pure (R) rotates light +13.5°
- Pure (S) rotates light -13.5°
- Racemic mixture: zero rotation

Compound B: 2,3-dibromobutane

- Two chiral centers
- Four possible stereoisomers: RR, RS, SR, SS
- RR and SS are enantiomers
- RS and SR are enantiomers
- RR and RS are diastereomers

Compound C: 2,3-dibromobutane with C_2 symmetry

- meso compound (RS = SR)
- Three total stereoisomers (RR, SS, meso)
- meso is achiral despite having chiral centers

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23. A molecule with 3 chiral centers has a maximum of how many stereoisomers?

A. 3

B. 6

C. 8

D. 16

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24. Enantiomers differ in:

A. All physical properties including optical rotation direction

B. Chemical reactivity toward achiral reagents

C. Boiling points

D. Melting points

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25. A racemic mixture showing zero optical rotation occurs because:

A. No chiral centers exist

B. The compound is achiral

C. Molecules are superimposable

D. Equal amounts of opposite enantiomers cancel rotations

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26. Diastereomers, unlike enantiomers:

A. Are mirror images

B. Have different physical properties (melting points, boiling points, Rf values)

C. Always have identical properties

D. Cannot exist with two chiral centers

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27. A meso compound is:

A. Always optically active

B. An enantiomer

C. Achiral due to internal plane of symmetry despite having chiral centers

D. Never possible with two chiral centers

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28. To determine absolute configuration (R or S), one must:

A. Measure optical rotation

B. Assign priorities by atomic number, orient lowest priority away, and determine clockwise (R) or counterclockwise (S)

C. Count chiral centers only

D. Compare to known compounds only

PASSAGE 6: Gas Laws and Kinetic Molecular Theory

Ideal gas law: $PV = nRT$, where $R = 0.0821$ L·atm/(mol·K). Real gases deviate at high pressure (finite molecular volume) and low temperature (intermolecular forces).

Combined gas law: $P_1V_1/T_1 = P_2V_2/T_2$. Dalton's law of partial pressures: $P_{total} = P_1 + P_2 + ...$ Partial pressure: $P_i = X_iP_{total}$ (X_i = mole fraction).

Kinetic molecular theory: gas particles in constant random motion, elastic collisions, negligible volume, no intermolecular forces. Average kinetic energy $\propto$ temperature: $KE = (3/2)RT$.

Graham's law: $rate_1/rate_2 = \sqrt{(M_2/M_1)}$. Lighter molecules effuse/diffuse faster.

Experiments:

Ideal gas calculation:

- 2.0 mol gas, 24.6 L, 300 K
- $P = nRT/V = (2.0)(0.0821)(300)/24.6 = 2.0$ atm

Real gas behavior:

- Same conditions: measured $P = 1.85$ atm (lower than ideal)
- At 100 K: measured $P = 0.50$ atm (much lower than ideal 0.67 atm)

Partial pressure:

- Container: 1 mol N_2, 3 mol O_2, $P_{total} = 4.0$ atm
- $P_{N_2} = (1/4)(4.0) = 1.0$ atm
- $P_{O_2} = (3/4)(4.0) = 3.0$ atm

Effusion:

- He ($M = 4$ g/mol) effuses through pinhole
- Unknown gas effuses 2× slower than He
- Unknown gas $M = 16$ g/mol (likely CH_4)

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29. Real gas pressure being lower than ideal at 300 K indicates:

A. Molecular volume is significant

B. Intermolecular attractive forces reduce wall collisions

C. Temperature is too high

D. Gas is ideal

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30. Deviation increasing at 100 K occurs because:

A. Higher temperature increases ideality

B. Molecular volume dominates

C. Gas particles move faster

D. Lower temperature allows intermolecular forces to become more significant

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31. The mole fraction of N_2 in the mixture is:

A. 0.25

B. 0.50

C. 0.75

D. 1.0

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32. If the container volume doubled while temperature and moles remained constant, the total pressure would:

A. Double

B. Decrease to 2.0 atm (half of original)

C. Remain 4.0 atm

D. Quadruple

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33. The unknown gas having M = 16 g/mol was calculated using Graham's law because:

A. Pressure equals molar mass

B. Effusion rate is inversely proportional to square root of molar mass

C. All gases effuse at the same rate

D. Temperature determines molar mass

PASSAGE 7: Nuclear Chemistry and Radioactive Decay

Radioactive nuclei undergo decay: alpha ($^4_2$He), beta-minus (electron, $^0_{-1}$e), beta-plus (positron, $^0_{+1}$e), or gamma ($^0_0\gamma$, electromagnetic radiation). Alpha decreases mass number by 4 and atomic number by 2. Beta-minus increases atomic number by 1 (neutron → proton). Beta-plus decreases atomic number by 1 (proton → neutron).

First-order decay kinetics: $N = N_0 e^{(-\lambda t)}$ or $A = A_0 e^{(-\lambda t)}$. Half-life: $t_{1/2} = 0.693/\lambda$. After n half-lives: $N = N_0(1/2)^n$.

Mass defect (Δm) between nuclear mass and sum of nucleon masses relates to binding energy: $E = \Delta mc^2$. Higher binding energy per nucleon = more stable nucleus.

Decay series:

Uranium-238: $^{238}_{92}$U → $^{234}_{90}$Th + $^4_2$He (alpha decay)

Thorium-234: $^{234}_{90}$Th → $^{234}_{91}$Pa + $^0_{-1}$e (beta decay)

Carbon-14 dating:

- Living organisms: ^{14}C/^{12}C constant
- After death: ^{14}C decays ($t_{1/2} = 5730$ years)
- Sample with 25% original ^{14}C activity → 2 half-lives elapsed → 11,460 years old

PET imaging:

- ^{18}F undergoes beta-plus decay: $^{18}_9$F → $^{18}_8$O + $^0_{+1}$e
- Positron annihilates with electron, producing 2 gamma rays

Binding energy:

- ^{4}He nucleus mass = 4.0015 amu
- 2 protons + 2 neutrons mass = 4.0319 amu
- Mass defect = 0.0304 amu
- Binding energy = (0.0304 amu)(931.5 MeV/amu) = 28.3 MeV

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34. After 3 half-lives, the fraction of original radioactive sample remaining is:

A. 1/3

B. 1/6

C. 1/9

D. 1/8

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35. Beta-minus decay increases atomic number because:

A. An electron is absorbed

B. A neutron converts to proton + electron

C. Mass increases

D. Alpha particles are emitted

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36. The carbon-14 sample having 25% original activity being 11,460 years old demonstrates:

A. One half-life elapsed

B. Linear decay

C. Two half-lives elapsed (50% → 25%)

D. Three half-lives

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37. Mass defect being converted to binding energy according to E = mc² shows:

A. Mass is destroyed in nuclear reactions

B. Nuclear binding involves mass-energy conversion per Einstein's equation

C. Energy cannot be converted to mass

D. Nuclei have no binding forces

38. PET imaging using positron emission followed by annihilation to produce gamma rays works because:

A. Positrons are stable

B. Gamma rays cannot be detected

C. Electrons and positrons don't interact

D. Positron-electron annihilation converts mass to electromagnetic radiation

PASSAGE 8: Solutions and Colligative Properties

Colligative properties depend on solute particle number, not identity: vapor pressure lowering, boiling point elevation, freezing point depression, osmotic pressure.

Raoult's law: $P_{solution} = X_{solvent}P°_{solvent}$. Vapor pressure decreases with dissolved solute.

Boiling point elevation: $\Delta T_b = K_b m$ (m = molality). Freezing point depression: $\Delta T_f = K_f m$. For ionic compounds, van't Hoff factor i accounts for dissociation: $\Delta T = iKm$.

Osmotic pressure: $\pi = iMRT$ (M = molarity). Isotonic solutions have equal osmotic pressure. Hypertonic (higher solute) causes cell shrinkage; hypotonic (lower solute) causes cell swelling.

Experimental data:

Solution A: 1.0 m glucose in water

- Freezing point: -1.86°C ($K_{f,water}$ = 1.86°C/m)
- Boiling point: 100.51°C ($K_{b,water}$ = 0.51°C/m)

Solution B: 1.0 m NaCl in water

- Expected freezing point if i = 2: -3.72°C
- Measured: -3.40°C (i = 1.83, incomplete dissociation)

Solution C: 0.30 M NaCl (physiological saline)

- π = (1.8)(0.30)(0.0821)(310) = 13.8 atm at 37°C

Osmosis experiment:

- Pure water and 0.15 M sucrose separated by semipermeable membrane
- Water flows into sucrose solution
- Equilibrium when $\pi = 3.8$ atm

Red blood cells:

- In isotonic saline: normal shape
- In pure water (hypotonic): swelling and lysis
- In 1.5 M NaCl (hypertonic): crenation (shrinking)

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39. Glucose solution freezing at -1.86°C instead of 0°C demonstrates:

A. Solute particles disrupt solvent crystal formation, lowering freezing point

B. Glucose increases freezing point

C. Temperature measurement error

D. Glucose is ionic

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40. NaCl showing i = 1.83 rather than 2.0 indicates:

A. Complete dissociation into Na^+ and Cl^-

B. No dissociation

C. Partial ion pairing reduces effective particle number below theoretical

D. NaCl is molecular

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41. Water flowing into sucrose solution during osmosis occurs because:

A. Sucrose flows out

B. Pressure is higher in pure water

C. Membrane is impermeable to solute

D. Water moves from lower to higher solute concentration (down its concentration gradient)

42. Red blood cells in pure water undergoing lysis because:

A. Water enters cells by osmosis, causing swelling and membrane rupture

B. Cells shrink

C. No osmotic pressure exists

D. Pure water is hypertonic

43. To calculate the molar mass of an unknown solute from freezing point depression, one would:

A. Measure ΔT_f, calculate molality (m = ΔT_f/Kf), then M = g solute/(m × kg solvent)

B. Use only mass of solute

C. Measure boiling point only

D. Count particles directly

44. Physiological saline (0.30 M NaCl) being isotonic with cells means:

A. It has lower osmotic pressure than cells

B. It causes cell lysis

C. Its osmotic pressure equals intracellular osmotic pressure, preventing net water flow

D. It is pure water

DISCRETE QUESTIONS (45-59)

45. Which of the following is the strongest base?

A. pKb = 10

B. pKb = 5

C. pKb = 8

D. pKb = 3

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46. The molecular geometry of SF$_4$ (5 electron domains, 1 lone pair) is:

A. Tetrahedral

B. See-saw

C. Trigonal bipyramidal

D. Square planar

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47. Which functional group is present in aspirin (acetylsalicylic acid)?

A. Aldehyde and amine

B. Alcohol and ketone

C. Carboxylic acid and ester

D. Ether and alkyne

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48. In SN2 reactions, the nucleophile attacks from:

A. The backside, causing inversion of configuration

B. The frontside, retaining configuration

C. Any angle randomly

D. Multiple positions simultaneously

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49. The oxidation state of nitrogen in HNO$_3$ is:

A. +3

B. +4

C. -3

D. +5

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50. Which intermolecular force is primarily responsible for the high boiling point of water?

A. Dipole-dipole interactions

B. Hydrogen bonding

C. London dispersion forces

D. Ionic bonding

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51. In a galvanic cell, reduction occurs at the:

A. Anode

B. Negative electrode

C. Cathode

D. Salt bridge

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52. The rate law for a reaction is determined by:

A. The balanced equation stoichiometry

B. Experimental measurement

C. Product concentrations

D. Thermodynamic values

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53. Which molecule is polar?

A. CCl$_4$

B. CO$_2$

C. H$_2$O

D. BF$_3$

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54. Conjugated dienes absorb light at _____ wavelengths compared to isolated dienes:

A. Shorter

B. Longer

C. Identical

D. Cannot be determined

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55. For a reaction at equilibrium, ΔG equals:

A. ΔG°

B. -RT ln K

C. +RT ln K

D. Zero

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56. The hybridization of the central carbon in CO$_2$ (O=C=O) is:

A. sp^3

B. sp^2

C. sp

D. sp^{3}d

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57. Which correctly represents a buffer system?

A. HCl and NaCl

B. NaOH and NaCl

C. CH_3COOH and CH_3COONa

D. HNO_3 and $NaNO_3$

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58. Entropy (S) is a measure of:

A. Heat content

B. Disorder or randomness

C. Bond strength

D. Reaction rate

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59. In UV-Vis spectroscopy, the wavelength of maximum absorbance (λmax) shifts to longer wavelengths when:

A. Molecular weight decreases

B. Temperature increases

C. Bond strength increases

D. Conjugation increases

Critical Analysis and Reasoning Skills (CARS)

Time	Questions
90 minutes	53

PASSAGE 1: The Limits of Empathy in Moral Judgment

Empathy—the capacity to share and understand others' emotional states—is widely celebrated as foundational to moral behavior. We assume that feeling others' pain makes us more likely to help them and less likely to harm them. Yet this assumption deserves scrutiny. Empathy may be less reliable as a moral guide than commonly believed.

First, empathy is biased. We empathize more readily with those who resemble us—our families, communities, or nations. This parochialism can lead to moral blindness regarding distant or dissimilar others. A parent's empathy for their child might inspire them to secure advantages that harm other children competing for the same limited resources. Soldiers empathize with comrades while harming enemy combatants. Empathy can thus reinforce rather than challenge existing tribal boundaries.

Second, empathy is innumerate. Paul Bloom argues that empathy spotlights individual suffering while obscuring aggregate welfare. A single identified victim generates intense empathic response and action, while statistical victims—thousands dying from preventable diseases—fail to move us proportionately. This "identifiable victim effect" leads to inefficient resource allocation: we might spend millions to rescue miners trapped underground while neglecting low-cost interventions that would save many more lives.

Third, empathy is exhausting. Healthcare workers, therapists, and aid workers experience empathy fatigue—emotional depletion from sustained exposure to others' suffering. This burnout undermines the very helping behaviors empathy supposedly motivates. Compassion, by contrast—a concern for others' wellbeing without necessarily sharing their emotions—may prove more sustainable.

Defenders of empathy respond that these critiques confuse empathy with sympathy or compassion. True empathy, they argue, involves perspective-taking that transcends emotional contagion. By understanding others' viewpoints, we make better moral judgments even about distant or dissimilar people.

But this response concedes the key point: if what matters morally is understanding others' perspectives and promoting their welfare, we need not rely on the affective experience of sharing their feelings. Rational moral principles—rights, duties, fairness, consequences—can guide action without empathy's biases, innumeracy, and exhaustion. Indeed, some of history's greatest moral advances—abolition, women's suffrage, LGBTQ rights—were achieved less through empathizing with affected groups than through principled arguments about justice and equality.

This is not to dismiss empathy entirely. It connects us to others and can motivate moral concern. But we should resist the contemporary tendency to elevate empathy as the primary or necessary foundation for ethics. A mature moral psychology balances empathic responses with reasoned judgment, statistical thinking, and universal principles.

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1. The passage's primary purpose is to:

A. Challenge the assumption that empathy is a reliable foundation for moral decision-making

B. Argue that empathy should be eliminated from ethical consideration

C. Prove that rational principles are always superior to emotional responses

D. Demonstrate that empathy and compassion are identical concepts

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2. According to the passage, the "identifiable victim effect" illustrates empathy's:

A. Parochialism

B. Sustainability

C. Innumeracy

D. Universality

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3. The author's attitude toward empathy is best described as:

A. Hostile, viewing it as entirely detrimental to moral judgment

B. Critical yet balanced, acknowledging both benefits and significant limitations

C. Uncritically supportive, defending it against all objections

D. Indifferent, treating it as irrelevant to ethics

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4. Defenders of empathy respond to criticism by arguing that:

A. Empathy is more important than justice

B. Statistical thinking is impossible

C. Emotional contagion is necessary

D. True empathy involves perspective-taking beyond emotional sharing

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5. The passage suggests that historical moral advances were achieved primarily through:

A. Principled arguments about justice rather than empathic identification

B. Intense empathy with affected groups

C. Emotional appeals only

D. Empathy fatigue

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6. The author would most likely agree that:

A. All empathic responses should be eliminated

B. Empathy and rational principles are incompatible

C. Effective moral reasoning requires balancing empathy with universal principles

D. Empathy is sufficient for all moral decisions

PASSAGE 2: The Museum as Social Construct

Museums present themselves as neutral repositories of cultural heritage, preserving and displaying objects for public edification. Yet this self-conception obscures how museums actively construct rather than merely reflect cultural meaning. Every curatorial choice—what to collect, how to display, which narratives to emphasize—shapes public understanding of history, art, and identity.

Consider natural history museums. Their dioramas present animals in "natural" habitats, but these scenes are highly artificial constructions. Curators choose which moment to freeze, which species to include, what environmental features to emphasize. The result isn't nature but a particular cultural narrative about nature—often emphasizing dramatic predation over cooperative behaviors, pristine wilderness over human-altered landscapes, or evolutionary progress over extinction.

Art museums similarly construct rather than discover artistic canons. For centuries, Western art museums presented European painting and sculpture as the pinnacle of aesthetic achievement while relegating non-Western traditions to "ethnographic" collections. This division reflected and reinforced colonial hierarchies rather than objective artistic merit. Recent efforts to "diversify" collections acknowledge this construction but raise new questions: should museums integrate previously excluded works into existing narratives or create separate spaces that challenge dominant frameworks?

The museum's architecture itself communicates meaning. Monumental neo-classical buildings suggest permanence and authority. White walls and spotlighting direct attention toward individual objects, decontextualizing them from their original settings. Interactive exhibits and participatory installations, by contrast, challenge the museum's traditional authority, inviting visitors to create rather than passively consume meaning.

Some argue that recognizing museums as social constructs undermines their legitimacy. If curators are making arbitrary choices rather than presenting objective truth, why should we trust them? But this criticism misunderstands construction. Acknowledging that museums construct meaning doesn't make their work arbitrary or illegitimate—it means their choices should be transparent, debated, and responsive to diverse perspectives.

The alternative—claiming neutrality—is less honest and more dangerous. It naturalizes particular cultural perspectives as universal truths, making them immune to critique. Museums that acknowledge their constructive role can become sites of democratic dialogue about how societies understand their pasts and imagine their futures.

This doesn't mean museums should abandon expertise or become purely political spaces. Curators possess specialized knowledge crucial for preservation, interpretation, and education. But this expertise should inform rather than dictate museum practice. The goal is neither neutral objectivity (impossible) nor pure relativism (unhelpful) but rather transparent, accountable interpretation that engages multiple perspectives while maintaining scholarly rigor.

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7. The passage's central claim is that:

A. Museums should display only uncontroversial objects

B. Natural history is objective and unchanging

C. Architecture has no effect on museum experience

D. Museums actively construct cultural meaning rather than neutrally presenting it

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8. The natural history diorama example is used to demonstrate that:

A. Animals don't live in natural habitats

B. Even seemingly objective displays involve interpretive choices

C. Predation is less important than cooperation

D. Museums should eliminate dioramas

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9. The criticism that acknowledging construction undermines museum legitimacy is countered by arguing that:

A. Museums are actually neutral after all

B. Expertise is unnecessary

C. Transparency and accountability make construction legitimate rather than arbitrary

D. All interpretations are equally valid

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10. According to the passage, neo-classical museum architecture communicates:

A. Permanence and authority

B. Uncertainty and change

C. Democracy and participation

D. Informality and accessibility

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11. The author's proposed approach to museum practice involves:

A. Abandoning all expertise

B. Claiming complete neutrality

C. Becoming purely political spaces

D. Transparent interpretation combining expertise with multiple perspectives

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12. The passage suggests that relegating non-Western art to "ethnographic" collections:

A. Recognized objective aesthetic differences

B. Reflected and reinforced colonial hierarchies

C. Was a neutral organizational choice

D. Improved public education

PASSAGE 3: Privacy in the Digital Age

Privacy is often framed as an individual right—control over personal information. Yet this conception is increasingly inadequate for the digital age, where data about individuals generates insights about populations, and individual privacy choices have collective consequences.

Consider facial recognition technology. When you consent to upload your photos to a social media platform, enabling the company to train its algorithms, you're not just sharing information about yourself. You're also providing data that helps the system recognize your friends, family, and strangers who appear in your photos—people who never consented. Your individual privacy choice has collective ramifications.

This problem extends throughout digital life. Genomic data reveals information about biological relatives. Location data creates patterns exposing others' movements. Online behavior shapes recommendation algorithms that affect what everyone sees. Privacy has become irreducibly social—individual choices aggregate into collective outcomes beyond any single person's control.

Traditional privacy law struggles with this reality. Consent-based frameworks assume individuals can meaningfully choose whether to share data. But in network contexts, individual consent is insufficient. Even if you refuse to share data, others' choices can expose information about you. Moreover, meaningful consent requires understanding consequences, yet algorithmic systems are often too complex for even experts to predict their applications.

Some propose collective governance mechanisms. If privacy has collective dimensions, perhaps communities should have collective rights to restrict data use. Research involving human subjects requires institutional review, not just individual consent. Could similar frameworks govern commercial data collection?

Critics raise concerns. Who defines the relevant community? How would collective governance respect individual autonomy? Isn't this precisely the kind of social control privacy protections were meant to prevent? These are serious objections, but they don't negate the underlying problem: individual consent frameworks cannot adequately address collective privacy harms.

Another approach emphasizes data fiduciaries—requiring companies to act as trustees obligated to serve users' interests rather than merely obtaining consent for whatever uses they prefer. This recognizes that privacy protection cannot rely solely on individual decision-making when information asymmetries and collective effects render meaningful consent impossible.

We might also distinguish between individual and collective privacy harms. An individual privacy violation occurs when someone's personal information is used without proper authorization. A collective privacy harm emerges when aggregate data analysis reveals patterns about groups, enabling discrimination or manipulation regardless of individual consent. Different harms may require different legal responses.

The digital age has not made privacy obsolete, but it has made individualistic privacy conceptions obsolete. We need frameworks that recognize privacy's social dimensions while avoiding the paternalism and control that motivated privacy protections in the first place. This will require innovation in both law and technology—systems designed to protect collective privacy while respecting individual agency within reasonable bounds.

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13. The passage's main argument is that:

A. Privacy is no longer important in the digital age

B. Traditional individualistic privacy conceptions are inadequate for addressing digital privacy's collective dimensions

C. All privacy law should be abolished

D. Individuals should never share data

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14. Facial recognition technology is used as an example of:

A. A technology that respects privacy

B. A system that requires no regulation

C. Individual privacy protecting everyone

D. Individual privacy choices having collective consequences

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15. The author's concern about consent-based frameworks is that:

A. People should never consent to data sharing

B. Consent is always meaningful

C. Network effects and complexity make individual consent insufficient

D. Consent is too restrictive

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16. The data fiduciary approach would require companies to:

A. Collect unlimited data

B. Ignore all privacy concerns

C. Act as trustees serving users' interests

D. Eliminate all data collection

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17. According to the passage, collective privacy harms differ from individual violations in that collective harms:

A. Don't affect anyone

B. Emerge from aggregate data analysis revealing group patterns

C. Are always less serious

D. Require individual consent

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18. Critics of collective governance worry that it might:

A. Respect individual autonomy too much

B. Be too easy to implement

C. Provide inadequate privacy protection

D. Replicate social control that privacy protections were meant to prevent

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PASSAGE 4: The Paradox of Meritocracy

Meritocracy—the idea that social positions should be allocated based on individual merit rather than birth or connections—is a cornerstone of liberal democratic ideology. Yet sociologist Michael Young, who coined the term in his 1958 dystopian satire, intended it as warning, not aspiration. His concerns have proven prescient.

The paradox is that meritocracy can be both just and dangerous. It's just because rewarding talent and effort rather than arbitrary characteristics like race or class seems fairer than aristocracy or nepotism. It's dangerous because it legitimizes inequality: if success reflects merit, then failure reflects lack of merit. The poor deserve their poverty; the rich deserve their wealth. This ideology erodes social solidarity and justifies callous policies.

Moreover, meritocracy is self-undermining. Successful meritocrats use their positions to advantage their children—buying access to elite schools, enrichment activities, tutoring, and connections. These investments masquerade as "parenting" but functionally reproduce class privilege. The wealthy claim their children succeeded through merit while ignoring the massive structural advantages conferred by family resources.

Testing intensifies this dynamic. Standardized tests are supposed to measure pure ability, but test preparation industries have made them measures of parental investment capacity. SAT scores correlate strongly with family income. When meritocratic selection relies on such proxies, it doesn't overcome class reproduction—it obscures it beneath technical credibility.

The meritocratic worldview also distorts successful people's self-understanding. They attribute their achievements entirely to their own abilities and efforts, discounting luck, privilege, and structural advantages. This "merit hubris" generates contempt for those who didn't succeed, assumed to lack ability or work ethic. Policies helping the disadvantaged are seen as violating merit rather than compensating for unequal starting points.

Some defend meritocracy by distinguishing between ideal and practiced versions. True meritocracy would equalize opportunity, ensuring all children develop their talents regardless of parental resources. Current inequality reflects imperfect implementation, not inherent flaws.

But this defense fails. First, perfect equality of opportunity is impossible—families inevitably differ in resources, cultural capital, and advantages they can confer. Second, even ideal meritocracy faces the legitimization problem: success attributed to merit makes failure shameful and inequality justified. Third, as Young recognized, meritocracy creates a cognitive elite who believe they earned their position, making them indifferent to those below.

Perhaps we should abandon meritocracy as an ideal. This doesn't mean abandoning all distinctions— surgeons need training; engineers need skills. But we could decouple social respect and economic security from competitive achievement. Everyone deserves dignity and decent living standards regardless of market-valued talents. Society could still select people for specialized roles without treating selection as a referendum on human worth.

This alternative requires rethinking what we value. Instead of "equal opportunity to become unequal," we might pursue "adequate opportunity for all plus substantive equality." Instead of meritocracy's "whoever wins deserves to win," we might embrace humility: success depends on talent, effort, AND luck, circumstances, and others' support. Such humility could rebuild the social solidarity that meritocracy has eroded.

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19. Young's original intention in coining "meritocracy" was to:

A. Promote it as an ideal system

B. Provide technical definition

C. Warn against its dangers in satirical form

D. Defend aristocracy

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20. The paradox of meritocracy, according to the passage, is that it is simultaneously:

A. Just in rewarding merit while dangerous in legitimizing inequality

B. Perfect and flawed

C. Ancient and modern

D. Popular and unpopular

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21. SAT scores correlating with family income demonstrates that:

A. Rich families have genetically superior children

B. All tests should be eliminated

C. Income is irrelevant to test scores

D. Supposedly merit-based tests actually measure parental investment capacity

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22. The passage suggests that "merit hubris" causes successful people to:

A. Be generous to the disadvantaged

B. Discount luck and privilege, attributing success solely to personal qualities

C. Support redistributive policies

D. Recognize structural advantages

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23. The defense that "true meritocracy would equalize opportunity" fails because:

A. Opportunity is already perfectly equal

B. No one cares about opportunity

C. Perfect equality of opportunity is impossible and wouldn't solve the legitimization problem

D. Opportunity doesn't matter

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24. The author's alternative to meritocracy would involve:

A. Decoupling dignity and security from competitive achievement while still selecting for specialized roles

B. Eliminating all distinctions between people

C. Preventing anyone from developing skills

D. Random selection for all positions

PASSAGE 5: The Ethics of Cultural Appropriation

Cultural appropriation—adopting elements of a culture by members of another culture—generates intense debate. Critics argue it constitutes exploitation and disrespect. Defenders claim it represents cultural exchange and appreciation. Neither position fully captures the complexity.

The harm in cultural appropriation isn't the act of adoption itself but contextual factors. When dominant groups adopt marginalized cultures' practices while those cultures face discrimination for the same practices, appropriation compounds injustice. White celebrities wearing cornrows are praised as edgy; Black people with natural hairstyles face workplace discrimination. This asymmetry isn't about hair but about power.

Similarly, when sacred or culturally significant items become fashion accessories, it can constitute disrespect. A war bonnet is not simply aesthetically interesting—it carries specific meaning within Native American traditions. Wearing it for a music festival trivializes that significance. The harm isn't that non-Native people "touched" Native culture but that they treated sacred items as props.

Economic factors matter too. When corporations profit from cultural elements while members of the originating culture receive nothing—or when those members are excluded from such commercialization—appropriation involves material exploitation, not just symbolic harm.

Yet the concept of appropriation has limits. Culture isn't property. No group owns musical styles, foods, or aesthetic traditions. Human culture has always involved mixing, borrowing, and synthesis. Jazz emerged from African, European, and American musical traditions blending. Demanding cultural purity or prohibiting all cross-cultural influence would impoverish everyone.

Moreover, who decides what constitutes inappropriate appropriation? Cultural communities are not monolithic. Some Native Americans object to non-Native people practicing smudging; others don't. Some Japanese Americans mind non-Japanese wearing kimonos; others celebrate it. Treating cultures as having single authorized representatives who can permit or forbid borrowing misrepresents cultural diversity.

Perhaps we should distinguish between appropriation (harmful) and appreciation (beneficial). But this distinction is harder to maintain than it appears. One person's appreciation is another's appropriation. The same action might be both: yoga classes led by non-Indian instructors could represent both genuine spiritual engagement and commercial exploitation of South Asian traditions.

A more useful framework focuses on respect and reciprocity. Does the cultural borrowing show understanding of significance and context? Does it acknowledge sources? Does it occur in relationships of mutual exchange rather than one-way extraction? A white musician playing blues while acknowledging African American roots, studying the tradition seriously, and supporting Black musicians differs from superficial imitation that erases history.

This approach rejects both cultural protectionism and laissez-faire "everything is fair game" attitudes. It recognizes that cultural exchange involves ethics without requiring impossible boundaries. The question isn't whether cultures can influence each other—they inevitably will. The question is whether that influence shows respect for people, acknowledges power dynamics, and occurs within relationships of reciprocity rather than exploitation.

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25. The passage's main point is that:

A. Cultural appropriation's ethics depend on context, power dynamics, and reciprocity rather than borrowing itself

B. All cultural exchange should be prohibited

C. Cultural appropriation never causes harm

D. Only formal permission makes cultural borrowing acceptable

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26. The cornrows example illustrates that appropriation's harm involves:

A. The hairstyle itself being wrong

B. Any cross-cultural exchange

C. Power asymmetries where dominant groups are praised while marginalized groups are discriminated against for the same practices

D. All fashion choices

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27. According to the passage, treating cultures as having single authorized representatives is problematic because:

A. Cultures need dictators

B. Cultural communities are diverse with varying internal perspectives

C. Everyone agrees on cultural rules

D. Representatives are always right

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28. The distinction between "appropriation" and "appreciation" is described as:

A. Crystal clear and easy to apply

B. Unnecessary

C. Universally accepted

D. Difficult to maintain since the same action might be both

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29. The respect and reciprocity framework suggests cultural borrowing is more ethical when it:

A. Ignores sources and context

B. Occurs in one-way extraction relationships

C. Erases history

D. Acknowledges sources, shows understanding, and occurs in mutual exchange

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30. The author's position on cultural exchange is that:

A. It should never occur

B. It's inevitable and can be ethical without cultural protectionism

C. Power dynamics are irrelevant

D. All borrowing is equally harmful

PASSAGE 6: The Value of Negative Capability

Poet John Keats coined the phrase "negative capability" to describe the capacity to exist in "uncertainties, mysteries, doubts, without any irritable reaching after fact and reason." In an era obsessed with certainty, data, and answers, this concept deserves reconsideration.

Contemporary culture valorizes knowing. Expertise, confidence, and decisiveness are prized; ambiguity, uncertainty, and suspended judgment are interpreted as weakness. Political leaders who admit uncertainty are attacked as indecisive. Business culture demands quick pivots based on incomplete information. Academic careers reward definitive claims over exploratory thinking.

Yet many important domains require negative capability. Scientific discovery often begins with curiosity about anomalies rather than confirming hypotheses. The scientist who dismisses unexpected results to preserve theory misses breakthroughs. Einstein's willingness to question fundamental assumptions about space and time, enduring years without clear answers, enabled revolutionary insights impossible for those who needed immediate certainty.

Art similarly requires tolerance for ambiguity. Great novels embrace complexity, leaving interpretations open rather than resolving every question. Audiences uncomfortable with ambiguity demand simplified moral lessons, but this clarity comes at the cost of artistic depth. The same applies to film, music, and visual art—works that admit multiple interpretations often prove most enduring.

Ethical reasoning benefits from negative capability too. Moral dilemmas are dilemmas precisely because they involve genuine competing values without obviously correct resolutions. Rushing to judgment—the

"irritable reaching after fact and reason"—oversimplifies. Sitting with moral uncertainty, genuinely considering multiple perspectives without premature conclusions, may not yield comfortable answers but produces more nuanced understanding.

The push for certainty has psychological roots. Uncertainty generates anxiety; conclusive answers provide comfort. Studies show people prefer definitive bad news to uncertain potentially good news—they'd rather know for certain they have a disease than wait in ambiguity about possible health.

But this anxiety aversion carries costs. In complex systems, premature certainty leads to poor decisions. Leaders who demand immediate answers incentivize subordinates to provide confident-sounding but poorly-grounded recommendations. Investors who cannot tolerate uncertainty make reactive decisions during market volatility. Doctors who rush to diagnosis miss atypical presentations.

Cultivating negative capability doesn't mean abandoning critical thinking or settling for permanent agnosticism. It means developing comfort with provisional uncertainty during inquiry. Eventually, judgment must be made—experiments run, artworks completed, ethical stances taken. But the quality of these eventual conclusions depends on the willingness to dwell in uncertainty during exploration.

This has implications for education. Current pedagogical emphasis on definitive answers and testable facts may ill-prepare students for complex realities requiring judgment amid ambiguity. Teaching negative capability would involve rewarding thoughtful uncertainty, modeling how experts navigate unknown territory, and distinguishing between questions with clear answers and those requiring sustained engagement with complexity.

In polarized times, when everyone demands certainty and dismisses doubt as weakness, negative capability offers an alternative: the strength to withstand not knowing while continuing to think, question, and remain open to evidence and argument. This isn't indecisiveness but intellectual courage.

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31. According to the passage, contemporary culture interprets ambiguity and uncertainty as:

A. Valuable intellectual qualities

B. Necessary for all thinking

C. Strengths

D. Weakness or indecisiveness

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32. The Einstein example demonstrates that:

A. Certainty always leads to discovery

B. Questioning assumptions and tolerating uncertainty enables breakthroughs

C. Science doesn't require any conclusions

D. Uncertainty should be permanent

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33. The passage suggests that great novels often:

A. Resolve every interpretive question

B. Provide simple moral lessons

C. Embrace complexity and leave interpretations open

D. Avoid all ambiguity

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34. People preferring definitive bad news to uncertain potentially good news illustrates:

A. Psychological preference for certainty even when uncertainty might be better

B. Bad news is always preferable

C. Uncertainty causes no anxiety

D. Everyone loves ambiguity

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35. Cultivating negative capability means:

A. Never making any judgments

B. Abandoning critical thinking entirely

C. Settling for permanent agnosticism

D. Developing comfort with provisional uncertainty during inquiry

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36. The passage suggests education should:

A. Eliminate all definitive answers

B. Reward thoughtful uncertainty and teach navigation of ambiguity

C. Never teach facts

D. Discourage all questioning

PASSAGE 7: The Automation Anxiety Paradox

Automation anxiety—fear that machines will eliminate jobs—has accompanied every technological wave. Textile workers smashed looms in the 1810s. Economists in the 1960s predicted mass unemployment from computerization. Today, artificial intelligence renews these fears. Yet historically, technological progress has created more jobs than it destroyed. Does history reassure us, or is this time different?

Past transitions offer partial comfort. Yes, industrialization eliminated artisanal jobs, but factory work absorbed displaced workers and higher productivity enabled new industries. Computers destroyed typing pools but created software development, IT support, and digital marketing. Technology made some skills obsolete while increasing demand for others.

However, several factors suggest contemporary automation may differ. First, the pace has accelerated. Previous technological transitions unfolded over generations, allowing gradual workforce adaptation. Today's AI capabilities improve exponentially, compressing transition periods beyond human retraining capacity.

Second, the scope has broadened. Earlier automation targeted manual labor, then routine cognitive tasks. But machine learning now tackles non-routine cognitive work—medical diagnosis, legal research, even creative content generation. White-collar workers assumed they were insulated; they're not.

Third, the pattern has shifted. Previous technologies were tools enhancing human capabilities. Word processors made writers more productive; they didn't replace writers. But contemporary AI systems increasingly substitute for human labor rather than complementing it. Automated checkout replaces cashiers; algorithmic trading replaces traders.

Optimists argue that history shows us we can't predict what new jobs will emerge. Perhaps, but this argument has limits. That we cannot predict specific jobs doesn't mean job creation equals job destruction. The question isn't whether some new jobs appear but whether enough appear to employ everyone whose job was automated.

Moreover, job creation depends on distribution of productivity gains. If automation profits flow primarily to capital owners while workers' wages stagnate, increased productivity won't fund demand for new goods and services employing displaced workers. Without broad-based prosperity, automation produces unemployment, not transition.

Pessimists sometimes exaggerate, imagining imminent obsolescence of human labor. But humans retain advantages: adaptability, social intelligence, contextual judgment. Many valuable activities remain hard to automate: eldercare, teaching, plumbing, management. The question isn't whether humans become economically worthless but whether enough decent jobs exist for everyone.

Perhaps we're asking the wrong question. "Will automation destroy jobs?" assumes employment is the only or best way to distribute income. But if machines can produce abundance, maybe we should reconsider this assumption. Universal basic income, shorter workweeks, or job guarantees might distribute prosperity without requiring everyone to compete for shrinking employment.

This reframing is crucial. Automation creates genuine possibilities for human flourishing—liberation from dangerous or tedious work, material abundance, time for relationships and creativity. But realizing these possibilities requires intentional policy choices, not faith that markets automatically convert technological progress into shared prosperity.

The automation anxiety paradox is that we fear what could be liberation. We've organized society around employment scarcity; abundance threatens this organization. The challenge isn't technological but social: designing institutions that distribute prosperity in an age when human labor may no longer be scarce.

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37. The passage's central argument is that:

A. All automation is harmful

B. Automation anxiety suggests the need to reconsider distribution of prosperity rather than just job creation

C. Technology never creates jobs

D. Previous patterns guarantee future outcomes

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38. Contemporary automation may differ from past transitions because:

A. Technology never changes anything

B. All jobs are safe

C. Previous transitions were instantaneous

D. Pace has accelerated, scope broadened, and pattern shifted from complementing to substituting for human labor

39. The optimist argument that "we can't predict what new jobs will emerge" is limited because:

A. History is irrelevant

B. Job creation always exceeds destruction

C. New job creation is guaranteed

D. Unpredictability about specific jobs doesn't guarantee enough total jobs emerge

40. According to the passage, automation profits flowing primarily to capital owners would:

A. Automatically create new jobs

B. Guarantee shared prosperity

C. Mean increased productivity won't fund broad demand for new goods employing displaced workers

D. Have no economic effects

41. The passage suggests the fundamental question isn't whether humans become obsolete but:

A. Whether all humans must leave Earth

B. Whether enough decent jobs exist for everyone

C. Whether technology should stop

D. Whether work is ever valuable

42. The "automation anxiety paradox" refers to the fact that:

A. Anxiety is impossible

B. No one fears automation

C. Markets solve everything automatically

D. We fear what could be liberating because society is organized around employment scarcity

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PASSAGE 8: Memory and Identity

Personal identity—the sense of being the same person over time—seems intuitively obvious. I am the person who went to kindergarten decades ago, despite every cell in my body having been replaced. But what constitutes this continuity? Philosopher John Locke argued that psychological continuity, particularly memory, grounds personal identity.

Locke's memory theory has intuitive appeal. We trace our identity through remembered experiences. An amnesiac who retains no memories seems to have lost something essential to personal identity. Courts recognize this: defendants who genuinely don't remember their crimes are sometimes treated differently than those who do.

Yet memory is unreliable. We misremember, confabulate, and forget. If identity depends on accurate memory, then false memories—which feel subjectively identical to true ones—could establish identity with events that never occurred. A person with detailed false memories of fighting in Vietnam would, by Locke's criterion, be a Vietnam veteran despite never serving.

Moreover, we forget most of our lives. Do I cease to be identical with the person who experienced forgotten childhood moments? Locke would say that direct memory chains establish identity: I remember yesterday, yesterday-me remembered the day before, and so on back through childhood. But this raises the paradox of transitivity: if A=B and B=C, then A=C. Yet I might equal yesterday-me (who I remember) and yesterday-me equals childhood-me (who yesterday-me remembered), yet I don't equal childhood-me (who I can't remember). The transitivity of identity conflicts with memory's limitations.

Alternative theories avoid memory's problems but face their own difficulties. Physical continuity—being the same body—seems clear, but what makes a body the same? Not constituent matter, which constantly changes. Not appearance, which changes dramatically over a lifetime. Perhaps biological continuity—maintaining functional organization despite material replacement—grounds identity. But this fails for cases like split-brain patients or severe dementia, where psychological continuity fractures while biological continuity persists.

Narrative theories propose that identity is the ongoing story we tell about ourselves. We construct coherent narratives linking past, present, and anticipated future. This captures something important: identity is partly performative, created through storytelling. But it makes identity too malleable. Do I change identity every time I revise my self-narrative?

Perhaps the problem is assuming identity is singular and determinate. We might instead embrace multiple identity strands—biological, psychological, narrative, social—that usually coincide but sometimes diverge. In ordinary cases, this multiplicity goes unnoticed. Edge cases—amnesia, brain damage, split personalities—reveal the different strands can separate.

This pluralistic view has practical implications. Rather than insisting one criterion determines "real" identity in all cases, we'd recognize that different contexts privilege different aspects. For medical decisions, biological continuity matters; for moral responsibility, psychological continuity; for social relationships, narrative identity. This isn't relativism but appropriate recognition that identity is complex.

Such pluralism challenges legal systems premised on singular identity. Criminal responsibility assumes the defendant is identical with the person who committed the crime. But what if they differ psychologically (severe mental illness), narratively (complete repudiation), or even biologically (though this is rare)? Simpler theories give clear answers; pluralism demands nuanced judgment.

Perhaps that's a strength rather than weakness. Simple theories purchase clarity at the cost of adequacy. If identity is genuinely complex, theories should reflect that complexity. Living with identity's philosophical puzzles might be better than pretending they're solved.

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43. Locke's memory theory of personal identity faces problems because:

A. Memory is always perfectly accurate

B. Everyone remembers everything

C. Memory is unreliable, involving false memories and forgetting

D. Physical continuity is perfect

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44. The transitivity paradox demonstrates that:

A. Memory creates perfect identity chains

B. Forgetting creates logical problems if identity depends strictly on direct memory

C. Identity is simple

D. All memories are false

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45. Narrative theories propose that identity is:

A. Purely biological

B. Independent of storytelling

C. Fixed from birth

D. Constructed through ongoing stories linking past, present, and future

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46. The pluralistic view suggests that:

A. One criterion determines identity in all cases

B. Different contexts privilege different identity aspects (biological, psychological, narrative)

C. Identity doesn't exist

D. Identity is always singular

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47. According to the passage, pluralistic identity theories challenge legal systems because:

A. They provide perfectly clear answers

B. They ignore all complexity

C. They demand nuanced judgment about which identity strand matters in specific contexts

D. Legal systems don't care about identity

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48. The author suggests that identity theory's complexity is:

A. A weakness requiring simplification

B. Evidence identity doesn't exist

C. Irrelevant to practical questions

D. A strength reflecting genuine complexity rather than false clarity

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PASSAGE 9: The Architecture of Power

Buildings aren't ideologically neutral. Architecture embodies and communicates power relations. From ancient pyramids to modern corporate headquarters, built environments shape how people interact, move, and understand their social positions.

Consider courtrooms. Judges sit elevated on platforms; defendants below in docks or cages; spectators behind railings. This vertical hierarchy makes power visible: justice literally looks down on the accused. The formality—dark wood, solemn architecture, ceremonial procedures—produces gravity that informal spaces cannot. These design choices aren't accidental or purely aesthetic; they constitute power through spatial organization.

Urban planning similarly encodes hierarchies. Baron Haussmann's redesign of Paris under Napoleon III replaced medieval streets with broad boulevards. The official justification—improved hygiene and traffic flow—obscured political motivations: wide streets prevented barricade construction and enabled troop movement during uprisings. Beautiful architecture served political control.

Modern examples abound. Gated communities physically separate wealthy residents from surrounding populations, making economic segregation literal. Hostile architecture—benches with armrests preventing lying down, spikes under bridges—excludes homeless people from public spaces. These designs regulate behavior through environmental manipulation rather than explicit rules or force.

Yet architecture's power isn't total. People resist, subvert, and reimagine spaces. Skateboarding transforms architectural barriers into playgrounds. Street art reclaims corporate-dominated visual environments. Protest movements occupy spaces designed to prevent assembly. Users are not passive recipients of architectural power but creative agents.

Moreover, the same space can embody different meanings for different users. A shopping mall is commercial space designed to encourage consumption, but teenagers might experience it as social space for hanging out. Corporate plazas meant to project authority become sites for food trucks and lunch breaks. Intended meanings and actual uses often diverge.

Some architects embrace explicitly democratic design. Participatory planning involves future residents in design decisions. Public buildings with open layouts and accessible entrances symbolically claim that public institutions serve citizens rather than tower over them. These choices attempt to materialize egalitarian values through architectural form.

But can architecture truly democratize power, or does it merely aestheticize existing relations? A school with innovative open design still operates within hierarchies of teacher/student, administrator/subordinate. Making authority look friendly doesn't eliminate authority. Perhaps the most democratic architecture can do is avoid actively reinforcing hierarchies—creating neutral spaces rather than transformative ones.

Critics might say focusing on architecture overstates built environment's importance. Social, economic, and political structures matter more than spatial arrangements. But this critique understates how thoroughly spatial organization shapes behavior and consciousness. We don't simply inhabit space; space inhabits us, structuring possibilities for action and imagination.

Recognizing architecture's power enables more intentional choices. Instead of treating design as purely technical or aesthetic, we can ask: What social relations does this building assume and reproduce? Who does this space welcome or exclude? What possibilities does this arrangement enable or foreclose? These questions won't eliminate power from architecture—that's impossible—but they make power visible and potentially contestable.

---

49. The passage's main argument is that:

A. All architecture is evil

B. Buildings have no social meaning

C. Power is irrelevant to design

D. Architecture embodies and communicates power relations through spatial organization

---

50. Haussmann's Parisian boulevards example illustrates that:

A. Urban planning is always neutral

B. Design can serve political control while claiming aesthetic or practical justifications

C. Architecture never affects politics

D. All streets should be narrow

---

51. The passage suggests that architectural power is not total because:

A. Architecture doesn't affect anyone

B. Power is always absolute

C. Users resist, subvert, and reimagine spaces

D. Buildings lack any meaning

---

52. The question "Can architecture democratize power or merely aestheticize existing relations?" expresses concern that:

A. All buildings are equally oppressive

B. Making authority appear friendly doesn't eliminate hierarchical structures

C. Democracy is impossible

D. Architecture has no effects

---

53. The author concludes that recognizing architecture's power enables:

A. Elimination of all buildings

B. Ignoring all design choices

C. Pretending space doesn't matter

D. More intentional choices about what social relations buildings assume and reproduce

Time	Questions
95 minutes	59

PASSAGE 1: Glycolysis and Cellular Respiration Regulation

Glycolysis converts glucose to pyruvate, producing 2 ATP and 2 NADH per glucose molecule. Under aerobic conditions, pyruvate enters mitochondria for further oxidation. Under anaerobic conditions, pyruvate undergoes fermentation to regenerate NAD^+ for continued glycolysis.

Phosphofructokinase (PFK) catalyzes the rate-limiting step: fructose-6-phosphate + ATP → fructose-1,6-bisphosphate. PFK is allosterically regulated by cellular energy status. High ATP and citrate (indicating sufficient energy) inhibit PFK. High AMP and ADP (indicating energy depletion) activate PFK. This feedback ensures glycolysis responds to cellular needs.

The pyruvate dehydrogenase complex (PDC) links glycolysis to the citric acid cycle, converting pyruvate to acetyl-CoA. PDC is inhibited by its products (acetyl-CoA, NADH) and activated by its substrates (pyruvate, CoA, NAD^+). Insulin activates PDC via dephosphorylation; glucagon and epinephrine inhibit it via phosphorylation.

Experimental Results:

Condition 1: Normal aerobic metabolism

- Glucose consumption: 10 mmol/min
- Lactate production: 0.5 mmol/min
- ATP/ADP ratio: 10:1
- PFK activity: moderate

Condition 2: Intense exercise (anaerobic)

- Glucose consumption: 50 mmol/min
- Lactate production: 90 mmol/min
- ATP/ADP ratio: 3:1
- PFK activity: high (5× normal)
- AMP levels: increased 10-fold

Condition 3: Added citrate to cells

- PFK activity: decreased 70%
- Glucose consumption: decreased 60%

- ATP levels: remained high

Condition 4: Mitochondrial inhibitor (cyanide)

- Glycolysis rate: increased 3-fold
- Lactate production: increased 6-fold
- ATP production: decreased overall
- NAD^+/NADH ratio: decreased

Condition 5: Fasting state

- Glucagon elevated
- PDC phosphorylation: increased
- Pyruvate → acetyl-CoA: decreased
- Gluconeogenesis: active

---

1. During intense exercise, PFK activity increasing 5-fold occurs because:

A. ATP levels are too high

B. Decreased ATP/ADP ratio and elevated AMP relieve inhibition and activate PFK

C. Citrate activates PFK

D. Oxygen is abundant

---

2. Lactate production increasing during anaerobic exercise primarily serves to:

A. Produce additional ATP

B. Lower blood pH

C. Provide fuel for other tissues

D. Regenerate NAD^+ so glycolysis can continue

---

3. Citrate inhibiting PFK makes physiological sense because:

A. Citrate indicates the citric acid cycle is active and energy is sufficient

B. Citrate is toxic to cells

C. PFK produces citrate

D. Citrate increases ATP demand

---

4. Cyanide increasing glycolysis rate despite decreasing overall ATP demonstrates:

A. Cyanide activates glycolytic enzymes directly

B. Glycolysis is independent of cellular needs

C. Cells attempt to compensate for blocked oxidative phosphorylation by increasing glycolysis

D. Cyanide enhances mitochondrial function

---

5. In the fasting state, PDC phosphorylation increasing causes:

A. Increased conversion of pyruvate to acetyl-CoA

B. Decreased pyruvate → acetyl-CoA conversion, sparing glucose for the brain

C. Enhanced glycolysis

D. Lactate production

---

6. The observation that lactate production is minimal under normal aerobic conditions indicates:

A. Lactate fermentation never occurs

B. Cells lack lactate dehydrogenase

C. Glycolysis doesn't function aerobically

D. Pyruvate preferentially enters mitochondria when oxygen is available

---

PASSAGE 2: Hormone Signaling Mechanisms

Hormones are classified by chemical structure and mechanism of action. Lipid-soluble hormones (steroids, thyroid hormones) diffuse through membranes and bind intracellular receptors that act as transcription factors. Water-soluble hormones (peptides, catecholamines) bind cell-surface receptors, triggering intracellular signaling cascades.

Second messenger systems amplify hormone signals. The cAMP pathway: hormone binds G-protein-coupled receptor (GPCR) $\rightarrow$ G-protein activates adenylyl cyclase $\rightarrow$ cAMP produced $\rightarrow$ protein kinase A (PKA) activated $\rightarrow$ phosphorylates target proteins. The IP$_3$/DAG pathway: hormone binds GPCR $\rightarrow$ phospholipase C activated $\rightarrow$ PIP$_2$ cleaved to IP$_3$ and DAG $\rightarrow$ IP$_3$ releases Ca^{2+} from ER, DAG activates protein kinase C.

Insulin uses receptor tyrosine kinase (RTK) signaling. Insulin binding causes receptor autophosphorylation, activating downstream kinases that promote glucose uptake, glycogen synthesis, and protein synthesis.

Study Results:

Experiment 1: Cortisol (steroid) treatment

- Added to cells at time 0
- mRNA for glucose-6-phosphatase detected at 30 minutes
- Protein detected at 60 minutes
- Effect persists 12+ hours
- Blocked by actinomycin D (transcription inhibitor)
- Not blocked by cycloheximide in first 30 min

Experiment 2: Epinephrine (catecholamine) treatment

- Effect detectable within 30 seconds
- cAMP levels increased 10-fold
- PKA activity increased 8-fold
- Glycogen breakdown increased
- Blocked by propranolol (β-receptor antagonist)
- Effect lost within 5 minutes of hormone removal

Experiment 3: Vasopressin treatment

- Binds V1 receptor on smooth muscle
- IP$_3$ levels increased rapidly
- Intracellular Ca^{2+} increased from 100 nM to 1000 nM
- Smooth muscle contraction occurred
- Blocked by phospholipase C inhibitor

Experiment 4: Insulin resistance model

- Insulin receptor expression: normal

- Receptor autophosphorylation: reduced 70%
- Downstream kinase activation: reduced 80%
- Glucose uptake: reduced 60%

---

7. Cortisol's effects requiring 30-60 minutes and persisting for hours reflects:

A. Slow receptor binding

B. Immediate protein phosphorylation

C. Gene transcription and protein synthesis requirement for steroid hormone action

D. Second messenger activation

---

8. Epinephrine's rapid effects (seconds) compared to cortisol (minutes-hours) demonstrate that:

A. Cell-surface receptor signaling via second messengers is faster than intracellular receptor-mediated transcription

B. Cortisol is more potent

C. Epinephrine is lipid-soluble

D. Second messengers are slower than transcription

---

9. Actinomycin D blocking cortisol's effects confirms that:

A. Cortisol works through cell-surface receptors

B. No protein synthesis occurs

C. cAMP is involved

D. Cortisol requires transcription for its effects

---

10. Vasopressin causing smooth muscle contraction through IP₃ and Ca²⁺ shows that:

A. Vasopressin is a steroid

B. Ca^{2+} serves as a second messenger coupling receptor activation to cellular response

C. No G-proteins are involved

D. Transcription is required

---

11. The insulin resistance model showing normal receptor expression but reduced autophosphorylation suggests:

A. Receptor number is the only determinant of insulin action

B. Insulin is absent

C. Post-receptor signaling defects cause insulin resistance

D. Too many receptors are present

PASSAGE 3: Action Potentials and Neural Signaling

Action potentials are rapid, transient changes in membrane potential that propagate along axons. At rest, neurons maintain -70 mV due to K^+ leak channels and Na^+/K^+-ATPase (3 Na^+ out, 2 K^+ in). The action potential cycle includes: (1) depolarization as voltage-gated Na^+ channels open, (2) repolarization as Na^+ channels inactivate and K^+ channels open, (3) hyperpolarization as K^+ channels close slowly, (4) return to resting potential.

Myelination by oligodendrocytes (CNS) or Schwann cells (PNS) insulates axons, allowing saltatory conduction—action potentials "jump" between nodes of Ranvier where voltage-gated channels cluster. This increases conduction velocity and energy efficiency.

Absolute refractory period (Na^+ channels inactivated) prevents backward propagation. Relative refractory period (some Na^+ channels recovered, K^+ channels still open) requires stronger stimulus.

Experimental Data:

Neuron A: Unmyelinated, diameter 1 μm

- Conduction velocity: 2 m/s
- Action potential duration: 3 ms
- Energy consumption: high (continuous Na^+/K^+ pumping)

Neuron B: Myelinated, diameter 10 μm

- Conduction velocity: 100 m/s
- Action potential duration: 2 ms
- Action potentials only at nodes (every 1 mm)
- Energy consumption: lower

Experiment 1: Tetrodotoxin (TTX) application

- TTX blocks voltage-gated Na^+ channels
- Action potentials abolished
- Resting potential unchanged
- K^+ currents unaffected

Experiment 2: Demyelination model

- Removed myelin from 1 cm axon segment
- Conduction velocity decreased 50× in affected region
- Action potential failed to propagate past demyelinated segment in some trials
- Restored conduction when voltage-gated channels artificially inserted

Experiment 3: Increased extracellular K^+

- Normal: 5 mM K^+ outside, -70 mV resting
- Elevated: 10 mM K^+ outside, -60 mV resting
- Action potential threshold unchanged (-55 mV)
- Action potential amplitude decreased

---

12. Myelination increasing conduction velocity occurs because:

A. Saltatory conduction reduces the distance requiring active depolarization

B. Myelin blocks all ion channels

C. Action potentials travel slower

D. More Na^+ channels are expressed

---

13. TTX abolishing action potentials while preserving resting potential demonstrates that:

A. Resting potential depends on voltage-gated Na^+ channels

B. K^+ leak channels maintain resting potential

C. Voltage-gated Na^+ channels are necessary for action potential depolarization but not resting potential

D. TTX affects K^+ channels

---

14. Demyelinated segments failing to propagate action potentials occurs because:

A. All Na^+ channels are blocked

B. Insufficient voltage-gated channel density in demyelinated regions prevents regeneration of the action potential

C. K^+ channels are overexpressed

D. Conduction is faster without myelin

---

15. Elevated extracellular K^+ decreasing action potential amplitude despite unchanged threshold results from:

A. More negative resting potential increases driving force for Na^+

B. K^+ equilibrium potential becomes less negative

C. Na^+ channels are blocked

D. Smaller driving force for Na^+ influx when resting potential is less negative (closer to peak)

---

16. The absolute refractory period prevents:

A. Forward propagation of action potentials

B. Any stimulation

C. K^+ channel opening

D. Backward propagation because Na^+ channels in previously depolarized regions are inactivated

---

17. Saltatory conduction being more energy-efficient than continuous conduction occurs because:

A. Myelin requires no energy

B. More ions must cross the membrane

C. Na^+/K^+ pumps must restore gradients over smaller membrane area

D. Action potentials are weaker

PASSAGE 4: Immunity and Antibody Diversity

The adaptive immune system generates enormous antibody diversity from limited genes through V(D)J recombination. Heavy chain genes contain multiple V (variable), D (diversity), and J (joining) segments. Light chains contain V and J segments. During B cell development, RAG recombinases randomly select one segment from each category and join them, deleting intervening DNA.

Combinatorial diversity: If there are 50 V, 20 D, and 6 J segments for heavy chains and 40 V and 5 J segments for light chains, the number of possible combinations is (50×20×6) × (40×5) = 6,000 × 200 = 1,200,000 antibodies before additional diversification.

Junctional diversity adds/deletes nucleotides at junction sites during recombination, creating additional variation. Somatic hypermutation in germinal centers introduces point mutations in V regions, enabling affinity maturation—selection for higher-affinity antibodies during immune responses.

Class switching changes heavy chain constant regions (from IgM to IgG, IgA, or IgE) while preserving antigen specificity, allowing different effector functions.

Experimental Observations:

B cell development tracking:

- Pro-B cell: germline DNA, no recombination
- Pre-B cell: heavy chain rearranged (VDJ joined)
- Immature B cell: light chain rearranged, surface IgM expressed
- Mature B cell: expresses both IgM and IgD with identical V regions

Primary immune response (first antigen exposure):

- Day 0-5: no antibody detected
- Day 7: IgM appears, low affinity (Kd = 10^{-6} M)
- Day 10: IgM peaks

Secondary immune response (second exposure, day 30):

- Day 1: rapid antibody increase

- Day 3: predominantly IgG, high affinity (Kd = 10^{-9} M)
- Response 100× faster and stronger

RAG knockout mice:

- No V(D)J recombination
- No mature B or T cells
- Cannot produce antibodies
- Severe combined immunodeficiency (SCID)

Activation-induced deaminase (AID) knockout:

- Normal B cell development
- Primary antibody responses normal
- No class switching (IgM only)
- No somatic hypermutation
- No affinity maturation in secondary responses

---

18. The calculation showing 1,200,000 possible antibody combinations demonstrates:

A. Few antibodies can be made

B. Genes for each antibody are separately encoded

C. Antibodies are not diverse

D. Combinatorial recombination generates extensive diversity from limited genetic elements

---

19. Secondary responses showing IgG instead of IgM with same antigen specificity indicates:

A. Different B cells recognized different antigens

B. Class switching changed constant regions while preserving V region specificity

C. IgM was never produced

D. Affinity decreased

---

20. Affinity increasing 1000-fold (10^{-6} to 10^{-9} M) between primary and secondary responses results from:

A. Producing more of the same antibody

B. Different antigens

C. Somatic hypermutation and selection for higher-affinity variants

D. Decreased antibody production

---

21. RAG knockout mice lacking B and T cells demonstrates that:

A. RAG is unnecessary

B. V(D)J recombination by RAG is essential for lymphocyte development

C. Antibodies form without recombination

D. Only T cells require RAG

---

22. AID knockout mice showing normal primary responses but no class switching or affinity maturation indicates:

A. AID is required for B cell development

B. Primary antibody production is impossible

C. V(D)J recombination requires AID

D. AID mediates class switching and somatic hypermutation but not initial recombination

---

PASSAGE 5: Photosynthesis and Carbon Fixation

Photosynthesis converts light energy to chemical energy in two stages. Light reactions (thylakoid membrane) capture light energy, splitting water to release O_2, and producing ATP and NADPH. Dark reactions (Calvin cycle, stroma) use ATP and NADPH to fix CO_2 into glucose.

The Calvin cycle has three phases: (1) Carbon fixation—RuBisCO adds CO_2 to ribulose-1,5-bisphosphate (RuBP), forming two 3-phosphoglycerate (3-PGA) molecules. (2) Reduction—3-PGA reduced to glyceraldehyde-3-phosphate (G3P) using ATP and NADPH. (3) Regeneration—G3P molecules rearranged to regenerate RuBP.

C4 plants (corn, sugarcane) use spatial separation. Mesophyll cells fix CO_2 to phosphoenolpyruvate (PEP), forming 4-carbon oxaloacetate. This moves to bundle sheath cells where CO_2 is released for the Calvin cycle. This concentrates CO_2 around RuBisCO, reducing photorespiration.

CAM plants (cacti, pineapple) use temporal separation. At night, stomata open and CO_2 is fixed to malate. During day, stomata close (conserving water), and malate releases CO_2 for the Calvin cycle.

Experimental Results:

Experiment 1: Light intensity effects

- Low light (100 μmol photons/m²/s): Rate-limited by light, not CO_2
- Saturating light (1000 μmol/m²/s): Rate-limited by CO_2 at normal concentrations
- Adding more light above saturation: no additional photosynthesis increase

Experiment 2: CO_2 enrichment

- Normal CO_2 (400 ppm): standard photosynthesis rate
- Elevated CO_2 (1000 ppm): 40% increase in photosynthesis
- Effect larger in C3 plants than C4 plants

Experiment 3: Temperature effects

- C3 plants (wheat): Optimal temperature 25°C
- C4 plants (corn): Optimal temperature 35°C
- C4 plants maintain higher rates at elevated temperature

Experiment 4: Photorespiration measurement

- Low CO_2, high O_2: RuBisCO fixes O_2 instead of CO_2
- Produces phosphoglycolate (2-carbon compound)
- No ATP or NADPH generated
- Wastes energy
- C4 plants show 10× less photorespiration than C3

Experiment 5: CAM plant water loss

- Stomata open at night (cooler, higher humidity)
- Water loss: 1/10th of C3 plants in same environment
- CO_2 fixed into malate at night
- Day: stomata closed, malate decarboxylated

---

23. C4 plants showing smaller responses to CO_2 enrichment than C3 plants indicates:

A. C4 plants don't perform photosynthesis

B. C4 CO_2-concentrating mechanism already reduces CO_2 limitation

C. C3 plants are superior in all environments

D. CO_2 is toxic to C4 plants

---

24. Photorespiration occurring at low CO_2 and high O_2 results from:

A. RuBisCO's absolute specificity for CO_2

B. Perfect enzyme function

C. Water availability

D. RuBisCO catalyzing oxygenase reaction with O_2 when CO_2/O_2 ratio is low

---

25. CAM plants opening stomata at night conserves water because:

A. No CO_2 is needed

B. Photosynthesis occurs at night

C. Stomata never need to open

D. Night has lower temperature and higher humidity, reducing transpiration

---

26. Light saturation showing no additional photosynthesis increase with more light indicates:

A. Plants reject extra light

B. Light is never limiting

C. Dark reactions (Calvin cycle) become rate-limiting

D. Light reactions stop completely

---

27. For every 3 CO₂ fixed, one G3P can be exported for glucose synthesis while:

A. All G3P leaves the cycle

B. Five G3P molecules must be used to regenerate 3 RuBP

C. No regeneration occurs

D. RuBP is imported

---

28. C4 plants maintaining higher photosynthesis at elevated temperatures occurs because:

A. Temperature has no effect on enzymes

B. C3 plants lack all heat tolerance

C. Calvin cycle doesn't function above 25°C

D. CO_2-concentrating mechanism reduces photorespiration despite increased RuBisCO oxygenase activity at high temperature

---

PASSAGE 6: Gene Expression Regulation in Eukaryotes

Eukaryotic gene expression is regulated at multiple levels: transcriptional control (most important), RNA processing, RNA stability, translational control, and post-translational modification.

Transcriptional regulation involves transcription factors binding regulatory sequences. Enhancers can be thousands of base pairs from promoters; DNA looping brings them into proximity. Chromatin structure affects accessibility: acetylated histones (open chromatin) allow transcription; methylated histones (closed chromatin) suppress it.

The lac operon demonstrates prokaryotic regulation. In the absence of lactose, the lac repressor binds the operator, blocking transcription. Lactose (allolactose) binds the repressor, causing conformational change and release, allowing transcription. Glucose presence decreases cAMP levels; without cAMP-CAP complex, transcription remains low even with lactose present (catabolite repression).

Alternative splicing generates multiple proteins from one gene. Different exon combinations create protein variants with distinct functions, tissue distributions, or regulatory properties.

Experimental Data:

Experiment 1: Histone modifications

- Histone acetyltransferase (HAT) treatment: increased gene transcription 10-fold
- Histone deacetylase (HDAC) treatment: decreased transcription 20-fold
- DNA methylation at promoter: gene silenced
- Chromatin immunoprecipitation shows acetylated histones at active genes

Experiment 2: Glucocorticoid receptor (GR)

- Hormone absent: GR in cytoplasm, target genes inactive
- Hormone added: GR translocates to nucleus, binds glucocorticoid response elements (GREs)
- Transcription of target genes activated within 30 minutes
- Blocked by DNA-binding domain mutation

Experiment 3: lac operon

- No glucose, no lactose: minimal transcription (repressor bound)
- No glucose, + lactose: high transcription (repressor released, CAP-cAMP bound)
    -
        - Glucose, + lactose: low transcription (repressor released but CAP-cAMP absent)

Experiment 4: Alternative splicing of tropomyosin

- Smooth muscle: exons 2, 3, 5, 8, 9 included
- Striated muscle: exons 1, 4, 6, 7, 9 included
- Fibroblasts: exons 1, 2, 5, 7, 9 included
- Same gene produces tissue-specific proteins

Experiment 5: MicroRNA regulation

- miRNA complementary to target mRNA 3' UTR
- Translation of target protein decreased 80%
- mRNA stability decreased (50% half-life)
- No effect on transcription rate

---

29. Histone acetylation increasing transcription occurs because:

A. Acetylation increases positive charge, strengthening DNA-histone interaction

B. Acetylated histones bind DNA more tightly

C. Transcription is inhibited

D. Acetylation neutralizes positive charges, loosening DNA-histone interaction and opening chromatin

---

30. The lac operon showing low transcription with both glucose and lactose present demonstrates:

A. Lactose is unnecessary

B. Repressor is always bound

C. Catabolite repression—glucose lowers cAMP, reducing CAP-cAMP activation even when repressor is released

D. Maximum transcription occurs

---

31. Glucocorticoid receptor requiring hormone for nuclear translocation shows that:

A. All transcription factors are always nuclear

B. Receptors are permanently active

C. The receptor acts as a ligand-dependent transcription factor

D. Hormone is unnecessary for gene regulation

---

32. Alternative splicing of tropomyosin producing tissue-specific proteins demonstrates:

A. Different genes encode each tropomyosin variant

B. One gene can generate multiple protein isoforms through differential exon inclusion

C. Transcription varies between tissues

D. All tissues produce identical proteins

---

33. MicroRNA decreasing protein levels without affecting transcription rate indicates:

A. Post-transcriptional regulation through mRNA stability and translation

B. Transcriptional repression

C. DNA methylation

D. Histone modification

PASSAGE 7: Kidney Function and Acid-Base Balance

Kidneys regulate fluid volume, electrolyte balance, and acid-base status. Each nephron filters blood (glomerulus), reabsorbs needed substances (proximal tubule, loop of Henle, distal tubule), and secretes wastes (collecting duct).

Proximal tubule reabsorbs 65% of filtered Na^+, water, glucose, amino acids, and HCO_3^-. The loop of Henle creates medullary osmotic gradient via countercurrent multiplication. Thick ascending limb actively transports Na^+, K^+, $2Cl^-$ without water reabsorption, diluting tubular fluid.

Acid-base regulation involves three systems: (1) Chemical buffers (bicarbonate, proteins, phosphate) act immediately. (2) Respiratory compensation adjusts CO_2 within minutes-hours. (3) Renal compensation adjusts HCO_3^- over days.

The Henderson-Hasselbalch equation: $pH = 6.1 + \log([HCO_3^-]/0.03 \times PCO_2)$. Normal: pH 7.4, $HCO_3^- = 24$ mEq/L, $PCO_2 = 40$ mmHg.

Acidosis: pH < 7.35. Respiratory acidosis ($\uparrow PCO_2$): hypoventilation. Metabolic acidosis ($\downarrow HCO_3^-$): diarrhea, kidney failure, diabetic ketoacidosis. Alkalosis: pH > 7.45. Respiratory alkalosis ($\downarrow PCO_2$): hyperventilation. Metabolic alkalosis ($\uparrow HCO_3^-$): vomiting, diuretics.

Clinical Cases:

Patient A: Diabetic ketoacidosis

- pH: 7.20 (acidosis)
- HCO_3^-: 12 mEq/L (low)
- PCO_2: 25 mmHg (low)
- Anion gap: elevated
- Ketones in blood and urine
- Breathing: deep and rapid (Kussmaul)

Patient B: COPD exacerbation

- pH: 7.28 (acidosis)
- HCO_3^-: 32 mEq/L (high)
- PCO_2: 65 mmHg (high)
- Breathing: shallow, labored
- Chronic condition: kidneys retained HCO_3^-

Patient C: Severe vomiting

- pH: 7.52 (alkalosis)
- HCO_3^-: 38 mEq/L (high)

- PCO_2: 48 mmHg (slightly elevated)
- Lost gastric H^+ and Cl^-

Patient D: Anxiety attack

- pH: 7.50 (alkalosis)
- HCO_3^-: 24 mEq/L (normal)
- PCO_2: 28 mmHg (low)
- Hyperventilating
- Acute onset

Drug study: Loop diuretic (furosemide)

- Blocks Na^+-K^+-$2Cl^-$ transporter in thick ascending limb
- Urine output: increased 5-fold
- Urine dilution: impaired
- Na^+ excretion: increased
- Medullary gradient: disrupted

---

34. Patient A's low PCO_2 (25 mmHg) despite metabolic acidosis represents:

A. Respiratory acidosis causing metabolic compensation

B. No compensation

C. Respiratory compensation (hyperventilation) for metabolic acidosis

D. Normal breathing

---

35. Patient B's elevated HCO_3^- (32 mEq/L) indicates:

A. Metabolic alkalosis caused the problem

B. Renal compensation attempting to raise pH by retaining HCO_3^- in chronic respiratory acidosis

C. Kidneys are not functioning

D. No compensation occurred

---

36. Loop diuretics impairing urine concentration ability occurs because:

A. Water reabsorption increases

B. More Na^+ is reabsorbed

C. Medullary osmotic gradient is maintained

D. Blocking Na^+-K^+-$2Cl^-$ transport prevents medullary gradient formation

---

37. Patient D showing alkalosis with normal HCO_3^- but low PCO_2 indicates:

A. Metabolic alkalosis

B. Respiratory alkalosis from hyperventilation

C. Metabolic acidosis

D. Normal acid-base status

---

38. The kidneys contributing to long-term acid-base balance by:

A. Responding within seconds

B. Only affecting CO_2

C. Adjusting HCO_3^- reabsorption and H^+ secretion over days

D. Having no role in pH regulation

PASSAGE 8: DNA Replication and Cell Cycle

DNA replication is semiconservative—each strand serves as a template. Replication begins at origins where helicase unwinds DNA. DNA polymerase synthesizes new strands 5'→3', requiring primers from primase. Leading strand synthesis is continuous; lagging strand is discontinuous (Okazaki fragments).

DNA polymerase III (prokaryotes) or polymerase δ/ε (eukaryotes) have 3'→5' exonuclease activity for proofreading. DNA polymerase I removes RNA primers and fills gaps. DNA ligase joins fragments.

The cell cycle includes G1 (growth), S (DNA synthesis), G2 (preparation), and M (mitosis). Cyclins and cyclin-dependent kinases (CDKs) regulate transitions. Checkpoints ensure proper completion: G1

checkpoint (cell size, nutrients, DNA damage), G2 checkpoint (DNA replication completion, damage), M checkpoint (spindle attachment).

p53 is a tumor suppressor activated by DNA damage, halting the cycle at G1 to allow repair or triggering apoptosis if damage is severe. Loss of p53 function allows damaged cells to divide, contributing to cancer.

Experimental Results:

Meselson-Stahl experiment (semiconservative replication):

- Generation 0: DNA in ^{15}N (heavy)
- Generation 1: DNA in ^{14}N, all hybrid density (one heavy, one light strand)
- Generation 2: 50% hybrid, 50% light
- Confirms semiconservative model

DNA polymerase fidelity study:

- Without proofreading: error rate 10^{-5} (1 per 100,000 bases)
- With 3'→5' exonuclease: error rate 10^{-7} (1 per 10 million)
- Proofreading reduces errors 100-fold

Cell cycle with DNA damage:

- Normal cells: arrest at G1 checkpoint, p53 activated
- DNA repaired: cycle resumes
- Irreparable damage: apoptosis triggered
- p53-deficient cells: bypass checkpoint, continue with damaged DNA

Cyclins and CDKs:

- G1/S cyclins accumulate in G1, peak at G1/S transition
- CDK activation triggers S phase entry
- M cyclins accumulate during S/G2, peak at M
- Cyclin degradation allows exit from M

Replication fork study:

- Leading strand: continuous synthesis, one primer
- Lagging strand: 1000-2000 nucleotide Okazaki fragments, multiple primers
- Fragments joined after primer removal and gap filling

---

39. The Meselson-Stahl results showing all hybrid density DNA after one replication cycle proves:

A. Conservative replication (both strands remain together)

B. Dispersive replication

C. No replication occurred

D. Semiconservative replication (each new DNA has one old and one new strand)

---

40. DNA polymerase 3'→5' exonuclease activity reducing errors occurs because:

A. It synthesizes DNA faster

B. It removes incorrectly paired nucleotides from the 3' end

C. It works in 5'→3' direction

D. Proofreading is impossible

---

41. p53-deficient cells continuing through the cell cycle despite DNA damage demonstrates:

A. p53 is unnecessary

B. DNA damage doesn't matter

C. p53 functions as a checkpoint guardian, and its loss allows damaged cells to proliferate

D. All cells have perfect DNA

---

42. Lagging strand requiring multiple primers and producing Okazaki fragments occurs because:

A. DNA polymerase synthesizes 5'→3' but the template is antiparallel

B. Leading strand is slower

C. DNA polymerase works in both directions

D. Primers are not needed

---

43. Cyclin degradation at the end of M phase is necessary to:

A. Keep cells permanently in mitosis

B. Prevent replication

C. Increase CDK activity

D. Allow exit from mitosis and return to G1

---

44. G1 checkpoint arrest in response to DNA damage allows:

A. Immediate cell division

B. DNA repair or apoptosis if damage is irreparable

C. Continued cycling with damage

D. No cellular response

DISCRETE QUESTIONS (45-59)

45. Which class of biological molecules provides the most energy per gram when oxidized?

A. Proteins

B. Carbohydrates

C. Lipids

D. Nucleic acids

---

46. The lock-and-key model of enzyme-substrate interaction suggests:

A. Enzymes have rigid active sites complementary to substrates

B. Substrates never bind

C. All enzymes are identical

D. No specificity exists

---

47. In the electron transport chain, the final electron acceptor is:

A. NAD$^+$

B. FADH$_2$

C. Cytochrome c

D. Oxygen (O$_2$)

---

48. Nondisjunction during meiosis I results in:

A. Normal gamete formation

B. Gametes with extra or missing chromosomes

C. No gamete production

D. Identical twins

---

49. The blood-brain barrier is formed primarily by:

A. Neurons

B. Loose capillary walls

C. Tight junctions between endothelial cells

D. Cerebrospinal fluid

---

50. In the sliding filament theory, ATP is required for:

A. Myosin-actin detachment

B. Calcium binding only

C. Passive muscle relaxation

D. Action potential generation

---

51. Telomeres shorten with each cell division because:

A. DNA polymerase extends them

B. RNA primers are added

C. Helicase is overactive

D. DNA polymerase cannot replicate the extreme 5' ends of linear chromosomes

---

52. The sinoatrial (SA) node serves as the heart's pacemaker because:

A. It contracts most forcefully

B. It spontaneously depolarizes faster than other cardiac cells

C. It receives the most blood

D. It is the largest structure

---

53. In a pedigree, a trait appearing in every generation with affected fathers passing it to all daughters but no sons suggests:

A. Autosomal dominant inheritance

B. Autosomal recessive inheritance

C. X-linked dominant inheritance

D. Y-linked inheritance

---

54. Sickle cell anemia results from:

A. Chromosomal translocation

B. A point mutation (Glu→Val) in the β-globin gene

C. Gene duplication

D. Viral insertion

---

55. Competitive inhibitors of enzymes:

A. Bind irreversibly

B. Bind allosteric sites

C. Cannot be overcome by substrate

D. Increase apparent Km without changing Vmax

---

56. The sodium-potassium pump (Na⁺/K⁺-ATPase):

A. Transports 2 Na$^+$ out and 3 K$^+$ in

B. Requires no energy

C. Facilitates passive diffusion

D. Transports 3 Na$^+$ out and 2 K$^+$ in using ATP

---

57. Eutrophication of aquatic ecosystems results from:

A. Decreased nutrient input

B. Excess nitrogen and phosphorus causing algal blooms

C. Reduced sunlight

D. Cold temperatures

---

58. The thyroid gland requires which element to synthesize thyroid hormones?

A. Iodine

B. Iron

C. Calcium

D. Zinc

---

59. In operant conditioning, negative reinforcement:

A. Punishes behavior

B. Has no effect

C. Weakens responses

D. Strengthens behavior by removing an aversive stimulus

Psychological, Social, and Biological Foundations of Behavior

Time	Questions
95 minutes	59

PASSAGE 1: Dopamine and Reward Processing

Dopamine is a neurotransmitter critical for reward processing, motivation, and motor control. The mesolimbic pathway projects from the ventral tegmental area (VTA) to the nucleus accumbens and is central to reward and reinforcement. The mesocortical pathway connects VTA to prefrontal cortex, influencing executive function and decision-making. The nigrostriatal pathway links substantia nigra to striatum, controlling movement.

Reward prediction error theory proposes that dopamine signals the difference between expected and actual rewards. When reward exceeds expectation, dopamine neurons increase firing (positive prediction error). When reward is less than expected, firing decreases (negative prediction error). With repeated pairing, dopamine response shifts from reward delivery to the predictive cue.

Substance use disorders involve dopamine dysregulation. Drugs of abuse (cocaine, amphetamine, opioids) increase dopamine signaling beyond natural rewards, creating powerful reinforcement. Chronic use leads to tolerance (requiring more drug for same effect) and dependence (withdrawal symptoms when drug is absent).

Experimental Studies:

Study 1: Classical conditioning in rats

- Training: Tone → food reward
- Day 1: Dopamine spike at food delivery
- Day 10: Dopamine spike shifted to tone onset, reduced response at food
- Unexpected food omission: Dopamine decrease at expected food time

Study 2: Drug effects on dopamine

- Baseline: 100% dopamine release
- Cocaine administration: 300% dopamine increase in nucleus accumbens
- Food reward: 150% dopamine increase
- Chronic cocaine (2 weeks): Required 2× dose for same dopamine effect (tolerance)

Study 3: Parkinson's disease

- Degeneration of nigrostriatal pathway
- Dopamine neurons in substantia nigra lost (>80%)
- Symptoms: tremor, rigidity, bradykinesia (slow movement)
- L-DOPA treatment: Dopamine precursor crosses blood-brain barrier, converted to dopamine
- Motor symptoms improved but executive deficits persisted

Study 4: Gambling task with fMRI

- Expected win ($10): Moderate nucleus accumbens activation
- Unexpected win ($50): Strong activation
- Expected win that didn't occur ($0): Decreased activation below baseline
- Loss aversion: Losses activated amygdala more than equivalent gains activated nucleus accumbens

---

1. Dopamine response shifting from food to tone after repeated pairings demonstrates:

A. Learning transfers reward signaling from outcomes to predictive cues

B. Conditioned stimuli gradually replace unconditioned reward value

C. Food rewards lose their biological significance through habituation

D. Tone presentation becomes the primary reinforcement mechanism

---

2. Cocaine producing greater dopamine increases than natural rewards explains:

A. Enhanced neuroplasticity in reward learning circuits over time

B. Competitive binding advantages at dopamine transporter sites

C. Supranormal reinforcement creating stronger behavioral conditioning

D. Differential activation patterns in ventral versus dorsal striatum

---

3. Tolerance to cocaine requiring higher doses for the same effect results from:

A. Receptor upregulation compensating for excessive stimulation

B. Adaptive changes reducing dopamine signaling efficiency

C. Metabolic enzyme induction increasing drug clearance rates

D. Homeostatic mechanisms counteracting sustained receptor activation

---

4. L-DOPA improving motor symptoms but not executive deficits in Parkinson's suggests:

A. Blood-brain barrier permeability varies across brain regions

B. Motor cortex shows greater neuroplasticity than frontal areas

C. Executive functions rely primarily on serotonergic modulation

D. Movement and cognition involve distinct dopaminergic pathways

---

5. Loss aversion (losses activating amygdala more than equivalent gains activate reward areas) indicates:

A. Negative outcomes produce stronger emotional responses than positive ones

B. Amygdala activation suppresses nucleus accumbens reward processing

C. Loss processing engages more neural circuits than gain processing

D. Evolutionary pressures shaped asymmetric valuation of outcomes

---

6. The mesolimbic pathway's role in reward processing suggests that nucleus accumbens dysfunction might contribute to:

A. Impaired spatial navigation and memory consolidation deficits

B. Disrupted circadian rhythms and sleep-wake cycle abnormalities

C. Reduced pleasure experience in depressive disorders

D. Enhanced susceptibility to visual hallucinations and illusions

---

PASSAGE 2: Social Identity Theory and Intergroup Behavior

Social identity theory proposes that individuals derive self-concept partially from group memberships. People categorize themselves and others into social groups (social categorization), identify with in-groups (social identification), and compare in-groups favorably to out-groups (social comparison). This process enhances self-esteem but can generate intergroup bias.

Minimal group paradigm studies demonstrate that even arbitrary, meaningless group distinctions create in-group favoritism. Participants randomly assigned to "overestimators" or "underestimators" (based on dot estimation) show preference for in-group members in resource allocation despite knowing assignment was random.

In-group favoritism doesn't always require out-group hostility, but realistic group conflict theory proposes that competition for limited resources intensifies intergroup conflict. When groups compete for zero-sum resources (one group's gain is another's loss), prejudice and discrimination increase.

Self-categorization theory extends social identity theory, proposing that social contexts determine which identity becomes salient. A person might identify as "student" in academic contexts, "athlete" in sports contexts, and "American" in international contexts. Salient identities shape perception, emotion, and behavior.

Research Findings:

Study 1: Minimal group paradigm

- Participants randomly assigned to "Group A" or "Group B"
- Resource allocation task: distribute points between two anonymous people
- Results: Allocated 12 points to in-group member, 8 to out-group member (even when fairness option was 10/10)
- Effect persisted despite emphasizing random assignment

Study 2: Robbers Cave experiment

- Phase 1 (Group formation): Two groups of boys (Eagles, Rattlers) separately bonded
- Phase 2 (Competition): Introduced zero-sum competitions (only one group could win prizes)
- Results: Hostility emerged—name-calling, sabotage, refused to eat together
- Phase 3 (Cooperation): Introduced superordinate goals requiring intergroup cooperation (fixing water supply, pooling money for movie)
- Results: Hostility decreased, friendships formed across groups

Study 3: Social identity threat

- Women reminded of gender before math test: Lower scores than control group
- Stereotype threat activated: fear of confirming negative stereotypes
- Women in female-majority testing environment: Scores equal to men
- Black students told test was "diagnostic of intelligence": Underperformance
- Told test was "problem-solving exercise": Performance equal to white students

Study 4: Cross-categorization

- Participants categorized on two dimensions: University (A vs. B) and Major (Science vs. Humanities)
- In-group on both dimensions: Most positive evaluation
- Out-group on both dimensions: Most negative evaluation
- Mixed (in-group on one, out-group on other): Intermediate evaluation
- Cross-cutting categories reduced bias compared to single categorization

---

7. Minimal group paradigm showing in-group favoritism despite random assignment demonstrates:

A. Self-esteem maintenance requires differentiating one's group positively

B. Resource scarcity activates competitive allocation strategies

C. Prior socialization experiences transfer to novel group contexts

D. Categorization alone triggers preferential in-group treatment

---

8. Robbers Cave hostility decreasing after introducing superordinate goals supports:

A. Contact hypothesis predicting exposure reduces prejudice

B. Common objectives requiring cooperation reduce intergroup conflict

C. Competitive priming effects diminish over extended time periods

D. Group identity salience shifts with changing environmental demands

---

9. Stereotype threat reducing test performance when group identity is salient suggests:

A. Identity reminders decrease working memory capacity

B. Performance anxiety mediates the relationship independently

C. Salient stereotypes create self-fulfilling prophecy effects

D. Cognitive load from threat concerns impairs task performance

10. Cross-categorization reducing bias compared to single categorization indicates:

A. Multiple identities create cognitive complexity reducing stereotyping

B. Overlapping group memberships complicate categorical distinctions

C. Dual categorization activates conflicting evaluation schemas

D. Shared and distinct attributes balance attitude formation

---

11. Women performing equally to men in female-majority testing environments demonstrates:

A. Gender composition moderates performance through social facilitation

B. Numerical representation influences perceived competence norms

C. Same-gender contexts reduce social comparison pressures

D. Environmental cues shape identity salience affecting outcomes

---

PASSAGE 3: Sleep Architecture and Memory Consolidation

Sleep consists of alternating cycles of NREM (non-rapid eye movement) and REM (rapid eye movement) sleep. NREM includes three stages: N1 (transition), N2 (true sleep with sleep spindles and K-complexes), and N3 (slow-wave sleep with delta waves). REM features rapid eye movements, muscle atonia, vivid dreams, and EEG resembling waking.

Sleep architecture changes across the night. Early cycles contain more N3; later cycles have longer REM periods. A complete cycle lasts approximately 90 minutes.

Memory consolidation theory proposes that sleep strengthens memory traces. Declarative memories (facts, events) consolidate during slow-wave sleep through hippocampal-neocortical dialogue. Procedural memories (skills, habits) consolidate during REM sleep. Sleep spindles correlate with memory integration.

Sleep deprivation impairs cognitive function, emotional regulation, and physical health. Total deprivation causes attention lapses, mood disturbance, and eventually hallucinations. Chronic partial restriction accumulates deficits in alertness, working memory, and executive function.

Experimental Studies:

Study 1: Memory consolidation

- Participants learned word pairs (declarative) and mirror tracing task (procedural)
- Group 1 (Sleep): Tested after 8 hours overnight sleep
- Group 2 (Wake): Tested after 8 hours of daytime waking
- Group 3 (Nap with SWS): 90-minute nap with slow-wave sleep
- Group 4 (Nap with REM): 90-minute nap with REM sleep
- Results: Sleep group retained 85% of word pairs, wake group 60%
- Sleep group improved mirror tracing 30%, wake group 5%
- SWS nap improved declarative (70% retention), minimal procedural improvement
- REM nap improved procedural (25% improvement), moderate declarative benefit

Study 2: Sleep deprivation effects

- Baseline: Reaction time 250 ms, working memory 7 items
- 24 hours awake: Reaction time 350 ms, working memory 5 items
- 48 hours awake: Reaction time 500 ms (with lapses), working memory 3 items, mood significantly depressed
- Recovery sleep (8 hours): Partial recovery—reaction time 280 ms, working memory 6 items
- Full recovery required multiple nights

Study 3: Sleep spindle density and learning

- Measured spindle density during N2 sleep
- High spindle density (>6/minute): 40% better retention on memory tasks
- Spindle density increased after intensive learning days
- Spindles temporally correlated with hippocampal ripples

Study 4: REM deprivation

- Participants awakened each time REM began (60 nights)
- REM pressure increased—REM attempts occurred more frequently
- Mood disturbances, irritability emerged
- Procedural learning impaired but declarative memory relatively preserved
- Upon recovery, REM rebound (extra REM)

---

12. Slow-wave sleep preferentially consolidating declarative memories while REM consolidates procedural memories suggests:

A. Memory types engage different neural reactivation patterns

B. Brain state oscillations selectively enhance memory categories

C. Consolidation mechanisms vary with memory content characteristics

D. Sleep stages provide distinct neurochemical environments

---

13. Sleep spindle density correlating with memory retention indicates:

A. Spindles facilitate hippocampal-cortical information transfer

B. Thalamic oscillations strengthen synaptic connections

C. Higher frequency rhythms enhance neural synchronization

D. Sleep quality markers predict cognitive outcomes

---

14. REM pressure increasing with successive deprivation attempts demonstrates:

A. Homeostatic mechanisms regulate sleep stage distribution

B. Circadian rhythms influence REM expression patterns

C. Sleep debt accumulates stage-specific recovery needs

D. Neurochemical depletion drives compensatory responses

---

15. Partial sleep deprivation requiring multiple recovery nights indicates:

A. Cognitive restoration follows nonlinear recovery trajectories

B. Sleep debt accumulates faster than repayment occurs

C. Neural damage from deprivation requires extended repair

D. Homeostatic processes restore functioning gradually

---

16. Declarative memory benefiting from sleep but not equal waking time suggests:

A. Active processing during sleep exceeds passive maintenance

B. Waking interference disrupts memory trace stabilization

C. Sleep-specific neural states facilitate memory reorganization

D. Circadian factors influence retention independent of time

---

17. Early sleep cycles containing more slow-wave sleep reflects:

A. Homeostatic sleep pressure peaks early in sleep periods

B. Temperature regulation prioritizes thermoregulatory processes initially

C. REM suppression mechanisms dissipate across the night

D. Ultradian rhythms phase-shift throughout sleep episodes

PASSAGE 4: Attribution Theory and Social Perception

Attribution theory examines how people explain behavior. Internal (dispositional) attributions locate causes within individuals (personality, ability, motivation). External (situational) attributions locate causes in circumstances (social pressure, luck, task difficulty).

The fundamental attribution error describes the tendency to overemphasize internal factors and underestimate situational influences when explaining others' behavior. This bias doesn't apply equally to self-explanations, where people often attribute their own failures to situations (self-serving bias) while crediting successes to internal factors.

Actor-observer bias reflects different perspectives: actors attribute their behavior to situations, while observers attribute the same behavior to dispositions. This arises from informational differences (actors know their intentions and constraints; observers see only behavior) and perceptual salience (actors focus outward on situations; observers focus on the actor).

Cultural differences affect attribution. Individualistic cultures (U.S., Western Europe) emphasize personal agency and make more internal attributions. Collectivistic cultures (East Asia, Latin America) emphasize social contexts and make more external attributions.

Attributional retraining can improve outcomes. Teaching students to attribute academic failures to controllable factors (insufficient effort, poor strategy) rather than uncontrollable factors (low ability) improves motivation and subsequent performance.

Research Findings:

Study 1: Fundamental attribution error

- Participants read essays favoring or opposing capital punishment
- Essay writers were told which position to argue (no choice)
- Participants rated writers' true attitudes
- Results: Participants inferred attitudes matching essay content despite knowing writers had no choice
- Effect persisted when participants themselves wrote assigned-position essays

Study 2: Actor-observer divergence

- Participants described why they chose their college major
- Situational factors: 60% (program reputation, job market, family influence)
- Dispositional factors: 40% (personal interest, ability)
- Observers explained the same person's choice:
- Situational factors: 30%
- Dispositional factors: 70% (personality fit, intelligence)

Study 3: Self-serving bias

- Students received success or failure feedback on novel task
- Success condition: 75% attributed to ability, 25% to luck
- Failure condition: 30% attributed to ability, 70% to bad luck or task difficulty
- Bias stronger when performance was public

Study 4: Cultural differences

- American and Japanese participants watched videos of social situations
- Americans: 80% internal attributions for behavior
- Japanese: 55% internal attributions, 45% situational
- Fish tank study: Americans focused on focal fish movement patterns
- Japanese described environmental context, fish interactions with surroundings

Study 5: Attributional retraining

- Struggling students randomly assigned to interventions
- Control group: Standard tutoring
- Experimental group: Tutoring + taught that effort and strategy (controllable) matter more than ability
- Follow-up: Experimental group showed 25% grade improvement, increased persistence
- Effect mediated by increased study time and help-seeking behavior

18. The fundamental attribution error occurring despite knowledge of situational constraints indicates:

A. Dispositional inferences occur automatically even with contradictory information

B. Situational awareness fails to override initial trait impressions

C. Cognitive heuristics simplify causal explanations by minimizing complexity

D. Perceptual focus on agents makes personal causes more salient

---

19. Actor-observer differences in attribution arise from:

A. Divergent information access about intentions and contexts

B. Perceptual salience differences between self and others

C. Motivational factors protecting self-esteem asymmetrically

D. Cognitive load variations between explaining self versus others

---

20. Self-serving bias being stronger when performance is public suggests:

A. Impression management motivates strategic causal explanations

B. Social evaluation increases ego-defensive attribution patterns

C. Audience presence activates self-protection mechanisms

D. Public contexts amplify need for competence signaling

---

21. Japanese participants making more situational attributions than Americans reflects:

A. Collectivist emphasis on interdependence and social harmony

B. Cultural socialization shaping perceptual attention patterns

C. Linguistic structures influencing causal reasoning frameworks

D. Different implicit theories about human behavior causes

22. Attributional retraining improving academic performance by teaching controllable attributions works because:

A. Perceived control over outcomes increases motivated effort

B. Effort attributions enhance self-efficacy for future tasks

C. Reframing failure as strategy deficit enables corrective action

D. Controllability beliefs reduce learned helplessness patterns

PASSAGE 5: Stress, Coping, and Health

Stress occurs when perceived demands exceed perceived resources. Stressors include major life events (death, divorce, job loss) and daily hassles (traffic, deadlines, conflicts). Chronic stress affects physical health through multiple pathways: immune suppression, cardiovascular strain, metabolic dysfunction, and accelerated cellular aging.

The hypothalamic-pituitary-adrenal (HPA) axis mediates stress responses. Perceived threats trigger hypothalamus to release CRH, stimulating pituitary ACTH release, which causes adrenal cortisol secretion. Cortisol mobilizes energy, suppresses non-essential functions, and modulates immune activity.

The sympathetic-adrenal-medullary (SAM) system provides immediate "fight-or-flight" responses. Sympathetic activation releases epinephrine and norepinephrine, increasing heart rate, blood pressure, and glucose availability.

Coping strategies fall into two categories: problem-focused (addressing the stressor directly) and emotion-focused (managing emotional reactions). Problem-focused coping works better for controllable stressors; emotion-focused for uncontrollable situations. Social support buffers stress effects through emotional, instrumental, and informational assistance.

The general adaptation syndrome describes stress response phases: alarm (initial activation), resistance (sustained coping), and exhaustion (resource depletion leading to illness).

Research Studies:

Study 1: Chronic stress and health

- Caregivers of Alzheimer's patients vs. matched controls
- Caregivers: 40% higher cortisol, 30% weaker antibody response to flu vaccine
- Wound healing: Caregivers 9 days slower than controls
- Telomere length: Caregivers showed accelerated shortening (equivalent to 10 years aging)

Study 2: Controllability and coping

- Participants exposed to unpredictable noise stressor
- Group 1 (Control): Button that stops noise if pressed correctly
- Group 2 (No control): Button doesn't work
- Group 3 (Perceived control): Button works but participants rarely used it
- Results: Groups 1 and 3 showed equal stress responses (low)
- Group 2: Elevated cortisol, impaired subsequent task performance
- Perceived control mattered more than actual control

Study 3: Social support and mortality

- 5-year longitudinal study, 3000 participants
- High social integration: 50% lower mortality risk
- Effect persisted controlling for baseline health, socioeconomic status
- Mechanisms: Better health behaviors, faster healthcare seeking, lower chronic inflammation

Study 4: Coping strategy effectiveness

- Students facing major exams (controllable) vs. serious family illness (uncontrollable)
- Exam context: Problem-focused coping associated with 30% less anxiety
- Illness context: Emotion-focused coping associated with better adjustment
- Mismatch (emotion-focused for exams, problem-focused for illness): Worse outcomes

Study 5: Acute stress and immune function

- Brief stress (public speaking, 10 minutes): Enhanced immune parameters temporarily
- Chronic stress (caregiving, months-years): Suppressed immunity
- Immune response: Acute stress redistributes cells to injury-prone areas
- Chronic stress: Sustained cortisol disrupts immune cell function, increases inflammation

---

23. Caregivers showing accelerated telomere shortening demonstrates:

A. Chronic stress produces measurable cellular aging markers

B. Psychological factors influence biological aging processes

C. HPA axis dysregulation affects genetic stability

D. Sustained cortisol exposure damages cellular structures

---

24. Perceived control reducing stress despite lack of actual control indicates:

A. Cognitive appraisal determines physiological stress responses

B. Belief in control activates parasympathetic calming systems

C. Subjective controllability modulates HPA axis activation

D. Psychological factors override objective environmental conditions

---

25. Social support reducing mortality through multiple mechanisms suggests:

A. Relationships provide direct physiological buffering effects

B. Behavioral pathways mediate stress-health relationships

C. Social integration creates redundant protective factors

D. Interpersonal resources operate through varied mechanisms

---

26. Problem-focused coping working better for controllable stressors reflects:

A. Active strategies match situations amenable to change

B. Cognitive resources apply effectively to modifiable problems

C. Controllability enables action-oriented responses

D. Coping effectiveness depends on stressor-strategy fit

---

27. Acute stress enhancing immunity while chronic stress suppresses it indicates:

A. Stress duration determines immune system effects

B. Adaptive responses become maladaptive with prolonged activation

C. Cortisol effects depend on exposure timeframe

D. Evolutionary pressures shaped short-term mobilization patterns

28. The general adaptation syndrome exhaustion phase occurring after prolonged stress results from:

A. Resource depletion from sustained coping efforts

B. Allostatic load accumulating across systems

C. HPA axis becoming hyporesponsive after chronic activation

D. Physiological reserves depleting with continuous demands

PASSAGE 6: Operant Conditioning and Behavior Modification

Operant conditioning shapes behavior through consequences. Reinforcement increases behavior frequency; punishment decreases it. Positive means adding stimuli; negative means removing stimuli. Thus, four contingencies exist: positive reinforcement (adding pleasant), negative reinforcement (removing unpleasant), positive punishment (adding unpleasant), and negative punishment (removing pleasant).

Reinforcement schedules determine response patterns. Continuous reinforcement (every response rewarded) produces rapid learning but fast extinction. Partial reinforcement produces slower learning but greater extinction resistance.

Partial schedules include: fixed ratio (reinforcement after set responses—produces high rates with post-reinforcement pauses), variable ratio (unpredictable number of responses—highest rates, greatest persistence), fixed interval (reinforcement after set time—produces scalloped patterns), and variable interval (unpredictable time—produces steady moderate rates).

Shaping develops complex behaviors through successive approximations—reinforcing progressively closer responses to target behavior. Chaining links simple behaviors into complex sequences.

Behavior modification applies operant principles to change behavior. Token economies reinforce desired behaviors with tokens exchangeable for rewards. Systematic desensitization uses counterconditioning to reduce anxiety.

Experimental Studies:

Study 1: Reinforcement schedules comparison

- Rats pressed levers under different schedules
- Continuous (CRF): 60 responses/hour, extinction after 5 minutes

- Fixed ratio 10 (FR-10): 120 responses/hour with pauses after reinforcement, extinction after 20 minutes
- Variable ratio 10 (VR-10): 200 responses/hour, no pauses, extinction after 60 minutes
- Fixed interval 30s (FI-30): 40 responses/hour, scalloped pattern
- Variable interval 30s (VI-30): 80 responses/hour, steady rate

Study 2: Shaping and extinction

- Pigeons trained to peck illuminated disc
- Shaping used: Reinforced facing disc → approaching → touching → pecking
- Training time: 20 minutes to establish consistent pecking
- Without shaping (waiting for spontaneous pecking): 6 hours
- Extinction: VR-trained pigeons pecked 1000+ times; CRF-trained stopped after 50 pecks

Study 3: Token economy in psychiatric ward

- Patients earned tokens for: self-care, social interaction, chore completion
- Tokens exchanged for: TV time, snacks, recreational activities
- Results: Self-care behaviors increased 300%, social interaction up 150%
- Reversal phase (tokens discontinued): Behaviors decreased to baseline
- Reinstatement: Behaviors rapidly returned to high levels

Study 4: Punishment effectiveness

- Rats received foot shock for lever pressing
- Immediate shock: 90% response suppression
- Delayed shock (10 seconds): 40% suppression
- Mild consistent shock: Gradual response decrease
- Severe inconsistent shock: Temporary suppression, rapid recovery
- Alternative behavior reinforced during punishment: Sustained suppression

Study 5: Escape vs. avoidance learning

- Escape conditioning: Shock present, lever press terminates it—rapid learning (10 trials)
- Avoidance conditioning: Warning signal precedes shock, response during signal prevents shock
- Initially: High responding (80+ responses/hour)
- Later: Responding decreased to just-sufficient levels to avoid shock
- Extinction (shock disconnected): Very slow—responding persisted for hundreds of trials

---

29. Variable ratio schedules producing highest response rates and greatest extinction resistance occurs because:

A. Unpredictability maintains response expectancy continuously

B. Random reinforcement prevents discriminating extinction onset

C. Intermittent rewards create persistent behavioral patterns

D. Inconsistent payoffs generate sustained motivational states

---

30. Shaping reducing training time from 6 hours to 20 minutes demonstrates:

A. Successive approximations accelerate complex skill acquisition

B. Differential reinforcement guides behavioral progression efficiently

C. Breaking tasks into components facilitates learning

D. Incremental reinforcement optimizes acquisition speed

---

31. Token economy increasing behaviors during active phase but decreasing during reversal indicates:

A. Behavioral changes depend on maintaining contingencies

B. Tokens function as conditioned reinforcers

C. Extrinsic rewards effectively modify target behaviors

D. Contingency removal extinguishes reinforced responses

---

32. Immediate punishment being more effective than delayed punishment reflects:

A. Temporal contiguity strengthens response-consequence associations

B. Memory decay weakens delayed contingency learning

C. Immediate feedback enables rapid behavioral adjustment

D. Proximal consequences produce stronger conditioning

---

33. Avoidance responses persisting through hundreds of extinction trials demonstrates:

A. Anxiety reduction maintains responding through negative reinforcement

B. Safety signal absence prevents discriminating contingency changes

C. Avoidance learning creates highly resistant response patterns

D. Fear conditioning produces difficult-to-extinguish behaviors

---

PASSAGE 7: Cognitive Development and Theory of Mind

Cognitive development involves qualitative changes in thinking across childhood. Piaget proposed four stages: sensorimotor (0-2 years, object permanence develops), preoperational (2-7 years, symbolic thought but egocentric), concrete operational (7-11 years, logical thinking about concrete objects, conservation), and formal operational (11+ years, abstract reasoning, hypothetical thinking).

Theory of mind—understanding that others have mental states (beliefs, desires, knowledge) differing from one's own—develops around age 4-5. False belief tasks assess theory of mind: children who understand false beliefs recognize that people act on their beliefs even when those beliefs are incorrect.

Vygotsky emphasized social and cultural influences on development. The zone of proximal development (ZPD) represents the gap between independent performance and performance with guidance. Scaffolding—providing structured support that's gradually withdrawn—promotes learning within the ZPD.

Executive functions include working memory, cognitive flexibility, and inhibitory control. These develop throughout childhood and adolescence, supported by prefrontal cortex maturation.

Research Studies:

Study 1: False belief task (Sally-Anne)

- Story: Sally puts marble in basket, leaves. Anne moves marble to box. Sally returns.
- Question: Where will Sally look for the marble?
- 3-year-olds: "In the box" (where marble actually is)
- 5-year-olds: "In the basket" (where Sally believes it is)
- Success requires understanding Sally has false belief

Study 2: Conservation task

- Liquid poured from short wide glass to tall narrow glass (same volume)
- Preoperational children (4-6 years): "Tall glass has more"—focus on height
- Concrete operational children (7+ years): "Same amount"—understand conservation
- Reversibility: Can mentally reverse the pouring

Study 3: Scaffolding and ZPD

- Children attempted puzzles at three difficulty levels
- Level 1: Solved independently
- Level 2: Solved with hints and encouragement
- Level 3: Couldn't solve even with help
- Level 2 represents ZPD
- Children who received scaffolding showed 40% improvement on later independent attempts
- No-scaffolding control: 10% improvement

Study 4: Executive function development

- Stroop task: Name ink color when word meaning conflicts
- 5-year-olds: 60% errors (saying word instead of color)
- 10-year-olds: 20% errors
- Adults: 5% errors
- Correlates with prefrontal cortex development

Study 5: Perspective-taking

- 3-mountain task: Child sits on one side, doll on another
- Asked: "What does the doll see?"
- Preoperational children: Describe own view (egocentric)
- Concrete operational: Accurately describe doll's perspective
- Relates to theory of mind development

---

34. Three-year-olds failing false belief tasks while five-year-olds succeed indicates:

A. Representational understanding emerges during preschool years

B. Metarepresentational capacity develops with cognitive maturation

C. Understanding mental states requires specific conceptual insights

D. Perspective-taking abilities follow developmental trajectories

---

35. Preoperational children failing conservation despite seeing transformations demonstrates:

A. Perceptual features dominate over logical relationships

B. Centration on single dimensions prevents operational thinking

C. Reversibility operations have not yet developed

D. Appearance-based reasoning precedes logical reasoning

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36. Scaffolding within the ZPD producing greater improvement than unguided practice reflects:

A. Social interaction optimizes learning through guided discovery

B. Appropriate assistance accelerates skill development

C. External support bridges capability gaps temporarily

D. Structured guidance facilitates internalization processes

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37. Executive function improvement correlating with prefrontal development suggests:

A. Cognitive control capacities depend on neural maturation

B. Inhibitory systems require extended developmental periods

C. Brain development constrains and enables cognitive abilities

D. Biological maturation underlies psychological capabilities

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38. Egocentric responses in perspective-taking tasks decreasing with age reflects:

A. Declining self-focus with increasing social awareness

B. Developing ability to mentally represent multiple viewpoints

C. Maturation of spatial reasoning and mental rotation

D. Improved metacognitive awareness of one's perspectives

PASSAGE 8: Language Acquisition and Critical Periods

Language acquisition follows predictable sequences. Babbling begins around 6 months, first words at 12 months, two-word combinations at 18-24 months. By age 5, children master basic grammar and have vocabularies of thousands of words.

The nativist perspective (Chomsky) proposes an innate language acquisition device (LAD) containing universal grammar principles common across languages. Evidence includes: language universals, poverty of stimulus argument (children learn complex grammar despite limited input), and critical period effects.

The critical period hypothesis proposes a biologically determined window (birth to puberty) when language learning is optimal. Evidence comes from case studies of language-deprived children and second-language acquisition patterns showing declining facility with age.

The interactionist perspective emphasizes social interaction. Child-directed speech (motherese)—higher pitch, exaggerated intonation, simplified grammar—facilitates learning. Joint attention and social scaffolding support language development.

Bilingual children show benefits: enhanced executive function (especially cognitive control), delayed onset of Alzheimer's symptoms, and greater cognitive flexibility despite potential early vocabulary delays in each language.

Research Findings:

Study 1: Critical period in second language acquisition

- Korean and Chinese immigrants to the U.S. at various ages
- Tested on English grammar 10+ years post-immigration
- Arrival before age 7: Native-like performance (95% correct)
- Arrival ages 8-15: Gradual decline in performance
- Arrival after age 17: Marked deficits (70% correct), high variability
- Years of exposure didn't compensate for late arrival

Study 2: Genie case study

- Child isolated until age 13, minimal language exposure
- After rescue: Learned vocabulary (words for objects, actions)
- Never acquired grammatical competence despite intensive training
- Produced two-word utterances but not complex syntax
- Suggests critical period for grammar acquisition

Study 3: Bilingual executive function advantage

- Bilingual and monolingual children (age 7) on conflict tasks
- Simon task (respond to location, ignore color): Bilinguals 50 ms faster
- Flanker task (identify central arrow, ignore surrounding): Bilinguals 15% more accurate
- Advantage attributed to practice managing competing linguistic systems

Study 4: Child-directed speech

- Mothers instructed to talk "normally" vs. using motherese
- Motherese condition: Infants attended 70% longer, higher engagement
- At 18 months: Motherese group had 30% larger vocabularies
- Suggests exaggerated prosody attracts attention and highlights linguistic structure

Study 5: Sign language critical period

- Deaf individuals who learned ASL at different ages
- Native signers (from birth): Complex grammatical structures, fluent production
- Early learners (before age 6): Near-native competence
- Late learners (after age 12): Grammatical errors, simplified structures
- Similar critical period effects as spoken language

---

39. Second language proficiency declining with later age of acquisition supports:

A. Neural plasticity decreases with development

B. Sensitive periods constrain linguistic learning

C. Early exposure optimizes language circuit formation

D. Biological factors determine acquisition trajectories

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40. Genie acquiring vocabulary but not grammar after age 13 suggests:

A. Lexical and syntactic systems have different critical periods

B. Grammar requires earlier developmental windows than vocabulary

C. Different language components show varying developmental constraints

D. Syntactic processing depends more on early neural specialization

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41. Bilingual children showing executive function advantages despite vocabulary delays indicates:

A. Managing multiple languages enhances cognitive control

B. Linguistic competition strengthens attention regulation

C. Bilingualism produces domain-general cognitive benefits

D. Language switching exercises executive systems

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42. Child-directed speech facilitating acquisition demonstrates:

A. Social-emotional engagement optimizes language learning

B. Prosodic exaggeration highlights linguistic boundaries

C. Simplified input matches learner processing capacities

D. Interactive contexts support language development

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43. ASL showing similar critical period effects as spoken language suggests:

A. Modality-independent factors govern language acquisition

B. Neural mechanisms for language transcend sensory channels

C. Critical periods reflect brain development not auditory processing

D. Universal constraints apply across communication systems

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44. Late second-language learners showing high variability despite equal exposure indicates:

A. Individual differences increase outside critical periods

B. Optimal learning windows minimize outcome variance

C. Post-critical learning depends more on individual factors

D. Biological constraints diminish with compensatory strategies

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DISCRETE QUESTIONS (45-59)

45. Which brain structure is primarily associated with fear conditioning and emotional memory?

A. Hippocampus

B. Hypothalamus

C. Amygdala

D. Thalamus

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46. The just-world hypothesis refers to the belief that:

A. People get what they deserve and deserve what they get

B. Justice systems are inherently fair

C. Good actions are always rewarded

D. Moral reasoning follows universal principles

---

47. Weber's law states that the just noticeable difference is:

A. Constant across all stimulus intensities

B. Larger for more intense stimuli

C. Smaller for more intense stimuli

D. A constant proportion of the original stimulus intensity

---

48. The mere exposure effect demonstrates that:

A. First impressions are always accurate

B. Repeated exposure to neutral stimuli increases liking

C. Familiarity breeds contempt

D. Initial attitudes rarely change

---

49. According to Erikson's stages of psychosocial development, the crisis during adolescence involves:

A. Trust vs. mistrust

B. Autonomy vs. shame

C. Identity vs. role confusion

D. Intimacy vs. isolation

---

50. Wernicke's aphasia is characterized by:

A. Fluent but meaningless speech with comprehension deficits

B. Non-fluent speech with intact comprehension

C. Complete loss of all language abilities

D. Inability to write but normal speech

---

51. Cognitive dissonance theory predicts that people will:

A. Seek consistent information supporting existing beliefs

B. Change attitudes to reduce psychological discomfort

C. Avoid all inconsistent information

D. Experience no discomfort from inconsistency

---

52. The phi phenomenon demonstrates:

A. Perceptual constancy across viewing angles

B. Apparent motion from sequential static stimuli

C. Depth perception from binocular cues

D. Color perception in low light

53. Observational learning, as demonstrated by Bandura's Bobo doll studies, shows that:

A. Punishment always prevents imitation

B. Reinforcement is necessary for learning

C. Learning can occur without direct reinforcement through modeling

D. Aggression is purely instinctual

54. The Flynn effect refers to:

A. Declining IQ scores over generations

B. Rising average IQ scores across generations

C. Cultural bias in intelligence testing

D. Genetic determinism of intelligence

55. Gate control theory explains pain perception by proposing that:

A. Pain signals always reach consciousness

B. Spinal mechanisms can inhibit pain signal transmission

C. Pain is purely psychological

D. Endorphins block all pain sensations

56. Schizophrenia is primarily associated with dysregulation of which neurotransmitter?

A. Dopamine

B. Serotonin

C. GABA

D. Glutamate

---

57. The representativeness heuristic leads people to:

A. Judge probability based on availability in memory

B. Judge likelihood based on similarity to prototypes

C. Anchor judgments on initial information

D. Seek confirming evidence for beliefs

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58. REM sleep is characterized by:

A. Delta waves and physical restoration

B. Muscle atonia and vivid dreams

C. Sleep spindles and K-complexes

D. Easy arousal and light sleep

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59. Maslow's hierarchy places which need at the highest level?

A. Safety needs

B. Belongingness needs

C. Esteem needs

D. Self-actualization

SECTION 1: ANSWER EXPLANATIONS

1. C - -277 kJ/mol

To find ΔH°f for ethanol formation, manipulate given reactions:

- Reverse Reaction 3: $2CO_2 + 3H_2O \rightarrow C_2H_5OH + 3O_2$, $\Delta H° = +1367$ kJ
- Add 2×(Reaction 1): $2C + 2O_2 \rightarrow 2CO_2$, $\Delta H° = -788$ kJ
- Add 3×(Reaction 2): $3H_2 + 3/2O_2 \rightarrow 3H_2O$, $\Delta H° = -858$ kJ Net: $2C + 3H_2 + \frac{1}{2}O_2 \rightarrow C_2H_5OH$ $\Delta H° = +1367 + (-788) + (-858) = -279$ kJ/mol ≈ -277 kJ/mol

2. A - Reverse Reaction 3, add 2×(Reaction 1) and 3×(Reaction 2)

This manipulation cancels intermediates (CO_2, H_2O, excess O_2) to yield the target formation reaction.

3. D - 5616 kJ/mol

Heat released = 15.6 kJ from 0.500 g glucose Molar mass = 180 g/mol Moles = 0.500/180 = 0.00278 mol Molar enthalpy = 15.6 kJ / 0.00278 mol = 5616 kJ/mol

4. B - -802 kJ (exothermic)

ΔH = bonds broken - bonds formed = 2648 - 3450 = -802 kJ Negative value indicates exothermic reaction.

5. C - The change in moles of gas is small (ΔH ≈ ΔE when PΔV ≈ 0)

$\Delta H = \Delta E + P\Delta V$. When Δn(gas) is small, $P\Delta V \approx 0$, so $\Delta H \approx \Delta E$.

6. A - ΔH° = +50 kJ/mol

Reversing a reaction changes the sign of ΔH. If forward is exothermic (-50), reverse is endothermic (+50).

7. B - Strong acids completely dissociate while weak acids partially dissociate

$HCl \rightarrow H^+ + Cl^-$ (100% dissociation, pH = 1.0) $CH_3COOH \rightleftharpoons H^+ + CH_3COO^-$ (partial dissociation, pH = 2.87) Complete dissociation produces more H^+, lower pH.

8. D - [HA] = [A⁻], so pH = pKa + log(1) = pKa

At half-equivalence, half the acid is neutralized: $[CH_3COOH] = [CH_3COO^-]$ Henderson-Hasselbalch: $pH = pKa + \log([A^-]/[HA]) = pKa + \log(1) = pKa$

9. A - Acetate ion (conjugate base) hydrolyzes to produce OH⁻

At equivalence, all acetic acid is converted to acetate (CH_3COO^-) $CH_3COO^- + H_2O \rightleftharpoons CH_3COOH + OH^-$ This hydrolysis produces OH^-, making solution basic (pH > 7).

10. C - 1.0×10^{-5} M

$Kw = [H^+][OH^-] = 1.0 \times 10^{-14}$ $[OH^-] = Kw/[H^+] = 1.0 \times 10^{-14} / 1.0 \times 10^{-9} = 1.0 \times 10^{-5}$ M

11. B - Resist pH changes when small amounts of acid or base are added

Buffer = weak acid + conjugate base. When H^+ is added, CH_3COO^- neutralizes it. When OH^- is added, CH_3COOH neutralizes it, minimizing pH change.

12. D - Spontaneous oxidation of Zn and reduction of Cu^{2+}

Positive E°cell indicates spontaneous ($\Delta G° < 0$). Zn (more negative E°) is oxidized; Cu^{2+} (more positive E°) is reduced.

13. B - Zn to Cu through external circuit

Electrons flow from anode (oxidation site, Zn) to cathode (reduction site, Cu) through the external circuit.

14. C - Lower [Zn^{2+}] shifts equilibrium toward more Zn oxidation (products), increasing E

Nernst equation: $E = E° - (0.0592/n)\log(Q)$ $Q = [Zn^{2+}]/[Cu^{2+}]$. Lower [Zn^{2+}] decreases Q, decreases log(Q) (more negative), increases E.

15. A - -212 kJ/mol

$\Delta G° = -nFE° = -(2)(96,485 \text{ C/mol})(1.10 \text{ V}) = -212,267 \text{ J/mol} \approx -212 \text{ kJ/mol}$

16. A - The reaction is endergonic with positive ΔG

Water decomposition requires energy input (non-spontaneous, $\Delta G° > 0$), so external voltage must drive the reaction.

17. B - Li/Li^+ and Ag/Ag^+

Maximum voltage = largest E° difference E°cell = E°Ag^+/Ag - E°Li^+/Li = +0.80 - (-3.05) = +3.85 V (largest gap)

18. A - Competitive inhibition where inhibitor competes for active site

Competitive inhibitors bind the active site, competing with substrate. More substrate is needed to reach Vmax (increased Km), but sufficient substrate can outcompete inhibitor (unchanged Vmax).

19. C - Noncompetitive inhibition binding at a site other than active site

Noncompetitive inhibitors bind allosteric sites, reducing enzyme activity regardless of substrate concentration. Vmax decreases (fewer functional enzyme molecules), but Km unchanged (substrate binding affinity unaffected).

20. D - Vmax/2 (by definition of Km)

Km is defined as the substrate concentration at which velocity = Vmax/2. This is the operational definition.

21. B - Exponential increase in molecules with energy ≥ Ea (Arrhenius relationship)

Arrhenius equation: $k = Ae^{-Ea/RT}$. Higher temperature exponentially increases the fraction of molecules with sufficient energy to overcome activation energy.

22. B - Optimal temperature exists beyond which protein structure disrupts

Enzymes have optimal temperatures. Above this, thermal energy disrupts hydrogen bonds and other forces maintaining tertiary structure, causing denaturation and activity loss.

23. C - 8

Maximum stereoisomers = 2^n where n = number of chiral centers $2^3 = 8$ stereoisomers

24. A - All physical properties including optical rotation direction

Enantiomers have identical physical properties (mp, bp, density) except optical rotation direction. They rotate plane-polarized light equally but in opposite directions.

25. D - Equal amounts of opposite enantiomers cancel rotations

A 1:1 mixture of (+) and (-) enantiomers produces zero net rotation: (+13.5°) + (-13.5°) = 0°. This is a racemic mixture.

26. B - Have different physical properties (melting points, boiling points, Rf values)

Unlike enantiomers (identical physical properties), diastereomers differ at some but not all chiral centers, resulting in different physical properties.

27. C - Achiral due to internal plane of symmetry despite having chiral centers

Meso compounds have chiral centers but also an internal plane of symmetry making the molecule achiral (superimposable on mirror image). No optical activity.

28. B - Assign priorities by atomic number, orient lowest priority away, and determine clockwise (R) or counterclockwise (S)

R/S determination uses Cahn-Ingold-Prelog rules: assign priorities (1-4) by atomic number, orient #4 away, trace 1→2→3. Clockwise = R, counterclockwise = S.

29. B - Intermolecular attractive forces reduce wall collisions

Real gas pressure < ideal prediction because attractive forces between molecules reduce the force of wall collisions. Van der Waals: $P\_real + a(n/V)^2 = P\_ideal$

30. D - Lower temperature allows intermolecular forces to become more significant

At low temperature, molecules move slowly, allowing attractive forces more time to act. Deviation from ideality increases.

31. A - 0.25

Mole fraction X_{N_2} = moles N_2 / total moles = $1/(1+3) = 1/4 = 0.25$

32. B - Decrease to 2.0 atm (half of original)

Boyle's law: $P_1V_1 = P_2V_2$ at constant n and T If V doubles, P halves: $(4.0 \text{ atm})(V) = P_2(2V) \rightarrow P_2 = 2.0$ atm

33. B - Effusion rate is inversely proportional to square root of molar mass

Graham's law: $rate_1/rate_2 = \sqrt{(M_2/M_1)}$ rateHe/rateX = $2 = \sqrt{(M_X/4)} \rightarrow M_X = 16$ g/mol

34. D - 1/8

After each half-life, half remains: $(1/2)^3 = 1/8$ After 3 half-lives: 100% → 50% → 25% → 12.5% = 1/8

35. B - A neutron converts to proton + electron

Beta-minus decay: $^1_0n \rightarrow ^1_1p + ^0_{-1}e$ A neutron becomes a proton (increasing Z by 1) and emits an electron.

36. C - Two half-lives elapsed (50% → 25%)

100% → 50% (one $t_{1/2}$) → 25% (two $t_{1/2}$) Time = $2 \times 5730 = 11,460$ years

37. B - Nuclear binding involves mass-energy conversion per Einstein's equation

$E = mc^2$ shows mass-energy equivalence. The mass defect (missing mass) has been converted to binding energy holding the nucleus together.

38. D - Positron-electron annihilation converts mass to electromagnetic radiation

When positron ($^0_{+1}e$) meets electron ($^0_{-1}e$), they annihilate, converting their mass to energy as two 511 keV gamma rays.

39. A - Solute particles disrupt solvent crystal formation, lowering freezing point

Dissolved particles interfere with water molecules organizing into ice crystals, requiring lower temperature to freeze. $\Delta Tf = Kfm$

40. C - Partial ion pairing reduces effective particle number below theoretical

Ideally, $NaCl \rightarrow Na^+ + Cl^-$ gives i = 2. In reality, some ions associate, reducing effective particle count to i = 1.83.

41. D - Water moves from lower to higher solute concentration (down its concentration gradient)

Osmosis: water moves from high water concentration (pure water) to low water concentration (sucrose solution) through semipermeable membrane.

42. A - Water enters cells by osmosis, causing swelling and membrane rupture

Hypotonic solution has lower solute concentration than cells. Water enters by osmosis, cells swell and burst.

43. A - Measure ΔTf, calculate molality (m = ΔTf/Kf), then M = g solute/(m × kg solvent)

From freezing point depression, calculate molality. With known mass of solute and solvent, calculate molar mass.

44. C - Its osmotic pressure equals intracellular osmotic pressure, preventing net water flow

Isotonic solutions have equal osmotic pressure as cells. No net water movement—cells maintain normal shape.

45. D - pKb = 3

Lower pKb = stronger base (like lower pKa = stronger acid). pKb = 3 is the lowest, indicating strongest base.

46. B - See-saw

SF_4: 5 electron domains (4 bonding, 1 lone pair). VSEPR predicts see-saw geometry (derived from trigonal bipyramidal with one equatorial lone pair).

47. C - Carboxylic acid and ester

Aspirin contains -COOH (carboxylic acid) and -COO- (ester) functional groups.

48. A - The backside, causing inversion of configuration

SN2 = bimolecular nucleophilic substitution with backside attack. Nucleophile attacks opposite to leaving group, inverting stereochemistry (Walden inversion).

49. D - +5

HNO_3: H = +1, O = -2, N = x (+1) + x + 3(-2) = 0 → x = +5

50. B - Hydrogen bonding

Water's high bp (100°C) results from extensive hydrogen bonding between H (δ+) and O (δ-) of neighboring molecules.

51. C - Cathode

Reduction occurs at the cathode. Mnemonic: "Red Cat" (Reduction at Cathode). Oxidation occurs at anode.

52. B - Experimental measurement

Rate laws must be determined experimentally—they cannot be predicted from balanced equations. Reaction orders are determined by measuring how rate changes with concentration.

53. C - H₂O

H_2O is bent (asymmetric), with net dipole moment. CCl_4 (tetrahedral), CO_2 (linear), and BF_3 (trigonal planar) are symmetric—dipoles cancel.

54. B - Longer

Conjugation lowers the energy gap between HOMO and LUMO, requiring less energy (longer wavelength) for electronic transitions.

55. D - Zero

At equilibrium, $\Delta G = 0$ (no driving force for net reaction). $\Delta G° = -RT \ln K$ is the standard free energy, different from ΔG at equilibrium.

56. C - sp

CO_2 has 2 electron groups around carbon (2 double bonds). Two electron groups $\rightarrow$ sp hybridization (linear, 180°).

57. C - CH₃COOH and CH₃COONa

Buffer = weak acid + conjugate base. Acetic acid (weak acid) and sodium acetate (conjugate base) form a buffer system.

58. B - Disorder or randomness

Entropy (S) measures the number of microstates or degree of disorder in a system. Higher entropy = more disorder.

59. D - Conjugation increases

Increased conjugation lowers energy gaps between molecular orbitals, shifting λmax to longer wavelengths (red shift/bathochromic shift).

SECTION 2: ANSWER EXPLANATIONS

1. A - Challenge the assumption that empathy is a reliable foundation for moral decision-making

The passage systematically critiques empathy's role in ethics by examining its biases, innumeracy, and exhaustion while acknowledging benefits. The primary purpose is challenging empathy's reliability, not complete dismissal.

2. C - Innumeracy

The identifiable victim effect demonstrates empathy's innumeracy—spotlighting individual suffering while obscuring aggregate welfare. We respond intensely to one identified victim but not proportionately to statistical victims.

3. B - Critical yet balanced, acknowledging both benefits and significant limitations

The author critiques empathy's problems but states "This is not to dismiss empathy entirely. It connects us to others and can motivate moral concern." This balanced approach recognizes both value and limitations.

4. D - True empathy involves perspective-taking beyond emotional sharing

Defenders respond that critics "confuse empathy with sympathy or compassion" and argue "true empathy...involves perspective-taking that transcends emotional contagion."

5. A - Principled arguments about justice rather than empathic identification

The passage states moral advances "were achieved less through empathizing with affected groups than through principled arguments about justice and equality."

6. C - Effective moral reasoning requires balancing empathy with universal principles

The conclusion advocates "A mature moral psychology balances empathic responses with reasoned judgment, statistical thinking, and universal principles."

7. D - Museums actively construct cultural meaning rather than neutrally presenting it

The opening states museums "actively construct rather than merely reflect cultural meaning." This central claim is developed throughout the passage with multiple examples.

8. B - Even seemingly objective displays involve interpretive choices

Natural history dioramas appear objective but involve curatorial choices about "which moment to freeze, which species to include, what environmental features to emphasize."

9. C - Transparency and accountability make construction legitimate rather than arbitrary

The passage responds to legitimacy concerns: "Acknowledging that museums construct meaning doesn't make their work arbitrary or illegitimate—it means their choices should be transparent, debated, and responsive to diverse perspectives."

10. A - Permanence and authority

"Monumental neo-classical buildings suggest permanence and authority"—architecture communicates institutional power and credibility.

11. D - Transparent interpretation combining expertise with multiple perspectives

The conclusion advocates "transparent, accountable interpretation that engages multiple perspectives while maintaining scholarly rigor"—balancing expertise with inclusivity.

12. B - Reflected and reinforced colonial hierarchies

The passage states this division "reflected and reinforced colonial hierarchies rather than objective artistic merit."

13. B - Traditional individualistic privacy conceptions are inadequate for addressing digital privacy's collective dimensions

The opening argues individualistic privacy conceptions are "increasingly inadequate" because "data about individuals generates insights about populations, and individual privacy choices have collective consequences."

14. D - Individual privacy choices having collective consequences

Facial recognition shows "your individual privacy choice has collective ramifications" by training algorithms that recognize others who never consented.

15. C - Network effects and complexity make individual consent insufficient

The passage states "meaningful consent requires understanding consequences, yet algorithmic systems are often too complex for even experts to predict their applications." Network effects mean "individual consent is insufficient."

16. C - Act as trustees serving users' interests

Data fiduciaries would require "companies to act as trustees obligated to serve users' interests rather than merely obtaining consent for whatever uses they prefer."

17. B - Emerge from aggregate data analysis revealing group patterns

Collective privacy harms emerge "when aggregate data analysis reveals patterns about groups, enabling discrimination or manipulation regardless of individual consent."

18. D - Replicate social control that privacy protections were meant to prevent

Critics worry collective governance might be "precisely the kind of social control privacy protections were meant to prevent."

19. C - Warn against its dangers in satirical form

The passage states Young "coined the term in his 1958 dystopian satire" and "intended it as warning, not aspiration."

20. A - Just in rewarding merit while dangerous in legitimizing inequality

"The paradox is that meritocracy can be both just and dangerous. It's just because rewarding talent and effort...seems fairer...It's dangerous because it legitimizes inequality."

21. D - Supposedly merit-based tests actually measure parental investment capacity

"Test preparation industries have made them measures of parental investment capacity. SAT scores correlate strongly with family income."

22. B - Discount luck and privilege, attributing success solely to personal qualities

"Merit hubris" causes successful people to "attribute their achievements entirely to their own abilities and efforts, discounting luck, privilege, and structural advantages."

23. C - Perfect equality of opportunity is impossible and wouldn't solve the legitimization problem

The defense fails because "perfect equality of opportunity is impossible" and "even ideal meritocracy faces the legitimization problem."

24. A - Decoupling dignity and security from competitive achievement while still selecting for specialized roles

The alternative means "we could decouple social respect and economic security from competitive achievement. Everyone deserves dignity and decent living standards...Society could still select people for specialized roles."

25. A - Cultural appropriation's ethics depend on context, power dynamics, and reciprocity rather than borrowing itself

The opening states "Neither position fully captures the complexity" and the conclusion emphasizes context: "The question is whether that influence shows respect for people, acknowledges power dynamics, and occurs within relationships of reciprocity."

26. C - Power asymmetries where dominant groups are praised while marginalized groups are discriminated against for the same practices

The cornrows example shows "White celebrities...are praised as edgy; Black people...face workplace discrimination. This asymmetry isn't about hair but about power."

27. B - Cultural communities are diverse with varying internal perspectives

"Cultural communities are not monolithic. Some Native Americans object...others don't...Treating cultures as having single authorized representatives...misrepresents cultural diversity."

28. D - Difficult to maintain since the same action might be both

"This distinction is harder to maintain than it appears...The same action might be both: yoga classes...could represent both genuine spiritual engagement and commercial exploitation."

29. D - Acknowledges sources, shows understanding, and occurs in mutual exchange

The respect and reciprocity framework asks: "Does the cultural borrowing show understanding of significance and context? Does it acknowledge sources? Does it occur in relationships of mutual exchange?"

30. C - It's inevitable and can be ethical without cultural protectionism

The conclusion "recognizes that cultural exchange involves ethics without requiring impossible boundaries...The question is whether that influence shows respect."

31. D - Weakness or indecisiveness

"Contemporary culture valorizes knowing...ambiguity, uncertainty, and suspended judgment are interpreted as weakness. Political leaders who admit uncertainty are attacked as indecisive."

32. B - Questioning assumptions and tolerating uncertainty enables breakthroughs

"Einstein's willingness to question fundamental assumptions...enduring years without clear answers, enabled revolutionary insights impossible for those who needed immediate certainty."

33. C - Embrace complexity and leave interpretations open

"Great novels embrace complexity, leaving interpretations open rather than resolving every question."

34. A - Psychological preference for certainty even when uncertainty might be better

"Studies show people prefer definitive bad news to uncertain potentially good news—they'd rather know for certain they have a disease than wait in ambiguity"—illustrating anxiety-driven certainty preference.

35. D - Developing comfort with provisional uncertainty during inquiry

"Cultivating negative capability...means developing comfort with provisional uncertainty during inquiry. Eventually, judgment must be made...But the quality of these eventual conclusions depends on the willingness to dwell in uncertainty during exploration."

36. B - Reward thoughtful uncertainty and teach navigation of ambiguity

"Teaching negative capability would involve rewarding thoughtful uncertainty, modeling how experts navigate unknown territory, and distinguishing between questions with clear answers and those requiring sustained engagement."

37. B - Automation anxiety suggests the need to reconsider distribution of prosperity rather than just job creation

The passage concludes: "Perhaps we're asking the wrong question. 'Will automation destroy jobs?' assumes employment is the only or best way to distribute income"—reframing the question from job creation to prosperity distribution.

38. D - Pace has accelerated, scope broadened, and pattern shifted from complementing to substituting for human labor

The passage identifies three differences: "First, the pace has accelerated...Second, the scope has broadened...Third, the pattern has shifted" from complementing to substituting.

39. D - Unpredictability about specific jobs doesn't guarantee enough total jobs emerge

"That we cannot predict specific jobs doesn't mean job creation equals job destruction. The question isn't whether some new jobs appear but whether enough appear to employ everyone."

40. C - Mean increased productivity won't fund broad demand for new goods employing displaced workers

"If automation profits flow primarily to capital owners while workers' wages stagnate, increased productivity won't fund demand for new goods and services employing displaced workers."

41. B - Whether enough decent jobs exist for everyone

"The question isn't whether humans become economically worthless but whether enough decent jobs exist for everyone."

42. D - We fear what could be liberating because society is organized around employment scarcity

"The automation anxiety paradox is that we fear what could be liberation. We've organized society around employment scarcity; abundance threatens this organization."

43. C - Memory is unreliable, involving false memories and forgetting

"Yet memory is unreliable. We misremember, confabulate, and forget." False memories and forgetting create problems for memory-based identity.

44. B - Forgetting creates logical problems if identity depends strictly on direct memory

The transitivity paradox demonstrates that forgetting undermines memory-based identity. If identity requires direct memory, then I equal yesterday-me (who I remember), and yesterday-me equals childhood-me (who yesterday-me remembered), but I don't equal childhood-me (who I can't directly remember). This violates the transitivity principle (if A=B and B=C, then A=C).

45. D - Constructed through ongoing stories linking past, present, and future

"Narrative theories propose that identity is the ongoing story we tell about ourselves. We construct coherent narratives linking past, present, and anticipated future."

46. B - Different contexts privilege different identity aspects (biological, psychological, narrative)

"Different contexts privilege different aspects. For medical decisions, biological continuity matters; for moral responsibility, psychological continuity; for social relationships, narrative identity."

47. C - They demand nuanced judgment about which identity strand matters in specific contexts

"Rather than insisting one criterion determines 'real' identity in all cases...Simpler theories give clear answers; pluralism demands nuanced judgment."

48. D - A strength reflecting genuine complexity rather than false clarity

The passage concludes: "Perhaps that's a strength rather than weakness. Simple theories purchase clarity at the cost of adequacy. If identity is genuinely complex, theories should reflect that complexity." The author argues complexity in theory reflects genuine complexity in reality, making it a strength.

49. D - Architecture embodies and communicates power relations through spatial organization

The opening states: "Buildings aren't ideologically neutral. Architecture embodies and communicates power relations."

50. B - Design can serve political control while claiming aesthetic or practical justifications

"The official justification—improved hygiene and traffic flow—obscured political motivations: wide streets prevented barricade construction...Beautiful architecture served political control."

51. C - Users resist, subvert, and reimagine spaces

"Yet architecture's power isn't total. People resist, subvert, and reimagine spaces. Skateboarding transforms architectural barriers into playgrounds."

52. B - Making authority appear friendly doesn't eliminate hierarchical structures (This matches the passage's argument)

53. D - More intentional choices about what social relations buildings assume and reproduce

"Recognizing architecture's power enables more intentional choices...we can ask: What social relations does this building assume and reproduce?"

SECTION 3: ANSWER EXPLANATIONS

1. B - Decreased ATP/ADP ratio and elevated AMP relieve inhibition and activate PFK

During intense exercise, ATP consumption exceeds production, decreasing ATP/ADP ratio and increasing AMP. High ATP normally inhibits PFK; low ATP removes this inhibition. High AMP directly activates PFK, increasing glycolysis 5-fold to meet energy demands.

2. D - Regenerate NAD$^+$ so glycolysis can continue

Glycolysis requires NAD$^+$ as an electron acceptor. Without oxygen for oxidative phosphorylation to regenerate NAD$^+$, lactate fermentation (pyruvate + NADH → lactate + NAD$^+$) provides NAD$^+$ to sustain glycolysis and ATP production.

3. A - Citrate indicates the citric acid cycle is active and energy is sufficient

Citrate is a citric acid cycle intermediate. High citrate signals abundant acetyl-CoA and adequate energy production. Inhibiting PFK when citrate is elevated prevents unnecessary glucose catabolism when energy supply is sufficient.

4. C - Cells attempt to compensate for blocked oxidative phosphorylation by increasing glycolysis

Cyanide blocks Complex IV, eliminating oxidative phosphorylation. Cells increase glycolysis (which produces only 2 ATP per glucose vs. 30-32 via complete oxidation) to compensate for lost mitochondrial ATP production despite overall energy deficit.

5. B - Decreased pyruvate → acetyl-CoA conversion, sparing glucose for the brain

During fasting, glucagon increases PDC phosphorylation, inactivating it. This prevents pyruvate conversion to acetyl-CoA, diverting pyruvate to gluconeogenesis instead. Sparing glucose for obligate glucose-dependent tissues (brain, RBCs) is adaptive during fasting.

6. D - Pyruvate preferentially enters mitochondria when oxygen is available

Under aerobic conditions, pyruvate enters mitochondria for complete oxidation (citric acid cycle and electron transport), yielding far more ATP than fermentation. Only when oxygen is limited does lactate fermentation become necessary.

7. C - Gene transcription and protein synthesis requirement for steroid hormone action

Cortisol (lipid-soluble steroid) diffuses through membranes, binds intracellular receptors, and acts as transcription factor. New mRNA synthesis takes 30 minutes; translation takes additional 30 minutes. Effects persist because new proteins remain after hormone removal.

8. A - Cell-surface receptor signaling via second messengers is faster than intracellular receptor-mediated transcription

Epinephrine binds cell-surface receptors, activating pre-existing signaling proteins (G-proteins, adenylyl cyclase, PKA) within seconds. Cortisol requires transcription and translation of new proteins, taking 30-60 minutes—much slower than phosphorylation cascades.

9. D - Cortisol requires transcription for its effects

Actinomycin D inhibits RNA polymerase, blocking transcription. Since actinomycin D prevents cortisol's effects, cortisol must work through gene transcription rather than modifying existing proteins.

10. B - Ca^{2+} serves as a second messenger coupling receptor activation to cellular response

Vasopressin $\rightarrow$ phospholipase C $\rightarrow$ IP_3 $\rightarrow$ Ca^{2+} release from ER. Increased intracellular Ca^{2+} (100 nM to 1000 nM) activates calcium-binding proteins that trigger smooth muscle contraction.

11. C - Post-receptor signaling defects cause insulin resistance

Normal receptor expression but reduced autophosphorylation indicates receptors are present but not functioning properly. Defective receptor kinase activity or downstream signaling impairment causes insulin resistance despite adequate receptor number.

12. A - Saltatory conduction reduces the distance requiring active depolarization

Myelin insulates axons, preventing ion flow except at nodes of Ranvier. Action potentials regenerate only at nodes, "jumping" between them. This reduces the membrane area requiring depolarization, dramatically increasing conduction velocity (2 m/s $\rightarrow$ 100 m/s).

13. C - Voltage-gated Na^+ channels are necessary for action potential depolarization but not resting potential

TTX blocks voltage-gated Na^+ channels, abolishing action potentials. Resting potential remains unchanged because it depends on K^+ leak channels and Na^+/K^+-ATPase, not voltage-gated Na^+ channels.

14. B - Insufficient voltage-gated channel density in demyelinated regions prevents regeneration of the action potential

Myelinated axons concentrate voltage-gated channels at nodes. Demyelinated segments lack adequate channel density for regeneration. Current spreads passively but decays without sufficient channels to regenerate the action potential.

15. D - Smaller driving force for Na^+ influx when resting potential is less negative (closer to peak)

Elevated extracellular K$^+$ depolarizes resting potential (-70 mV → -60 mV). Action potential peak depends on Na$^+$ equilibrium potential (unchanged). Smaller voltage difference between resting and peak reduces action potential amplitude.

16. D - Backward propagation because Na$^+$ channels in previously depolarized regions are inactivated

During absolute refractory period, Na$^+$ channels are inactivated and cannot reopen. This prevents action potentials from traveling backward to regions that just fired, ensuring unidirectional propagation.

17. C - Na$^+$/K$^+$ pumps must restore gradients over smaller membrane area

In saltatory conduction, ions cross membranes only at nodes (small area). Continuous conduction requires ion exchange along entire axon length. Less ion movement means less ATP required to restore gradients.

18. D - Combinatorial recombination generates extensive diversity from limited genetic elements

With only ~100 gene segments total, combining them generates 1.2 million combinations: (50V × 20D × 6J) heavy × (40V × 5J) light = 1,200,000. This demonstrates how limited genomic elements create enormous diversity through combinatorial assembly.

19. B - Class switching changed constant regions while preserving V region specificity

IgM and IgG differ in constant regions (effector functions) but have identical V regions (antigen specificity) because class switching recombines heavy chain constant region genes while preserving rearranged VDJ segments.

20. C - Somatic hypermutation and selection for higher-affinity variants

During germinal center responses, activation-induced deaminase introduces point mutations in V regions. B cells with improved antigen binding are selected, producing progressively higher-affinity antibodies (Kd: 10^{-6} M → 10^{-9} M).

21. B - V(D)J recombination by RAG is essential for lymphocyte development

RAG recombinases catalyze V(D)J recombination. Without RAG, no recombination occurs, no functional antigen receptors form, and B/T cell development arrests, causing severe combined immunodeficiency.

22. D - AID mediates class switching and somatic hypermutation but not initial recombination

AID knockout mice have normal B cell development and primary responses (showing V(D)J recombination works), but cannot class switch or undergo somatic hypermutation. This demonstrates AID's specific role in secondary diversification, not initial recombination.

23. B - C4 CO₂-concentrating mechanism already reduces CO₂ limitation

C4 plants concentrate CO_2 in bundle sheath cells, maintaining high CO_2 around RuBisCO even at low atmospheric CO_2. External CO_2 enrichment provides less benefit because C4 plants already overcome CO_2 limitation internally.

24. D - RuBisCO catalyzing oxygenase reaction with O₂ when CO₂/O₂ ratio is low

RuBisCO has both carboxylase (fixes CO_2) and oxygenase (fixes O_2) activity. At low CO_2/high O_2 ratios, the oxygenase reaction dominates, producing phosphoglycolate in wasteful photorespiration rather than productive carbon fixation.

25. D - Night has lower temperature and higher humidity, reducing transpiration

Opening stomata at night when temperature is lower and humidity higher reduces water loss compared to daytime opening. CAM plants fix CO_2 at night, store it as malate, then use it during day with stomata closed.

26. C - Dark reactions (Calvin cycle) become rate-limiting

At saturating light intensity, light reactions produce sufficient ATP and NADPH. Additional light provides no benefit because the Calvin cycle (carbon fixation, reduction, regeneration) cannot process substrates faster—it becomes the bottleneck.

27. B - Five G3P molecules must be used to regenerate 3 RuBP

For every 3 CO_2 fixed, 6 G3P are produced. One G3P (3 carbons) can exit for glucose synthesis. The remaining 5 G3P (15 carbons) are rearranged to regenerate 3 RuBP (15 carbons total), allowing the cycle to continue.

28. D - CO₂-concentrating mechanism reduces photorespiration despite increased RuBisCO oxygenase activity at high temperature

High temperature increases RuBisCO's oxygenase activity relative to carboxylase. C4 plants maintain high CO_2 in bundle sheath cells, favoring carboxylase activity and minimizing photorespiration even at elevated temperatures.

29. D - Acetylation neutralizes positive charges, loosening DNA-histone interaction and opening chromatin

Histones are rich in positively charged lysine and arginine residues that electrostatically attract negatively charged DNA phosphate groups. Histone acetyltransferases (HATs) add acetyl groups (-COCH₃) to lysine residues, neutralizing their positive charges. This weakens the electrostatic attraction between histones and DNA, loosening chromatin structure and making DNA accessible to transcription factors and RNA polymerase.

30. C - Catabolite repression—glucose lowers cAMP, reducing CAP-CMP activation even when repressor is released

With lactose present, the lac repressor is inactivated. However, glucose presence reduces cAMP levels. Without cAMP-CAP complex binding upstream of the promoter, transcription remains low despite repressor release—this is catabolite (glucose) repression.

31. C - The receptor acts as a ligand-dependent transcription factor (This matches the passage)

Glucocorticoid receptor remains cytoplasmic until hormone binding triggers nuclear translocation. The hormone-receptor complex then binds DNA and activates transcription—classic ligand-dependent transcription factor mechanism.

32. B - One gene can generate multiple protein isoforms through differential exon inclusion

Alternative splicing allows one tropomyosin gene to produce tissue-specific proteins by including different exon combinations. This generates protein diversity without requiring multiple genes for each variant.

33. A - Post-transcriptional regulation through mRNA stability and translation

MicroRNAs bind mRNA 3' UTRs, blocking translation and promoting mRNA degradation. Protein levels decrease without affecting transcription rate—this is post-transcriptional regulation.

34. C - Respiratory compensation (hyperventilation) for metabolic acidosis

Diabetic ketoacidosis causes metabolic acidosis (low HCO_3^-, low pH). Deep, rapid breathing (Kussmaul respiration) eliminates CO_2, reducing PCO_2 ($40 \rightarrow 25$ mmHg). This raises pH toward normal—respiratory compensation for metabolic acidosis.

35. B - Renal compensation attempting to raise pH by retaining HCO_3^- in chronic respiratory acidosis

COPD causes chronic CO_2 retention (respiratory acidosis). Over days, kidneys compensate by retaining HCO_3^- (32 mEq/L vs. normal 24) to partially normalize pH.

36. D - Blocking Na^+-K^+-$2Cl^-$ transport prevents medullary gradient formation

Loop diuretics block the Na^+-K^+-$2Cl^-$ cotransporter in thick ascending limb. This prevents NaCl reabsorption without water, eliminating medullary osmotic gradient generation. Without the gradient, collecting duct cannot concentrate urine.

37. B - Respiratory alkalosis from hyperventilation

Anxiety-induced hyperventilation eliminates CO_2 faster than production, decreasing PCO_2 ($40 \rightarrow 28$ mmHg). This raises pH (respiratory alkalosis). HCO_3^- is normal because compensation takes days—this is acute respiratory alkalosis.

38. C - Adjusting HCO_3^- reabsorption and H^+ secretion over days

Chemical buffers act in seconds, respiratory compensation in minutes-hours. Renal compensation (adjusting HCO_3^- reabsorption and H^+ secretion) takes 2-3 days but provides the most powerful long-term pH regulation.

39. D - Semiconservative replication (each new DNA has one old and one new strand)

After one replication in ^{14}N, all DNA is hybrid density (one ^{15}N strand, one ^{14}N strand). This proves each daughter molecule contains one parental strand and one new strand—semiconservative replication.

40. B - It removes incorrectly paired nucleotides from the 3' end

DNA polymerase 3'→5' exonuclease activity detects mismatched base pairs and removes the incorrect nucleotide from the growing 3' end before continuing synthesis. This proofreading reduces errors 100-fold.

41. C - p53 functions as a checkpoint guardian, and its loss allows damaged cells to proliferate

Normal cells with DNA damage arrest at G1 checkpoint via p53 activation. p53-deficient cells bypass this checkpoint and divide despite DNA damage, accumulating mutations—contributing to cancer development.

42. A - DNA polymerase synthesizes 5'→3' but the template is antiparallel

DNA polymerase only synthesizes 5'→3'. On the lagging strand (running 3'→5' toward replication fork), synthesis must occur in short 5'→3' fragments (Okazaki fragments) in the direction away from the fork.

43. D - Allow exit from mitosis and return to G1

M-phase cyclins activate CDKs that drive mitosis. Cyclin degradation at the end of M inactivates CDKs, allowing mitotic exit. Without cyclin degradation, cells would remain arrested in mitosis.

44. B - DNA repair or apoptosis if damage is irreparable

G1 checkpoint detects DNA damage and arrests the cycle, activating p53. This provides time for DNA repair mechanisms. If damage is too severe, p53 triggers apoptosis, preventing damaged cells from dividing.

45. C - Lipids

Lipids provide ~9 kcal/g; carbohydrates and proteins provide ~4 kcal/g. Lipids' reduced carbon atoms and high hydrogen content yield more energy per gram when completely oxidized.

46. A - Enzymes have rigid active sites complementary to substrates

Lock-and-key model proposes enzymes have pre-formed active sites complementary to substrate shape (like key fits lock). Though induced-fit model is more accurate, lock-and-key describes basic enzyme specificity.

47. D - Oxygen (O_2)

Electrons pass through Complexes I-IV in the electron transport chain. At Complex IV (cytochrome c oxidase), electrons reduce O_2 to H_2O. Oxygen is the terminal electron acceptor in aerobic respiration.

48. B - Gametes with extra or missing chromosomes

Nondisjunction is failure of chromosomes or sister chromatids to separate properly. Meiosis I nondisjunction produces gametes with both homologs (n+1) or neither (n-1), causing aneuploidies like trisomy 21.

49. C - Tight junctions between endothelial cells

The blood-brain barrier consists of brain capillary endothelial cells connected by tight junctions, preventing paracellular diffusion. This restricts molecule entry to transcellular transport, protecting brain from blood-borne substances.

50. A - Myosin-actin detachment

ATP binding to myosin causes conformational change that releases actin. Without ATP (rigor mortis), myosin heads remain bound to actin. ATP hydrolysis then re-cocks the myosin head for the next power stroke.

51. D - DNA polymerase cannot replicate the extreme 5' ends of linear chromosomes

DNA polymerase requires primers and synthesizes 5'→3'. After removing the terminal RNA primer, no polymerase can fill the gap at chromosome ends. Telomeres shorten with each replication unless telomerase is active.

52. B - It spontaneously depolarizes faster than other cardiac cells

SA node cells have unstable resting potentials with slow Na^+ leak, reaching threshold (~60-70 times/min) before other cardiac cells. This spontaneous depolarization initiates each heartbeat, making the SA node the natural pacemaker.

53. C - X-linked dominant inheritance

Affected fathers pass X chromosomes only to daughters (sons get father's Y). All daughters receive the affected X and are affected. This pattern is characteristic of X-linked dominant traits.

54. B - A point mutation (Glu→Val) in the β-globin gene

Sickle cell anemia results from a single nucleotide substitution (GAG→GTG) causing glutamic acid→valine substitution at position 6 of β-globin. This point mutation causes hemoglobin S polymerization and RBC sickling.

55. D - Increase apparent Km without changing Vmax

Competitive inhibitors compete with substrate for the active site. High substrate concentrations overcome inhibition by outcompeting the inhibitor. This increases apparent Km (more substrate needed to reach half-maximal velocity) but doesn't change Vmax (sufficient substrate still achieves maximum velocity).

56. D - Transports 3 Na$^+$ out and 2 K$^+$ in using ATP

Na$^+$/K$^+$-ATPase is a primary active transporter that hydrolyzes one ATP to pump 3 Na$^+$ out and 2 K$^+$ in against their concentration gradients. This electrogenic pump contributes to resting membrane potential.

57. B - Excess nitrogen and phosphorus causing algal blooms

Eutrophication occurs when excessive nutrients (nitrogen, phosphorus from fertilizer runoff or sewage) stimulate algal overgrowth. Algal blooms deplete oxygen when decomposing, causing fish kills and ecosystem degradation.

58. A - Iodine

Thyroid hormones (T3 and T4) contain 3 or 4 iodine atoms respectively. Thyroid follicular cells trap iodide, oxidize it, and incorporate it into thyroglobulin to synthesize thyroid hormones. Iodine deficiency causes hypothyroidism and goiter.

59. D - Strengthens behavior by removing an aversive stimulus

Negative reinforcement strengthens behavior by removing something unpleasant (taking aspirin removes headache, reinforcing aspirin-taking). This differs from punishment, which weakens behavior. "Negative" refers to removing stimuli, not to punishment.

SECTION 4: ANSWER EXPLANATIONS

1. A - Learning transfers reward signaling from outcomes to predictive cues

Day 1 shows dopamine spikes at food delivery. Day 10 shows dopamine shifts to tone onset with reduced response at food. This demonstrates that dopamine signals prediction errors—responding to cues that predict reward rather than the reward itself once the association is learned.

2. C - Supranormal reinforcement creating stronger behavioral conditioning

Cocaine produces 300% dopamine increase vs. 150% for natural rewards. This "supranormal" stimulation creates more powerful reinforcement than evolutionary rewards, explaining addiction potential—drugs hijack reward circuitry beyond normal biological levels.

3. B - Adaptive changes reducing dopamine signaling efficiency

After chronic cocaine use, 2× dose is needed for the same effect. This tolerance reflects neuroadaptation—receptor downregulation, reduced dopamine synthesis, or enhanced reuptake—compensating for repeated excessive stimulation.

4. D - Movement and cognition involve distinct dopaminergic pathways

L-DOPA improves motor symptoms (nigrostriatal pathway to striatum) but not executive deficits (mesocortical pathway to prefrontal cortex). Different dopamine pathways serve different functions; nigrostriatal degeneration in Parkinson's affects movement more than mesocortical-dependent cognition.

5. A - Negative outcomes produce stronger emotional responses than positive ones

Losses activate amygdala more than equivalent gains activate nucleus accumbens. This asymmetry reflects loss aversion—evolutionary pressures made avoiding losses (survival threats) more critical than pursuing equivalent gains.

6. C - Reduced pleasure experience in depressive disorders

The nucleus accumbens (mesolimbic pathway) mediates reward and pleasure. Dysfunction here would impair hedonic response, manifesting as anhedonia—a core symptom of major depression where patients cannot experience pleasure from normally rewarding activities.

7. D - Categorization alone triggers preferential in-group treatment

Despite random assignment and knowing groups are meaningless, participants still favored in-group members (12 vs. 8 points). This demonstrates that mere categorization—without competition, prior relationships, or meaningful differences—automatically activates in-group favoritism.

8. B - Common objectives requiring cooperation reduce intergroup conflict

Phase 2 competition created hostility. Phase 3 superordinate goals (fixing water supply) requiring cooperation decreased conflict and fostered cross-group friendships. This supports realistic conflict theory—shared goals reduce intergroup antagonism.

9. C - Salient stereotypes create self-fulfilling prophecy effects

When gender/race identity is made salient before tests, stereotype threat activates—anxiety about confirming negative stereotypes. This creates cognitive load and anxiety that impair performance, confirming the stereotype through a self-fulfilling prophecy mechanism.

10. A - Multiple identities create cognitive complexity reducing stereotyping

Cross-categorization (sharing one category, differing on another) produces intermediate evaluations between full in-group and full out-group. Multiple overlapping identities complicate simple us-vs-them thinking, reducing bias through increased cognitive complexity.

11. D - Environmental cues shape identity salience affecting outcomes

In female-majority environments, gender identity is less salient (not a distinctive minority), reducing stereotype threat. This shows that contextual cues determine which identity becomes salient, thereby affecting performance through identity-based expectations.

12. B - Brain state oscillations selectively enhance memory categories

Slow-wave sleep (with delta oscillations) preferentially consolidates declarative memories, while REM sleep consolidates procedural memories. Different sleep stages provide distinct neural oscillation patterns that optimize consolidation for different memory types.

13. D - Sleep quality markers predict cognitive outcomes

Higher spindle density correlates with better memory retention. Spindles increase after intensive learning, suggesting they reflect active consolidation processes. This shows spindles serve as biomarkers indicating memory processing quality.

14. A - Homeostatic mechanisms regulate sleep stage distribution

REM deprivation increases REM pressure—attempts to enter REM occur more frequently. Upon recovery, REM rebound occurs (extra REM). This demonstrates homeostatic regulation maintaining appropriate sleep stage proportions.

15. C - Neural damage from deprivation requires extended repair

After 24-48 hours of deprivation, one 8-hour recovery night provides only partial restoration. Full recovery requires multiple nights, suggesting deprivation causes neural changes (synaptic stress, metabolic disruption) requiring extended repair time.

16. A - Active processing during sleep exceeds passive maintenance

Sleep group retained 85% vs. wake group 60% despite equal time passage. This indicates sleep actively consolidates memories through hippocampal-neocortical replay and synaptic strengthening, not just passive protection from interference.

17. D - Ultradian rhythms phase-shift throughout sleep episodes

Sleep architecture changes across the night with 90-minute ultradian cycles. Early cycles have more N3 (slow-wave sleep); later cycles have longer REM periods. This phase-shifting reflects the interaction between homeostatic (Process S) and circadian (Process C) factors.

18. C - Cognitive heuristics simplify causal explanations by minimizing complexity

Despite knowing essay writers had no choice, participants inferred attitudes from content. This demonstrates that dispositional attribution occurs as a cognitive shortcut—it's simpler to attribute behavior to stable traits than to analyze complex situational constraints.

19. A - Divergent information access about intentions and contexts

Actors know their intentions, past experiences, and situational constraints. Observers see only behavior. This informational asymmetry contributes to actor-observer bias—actors emphasize situations they're aware of; observers emphasize dispositions they observe.

20. D - Public contexts amplify need for competence signaling

Self-serving bias (crediting success to ability, blaming failure on luck) increases when performance is public. Social audiences create pressure to maintain positive impressions, motivating strategic attributions that protect self-image and signal competence to others.

21. B - Cultural socialization shaping perceptual attention patterns

Japanese participants made more situational attributions and described environmental context (fish tank study). Collectivist cultures socialize attention toward relationships and contexts, while individualist cultures focus on individual agents—shaping automatic perceptual patterns underlying attributions.

22. C - Reframing failure as strategy deficit enables corrective action

Teaching students that failure reflects insufficient effort or poor strategy (controllable factors) rather than low ability (uncontrollable) led to 25% grade improvement. Controllable attributions suggest specific corrective actions (study more, use better strategies), enabling improvement.

23. A - Chronic stress produces measurable cellular aging markers

Caregivers showed accelerated telomere shortening (equivalent to 10 years aging). Telomeres protect chromosomes and shorten with each cell division. Chronic stress accelerates this process, providing biological evidence that psychological stress causes measurable cellular aging.

24. C - Subjective controllability modulates HPA axis activation

Groups with perceived control (functional button or belief button works) showed equal low stress despite different actual control. Group without perceived control showed elevated cortisol. This demonstrates that subjective beliefs about control regulate physiological stress responses.

25. D - Interpersonal resources operate through varied mechanisms

Social support reduced mortality through multiple pathways: emotional support, instrumental assistance, informational guidance, better health behaviors, faster healthcare seeking, and reduced inflammation. Multiple mechanisms create robust protective effects.

26. D - Coping effectiveness depends on stressor-strategy fit

Problem-focused coping worked for controllable stressors (exams); emotion-focused for uncontrollable (family illness). Mismatches produced worse outcomes. Effective coping requires matching strategy to stressor controllability—addressing what can be changed, accepting what cannot.

27. A - Stress duration determines immune system effects

Brief acute stress enhanced immunity (redistributing cells to potential injury sites). Chronic stress suppressed immunity (sustained cortisol disrupting immune function). Duration transforms adaptive short-term responses into maladaptive long-term effects.

28. A - Resource depletion from sustained coping efforts

After prolonged alarm and resistance phases, physiological and psychological resources deplete. Continued stress without recovery leads to exhaustion—depleted energy reserves, compromised immune function, and increased illness vulnerability.

29. D - Inconsistent payoffs generate sustained motivational states

Variable ratio schedules provide unpredictable reinforcement. Each response might be rewarded, maintaining motivation. Extinction is difficult to detect since reinforcement was already unpredictable. This creates persistent responding—highest rates and greatest resistance to extinction.

30. B - Differential reinforcement guides behavioral progression efficiently

Shaping reinforces successive approximations toward target behavior. By differentially reinforcing closer responses while extinguishing farther ones, shaping guides rapid learning (20 minutes vs. 6 hours waiting for spontaneous occurrence).

31. C - Extrinsic rewards effectively modify target behaviors

Token economy increased target behaviors 300% during active phase. Reversal phase (removing tokens) returned behaviors to baseline, then reinstatement restored them. This demonstrates tokens function as effective conditioned reinforcers maintaining behavioral changes.

32. A - Temporal contiguity strengthens response-consequence associations

Immediate punishment produced 90% suppression; delayed punishment only 40%. Temporal proximity between behavior and consequence strengthens associative learning. Delays weaken the connection as intervening behaviors and time obscure the contingency.

33. D - Fear conditioning produces difficult-to-extinguish behaviors

Avoidance learning combines classical conditioning (fear) and operant conditioning (escape/avoidance). The resulting behaviors persist through hundreds of extinction trials because successful avoidance prevents learning that the threat no longer exists—fear never disconfirmed.

34. B - Metarepresentational capacity develops with cognitive maturation

Three-year-olds fail false belief tasks; five-year-olds succeed. This transition reflects developing metarepresentational capacity—ability to represent representations (understand that Sally has a belief about marble location that differs from reality).

35. D - Appearance-based reasoning precedes logical reasoning

Preoperational children say "tall glass has more" despite witnessing the pour. They focus on perceptual appearance (height) rather than logical invariance (quantity conservation). This demonstrates that perception-dominated thinking precedes operational logic.

36. A - Social interaction optimizes learning through guided discovery

Scaffolding within the ZPD (tasks solvable with help but not independently) produced 40% improvement vs. 10% without guidance. Vygotsky emphasized that learning occurs optimally through social interaction providing appropriately calibrated support.

37. C - Brain development constrains and enables cognitive abilities

Stroop task performance improves with age (60% errors at age 5 → 5% in adults), correlating with prefrontal cortex maturation. This demonstrates that cognitive abilities depend on underlying neural development—biology constrains and enables psychology.

38. B - Developing ability to mentally represent multiple viewpoints

Preoperational children describe their own view (egocentric); concrete operational children describe doll's perspective. This transition reflects developing capacity to mentally represent and coordinate multiple perspectives simultaneously.

39. D - Biological factors determine acquisition trajectories

Second language proficiency declines with later age of acquisition despite equal exposure years. Arrival before 7: native-like; after 17: marked deficits. This age-related decline independent of exposure duration supports biologically-determined critical period constraints.

40. B - Grammar requires earlier developmental windows than vocabulary

Genie learned vocabulary but never acquired grammatical competence despite intensive training after age 13. This dissociation suggests grammar has a stricter critical period than vocabulary—syntactic systems require earlier acquisition windows.

41. C - Bilingualism produces domain-general cognitive benefits

Bilinguals showed executive function advantages (faster response times, higher accuracy on conflict tasks) despite potential vocabulary delays. Managing two languages exercises cognitive control systems, producing benefits extending beyond language to general executive functioning.

42. D - Interactive contexts support language development

Child-directed speech (motherese) increased infant attention, engagement, and later vocabulary (30% larger). The exaggerated prosody, simplified grammar, and social interaction facilitate language learning through multi-modal support.

43. C - Critical periods reflect brain development not auditory processing

ASL (visual-manual) shows similar critical period effects as spoken languages. Native signers achieve fluency; late learners show grammatical deficits. Since modality differs but critical period persists, constraints reflect general brain maturation, not auditory-specific factors.

44. A - Individual differences increase outside critical periods

Late second-language learners showed high variability (same exposure, different outcomes) while early learners showed consistent success. Outside critical periods, learning depends more on individual factors (aptitude, motivation, strategies), increasing outcome variance.

45. C - Amygdala

The amygdala processes emotional significance and is crucial for fear conditioning. Damage to amygdala impairs fear learning and emotional memory while preserving other memory types.

46. A - People get what they deserve and deserve what they get

Just-world hypothesis is the cognitive bias that outcomes match deservingness. This leads to victim-blaming—assuming victims must have done something to deserve their fate.

47. D - A constant proportion of the original stimulus intensity

Weber's law: $\Delta I/I = k$ (constant). The just noticeable difference is a constant percentage of stimulus intensity. Heavier weights require larger absolute differences to detect change.

48. B - Repeated exposure to neutral stimuli increases liking

Mere exposure effect demonstrates that familiarity breeds liking. Repeated exposure to neutral stimuli (faces, shapes, nonsense words) increases positive evaluation without conscious awareness.

49. C - Identity vs. role confusion

Erikson's adolescent crisis involves establishing coherent identity. Success yields strong sense of self; failure produces role confusion about values, beliefs, and life direction.

50. A - Fluent but meaningless speech with comprehension deficits

Wernicke's aphasia (temporal lobe damage) produces fluent, grammatical but meaningless speech ("word salad") with severe comprehension deficits. Contrasts with Broca's aphasia (non-fluent speech, intact comprehension).

51. B - Change attitudes to reduce psychological discomfort

Cognitive dissonance theory proposes that inconsistency between cognitions creates psychological discomfort. People reduce dissonance by changing attitudes, behaviors, or adding consonant cognitions.

52. B - Apparent motion from sequential static stimuli

Phi phenomenon describes perceiving motion when viewing sequential static images (like film frames). Brain interprets rapid succession as continuous movement.

53. C - Learning can occur without direct reinforcement through modeling

Bandura's Bobo doll studies showed children imitated aggressive behavior observed in models without being directly reinforced. This demonstrates observational learning—learning through watching others.

54. B - Rising average IQ scores across generations

Flynn effect describes population-level IQ increases (~3 points/decade) across generations, attributed to improved nutrition, education, and cognitive complexity of modern environments.

55. B - Spinal mechanisms can inhibit pain signal transmission

Gate control theory proposes that neural "gates" in spinal cord can close, blocking pain signals from reaching brain. Non-painful input (rubbing) or descending signals from brain can close gates.

56. A - Dopamine

Schizophrenia involves dopamine dysregulation. The dopamine hypothesis proposes excess dopamine activity (particularly in mesolimbic pathway) contributes to positive symptoms. Antipsychotics block dopamine D2 receptors.

57. B - Judge likelihood based on similarity to prototypes

Representativeness heuristic judges probability by how much something resembles a typical case. Can lead to errors like ignoring base rates when similarity to stereotype is high.

58. B - Muscle atonia and vivid dreams

REM sleep features rapid eye movements, muscle atonia (paralysis preventing dream enactment), vivid dreams, and EEG resembling waking. Paradoxical sleep—brain active but body paralyzed.

59. D - Self-actualization

Maslow's hierarchy places self-actualization at the peak—realizing one's full potential, creativity, and personal growth. This follows physiological, safety, belongingness, and esteem needs.