

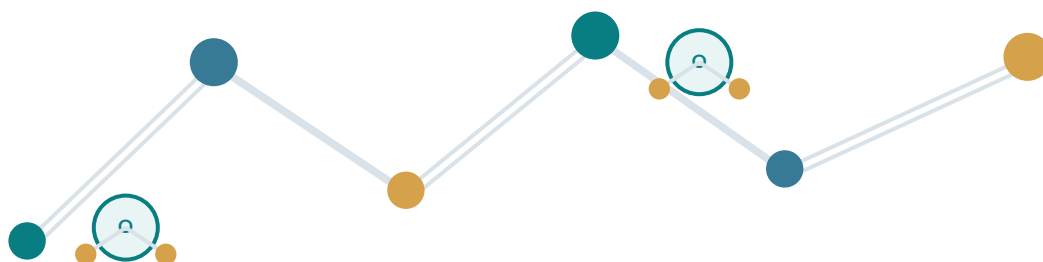
AP BIOLOGY

UNIT 01 / CHEMISTRY OF LIFE

FULL-LENGTH PRACTICE EXAMINATION

Chapter 1 preparation • The Princeton Review, AP Biology Premium Prep (29th edition)

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ASSESSMENT	QUESTIONS	TIME	SCORING
Unit 1 only	60 MCQ + 6 FRQ	90 + 90 min	60 pts + 34 pts

CANDIDATE INFORMATION

Student _____

Date _____

School _____

Form A • Chemistry of Life

Assessment scope: water and hydrogen bonding; elements of life; monomer-polymer chemistry; carbohydrates; lipids; nucleic acids; proteins.

SECTION I / MULTIPLE CHOICE

60 questions

Choose the single best answer for each item. Some questions share a stimulus, table, or graph. Record answers on the answer grid at the end.

ITEMS	TIME ALLOWED	MAXIMUM POINTS
60	90 minutes	60 points

Questions 1–25 / Independent items

For each question, select the response best supported by the information provided.

QUESTION 01

In a laboratory, two equal-mass samples of water receive identical amounts of thermal energy. Sample X begins at 10 °C and sample Y at 20 °C. Both samples have the same composition and mass. Which prediction is best supported?

- A The temperature of Y increases more because heating destroys its covalent O–H bonds.
- B The temperature of X increases more because colder water contains fewer hydrogen bonds.
- C Neither sample warms until every intermolecular hydrogen bond is broken.
- D The temperature increases by approximately the same amount in both samples, assuming the specific heat remains effectively constant.

QUESTION 02

A model shows one water molecule with a partial negative charge near oxygen and partial positive charges near both hydrogens. A neighboring water molecule is oriented with one hydrogen toward the first molecule's oxygen. What primarily stabilizes this alignment?

- A** A covalent O–H bond that connects oxygen atoms in separate water molecules
- B** An ionic bond formed after one water molecule permanently transfers a proton
- C** An attraction between identical partial charges that holds the molecules together
- D** An intermolecular hydrogen bond arising from electrostatic attraction between partial charges

QUESTION 03

Students compare how far water rises in narrow glass tubes of different inner diameters. Their hypothesis is that capillary rise depends on tube diameter. Which procedure best isolates the proposed variable?

- A** Use the same tube material and liquid conditions while varying only tube inner diameter.
- B** Compare the rise of water and ethanol in tubes of different diameters.
- C** Compare tubes at different diameters, but also allow ambient temperatures to differ.
- D** Compare narrow untreated tubes with wide tubes coated in a nonpolar film.

QUESTION 04

A freshwater pond experiences less daily temperature fluctuation than nearby exposed rock under comparable sunlight. Which property of water best explains the difference?

- A** The specific heat of water is high, so a given heat input produces a smaller temperature change.
- B** The ionic bonds between water molecules absorb all incident solar energy.
- C** Water has lower thermal conductivity than rock, so the water cannot gain heat.
- D** Water is chemically unable to exchange heat with the surrounding air.

QUESTION 05

A scientist finds a large, chemically diverse family of stable biological molecules built around chains and rings of one element. Which atomic property most directly accounts for this versatility?

- A** An atom of carbon has four valence electrons, which permits multiple stable covalent bond configurations.
- B** Carbon has a complete octet before any bonds form.
- C** Carbon has four protons and thus can form stable chains with itself.
- D** Carbon forms only single bonds, preventing rigid structures.

QUESTION 06

An organism grows in a medium lacking phosphorus but containing sufficient carbon, hydrogen, oxygen, and nitrogen. Which newly synthesized cellular structure is most directly constrained?

- A** A cellulose chain containing only glucose subunits
- B** A polypeptide backbone built entirely of peptide bonds
- C** A DNA sugar-phosphate backbone
- D** A triglyceride composed solely of glycerol and fatty acids

QUESTION 07

Researchers suspect nitrogen availability limits the production of a particular protein. Which paired treatment most directly tests that hypothesis?

- A** Supply extra nitrogen to both cultures while varying their carbon sources.
- B** Compare a nitrogen-enriched culture to one in which light and water supply are also reduced.
- C** Supply extra nitrogen to one of two otherwise identical cultures and compare protein output.
- D** Increase nitrogen and temperature in the treatment group and compare to an unmodified control.

QUESTION 08

A linear polymer is assembled from 14 monomers. Each linkage is formed in a dehydration reaction that releases one water molecule. How many water molecules are produced in assembling one polymer?

- A** 14
- B** 15
- C** 13
- D** 28

QUESTION 09

An enzyme catalyzes the complete breakdown of a polysaccharide into its constituent monosaccharides using water. The chemical process is best described as

- A** Water is consumed to create a larger sugar polymer from individual glucose units.
- B** Water is consumed as bonds between monomers are cleaved.
- C** Hydrogen bonds are replaced by peptide bonds as glucose is released.
- D** The reactant water is released to form additional covalent glycosidic bonds.

QUESTION 10

A biopolymer is synthesized with the same kinds of monomers as a natural polymer but in a different sequence and arrangement. Which claim is best justified?

- A** Its function can change because bond arrangement and monomer order influence three-dimensional properties.
- B** Different monomer order implies every covalent bond will be lost in water.
- C** Its function must be preserved because the elemental composition remains identical.
- D** Its function can change only if monomers of an entirely new chemical class are introduced.

QUESTION 11

Humans can digest starch more readily than cellulose, although both contain glucose. Which explanation best accounts for the difference?

- A** Cellulose lacks the carbon atoms present in starch.
- B** Different glycosidic linkages create structures recognized differently by digestive enzymes.
- C** Starch is composed of amino acids rather than monosaccharides.
- D** Cellulose contains no covalent bonds.

QUESTION 12

A plant-cell-wall polysaccharide resists stretching because adjacent, straight chains associate into parallel bundles. Which feature most directly supports this mechanical role?

- A** Cellulose becomes strong because all glucose units have ionic charges.
- B** Parallel cellulose chains spontaneously convert to branched glycogen.
- C** Aligned cellulose chains form extensive hydrogen-bonded interactions that strengthen fibrils.
- D** Adjacent chains form peptide bonds, creating fibrous proteins.

QUESTION 13

Two energy-storage polysaccharides have equal mass and glucose composition. One has more branch points. Which structural property is most likely greater in the more-branched molecule?

- A** Branching changes glucose from a monosaccharide to a nucleotide.
- B** More branch points usually yield more accessible nonreducing chain ends.
- C** More branched polymer necessarily contains more total glucose subunits despite equal mass.
- D** A higher branch count means alpha linkages must all be replaced with beta linkages.

QUESTION 14

A researcher wants to test whether different glycosidic bonds affect an enzyme's rate of polymer breakdown. What is the strongest comparison?

- A** Use equal masses of the same polymer but expose them to different enzyme doses.
- B** Compare two polymer preparations that differ in both linkage type and residual inhibitor content.
- C** Compare different polymers at different incubation times and normalize only by enzyme mass.
- D** Use equal glucose-equivalent concentrations of two polymers with different linkages and assay each with the same enzyme at matched pH and temperature.

QUESTION 15

When phospholipids are mixed with water, they spontaneously form structures in which the hydrocarbon tails face away from water. Which property best explains this behavior?

- A** Phospholipids dissolve into free nucleotides upon contact with water.
- B** Both heads and tails form equally strong hydrogen bonds to water.
- C** Each phospholipid contains two identical hydrophilic regions and no hydrophobic region.
- D** Polar head groups favor water while the nonpolar hydrocarbon tails minimize contact with it.

QUESTION 16

At a constant temperature, a membrane incorporates a greater proportion of phospholipids with cis-unsaturated fatty-acid tails. Which change is most likely, other factors equal?

- A** Cis double bonds introduce kinks that tend to disrupt dense packing of adjacent tails.
- B** Unsaturated tails become strongly charged and repel the water-facing heads.
- C** Cis double bonds make tails straighter and thus increase tight packing.
- D** Unsaturation removes the glycerol-phosphate region of each lipid.

QUESTION 17

A molecule consists of three fatty acids covalently attached to a glycerol backbone. Which function is most consistent with its structure?

- A** Formation of peptide-bonded catalytic sites
- B** A dense reserve of metabolizable chemical energy in fatty-acid chains
- C** Covalent storage of a base sequence for inheritance
- D** Formation of a sugar-phosphate genetic backbone

QUESTION 18

A short DNA segment has the sequence 5'-ACGTTA-3'. Which sequence correctly represents its complementary strand written from 3' to 5'?

- A 3'-ACGTTA-5'
- B 3'-TGCAAT-5'
- C 3'-UGCAAU-5'
- D 3'-TAACGT-5'

QUESTION 19

In a double-stranded DNA fragment, 28% of the nucleotides are adenine. What percentage are guanine, assuming conventional Watson-Crick pairing?

- A 22%
- B 72%
- C 44%
- D 28%

QUESTION 20

A nucleic-acid strand grows when a new nucleotide forms a covalent bond with the free 3' hydroxyl of the previous nucleotide. This observation best supports which conclusion?

- A Covalent phosphodiester linkages form only between complementary strands.
- B Hydrogen bonds between adjacent sugars dictate the direction of growth.
- C New nucleotides are attached at the free 3' end, giving strands a 5'→3' growth direction.
- D New nucleotides are attached at the free 5' end, producing 3'→5' strand growth.

QUESTION 21

A researcher changes several base pairs in a DNA molecule without altering the number of nucleotides. Which feature is definitely changed?

- A Its double-stranded architecture must be lost.
- B Its linear nucleotide sequence at the altered positions.
- C Its total number of sugar-phosphate units.
- D Its phosphodiester bonds become peptide bonds.

QUESTION 22

A protein variant differs from the original at one amino-acid position. The substituted residue has a different electric charge at cellular pH. Which outcome is best supported?

- A Primary structure is unchanged; only quaternary structure necessarily changes.
- B Primary structure changes; charge-dependent higher-order interactions might also change.
- C Tertiary structure must be completely destroyed in every cellular environment.
- D Secondary structure is unaltered because all R groups have the same charge.

QUESTION 23

A folded protein is shown as two separate polypeptide chains that associate to form a functional complex. Their association is an example of

- A Intrachain tertiary folding, because all complexes contain one chain
- B Primary structure, because the chains form one continuous covalent backbone
- C Quaternary structure, because multiple polypeptide subunits interact
- D Secondary structure, because association always creates alpha helices

QUESTION 24

Heating causes a soluble enzyme to lose most of its catalytic activity even though analysis detects no cleavage of peptide bonds. Which change best explains the observation?

- A Hydrolysis of peptide bonds that shortens every polypeptide
- B Conversion of all R groups into identical charged residues
- C Formation of new phosphodiester bonds between amino acids
- D Loss of interactions maintaining conformation while peptide bonds remain intact

QUESTION 25

An alpha helix within a protein remains locally intact, but the protein loses activity after a change in ionic strength. Which explanation is most consistent with these observations?

- A Ionic strength influences the sequence of DNA but cannot influence a folded protein.
- B Primary structure must have changed because ionic strength chemically replaces amino acids.
- C Retaining one alpha helix guarantees unchanged active-site geometry.
- D Changes in tertiary ionic interactions may alter function while local backbone hydrogen bonds retain the helix.

Questions 26–60 / Linked data sets

Each investigation is followed by five questions. Revisit the same table or graph as necessary.

DATA-BASED SET A / QUESTIONS 26–30

Water and surfaces

Researchers examine water movement through vertical microtubes with identical inner diameters. Tubes differ only in the surface coating. Each tube contains water at 22 °C, and measurements are taken after 2 minutes. Contact angle is measured on a flat sample of each coating; lower angles indicate better wetting. Five replicate tubes were used per treatment. Capillary height is measured relative to the reservoir surface; negative values indicate depression below that level.

Surface coating	Water contact angle	Capillary height (mm)
Untreated glass	28°	46
Hydrophilic polymer	19°	52
Nonpolar silane	108°	-3

Data are hypothetical and provided for assessment.

QUESTION 26

Which conclusion about the treatments is directly supported by the results?

- A The polar treatment causes a higher contact angle than the nonpolar treatment.
- B Surface coating is the only physical factor that can influence capillary rise.
- C The polar coating is associated with greater mean rise than the two other tested coatings.
- D The data alone establish an increase in xylem transpiration rate in intact plants.

QUESTION 27

Which molecular interaction most directly accounts for the different water rise in untreated glass and silane-coated tubes?

- A Greater capillary rise results because the hydrophilic surface decreases water's polarity.
- B A stronger attraction between water molecules and the surface contributes to adhesion on hydrophilic glass.
- C Greater surface tension necessarily results from a new covalent water–glass bond.
- D A nonpolar coating should attract water more strongly than a polar coating.

QUESTION 28

A researcher hypothesizes that tube diameter independently influences rise height. Which follow-up is most appropriate?

- A** Change tube diameter and liquid density concurrently, recording the largest height.
- B** Use only one radius, varying the contact angle of every trial.
- C** Increase tube radius and change the coating to keep water height constant.
- D** Use a series of tube radii for one surface material at fixed liquid temperature and composition.

QUESTION 29

Why would the data not justify the claim that greater wetting always causes higher water transport rates inside living plants?

- A** Capillary rise cannot occur in organisms containing salts.
- B** The 2-minute measurement proves that the surface chemistry has no effect.
- C** Whole-plant transport also depends on additional mechanisms not tested by isolated tubes.
- D** The contact-angle measurements cannot be repeated with living tissues.

QUESTION 30

How many millimeters higher is the capillary water level in hydrophilic-polymer tubes than in silane-coated tubes?

- A** 49 mm
- B** 55 mm
- C** 52 mm
- D** 58 mm

DATA-BASED SET B / QUESTIONS 31–35

Linkage specificity

Two purified glucose polymers (P and Q) of equal mass are incubated separately with enzymes E1 and E2. E1 is known to cleave certain alpha-glycosidic linkages; E2 cleaves beta-1,4 linkages. Reducing-sugar production (in arbitrary units) is measured after 20 minutes. Both polymers start with the same negligible background signal.

Polymer	No enzyme	With E1	With E2
P	2	81	3
Q	2	4	75

All assays used equal substrate concentration, pH, temperature, and enzyme concentration.

QUESTION 31

Based on the experiment, which enzyme-substrate pairing gives the strongest evidence of cleavage?

- A No enzyme with Q
- B E2 with P
- C E1 with Q
- D E1 with P

QUESTION 32

Which claim is best justified by the contrast between polymers P and Q?

- A Monomer composition uniquely fixes both linkage pattern and enzyme specificity.
- B Both enzymes must be equally effective because all polymers contain carbon.
- C Different linkage arrangements can cause distinct enzyme susceptibility despite identical glucose monomers.
- D The assays establish the full three-dimensional structures of both polymers.

QUESTION 33

Why is the 'no enzyme' column important?

- A It accounts for reductions in substrate mass during the hydrolysis step.
- B It estimates the reducing-sugar signal without an active added enzyme.
- C It confirms that the enzymes contain no glycosidic bonds.
- D It tests whether different buffers alone alter the linkage types.

QUESTION 34

A newly isolated glucose polymer is cleaved efficiently by E2 but minimally by E1. Which hypothesis is most consistent with these data?

- A** The polymer contains no alpha linkages anywhere because E1 has low activity.
- B** The polymer cannot be composed of glucose monomers because E1 is ineffective.
- C** The polymer must have a branched alpha-1,6 backbone.
- D** The polymer likely presents linkages recognized by E2, consistent with beta-1,4 cleavage activity.

QUESTION 35

Which additional observation would most strongly challenge the interpretation that linkage differences drive the enzyme-specific results?

- A** A contaminant specifically inhibits E1 in polymer Q preparations.
- B** Both polymers yield glucose after cleavage by a nonspecific catalyst.
- C** Independent repeats reproduce the observed enzyme-specific patterns.
- D** The solution contains equal buffer concentrations across the treatments.

DATA-BASED SET C / QUESTIONS 36–40

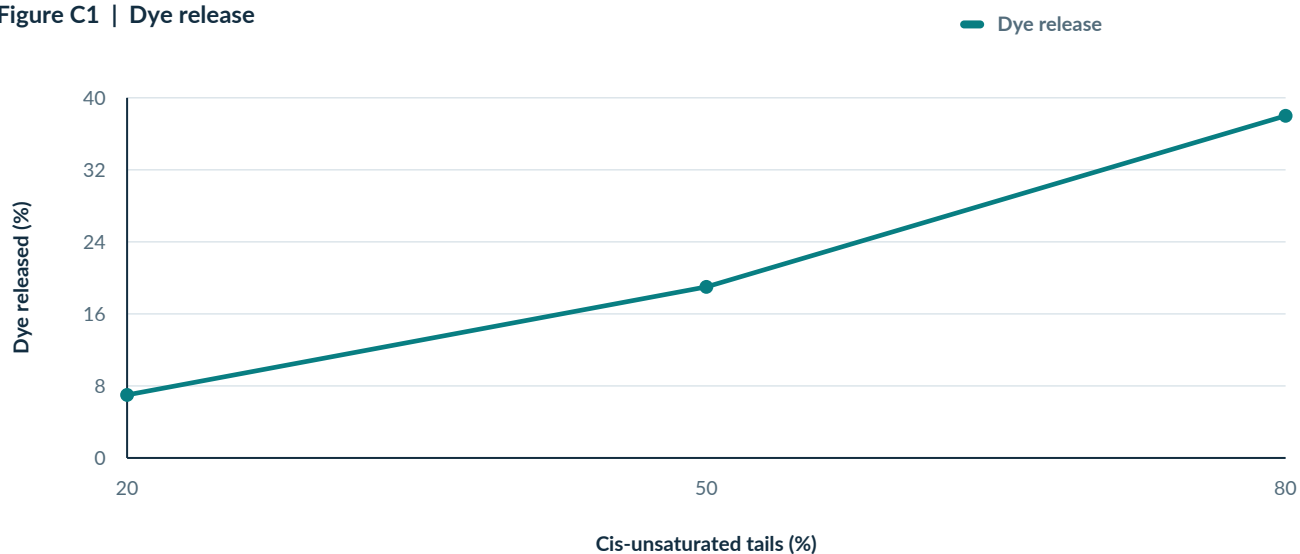
Lipid bilayer leakage

Researchers prepare artificial vesicles that are identical except for the composition of their phospholipid tails. Vesicles contain a fluorescent dye, and a larger percentage of dye released indicates greater leakage. Values are means of independent replicates at 20 °C.

Cis-unsaturated tails	20%	50%	80%
Dye released after 10 min	7%	19%	38%

The vesicles have comparable diameter, total lipid quantity, and dye loading.

Figure C1 | Dye release



QUESTION 36

Which statement is supported by the data at 20 °C?

- A Dye leakage increases linearly by precisely 10 percentage points per 10% change in unsaturation.
- B The three compositions show increasing dye leakage with increasing tail unsaturation.
- C Every lipid composition has identical permeability at a fixed temperature.
- D The data prove unsaturation changes the total mass of phospholipid in the vesicles.

QUESTION 37

Which molecular explanation best accounts for the observed trend?

- A Cis double bonds introduce hydrocarbon kinks that can reduce packing and increase leakage.
- B An increase in unsaturation increases the net positive charge of phospholipid heads.
- C Unsaturation causes each phospholipid to lose its amphipathic organization.
- D Cis double bonds create covalent links between neighboring membrane lipids.

QUESTION 38

Compared with the 20% unsaturated treatment, by how many percentage points does leakage increase in the 80% treatment?

- A 31
- B 38
- C 19
- D 5

QUESTION 39

Which additional measurement would best evaluate a proposed link between leakage and membrane packing?

- A Measure membrane order or fluidity independently under the same lipid compositions.
- B Measure phospholipid head-group charge after adding a different detergent to each treatment.
- C Measure lipid molecular mass instead of packing while changing solvent composition.
- D Measure only the length of the glass sample holder used for imaging.

QUESTION 40

Which limitation most directly prevents concluding that 80% unsaturation will always increase permeability in natural cell membranes?

- A Artificial vesicles necessarily contain no hydrocarbon tails.
- B The artificial vesicle results demonstrate that dye never crosses a bilayer.
- C Cell membranes always contain exactly 80% unsaturated tails.
- D Proteins, cholesterol, membrane asymmetry, and lipid mixtures can modify behavior in cells.

DATA-BASED SET D / QUESTIONS 41–45

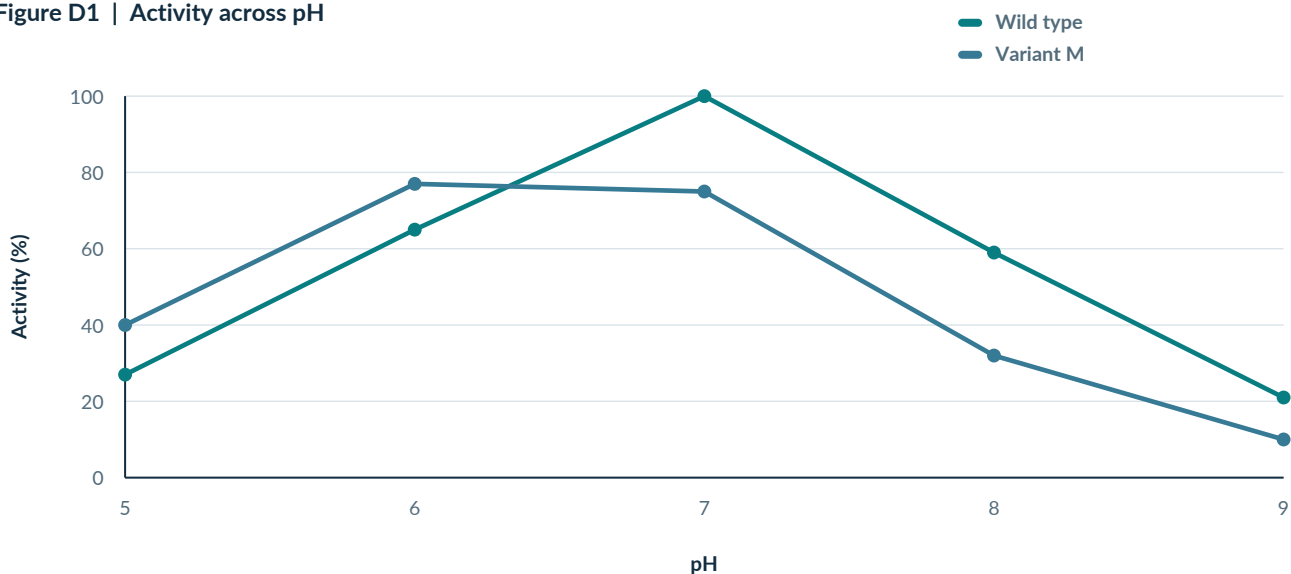
Protein substitution and pH

Two purified versions of an enzyme are assayed at equal protein concentration. Variant M differs from wild type (WT) by one substitution of a charged R group with an uncharged polar R group. Activities are reported as a percentage of the maximum observed WT activity.

pH	WT activity (%)	M activity (%)
5	27	40
6	65	77
7	100	75
8	59	32
9	21	10

Measurements are hypothetical; all other assay conditions are held constant.

Figure D1 | Activity across pH



QUESTION 41

At which pH is the difference M activity minus WT activity largest and positive?

- A pH 5
- B pH 6
- C pH 9
- D pH 7

QUESTION 42

A student predicts that variant M has a shifted pH-activity profile. Which statement best characterizes the available evidence?

- A WT and M peak at the same pH but differ only in magnitude.
- B M has greater activity than WT at every tested pH.
- C Among tested pH values, M peaks at pH 6 and WT peaks at pH 7.
- D WT activity after incubation is constant across the tested pH values.

QUESTION 43

How could the substitution plausibly affect the pH response of M?

- A Charge changes can alter only a protein's primary sequence, never its interactions.
- B Replacing a charged side chain can change electrostatic interactions that stabilize active conformations.
- C Removing a charged R group makes all other side chains permanently neutral.
- D Replacing one R group changes all peptide linkages to ester linkages.

QUESTION 44

Which experiment would most directly test whether variant M unfolds more readily than WT at pH 8?

- A Measure folded versus unfolded fractions of each variant at pH 8 using a structure-sensitive assay.
- B Compare the activity of WT and M at only one protein concentration without structural data.
- C Sequence unrelated genes and infer tertiary folding of WT and M.
- D Measure net enzyme activity at pH 7 and label the result 'unfolded fraction'.

QUESTION 45

Why would the activity data alone be insufficient to prove a change in tertiary structure?

- A Catalytic activity provides a direct measurement of every hydrogen bond in the protein.
- B A change in catalytic activity can follow a local active-site change without measurable global unfolding.
- C A loss of activity necessarily means all tertiary interactions disappear.
- D A charged R-group substitution cannot affect enzyme function.

DATA-BASED SET E / QUESTIONS 46–50

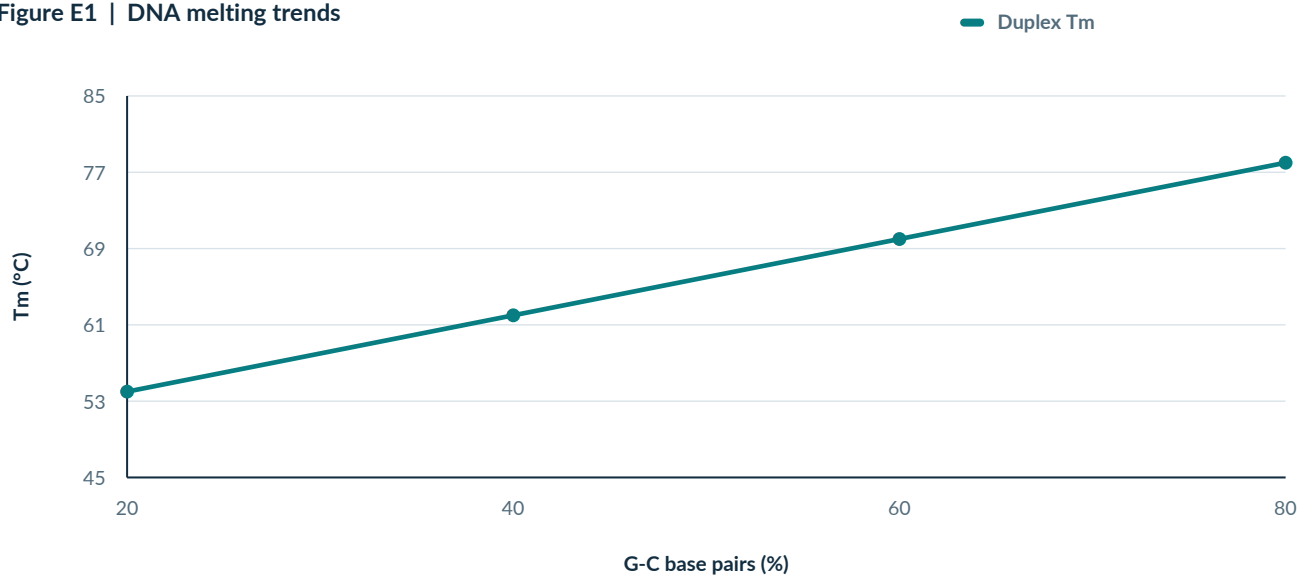
Duplex stability

Four short double-stranded DNA molecules of the same length are tested under identical salt conditions. The temperature at which half the duplexes are separated (T_m) is measured. Each sample contains only conventional A-T and G-C base pairs.

DNA sample	G-C base pairs (%)	T_m (°C)
J	20	54
K	40	62
L	60	70
M	80	78

The data depict a trend under this particular experimental design.

Figure E1 | DNA melting trends



QUESTION 46

Which sample has the greatest measured thermal stability under the assay conditions?

- A J
- B K
- C L
- D M

QUESTION 47

What is the increase in T_m from sample K to sample M?

- A 8 °C
- B 24 °C
- C 12 °C
- D 16 °C

QUESTION 48

Which structural feature is most consistent with the relationship shown?

- A A-T pairs cannot form hydrogen bonds and therefore separate immediately.
- B G-C pairs stabilize DNA by forming additional phosphodiester bonds between the strands.
- C Under the controlled conditions, increased G-C content is associated with stronger duplex interactions and higher T_m .
- D The measurements demonstrate that every G-C base has a higher mass than every A-T base pair.

QUESTION 49

Why is it not justified to assert that G-C percentage alone uniquely determines the T_m of every possible DNA molecule?

- A A-T bonds become covalent at temperatures below T_m .
- B Nucleotide sequence is irrelevant because all strands contain equal base compositions.
- C All DNA samples must have the same T_m if they have the same length.
- D Ionic environment, duplex length, and nearest-neighbor sequence can also change T_m .

QUESTION 50

Sample K contains 100 base pairs. Based on the given percentage, how many G-C base pairs does it contain?

- A 60
- B 20
- C 40
- D 80

DATA-BASED SET F / QUESTIONS 51–55

Branching and digestion

A digestive enzyme removes glucose residues only from the nonreducing ends of compatible alpha-linked storage polymers. Equal glucose-equivalent amounts of two substrates are incubated with excess enzyme at the same temperature and pH. The measured variable is released glucose in the first 3 minutes.

Substrate	Branches per 100 glucose	Glucose released (μmol)
Mostly linear polymer	2	14
Highly branched polymer	13	42

The enzyme cannot cleave internal glycosidic bonds and both substrates are otherwise compatible.

QUESTION 51

Which observation is directly supported?

- A The enzyme hydrolyzes beta-1,4 cellulose linkages.
- B The highly branched substrate must have fewer chain ends.
- C The mostly linear substrate contains no glucose.
- D The highly branched substrate releases three times as much glucose in the first 3 minutes.

QUESTION 52

Why does the highly branched substrate plausibly yield glucose more rapidly?

- A The branched polymer contains more total glucose because more glucose was loaded per well.
- B Branch points spontaneously hydrolyze without any enzyme or water.
- C More branch points provide additional nonreducing ends accessible to the specified enzyme.
- D The enzyme can only act on internal bonds in the unbranched chain.

QUESTION 53

A second scientist proposes that the difference is caused by the amount of enzyme rather than branching. Which feature of the original design addresses that concern?

- A The enzyme was present only in the highly branched treatment.
- B Both polymers were purified from the same species.
- C Both reactions contained the same excess enzyme in equivalent assay conditions.
- D The linear sample was incubated for a shorter period than the branched sample.

QUESTION 54

Which inference is NOT warranted by these data?

- A The number of accessible chain ends may contribute to the observed rate difference.
- B Additional nonreducing ends may allow more cleavage events.
- C Every enzyme acting on any linear glucose polymer must be slower than any enzyme acting on a branched polymer.
- D The branched substrate yields greater glucose release in this short assay.

QUESTION 55

If a different enzyme cleaved only internal glycosidic bonds, what is the strongest conclusion about the two substrates' relative rates?

- A The original data are insufficient to predict rates for an enzyme with different cleavage specificity.
- B The linear polymer must always be faster because internal bonds are more exposed.
- C Internal-acting enzymes cannot hydrolyze polysaccharides in water.
- D The branched polymer must always be faster, regardless of enzyme specificity.

DATA-BASED SET G / QUESTIONS 56–60

Identifying an unknown macromolecule

A researcher analyzes three purified substances. Each is subjected to complete hydrolysis, and the main types of fragments are identified. A separate test measures whether the intact substance is readily soluble in water.

Substance	Hydrolysis fragments	Water solubility
R	Amino acids	High
S	Nucleotides	High
T	Fatty acids + glycerol	Low

Assume each sample is chemically pure and the reported fragments are accurate.

QUESTION 56

Which identification best fits substance R?

- A Polysaccharide
- B Polypeptide
- C Nucleic acid
- D Triacylglycerol

QUESTION 57

Which covalent bond is the main linkage broken when substance S undergoes the reported hydrolysis?

- A Phosphodiester linkage between nucleotides
- B Glycosidic linkage between glucose monomers
- C Disulfide bridge connecting two amino acids
- D Peptide bond

QUESTION 58

Why does the low water solubility of T agree with its reported hydrolysis products?

- A Long hydrocarbon regions in glycerol-linked lipids are nonpolar and limit interaction with water.
- B All substances with an ester bond are insoluble for the same chemical reason.
- C Glycerol is nonpolar, so its hydroxyl groups repel water.
- D Hydrolysis into fatty acids proves the intact molecule has a phosphate-rich hydrophilic exterior.

QUESTION 59

Which analytical approach would most directly verify that R and S contain different classes of monomers?

- A Compare light scattering of the intact samples at different concentrations as a definitive monomer test.
- B Identify hydrolysis products with a separation assay that distinguishes amino acids from nucleotides.
- C Compare only the molecular mass of R and S without chemical characterization.
- D Determine whether R and S form solutions with the same pH without analyzing fragments.

QUESTION 60

Which additional evidence would be needed before concluding that T is specifically a triacylglycerol rather than another lipid containing fatty-acid and glycerol components?

- A Measure only the concentration of glycerol in the aqueous phase before hydrolysis.
- B Record the room temperature during the analysis of substance T.
- C Demonstrate that every fatty acid in the fragments has at least one carbon-carbon bond.
- D Determine the intact lipid's fatty-acid stoichiometry and whether phosphate-containing head groups are present.

SECTION II / FREE RESPONSE

6 written responses

Answer each part in complete, precise scientific statements. Include calculations, labeled graphs, and biological mechanisms where requested.

ITEMS	TIME ALLOWED	MAXIMUM POINTS
2 long + 4 short	90 minutes	34 rubric points

ABOUT SCIENTIFIC EXPLANATIONS

Use evidence → mechanism → conclusion. For predictions, specify the changed variable and justify the direction of the expected effect. Avoid claims stronger than the data support.

QUESTION 1 • 9 POINTS / LONG FRQ • EXPERIMENTAL ANALYSIS

Water polarity and capillary movement

A team investigates capillary rise in narrow tubes whose surfaces have different chemical properties. Each vertical tube has an inner radius of 0.25 mm, contains water at 22 °C, and is held at the same ambient conditions. The maximum stable height is measured in five independent tubes per treatment.

Treatment	Surface chemistry	Mean rise (mm)	SD (mm)
C	Untreated glass	43	3
H	Polar coating	51	4
N	Low-adhesion coating	4	2

- (a) [1 point] Identify the experimental treatment that produced the greatest mean water rise.
- (b) [1 point] Describe the effect of the low-adhesion coating relative to untreated glass.
- (c) [2 points] Explain how the polarity of water molecules and their interactions with the tube surface can account for the results.
- (d) [1 point] Calculate the percentage decrease in mean rise from treatment C to treatment N. Show your calculation.
- (e) [1 point] Identify one variable, other than the surface coating, that must be controlled to evaluate the effect of coating.
- (f) [1 point] Predict how increasing the tube radius, while keeping coating and other conditions constant, would generally affect capillary rise.
- (g) [2 points] Justify your prediction in part (f) using the relationship between adhesive/cohesive forces and the weight of the supported water column.

QUESTION 2 • 9 POINTS / LONG FRQ • EXPERIMENTAL ANALYSIS WITH GRAPHING

Protein folding, pH, and a residue substitution

Researchers compare two purified versions of an enzyme. WT is the wild-type protein, and V has one substitution replacing a negatively charged amino-acid side chain with an uncharged polar side chain. Equal amounts of enzyme are exposed to the indicated pH for 10 minutes, and catalytic activity is subsequently measured in the same standardized assay. Activities are given as percentages relative to WT activity at pH 7 (defined as 100%).

Incubation pH	WT activity (%)	V activity (%)
4	10	35
5	35	70
6	72	95
7	100	80
8	65	30
9	18	8

- (a) [1 point] Construct a line graph of enzyme activity versus incubation pH for BOTH proteins. Label both axes, identify the two series, and use an appropriate scale.
- (b) [1 point] Describe one difference between the activity profiles of WT and V supported by the results.
- (c) [1 point] Calculate the ratio of V to WT activity at pH 5; show the calculation.
- (d) [2 points] Explain how the substitution might change interactions among R groups and therefore alter enzyme activity after pH treatment.
- (e) [1 point] Predict which protein is more active after incubation at pH 6 under the described assay.
- (f) [1 point] Identify a control needed to test whether the difference at pH 6 is caused by the substitution rather than differing protein amounts.
- (g) [2 points] Explain why measurements of catalytic activity alone do not establish whether either protein underwent complete denaturation.

QUESTION 3 • 4 POINTS / SHORT FRQ • SCIENTIFIC INVESTIGATION

Testing a glycosidic-linkage hypothesis

Two purified glucose polymers, A and B, differ in glycosidic linkage arrangement. A student predicts that a specific enzyme hydrolyzes polymer A faster than polymer B under the same conditions.

- (a) [1 point] State a testable prediction for the amount of glucose released from the two polymers over a fixed interval.
- (b) [1 point] Identify the independent variable in the proposed experiment.
- (c) [1 point] Identify an appropriate negative control.
- (d) [1 point] Describe one way to distinguish enzyme specificity from a difference in initial substrate amount.

QUESTION 4 • 4 POINTS / SHORT FRQ • CONCEPTUAL ANALYSIS

A point mutation and protein function

A single amino-acid substitution replaces a nonpolar residue buried inside an enzyme with a charged residue. Activity decreases after the substitution, but the molecule remains a full-length polypeptide.

- (a) [1 point] Identify the level of protein structure that is necessarily changed by the substitution.
- (b) [1 point] Explain one way the replacement might affect tertiary structure.
- (c) [1 point] Predict how the change could affect the enzyme active site.
- (d) [1 point] Justify why the observation does not show that all peptide bonds were broken.

QUESTION 5 • 4 POINTS / SHORT FRQ • MODEL ANALYSIS

Antiparallel DNA structure

One strand of a double-stranded DNA molecule has the sequence 5'-GATCCG-3'. Assume canonical DNA base pairing.

- (a) [1 point] Write the complementary sequence with its orientation from 3' to 5'.
- (b) [1 point] Identify the chemical linkage connecting neighboring nucleotides within one strand.
- (c) [1 point] Describe one structural feature that distinguishes DNA from RNA.
- (d) [1 point] Explain why strands in a conventional DNA double helix are described as antiparallel.

QUESTION 6 • 4 POINTS / SHORT FRQ • DATA ANALYSIS

Membrane composition and permeability

Artificial membranes are built with equal lipid amounts and identical head groups but different percentages of cis-unsaturated tails. In a standardized test at 20 °C, membranes with 20%, 50%, and 80% unsaturated tails release 6%, 16%, and 35% of an enclosed dye, respectively, after 10 minutes.

- (a) [1 point] Describe the relationship between unsaturated-tail percentage and dye release in the data.
- (b) [1 point] Calculate the fold difference in dye release between 80% and 20% unsaturated-tail membranes.
- (c) [1 point] Explain the relationship between cis double bonds, hydrocarbon-tail packing, and the observed leakage.
- (d) [1 point] Identify one reason the result should not automatically be generalized to all living-cell membranes.

SECTION I / ANSWER GRID

Mark one option for every question.

Write the chosen letter clearly. Each item is worth one point.

NO.	A	B	C	D	NO.	A	B	C	D
01	☐	☐	☐	☐	31	☐	☐	☐	☐
02	☐	☐	☐	☐	32	☐	☐	☐	☐
03	☐	☐	☐	☐	33	☐	☐	☐	☐
04	☐	☐	☐	☐	34	☐	☐	☐	☐
05	☐	☐	☐	☐	35	☐	☐	☐	☐
06	☐	☐	☐	☐	36	☐	☐	☐	☐
07	☐	☐	☐	☐	37	☐	☐	☐	☐
08	☐	☐	☐	☐	38	☐	☐	☐	☐
09	☐	☐	☐	☐	39	☐	☐	☐	☐
10	☐	☐	☐	☐	40	☐	☐	☐	☐
11	☐	☐	☐	☐	41	☐	☐	☐	☐
12	☐	☐	☐	☐	42	☐	☐	☐	☐
13	☐	☐	☐	☐	43	☐	☐	☐	☐
14	☐	☐	☐	☐	44	☐	☐	☐	☐
15	☐	☐	☐	☐	45	☐	☐	☐	☐
16	☐	☐	☐	☐	46	☐	☐	☐	☐
17	☐	☐	☐	☐	47	☐	☐	☐	☐
18	☐	☐	☐	☐	48	☐	☐	☐	☐
19	☐	☐	☐	☐	49	☐	☐	☐	☐
20	☐	☐	☐	☐	50	☐	☐	☐	☐
21	☐	☐	☐	☐	51	☐	☐	☐	☐
22	☐	☐	☐	☐	52	☐	☐	☐	☐
23	☐	☐	☐	☐	53	☐	☐	☐	☐
24	☐	☐	☐	☐	54	☐	☐	☐	☐
25	☐	☐	☐	☐	55	☐	☐	☐	☐
26	☐	☐	☐	☐	56	☐	☐	☐	☐
27	☐	☐	☐	☐	57	☐	☐	☐	☐
28	☐	☐	☐	☐	58	☐	☐	☐	☐
29	☐	☐	☐	☐	59	☐	☐	☐	☐
30	☐	☐	☐	☐	60	☐	☐	☐	☐

Score (completed by teacher): _____ / 60

SECTION II / RESPONSE BOOKLET

Written-answer pages

Use the pages below to answer the free-response prompts. Question 2 includes blank graphing axes.

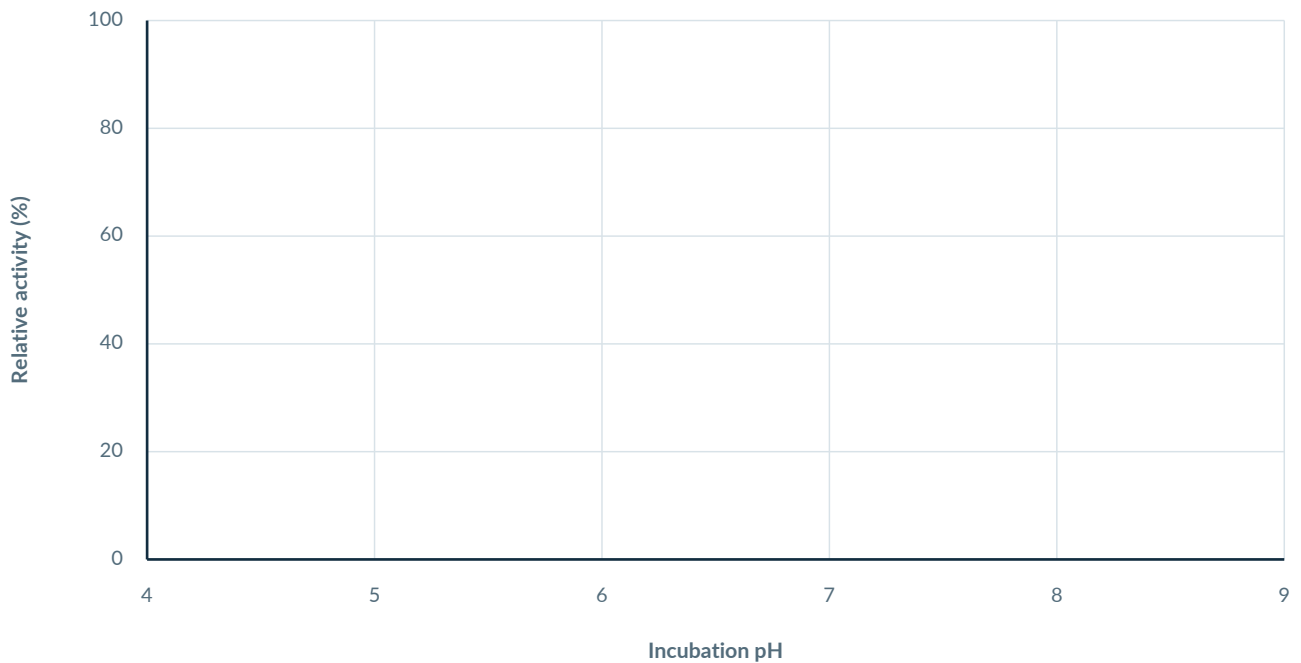
QUESTION 1 / RESPONSE SPACE

Refer to the corresponding question prompt. Use English scientific language and show calculations.

QUESTION 1 / CONTINUED

QUESTION 2 / GRAPH & RESPONSE SPACE

Plot both protein series. Include a legend on or near the graph.



Written responses: parts (b)–(g)

QUESTION 3 / RESPONSE SPACE

Refer to the corresponding question prompt. Use English scientific language and show calculations.

QUESTION 4 / RESPONSE SPACE

Refer to the corresponding question prompt. Use English scientific language and show calculations.

QUESTION 5 / RESPONSE SPACE

Refer to the corresponding question prompt. Use English scientific language and show calculations.

QUESTION 6 / RESPONSE SPACE

Refer to the corresponding question prompt. Use English scientific language and show calculations.

Record results after grading.

Review targets

This is a newly written, independently produced practice examination for Chapter 1. It is not a past examination, released College Board paper, or verified school midterm.