2000 AP® BIOLOGY FREE-RESPONSE QUESTIONS

BIOLOGY

SECTION II

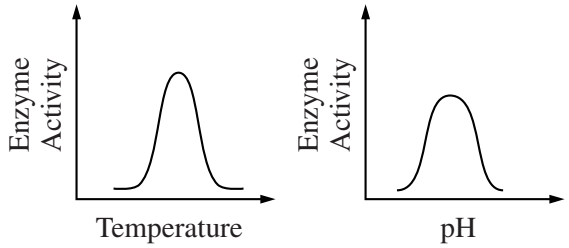
Time—90 minutes

4 Questions

Directions: Answer all questions. Write your answers on the pages following the questions in the pink booklet.

Answers must be in essay form. Outline form is NOT acceptable. Labeled diagrams may be used to supplement discussion, but in no case will a diagram alone suffice. It is important that you read each question completely before you begin to write.

1. The effects of pH and temperature were studied for an enzyme-catalyzed reaction. The following results were obtained.



   a) How do (1) temperature and (2) pH affect the activity of this enzyme? In your answer, include a discussion of the relationship between the structure and the function of this enzyme, as well as a discussion of how structure and function of enzymes are affected by temperature and pH.

   b) Describe a controlled experiment that could have produced the data shown for either temperature or pH. Be sure to state the hypothesis that was tested here.

2. Feedback mechanisms are used by organisms to maintain the steady-state physiological condition known as homeostasis. Choose **three** of the following and for each, explain how feedback mechanisms maintain homeostasis.

   a) Blood glucose concentration.

   b) Calcium ion concentration in blood.

   c) Body temperatures in mammals.

   d) Osmolarity of the blood.

   e) Pulse rate in mammals.

GO ON TO THE NEXT PAGE.

AP® Biology 2000 – Scoring Standards

Question 1 Scoring Guide

Each bullet is worth one point:

Part a. (maximum 6 points)

- **Optimum** temperature and pH *concept* [must include both temp and pH]
- **Enzyme/Substrate Fit** *concept*
  (function dependent on conformation complementarity between enzyme and substrate)
- **Tertiary** (and sometimes quarternary) structure **determines** function
- Description of enzyme **structure or function**, e.g.

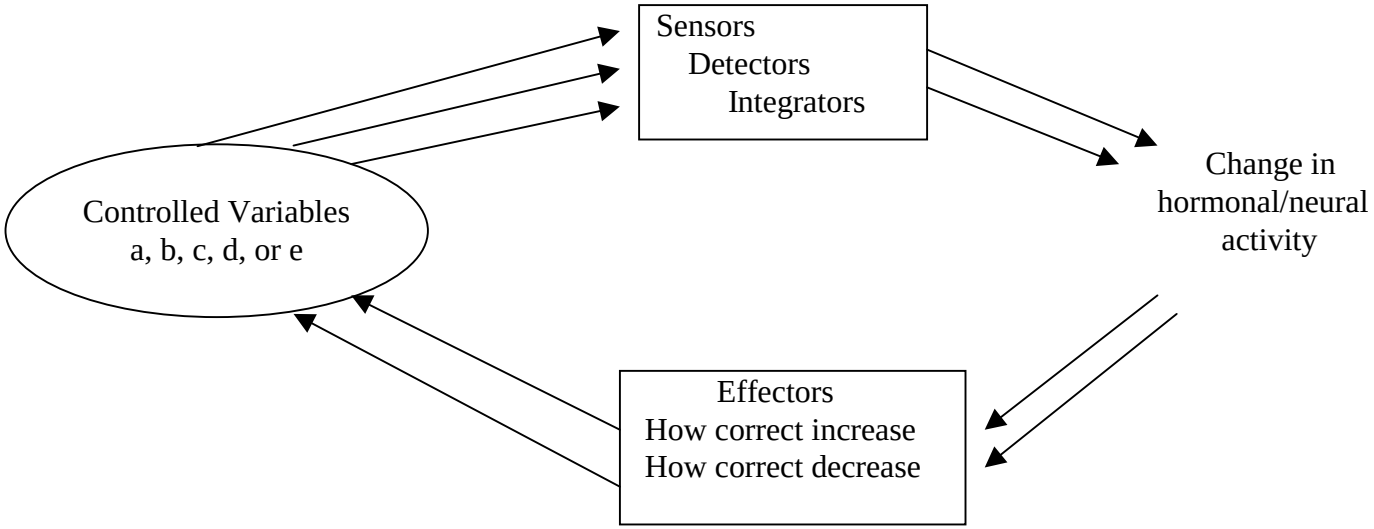
Structure	**Function**
Elegant description of primary to tertiary or primary to quarternary levels of structure	Increases rate of reaction
Protein folding/coiling	Increases proximity of reactants
Co-enzymes/co-factors	Decreases activation energy of the catalyzed reaction
Zymogens	Decreases time to reach equilibrium
Allosteric effectors	Induced fit and/or orbital steering ("bond stress")

- **Denaturation** *concept* [temp and/or pH] linked to decreased enzyme activity
  (e.g. "denaturation" in context or unfolding or change in 3D shape, **not** "enzyme breaks down")
- **How temperature affects** conformation
  (increased temperature breaks specific bonds, e.g. hydrogen, Van der Waals, disulfide bridges)
- **How pH affects** conformation
  (change in H^+ concentration causes a change in specific bond interactions, e.g. hydrogen; ionic; R-group interactions)
- **Kinetics** (increased or decreased molecular movement) linked to effect on enzyme activity due to increase or decrease in temperature up to the optimum

Part b. maximum 6 points

Experimental design must be relevant to the data shown in the graphs

- **What is measured** (e.g. product formed or substrate used)
- **How is it measured** (titration or spectrophotometry or color change or bubbles counted, etc.)
- The **independent variable** (temperature/pH) is **manipulated** to produce the results [at least 3 data points are identified]
- The described experiment **could produce these data**
  (Experimental design included sufficient range, varied the temp/pH of the reaction mix not the enzyme, what was measured, and how it was measured)
- Held **experimental factors constant (**specified at least one **)**
- Specified a **control group for comparison** (no enzyme or boiled enzyme or no substrate)
- **Verified** results (e.g. repeated trials; results represent an average)
- **Hypothesis** clearly related to experiment of choice, and clearly identified as a hypothesis; can use the if/then…form.



a) blood glucose concentration **4 pts max**

pancreas (islets of Langerhans, alpha cells, beta cells, membrane receptors)
↑ insulin (from pancreas) → all cell surfaces → lowers blood glucose levels
↑ glucagon (from pancreas) → liver → raises blood glucose levels

Bacterial Defenses Against Environmental Threats

Protection for bacterial cells against viruses, host organism defenses, abiotic environment, and other environmental threats:

Phages, Anti-Microbial Compounds

I: Solution: Cell wall (a physical barrier against penetration of a phage or the penetration of anti-microbial compounds)

Bile, Host Defenses, Viruses

II. Solutions:
- Lipopolysaccharide(s) (LPS) attached to the outer membrane of gram-negative (G–) bacteria; LPS contains the O-antigen (outward-facing)
- LPS repels fat-dissolving molecules such as bile, which might damage the bacterial cell membrane
- Changing the O-antigen (via mutation) protects against host's defenses (e.g., antibodies, memory B-cells, memory T-cells, plasma cells, etc.)
- Changing the O-antigen protects against viruses that utilize the O-antigen for bacterial cell recognition

Phagocytes, Antibodies, Viruses, Desiccation, Nutrient Deprivation, Waste Products

III: Solutions:
- Glycocalyx (capsule or slime layer)–any network of polysaccharides or glycoproteins secreted outside of the cell wall
- Protects bacteria from being engulfed by host phagocytes
- Protects bacteria from host antibodies
- Protects bacteria against desiccation
- Allows bacteria to form a spherical clump, protecting bacteria in interior
- Allows bacteria to form a layer on host tissue, protecting bacteria not directly exposed to extracellular fluid (ECF)
- Provides a reservoir for nutrients that bind to glycocalyx; these nutrients then are made available to bacterial cell
- Accumulates and stores waste products, preventing them from interfering with bacterial cell metabolism