AP BIOLOGY · UNIT 8 · TOPIC 8.1

Responses to the Environment

Learning objective 8.1.A Explain how the behavioral and physiological response of an organism is related to changes in internal or external environment, and 8.1.B explain how the behavioral responses of organisms affect their overall fitness and may contribute to the success of a population.

Name: Date: Period:

Use the tool **What an Organism Does About It**. Parts 1 to 3 use **Two ways to end up somewhere good**, Part 4 uses **Born knowing, or finding out**, and Parts 5 and 6 use **Why help anyone**. The course framework states that the specific mechanisms of these responses are **explicitly excluded** from the exam. This handout asks you to classify each response and to connect it to fitness, using the numbers the tool reports.

Part 1 · Three ways to move

The tool runs 400 animals for 400 steps each. Conditions are best at position **75**. The three groups differ only in what their steps are allowed to depend on. Click undirected, kinesis and taxis in turn and record the three readouts for each.

Movement	Ends near the optimum	Mean distance from it	Approach steps that went up-gradient
undirected			
kinesis			
taxis			

1. Describe the difference between taxis and kinesis.

2. In the Part 1 table, both kinesis and taxis put more animals near the optimum than the undirected control does.
(a) Describe what this comparison with the undirected control shows about the kinesis and taxis groups.

(b) Explain why the Ends near the optimum column alone cannot distinguish taxis from kinesis.

Part 2 · Can kinesis just try harder?

A kinesis has one setting: how strongly the animal slows down where conditions are good. If the amount of clustering defined the mechanism, a strong enough kinesis would be indistinguishable from taxis. The Can kinesis just try harder? panel reports runs at six slowing strengths. **Predict first**, in the margin, how the middle column changes as the slowing strength increases. Then record the values from the panel's table.

Slowing strength	Ends near the optimum	Approach steps up-gradient
0.500		
0.700		
0.900		
0.970		
0.990		
0.999		

3. (a) Describe the effect of increasing the slowing strength on the percentage of animals that end near the optimum.

(b) Describe the effect of increasing the slowing strength on the percentage of approach steps that went up-gradient.

4. Explain why increasing the slowing strength of a kinesis cannot make it match taxis, however strongly the animal responds.

Part 3 · Sorting responses

The table uses two separate distinctions. **Behavioral or physiological** is about whether the organism does something or its body does something. **Internal or external** is about where the cue comes from. Complete every row, then check your answers against the Responses, sorted table in the tool. One row is easy to misclassify.

Response	Behavioral or physiological?	Internal or external cue?	Why it improves survival or reproduction
Phototropism in plants			
Photoperiodism in plants			
Taxis in animals			
Kinesis in animals			
Nocturnal and diurnal activity			
Fight-or-flight response			
Plant response to herbivory			
Hunger			

5. Explain how the behavioral and physiological responses of an organism are related to changes in its internal or external environment.

6. (a) Describe the difference between an internal cue and an external cue.

(b) Identify one response in the Part 3 table that is triggered by an internal cue and one that is triggered by an external cue.

Part 4 · Born knowing, or finding out

There are four things an organism could do and only one is right, and which one is right keeps changing. An **innate** responder does whatever it was born doing: free, but only correct while the world happens to match. A **learned** responder works it out during its lifetime: almost always correct, but it pays for the time and the risk. Click each chip, from every 1 gen to every 600 gens, or read the Every speed of world, side by side table, and record every row.

Environment changes every	Innate fitness	Learned fitness	Winner
1 generation			
2 generations			
5 generations			
10 generations			
25 generations			
100 generations			
600 generations			

7. Using the Part 4 table, explain why fitness favors innate behaviors in some environments and learned behaviors in others.

8. One of the two fitness columns in the Part 4 table has the same value in every row.
(a) Identify the column.

(b) Explain why its value does not change.

Part 5 · A behavior that costs the animal doing it

An alarm call makes the caller more conspicuous to the predator and everyone else safer. A behavior like that ought to be selected against, and it is not. The resolution is to stop counting individuals and start counting **copies of the allele**. In the tool's model, helping costs the helper 0.1 and gives the relative a benefit of 0.3, for every relative. Click each relative. Record r and the benefit needed to repay one unit of cost (1 ÷ r; the tool's table also lists it). Then record whether the helping allele spreads, using the tool's verdict and the Allele after 200 generations readout.

Helping a…	Relatedness, r	Benefit needed to repay one unit of cost	Does the helping allele spread?
Identical twin			
Offspring			
Full sibling			
Half sibling			
Niece or nephew			
Grandchild			
First cousin			
Unrelated individual			

9. Explain how a behavior that is costly to the animal performing it can increase in frequency in a population.

10. In every row of the Part 5 table, the cost is 0.1 and the benefit is 0.3. Explain why the helping allele spreads for some relatives but not for others.

11. (a) Calculate the total relatedness of two brothers and the total relatedness of eight first cousins.

(b) Explain what this total means for a helper who dies to save them.

Part 6 · Signals

Organisms communicate through visual, audible, tactile, electrical and chemical signals, and use them to indicate dominance, find food, establish territory and ensure reproductive success. Fill in the channel and purpose for each. **One of these signals does not fit any of the four purposes**. Identify it, and do not place it under the nearest purpose.

Signal	Channel	What it is for
Bird song		
Territorial scent marking in mammals		
Coloration in flowering plants		
Coloration in animals		
The honeybee waggle dance		
Predator alarm call		
Electric fields in weakly electric fish		

12. Explain how a signaling behavior can be acted on by natural selection.

13. (a) Identify the signal in the Part 6 table that fits none of the four purposes.

(b) Explain why this signal cannot be explained by its benefit to the sender.

14. Explain how the behavioral responses of individuals contribute to the success of a population.

What the model simplifies

The arena is one-dimensional with a single smooth peak, and the taxis animals sense its direction imperfectly. Real gradients are patchy, noisy and often have several peaks. The comparison between the three movement rules survives all of that; the exact percentages do not.

The kinesis modeled here changes step length with conditions. Real kineses more often change turning rate than speed. The mathematics is the same in the respect that matters (more time spent in favorable conditions, with no directional information used), which is the property the panel is about.

Part 4 models the innate strategy as tracking the environment with a one-change lag and the learner as paying a fixed cost for near-perfect accuracy. Both are caricatures: real innate behavior is not always a lag behind selection, and real learning is neither uniformly costly nor uniformly accurate. What survives is the shape: the innate strategy's success depends on how fast the world changes and the learner's does not.

Hamilton's rule is used as the reasoning behind kin selection, which the course framework lists as an illustrative example. The exam is unlikely to ask for the inequality by name. The relatedness values are the idealized textbook ones for diploid organisms; real relatedness depends on a population's history of inbreeding, and the haplodiploid insects that supply the most famous examples of cooperation have a different set entirely.

The helping simulation applies the inclusive-fitness advantage directly to allele frequency. It demonstrates that the sign of $rB - C$ decides the outcome; it is not a population-genetic model anyone would publish.

The alarm call is deliberately labeled with a purpose that is not one of the four the framework lists, because none of the four fits it and filing it under the nearest one would plant an error a student could reproduce on an exam.