

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 attaches an unusual instruction to this topic: the specific mechanisms are **explicitly excluded** from the exam, twice over. So this handout is not a list of behaviors to memorize. It is about two things you can actually do — classify a response, and connect it to fitness — and every part asks you to compute something rather than recall it.

Part 1 · Three ways to move

Four hundred animals, four hundred steps each, and conditions that are best at position **75**. The three groups differ only in what their steps are allowed to depend on. Record all four numbers for each — the last column is the one that matters most and it is the one students skip.

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

1. Distinguish between taxis and kinesis.

2. Compare your first column for taxis and kinesis with the undirected control. Explain what that comparison does and does not tell you.

Part 2 · Can kinesis just try harder?

A kinesis has exactly one dial: how much to slow down where conditions are good. If the amount of clustering were what defined the mechanism, then turning that dial up far enough ought to make a kinesis indistinguishable from taxis. Fill in the second panel and find out whether it does. **Predict first**, in the margin, before you read the numbers off.

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

3. Describe what happens to the middle column as the slowing strength increases, and what happens to the right-hand column.

4. Explain why turning a kinesis up cannot make it match taxis, however strongly the animal responds.

Part 3 · Sorting responses

Two distinctions, and they are independent of each other. **Behavioral or physiological** is about whether the organism does something or its body does something. **Internal or external** is about where the cue came from. Fill both in for every row. One of these is a trap and it is worth finding it yourself.

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 environment.

6. Distinguish between an internal and an external cue, and give an example of each from your table.

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. Fill in every row, then look hard at which column moves and which does not.

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

7. Explain why fitness favors innate behaviors in some environments and learned behaviors in others.

8. One of your two fitness columns is identical in every row. Identify it and explain why.

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**. Fill in the relatedness for each recipient, then work out how much benefit it would take to repay one unit of cost — that is just one divided by r .

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 costs the animal performing it can nevertheless increase in a population.

10. The cost and the benefit are identical in every row of your table. Explain what decides whether the behavior spreads.

11. Show that two brothers and eight cousins come to the same total, and explain what that total means.

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** — find it, and do not force it into the nearest one.

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. Identify the signal that fits none of the four purposes, and explain why it needs a different kind of explanation from the others.

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

What the model simplifies

The arena is one-dimensional with a single smooth peak, and the animals sense it 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 kinesis 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.