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Worksheet

From drugs to climate change: hands-on experiments with *Daphnia* as a model organism

Daphnia as model organisms

Daphnia, a freshwater zooplanktonic keystone species, is a model organism with many practical advantages: simplicity of their culture under laboratory conditions, short life cycle, easy handling, high fecundity, parthenogenetic reproduction, and low cost of maintenance.

Daphnia are microcrustaceans (2–5 mm) that live in freshwater aquatic environments, lakes, or rivers with a weak current. They feed on algae and bacteria and are the main prey of many fish species and predatory invertebrates. The movements of their flattened leaf-like legs produce a water current that allows oxygenation and directs small, suspended particles into their mouth. They are filter feeders. Like all arthropods, *Daphnia* undergo moults, with a period that depends, primarily, on temperature (11 days at 10°C to 2 days at 25°C) and the availability of food, until they reach reproductive age.

Due to their translucent, chitinous exoskeleton, it is possible to observe, under a microscope or binocular magnifying glasses, *Daphnia*'s internal organs, such as the digestive tube, beating heart, big compound eye, eggs, or embryos (in females). They live from a month to a year, have a short life cycle, and present high fecundity with parthenogenetic reproduction, under favourable conditions. Since they are very sensitive animals, and because they have fundamental biological responses very similar to those of humans, they are used as models to test the effects of various social drugs, such as coffee, tobacco, and alcohol, on heart rate and are used to evaluate water quality. Freshwater ecosystems, among the most threatened in the world, provide drinking and irrigation water, food (fish, crustaceans, and molluscs), climate regulation, erosion prevention, and recreation for human society. Climate change is increasing the salt concentration of freshwaters, with a drastic effect on the health and survival of freshwater organisms. These organisms need to maintain an osmotic balance between the ion concentration within their cells and their body fluids; this is strongly influenced by the salinity of the surrounding water.

Activity 1: The rise and fall of a heartbeat

	Prediction (according to key below)	Control heart rate (bpm)	Experimental heart rate (bpm)
Tobacco			
Alcohol (6%)			
Alcohol (12%)			
Alcohol (20%)			
Coffee			

Key:

+++	big increase in heart rate
++	increase in heart rate
+	small increase in heart rate
0	no change in heart rate
−	small decrease in heart rate
−−	decrease in heart rate
−−−	big decrease in heart rate
x	heart stops

Questions

1. What is the purpose of having some *Daphnia* in water only?

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2. Why is the average of three heartbeat counts used?

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3. Why is a new *Daphnia* used for each experimental solution (social drug) tested?

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4. What is the advantage/importance of using clones?

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5. Compare predictions with experimental data.

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6. Discuss how *Daphnia* is a suitable biological model for studying multiple stressors.

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Activity 2: Climate change: how does salt exposure affect *Daphnia*?

NaCl (%)	Number of *Daphnia* that died after			% mortality (after 20 min)	Observations of *Daphnia* behaviour
	5 min	10 min	20 min		
0					
0.5					
1					
1.5					
2					

Questions

1. What is the purpose of having some *Daphnia* in water only?

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   _____

2. Calculate the LC_{50} of sodium chloride for *Daphnia*.

   _____

   _____

3. What do you think the long-term effect of salinization would be on *Daphnia* populations?

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4. In what ways can climate change affect freshwater ecosystems?

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5. Can you think of any implications of this research for human populations?

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