# A Cases for Evolution Education Question Guide

By: Merle K Heidemann, Jim J Smith, Alexa Warwick, Louise Mead, Peter JT White

## The Case of Toxin Resistance Evolution in Soft Shell Clams

This Evo-Ed case consists of five modules that support the teaching and learning of biology in the framework of evolution of toxin resistance in the soft shell clam *Mya arenaria*. Together, the modules present evidence that evolution occurs because of:

1) competition for resources and differential reproductive success in populations

2) heritable genetic variation and resulting differences in gene expression.

The following activities are designed to guide students' learning as they engage in the modules of this case. They can also be used as learning objectives. That is, "students will be able to" accomplish each of these as objectives.

The modules and activities are presented in the order in which they appear in the case and can be used as in-class activities, homework and/or formative assessments.

The background information on this case, and accompanying slides can be found at:
→ www.evo-ed.com/Pages/Clams

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### The Ecology of Soft Shell Clams

1) Explain why *Mya arenaria* is successful as an invasive species.

2) Develop a whiteboard animation/model of the food web in which the soft shell clam, *Mya arenaria*, is found. From this specific food web, construct a general one.

3) Research, document and categorize the food "particles" that *Mya arenaria* ingests as a filter feeder.

4) Describe asexual reproduction using dinoflagellates as a model. Explain how this mode of reproduction can result in large algal blooms.

5) Explain how the neurotoxin saxitoxin becomes biomagnified in the *Mya arenaria* food web and the possible effect this can have on each part of the food web including humans.

6) Predict and explain how saxitoxin resistance is advantageous to *Mya arenaria* individuals and populations. Explain how this is a disadvantage to *Mya* predators.

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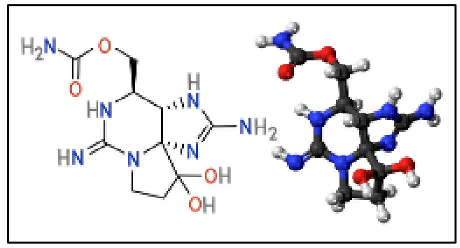
## The Cell Biology of Toxin Resistance in Soft Shell Clams

1) Describe the different structural parts of a neuron (nerve cells) and explain how each contributes to its function.



2) Explain the how the concentrations of sodium and potassium ions inside and outside of the axon membrane change as a signal is transmitted. Include in your explanation these proteins: voltage-gated sodium channel, voltage-gated potassium channel and sodium/potassium pump.

3) Construct a scientific definition at the cellular level of neuronal information.

4) Describe the differences between an R and S protein. Compare the result of saxitoxin interacting with neuronal sodium channels in resistant and non-resistant *Mya arenaria*.

5) Describe events at the axonal membrane if potassium channels were blocked and how that would affect neuronal information.

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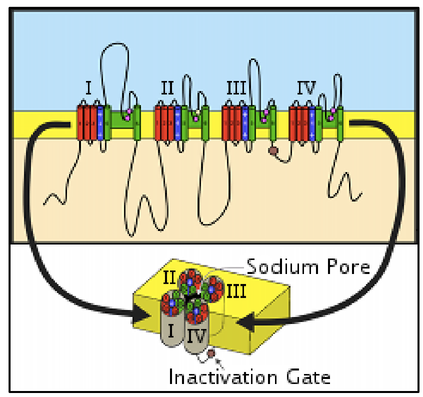
## The Genetics of Toxin Resistance in Soft Shell Clams




1) Explain the pattern of resistance to saxitoxin with the three allele combinations (SS, RS, and RR - slide 45) for the sodium channel protein.

2) Compare and contrast the differences between the R and S forms of the sodium channel protein in response to saxitoxin.

3) Describe the change(s) in the sodium channel gene that result in the R form. Correlate that to changes in the resulting protein.

4) Write a random 39 sequence of the four DNA nucleotides. From that, determine the resulting sequence of amino acids. Remember to first transcribe your "DNA" to RNA. If you generate STOP sequences, rewrite that section that would correspond to an amino acid. Randomly, 1) insert a nucleotide and determine the resulting sequence of amino acids; 2) delete a nucleotide and determine the resulting sequence of amino acids; 3) substitute one nucleotide for another and determine the resulting sequence of amino acids. Describe how the amino acid sequence changes from one "mutation" to another.

5) Determine whether the R allele is a loss of function or gain of function mutation. Explain your reasoning.

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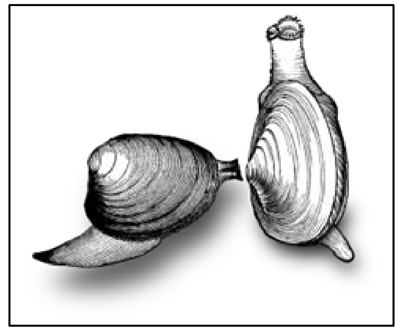
## The Fitness of Resistant and Non-resistant Soft Shell Clams



1) Explain why S alleles may persist both in populations exposed to saxitoxin and in those that are not.

2) Explain why the behavior of SS clams has an advantage over that of RR soft shell clams when there are few red tides.

3) Summarize the tradeoffs between being an RR, RS or SS soft shell clam.

4) Explain how having both resistant and non-resistant soft shell clams in a population affects both them (as prey) and their predators.

5) Determine why an SS clam would be easier for prey to catch than an RR clam.

6) Construct a general model based on soft shell clams of predator/prey relationships in an ecosystem.

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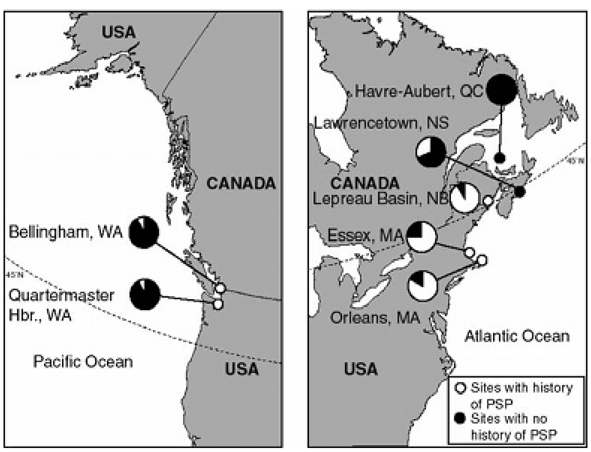
## The Population Genetics and Biogeography of Toxin Resistance in Soft Shell Clams

1) Using data from slides 68 – 77 correlate the distribution of R and S alleles in soft shell clams to biogeography and the presence of red tides.

2) Explain why selection occurs quickly in soft shell clams subjected to saxitoxin.

3) Explain why the frequencies of the R and S alleles rarely go to zero.

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