



AP Bio

FRQ Fridays

2018 #4
Gene Expression of Bed Bugs &
Error Bar Analysis



FRQ Friday #17

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The common bedbug (*Cimex lectularius*) is a species of insect that is becoming increasingly resistant to insecticides. Bedbugs possess several genes suspected of contributing to the resistance, including *P450*, *Abc8*, and *Cps*. To investigate the role of these genes in insecticide resistance, researchers deleted one or more of these genes in different strains of bedbugs, as indicated in Figure 1, and treated the strains with the insecticide beta-cyfluthrin. Each strain was genetically identical except for the deleted gene(s) and was equally fit in the absence of beta-cyfluthrin. The percent survival of each strain following beta-cyfluthrin treatment is shown in Figure 1.

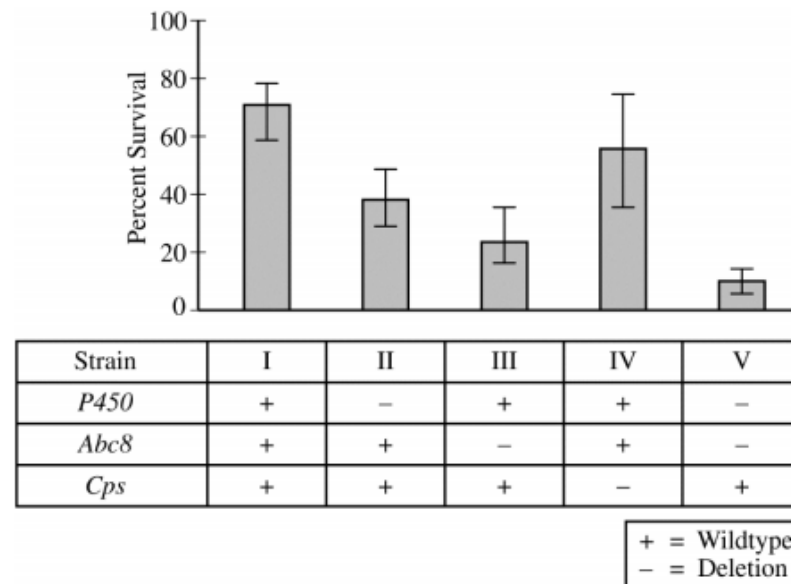
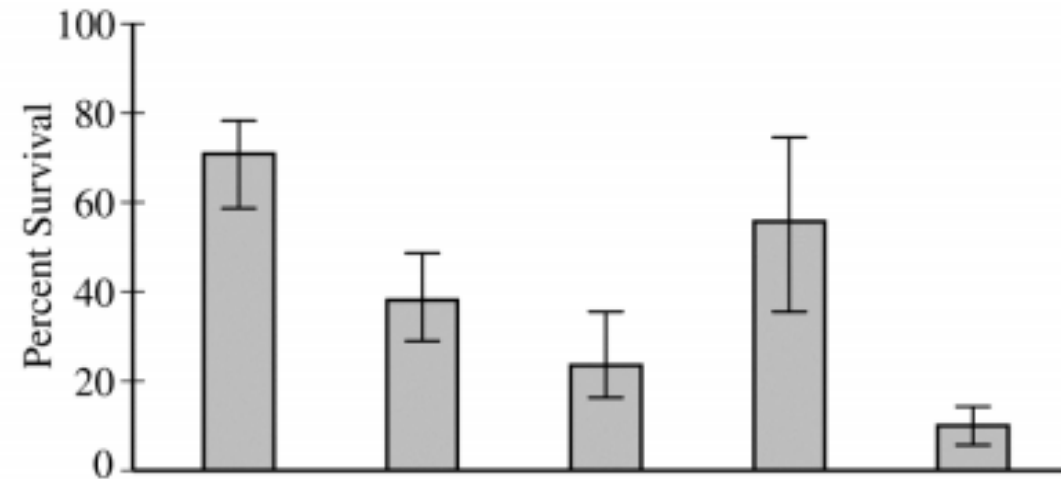


Figure 1. Percent survival of five strains of bedbugs treated with beta-cyfluthrin. A (+) indicates the gene is present; a (-) indicates the gene is deleted. Error bars represent the 95% confidence interval.





Strain	I	II	III	IV	V
<i>P450</i>	+	-	+	+	-
<i>Abc8</i>	+	+	-	+	-
<i>Cps</i>	+	+	+	-	+

+ = Wildtype
- = Deletion

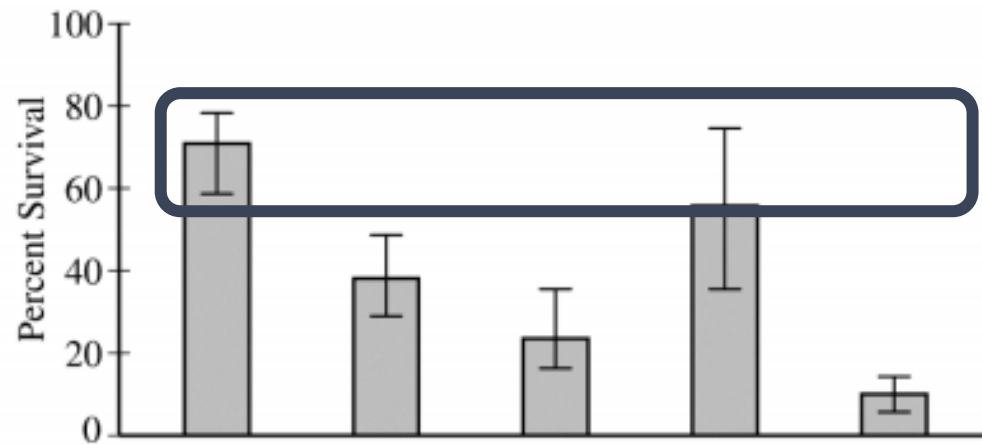
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(a) Identify the control strain in the experiment. Use the means and confidence intervals in Figure 1 to justify the claim that *Abc8* is effective at providing resistance to beta-cyfluthrin.



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<i>P450</i>	+	-	+	+	-
<i>Abc8</i>	+	+	-	+	-
<i>Cps</i>	+	+	+	-	+

Identification (1 point)

- Strain I

Justification (1 point)

- Error bars/CIs from strain I/control/WT do not overlap with strain III/*Abc8* deleted strain.
- Mean % survival of strain III/*Abc8* deletion falls outside the 95% confidence interval of strain I/control/WT.
- Strain III/*Abc8* deletion shows a statistically significant difference from strain I/control.

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a. Strain I was the control strain. *Abc8* is effective at providing resistance because when *Abc8* was deleted only 20% survived, and the confidence intervals between the strain without *Abc8* (III) and the

Hi!

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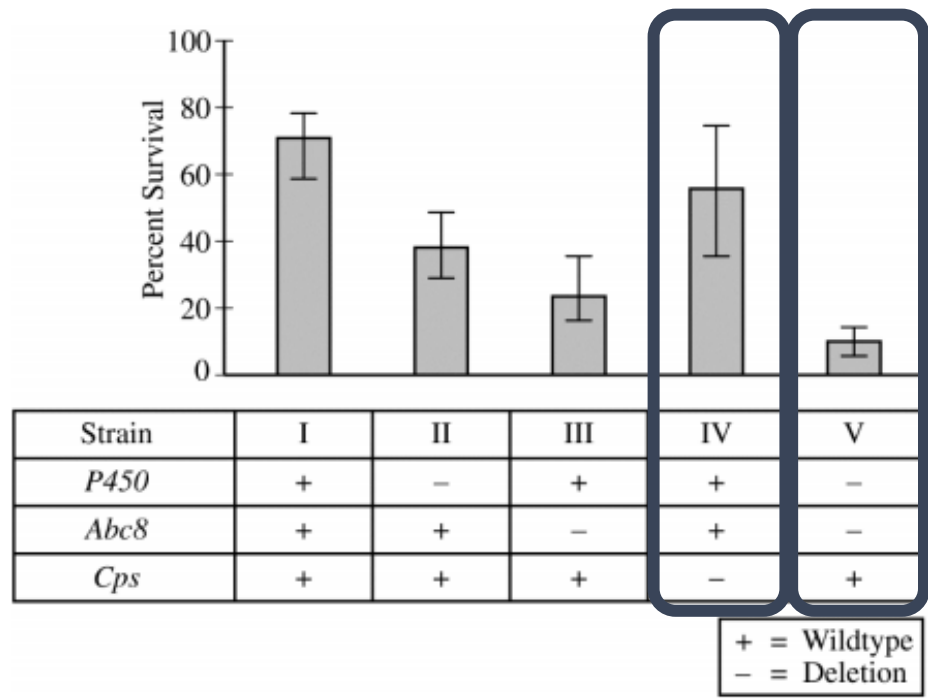
control (CI) did not overlap, meaning there is a reliable statistical difference between having the *Abc8* gene and not having it.



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(b) *P450* encodes an enzyme that detoxifies insecticides. *Abc8* encodes a transporter protein that pumps insecticides out of cells. *Cps* encodes an external structural protein located in the exoskeleton that greatly reduces the absorption of insecticides. Based on this information and the data in Figure 1, explain how a deletion of both *P450* and *Abc8* results in lower survival in bedbugs compared with a deletion of *Cps* only.



Explanation (1 point per row; 2 points maximum)

Strain	<i>P450</i> and <i>Abc8</i>	<i>Cps</i> only	Explanation
V	Deleted	Present	Bedbugs can neither detoxify nor pump out insecticide, which results in a lower chance of bedbug survival.
IV	Present	Deleted	Bedbugs can detoxify and pump out insecticide, which results in a higher chance of bedbug survival.



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b, When both $Abc8$ and $P450$ are deleted the cell cannot get rid of the insecticide that has been absorbed. So because CPs doesn't encode for an exoskeleton that completely stops the insecticide from getting into the cell, any insecticide that does get into the cell remains toxic and has no way of leaving. When just CPs is deleted the survival rate is much higher because although a higher concentration of insecticide is getting into the cell it is getting detoxified and being removed through the transporter pumps encoded by $Abc8$,





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