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DATA Nugget

The chromosome advantage: Lifespan differences across sexes

Featured scientists: Nicole Riddle (she/her) from the University of Alabama at Birmingham and Jamie Walters (he/him) from the University of Kansas.

Research Background

Many factors affect **lifespan**, or how long an organism lives. Different species, and individuals within a species, will all live to different ages. Across species, things like body size, metabolic rate, and genetics can all come into play. For example, larger animals tend to live longer than smaller organisms. Within a species, genetics and environmental conditions, such as being able to find food, the presence of predators, and disease, will also impact survival.

Scientists have also noticed that in many animal species, one sex tends to live longer than the other. Sometimes it is the males, and sometimes it is the females. Why might this be? To better understand aging differences across sexes, a group of scientists decided to work together. Each scientist studies a different species, so by combining their knowledge, they can look for patterns and see if there are consistent factors that are the cause.

Nicole and Jamie are two scientists in this group. Nicole studies fruit flies, while Jamie studies moths and butterflies. Even though fruit flies and moths are both insects, sex is determined differently. In most animals, **biological sex** is determined by specific **chromosomes**. These structures are inside cells and carry genetic information. Individuals usually have two sex chromosomes. Whether those two chromosomes are the same or different often determines whether their bodies develop as male or female.

In fruit flies, females have two of the same sex chromosomes (XX), while males have two different sex chromosomes (XY). In moths and butterflies, the pattern is reversed. Males have two of the same sex chromosomes (ZZ), while females have two different ones (ZW).

Nicole works with fruit flies (left) and Jamie studies pantry moths (right).

Plodia interpunctella female by Pekka Malinen, Luomus is licensed under CC BY-SA 4.0.

Nicole and Jamie wondered if having two different sex

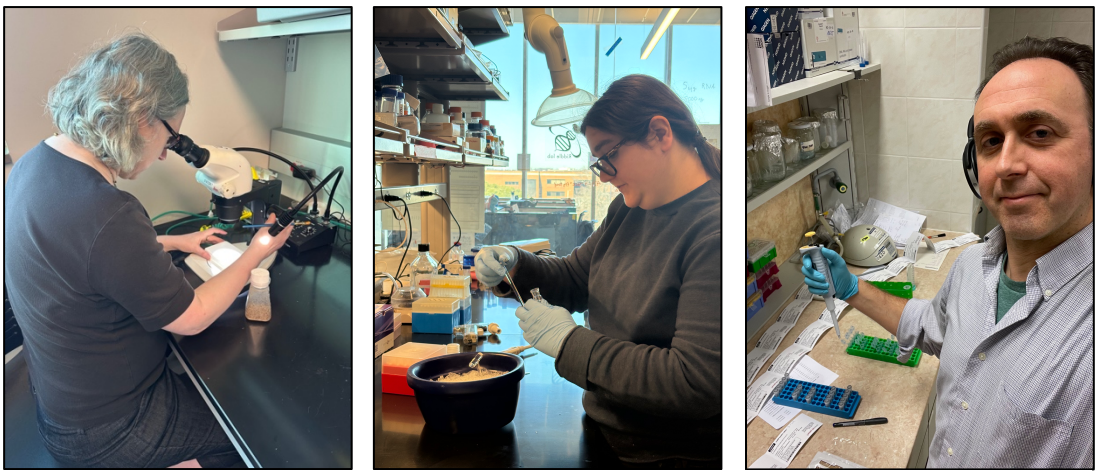
chromosomes might affect lifespan. When an individual has only one copy of a particular chromosome—like the X in XY males or the Z in ZW females—there is no second copy for the genes on that chromosome. If that single copy contains a harmful mutation or becomes damaged, the organism cannot rely on a second copy to make up for it. On the other hand, individuals with two of the same sex chromosomes (XX or ZZ) have a kind of "genetic backup". This extra protection might reduce the risk of problems that could lead to an earlier death.

To test their idea about sex chromosomes and lifespan, Nicole and Jamie designed an experiment called a **survival assay**. A survival assay is a laboratory experiment in which scientists carefully track how long organisms live under controlled conditions. By keeping the environment consistent, scientists can focus on the specific factor they want to study.

Nicole performed her survival assay with the fruit fly species, *Drosophila melanogaster*. Jamie worked with a pantry moth species called *Plodia interpunctella*. Both scientists already raise these species in their labs and carefully document the life cycles and age of each individual.

To set up their assays, Nicole and Jamie chose individuals that had emerged from the pupae stage around the same time. This step was important because they wanted to make sure all individuals had the same starting point. If some individuals had emerged a lot sooner, the results would not be accurate.

Nicole collected 100 female and 100 male fruit flies, and Jamie collected 60 male and 60 female moths. The insects were given plenty of food and kept in good environmental conditions, such as appropriate temperature and humidity. By reducing stress, they could better observe natural lifespan differences between males and females, rather than differences caused by harsh conditions.



Left: Nicole looking at fruit flies under the microscope; Center: Abigail, a graduate student in Nicole's lab, collecting fruit flies for a study; Right: Jamie running DNA extractions in the lab.

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Each day, Nicole and Jamie recorded how many males and females were still alive. This careful daily tracking allowed them to see how survival changed over time. The survival assay continued until the last individual had died. By the end of the experiment, Nicole and Jamie had detailed data showing how long males and females lived in each species. These results would help them test whether having two identical sex chromosomes—or two different ones—might influence lifespan.

Scientific Questions: How does lifespan differ across sexes in fruit flies and pantry moths? How does having two of the same or two different sex chromosomes affect lifespan?

What is the hypothesis? Find the hypothesis in the Research Background and underline it. A hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies.

Scientific Data:

Use the data from the survival assays to answer the scientific questions.

Fruit fly: *Drosophila melanogaster*

	Female		Male	
Day	Living	Percent Survival	Living	Percent Survival
1	100	100	100	100
5	100	100	98	98
10	97	97	95	95
15	91	91	93	93
20	88	88	79	79
25	82	82	54	54
30	78	78	35	35
35	74	74	24	24
40	69	69	14	14
45	57	57	7	7
50	49	49	5	5
55	43	43	3	3
60	31	31	0	0
65	10	10	0	0
70	1	1	0	0
74	0	0	0	0

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Pantry moth: *Plodia interpunctella*

	Female		Male	
Day	Living	Percent Survival	Living	Percent Survival
1	60	100.0	60	100.0
3	60	100.0	60	100.0
5	60	100.0	60	100.0
7	60	100.0	60	100.0
9	55	91.7	60	100.0
11	46	76.7	58	96.7
13	38	63.3	52	86.7
15	17	28.3	47	78.3
17	4	6.7	42	70.0
19	1	1.7	33	55.0
21	1	1.7	15	25.0
23	1	1.7	6	10.0
25	1	1.7	1	1.7

Note: The datasets have been shortened to show survival numbers every five days for the fruit flies and every two days for the pantry moths.

What data will you graph to answer the question?

Independent variables: _____

_____

Dependent variables: _____

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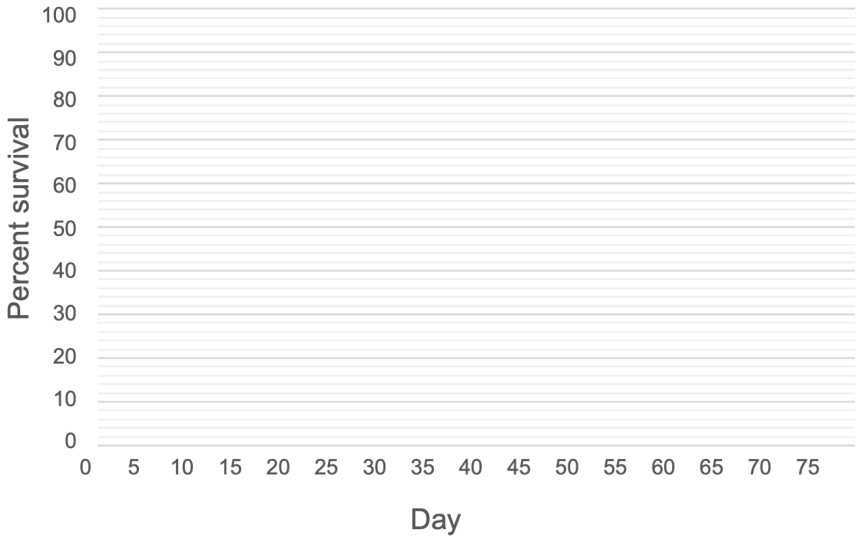
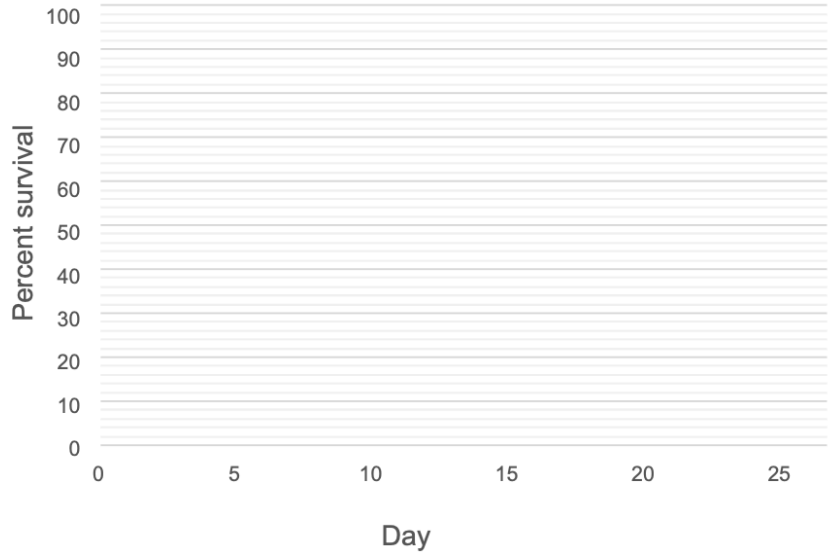
Draw your graphs below: Identify any changes, trends, or differences you see in your graph. Draw arrows pointing out what you see, and write one sentence describing what you see next to each arrow.

Drosophila melanogaster



Plodia interpunctella



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Interpret the data:

Make a claim that answers the scientific questions - How does lifespan differ across sexes in fruit flies and pantry moths? How does having two of the same or two different sex chromosomes affect lifespan?

What evidence was used to write your claim? Reference specific parts of the table or graph.

Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about the advantages of having one or two copies of sex chromosomes.

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Did the data support Nicole and Jamie's hypothesis? Use evidence to explain why or why not. If you feel the data are inconclusive, explain why.

Your next steps as a scientist: Science is an ongoing process. What new question(s) should be investigated to build on Nicole and Jamie's research? How do your questions build on the research that has already been done?