

## Appendix B: Test of Scientific Literacy Skills

**Directions:** There are 28 multiple-choice questions. You will have about 35 minutes to work on the questions. Be sure to answer as many of the questions as you can in the time allotted. You will receive attendance points for completing the entire assignment today. Your grade will depend on completeness and thoroughness, not on correct answers. But, try your best, your honest answers will help us better prepare the materials for the remainder of the semester.

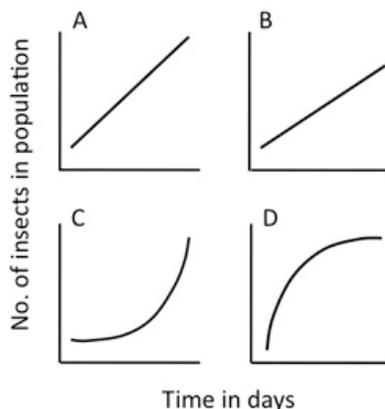
**Mark your answers on the scantron sheet.**

**Bubble in your #ID on your scantron.**

Do NOT use a calculator. Thank you for your participation in this project!

- Which of the following is a valid scientific argument?
  - Measurements of sea level on the Gulf Coast taken this year are lower than normal; the average monthly measurements were almost 0.1 cm lower than normal in some areas. These facts prove that sea level rise is not a problem.
  - A strain of mice was genetically engineered to lack a certain gene, and the mice were unable to reproduce. Introduction of the gene back into the mutant mice restored their ability to reproduce. These facts indicate that the gene is essential for mouse reproduction.
  - A poll revealed that 34% of Americans believe that dinosaurs and early humans co-existed because fossil footprints of each species were found in the same location. This widespread belief is appropriate evidence to support the claim that humans did not evolve from ape ancestors.
  - This winter, the northeastern US received record amounts of snowfall, and the average monthly temperatures were more than 2°F lower than normal in some areas. These facts indicate that climate change is occurring.
- While growing vegetables in your backyard, you noticed a particular kind of insect eating your plants. You took a rough count (see data below) of the insect population over time. Which graph shows the best representation of your data?

Time (days)	Insect Population (number)
2	7
4	16
8	60
10	123

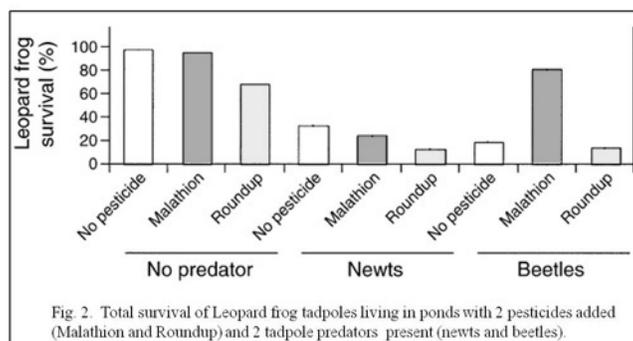


- A study about life expectancy was conducted using a random sample of 1,000 participants from the United States. In this sample, the average life expectancy was 80.1 years for females and 74.9 years for males. What is one way that you can **increase your certainty** that women truly live longer than men in the United States' general population?
  - Subtract the average male life expectancy from the average female expectancy. If the value is positive, females live longer.
  - Conduct a statistical analysis to determine if females live significantly longer than males.
  - Graph the mean (average) life expectancy values of females and males and visually analyze the data.
  - There is no way to increase your certainty that there is a difference between sexes.

## Appendix B: Test of Scientific Literacy Skills

4. Which of the following research studies is **least likely** to contain a confounding factor (variable that provides an alternative explanation for results) in its design?
- Researchers randomly assign participants to experimental and control groups. Females make up 35% of the experimental group and 75% of the control group.
  - To explore trends in the spiritual/religious beliefs of students attending U.S. universities, researchers survey a random selection of 500 freshmen at a small private university in the South.
  - To evaluate the effect of a new diet program, researchers compare weight loss between participants randomly assigned to treatment (diet) and control (no diet) groups, while controlling for average daily exercise and pre-diet weight.
  - Researchers tested the effectiveness of a new tree fertilizer on 10,000 saplings. Saplings in the control group (no fertilizer) were tested in the fall, whereas the treatment group (fertilizer) were tested the following spring.
5. Which of the following actions is a valid scientific course of action?
- A government agency relies heavily on two industry-funded studies in declaring a chemical found in plastics safe for humans, while ignoring studies linking the chemical with adverse health effects.
  - Journalists give equal credibility to both sides of a scientific story, even though one side has been disproven by many experiments.
  - A government agency decides to alter public health messages about breast-feeding in response to pressure from a council of businesses involved in manufacturing infant formula.
  - Several research studies have found a new drug to be effective for treating the symptoms of autism; however, a government agency refuses to approve the drug until long term effects are known.

**Background for question 6:** The following graph appeared in a scientific article<sup>1</sup> about the effects of pesticides on tadpoles in their natural environment.

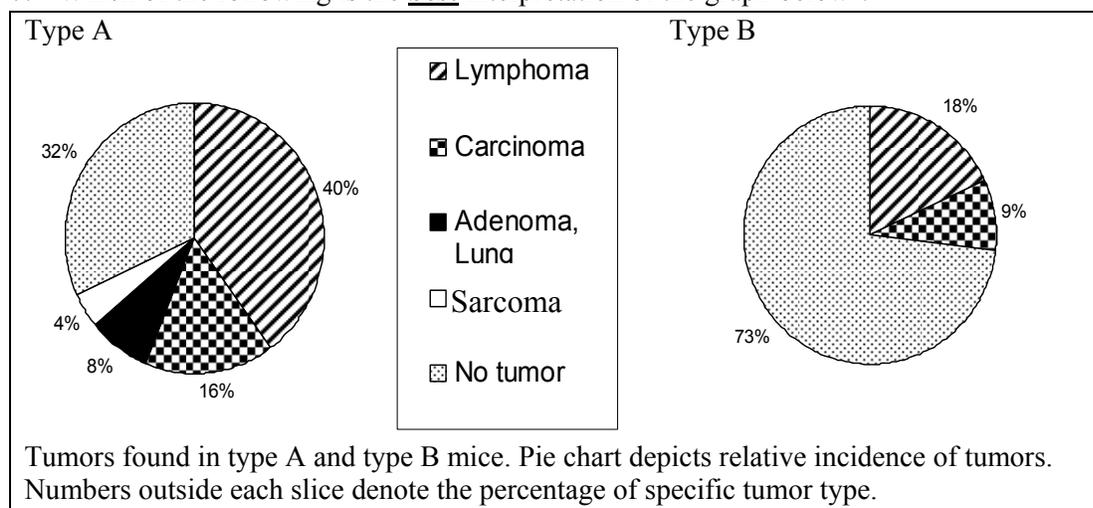


6. When beetles were introduced as predators to the Leopard frog tadpoles, and the pesticide Malathion was added, the results were unusual. Which of the following is a plausible hypothesis to explain these results?
- The Malathion killed the tadpoles, causing the beetles to be hungrier and eat more tadpoles.
  - The Malathion killed the tadpoles, so the beetles had more food and their population increased.
  - The Malathion killed the beetles, causing fewer tadpoles to be eaten.
  - The Malathion killed the beetles, causing the tadpole population to prey on each other.

<sup>1</sup> Modified from Relyea, R.A., N.M. Schoeppner, J.T. Hoverman. 2005. Pesticides and amphibians: the importance of community context. *Ecological Applications* 15: 1125-1134

## Appendix B: Test of Scientific Literacy Skills

7. Which of the following is the **best** interpretation of the graph below<sup>2</sup>?



- a. Type “A” mice with Lymphoma were more common than type “A” mice with no tumors.
  - b. Type “B” mice were more likely to have tumors than type “A” mice.
  - c. Lymphoma was equally common among type “A” and type “B” mice.
  - d. Carcinoma was less common than Lymphoma only in type “B” mice.
8. Creators of the Shake Weight, a moving dumbbell, claim that their product can produce “incredible strength!” Which of the additional information below would provide the **strongest evidence** supporting the effectiveness of the Shake Weight for increasing muscle strength?
- a. Survey data indicates that on average, users of the Shake Weight report working out with the product 6 days per week, whereas users of standard dumbbells report working out 3 days per week.
  - b. Compared to a resting state, users of the Shake Weight had a 300% increase in blood flow to their muscles when using the product.
  - c. Survey data indicates that users of the Shake Weight reported significantly greater muscle tone compared to users of standard dumbbells.
  - d. Compared to users of standard dumbbells, users of the Shake Weight were able to lift weights that were significantly heavier at the end of an 8-week trial.
9. Which of the following is **not** an example of an appropriate use of science?
- a. A group of scientists who were asked to review grant proposals based their funding recommendations on the researcher’s experience, project plans, and preliminary data from the research proposals submitted.
  - b. Scientists are selected to help conduct a government-sponsored research study on global climate change based on their political beliefs.
  - c. The Fish & Wildlife Service reviews its list of protected and endangered species in response to new research findings.
  - d. The Senate stops funding a widely used sex-education program after studies show limited effectiveness of the program.

<sup>2</sup> Modified from Wang, Y., S. Klumpp, H.M. Amin, H. Liang, J. Li, Z. Estrov, P. Zweidler-McKay, S.J.Brandt, A. Agulnick, L. Nagarajan. 2010. SSBP2 is an *in vivo* tumor suppressor and regulator of LDB1 stability. *Oncogene* 29: 3044-3053.

## Appendix B: Test of Scientific Literacy Skills

**Background for question 10:** Your interest is piqued by a story about human pheromones on the news. A Google search leads you to the following website:

**EROS FOUNDATION**

**Special Sale**  
Pheromone 10.13™ increase romance in your life; 1.6 oz. bottle normally \$98.50. (25% off for first time customers.) [Order Now](#)

EROS HOME | EROS SCIENCE | PHEROMONE DISCOVERY | BOOKS AND PRODUCTS | MEDIA ARTICLES | CONTACT US | VIDEO LINKS

**Shortcuts**  
Click here To Order From Eros  
Privacy Protection  
Share

**Explore the Site**  
Eros Home  
Top Stories  
Dr. Baxter's Articles  
Discoveries  
Baxter in the Scientific Community  
Other Health Research  
Published Scientific Articles

**Welcome to the Eros Foundation a biomedical research facility**

**Founded in 1995 by Dr. Millicent Baxter President,**

Biologist and co-discoverer of pheromones in humans  
*and author of:*

**Hormones and your Health:** The Smart Woman's Guide to Hormonal and Alternative Therapies for Menopause  
[To Order Click Here](#)

Dr. Millicent Baxter, B.S. in Psychology cum laude from Utica College in 1981, earned her Ph.D. in Biology from Duke University in 1987 followed by postdoctoral work in behavioral endocrinology at Stanford University. In 1995 she co-founded the Women's Wellness Program at the Hospital of State University of New York, Buffalo. She has published over 35 scientific papers, is co-inventor on 5 patents and author of eight books on women's health.

**Eros Science...**  
Fragrance additives to enhance sex-appeal  
Scientific articles by  
**Dr. Baxter**  
Discoveries and Bibliography  
In the Scientific Community

**Scholarly Peer-Reviewed Published Eros Science**  
In December 2010, the International Menopause Society journal published Dr. Baxter's invited review of a published paper showing breast cancer seemed to decrease. The 2002 WHI study and subsequent media caused women to stop using hormone replacement therapy.

Baxter, M, McColl NL, Leiberman, E, Calabrese-Stone E, (2000) Sexual response in women, *Obstetrics & Gynecology* 95:4(Supplement) April 2000, 19S.

Baxter M, McColl NL, Leiberman, E (1998) Pheromonal Influences on Sociosexual Behavior. *Archives of Sexual Behavior* 24:1-13

Baxter M, Calabrese-Stone E (1998) Women After 40 Years of Age: The Role of Sex Hormones and Pheromones. *Disease-A-Month*, 44:423-546

**Breast Cancer in Postmenopausal Women: What is the Real Risk?** Dr. Baxter's oral presentation and abstract was accepted for the 65th annual meeting of the American Society of Reproductive Medicine (ASRM) October 2009

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10. For this website (Eros Foundation), which of the following characteristics is **most important** in your confidence that the resource is accurate or not.
- The resource may not be accurate, because appropriate references are not provided.
  - The resource may not be accurate, because the purpose of the site is to advertise a product.
  - The resource is likely accurate, because appropriate references are provided.
  - The resource is likely accurate, because the website's author is reputable.

## Appendix B: Test of Scientific Literacy Skills

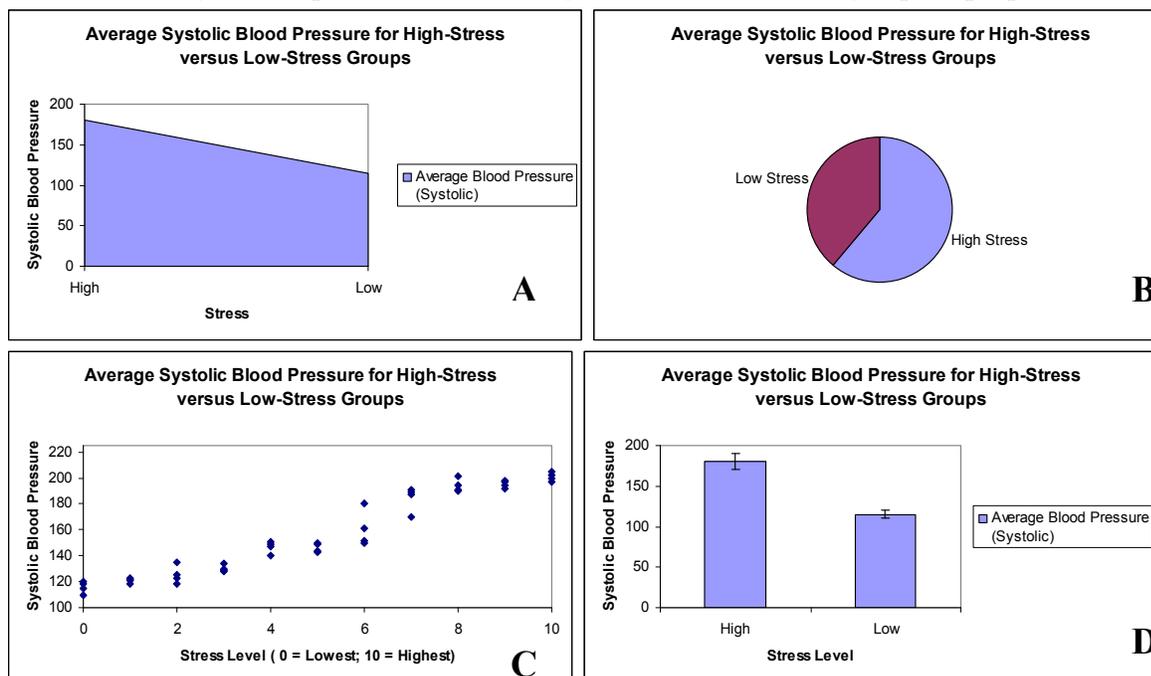
**Background for questions 11 – 14:** Use the excerpt below (modified from a recent news report on MSNBC.com) for the next few questions.

*“A recent study, following more than 2,500 New Yorkers for 9+ years, found that people who drank diet soda every day had a 61% higher risk of vascular events, including stroke and heart attack, compared to those who avoided diet drinks. For this study, Hannah Gardner’s research team randomly surveyed 2,564 New Yorkers about their eating behaviors, exercise habits, as well as cigarette and alcohol consumption. Participants were also given physical check-ups, including blood pressure measurements and blood tests for cholesterol and other factors that might affect the risk for heart attack and stroke. The increased likelihood of vascular events remained even after Gardner and her colleagues accounted for risk factors, such as smoking, high blood pressure and high cholesterol levels. The researchers found no increased risk among people who drank regular soda.”*

11. The findings of this study suggest that consuming diet soda might lead to increased risk for heart attacks and strokes. From the statements below, identify **additional evidence that supports** this claim:
  - a. Findings from an epidemiological study suggest that NYC residents are 6.8 times more likely to die of vascular-related diseases compared to people living in other U.S. cities.
  - b. Results from an experimental study demonstrated that individuals randomly assigned to consume one diet soda each day were twice as likely to have a stroke compared to those assigned to drink one regular soda each day.
  - c. Animal studies suggest a link between vascular disease and consumption of caramel-containing products (ingredient that gives sodas their dark color).
  - d. Survey results indicate that people who drink one or more diet soda each day smoke more frequently than people who drink no diet soda, leading to increases in vascular events.
12. The excerpt above comes from what type of source of information?
  - a. Primary (Research studies performed, written and then submitted for peer-review to a scientific journal.)
  - b. Secondary (Reviews of several research studies written up as a summary article with references that are submitted to a scientific journal.)
  - c. Tertiary (Media reports, encyclopedia entries or documents published by government agencies.)
  - d. None of the above
13. The lead researcher was quoted as saying, “I think diet soda drinkers need to stay tuned, but I don’t think that anyone should change their behaviors quite yet.” Why didn’t she warn people to stop drinking diet soda right away?
  - a. The results should be replicated with a sample more representative of the U.S. population.
  - b. There may be significant confounds present (alternative explanations for the relationship between diet sodas and vascular disease).
  - c. Subjects were not randomly assigned to treatment and control groups.
  - d. All of the above
14. Which of the following attributes is **not** a strength of the study’s research design?
  - a. Collecting data from a large sample size.
  - b. Randomly sampling NYC residents.
  - c. Randomly assigning participants to control and experimental groups.
  - d. All of the above.

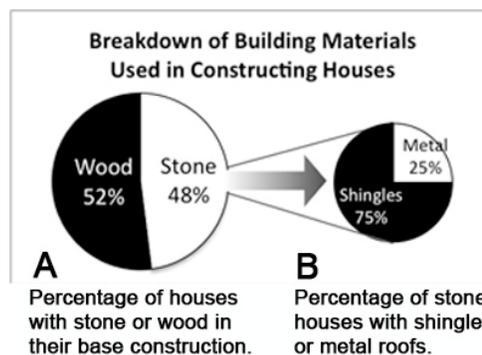
## Appendix B: Test of Scientific Literacy Skills

15. Researchers found that chronically stressed individuals have significantly higher blood pressure compared to individuals with little stress. Which graph would be most appropriate for displaying the mean (average) blood pressure scores for high-stress and low-stress groups of people?



**Background for question 16:** Energy efficiency of houses depends on the construction materials used and how they are suited to different climates. Data was collected about the types of building materials used in house construction (results shown below). Stone houses are more energy efficient, but to determine if that efficiency depends on roof style, data was also collected on the percentage of stone houses that had either shingles or a metal roof.

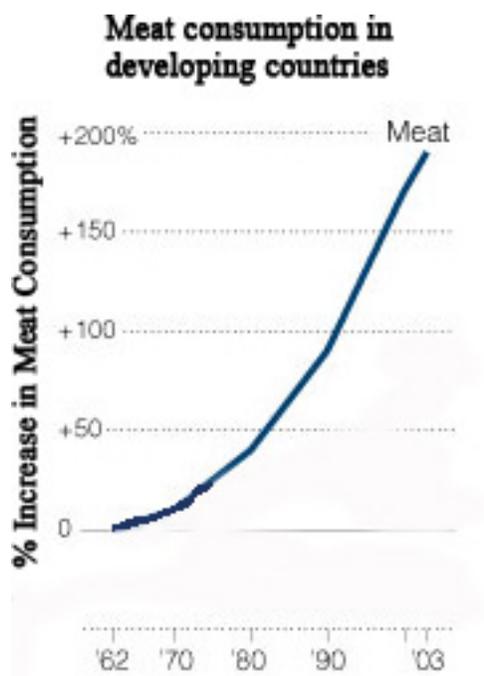
16. What proportion of houses were constructed of a stone base with a shingled roof?
- 25%
  - 36%
  - 48%
  - Cannot be calculated without knowing the original number of survey participants.



17. The **most important** factor influencing you to categorize a research article as trustworthy science is:
- the presence of data or graphs
  - the article was evaluated by unbiased third-party experts
  - the reputation of the researchers
  - the publisher of the article

## Appendix B: Test of Scientific Literacy Skills

18. Which of the following is the **most accurate** conclusion you can make from the data in this graph<sup>3</sup>?

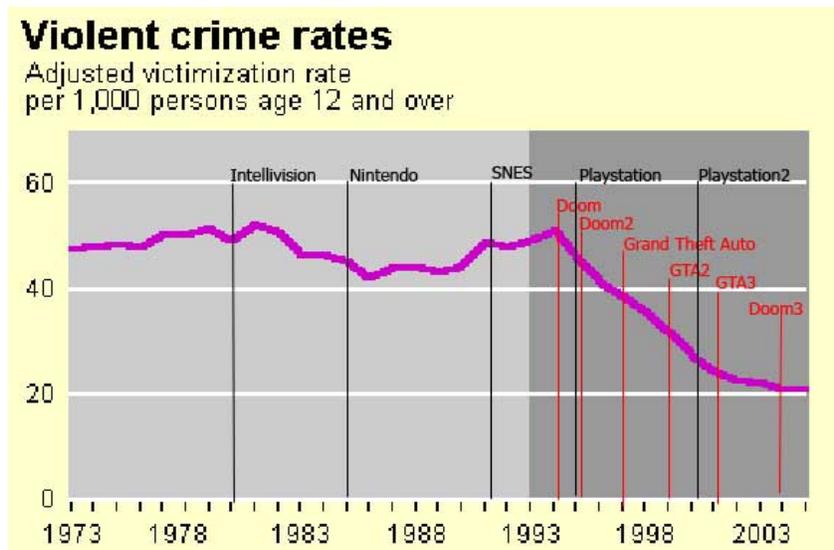


- a. The largest increase in meat consumption has occurred in the past 20 years.
  - b. Meat consumption has increased at a constant rate over the past 40 years.
  - c. Meat consumption doubles in developing countries every 20 years.
  - d. Meat consumption increases by 50% every 10 years.
19. Two studies estimate the mean caffeine content of an energy drink. Each study uses the same test on a random sample of the energy drink. Study 1 uses 25 bottles, and study 2 uses 100 bottles. Which statement is true?
- a. The estimate of the actual mean caffeine content from each study will be equally uncertain.
  - b. The uncertainty in the estimate of the actual mean caffeine content will be smaller in study 1 than in study 2.
  - c. The uncertainty in the estimate of the actual mean caffeine content will be larger in study 1 than in study 2.
  - d. None of the above
20. A hurricane wiped out 40% of the wild rats in a coastal city. Then, a disease spread through stagnant water killing 20% of the rats that survived the hurricane. What percentage of the original population of rats is left after these 2 events?
- a. 40%
  - b. 48%
  - c. 60%
  - d. Cannot be calculated without knowing the original number of rats.

<sup>3</sup> Modified from Rosenthal, Elizabeth. 2008. As More Eat Meat, a Bid to Cut Emissions. New York Times, December 3, 2008. Accessed June 9, 2011 <http://www.nytimes.com/2008/12/04/science/earth/04meat.html>

## Appendix B: Test of Scientific Literacy Skills

**Background for question 21:** A videogame enthusiast argued that playing violent video games (e.g., Doom, Grand Theft Auto) does not cause increases in violent crimes as critics often claim. To support his argument, he presents the graph below. He points out that the rate of violent crimes has decreased dramatically, beginning around the time the first “moderately violent” video game, Doom, was introduced.



21. Considering the information presented in this graph, what is the **most critical flaw** in the blogger’s argument?
- Violent crime rates appear to increase slightly after the introduction of the Intellivision and SNES game systems.
  - The graph does not show violent crime rates for children under the age of 12, so results are biased.
  - The decreasing trend in violent crime rates may be caused by something other than violent video games
  - The graph only shows data up to 2003. More current data are needed.
22. Your doctor prescribed you a drug that is brand new. The drug has some significant side effects, so you do some research to determine the effectiveness of the new drug compared to similar drugs on the market. Which of the following sources would provide the **most accurate** information?
- the drug manufacturer’s pamphlet/website
  - a special feature about the drug on the nightly news
  - a research study conducted by outside researchers
  - information from a trusted friend who has been taking the drug for six months
23. A gene test shows promising results in providing early detection for colon cancer. However, 5% of all test results are falsely positive; that is, results indicate that cancer is present when the patient is, in fact, cancer-free. Given this false positive rate, how many people out of 10,000 would have a false positive result and be alarmed unnecessarily?
- 5
  - 35
  - 50
  - 500

## Appendix B: Test of Scientific Literacy Skills

24. Why do researchers use statistics to draw conclusions about their data?
- Researchers usually collect data (information) about everyone/everything in the population.
  - The public is easily persuaded by numbers and statistics.
  - The true answers to researchers' questions can only be revealed through statistical analyses.
  - Researchers are making inferences about a population using estimates from a smaller sample.
25. A researcher hypothesizes that immunizations containing traces of mercury **do not** cause autism in children. Which of the following data provides the **strongest** test of this hypothesis?
- a count of the number of children who were immunized and have autism
  - yearly screening data on autism symptoms for immunized and non-immunized children from birth to age 12
  - mean (average) rate of autism for children born in the United States
  - mean (average) blood mercury concentration in children with autism

**Background for Question 26:** You've been doing research to help your grandmother understand two new drugs for osteoporosis. One publication, *Eurasian Journal of Bone and Joint Medicine*, contains articles with data only showing the effectiveness of one of these new drugs. A pharmaceutical company funded the *Eurasian Journal of Bone and Joint Medicine* production and most advertisements in the journal are for this company's products. In your searches, you find other articles that show the same drug has only limited effectiveness.

26. Pick the **best** answer that would help you decide about the credibility of the *Eurasian Journal of Bone and Joint Medicine*:
- It is not a credible source of scientific research because there were advertisements within the journal.
  - It is a credible source of scientific research because the publication lists reviewers with appropriate credentials who evaluated the quality of the research articles prior to publication.
  - It is not a credible source of scientific research because only studies showing the effectiveness of the company's drugs were included in the journal.
  - It is a credible source of scientific research because the studies published in the journal were later replicated by other researchers.
27. Which of the following actions is a valid scientific course of action?
- A scientific journal rejects a study because the results provide evidence against a widely accepted model.
  - The scientific journal, *Science*, retracts a published article after discovering that the researcher misrepresented the data.
  - A researcher distributes free samples of a new drug that she is developing to patients in need.
  - A senior scientist encourages his graduate student to publish a study containing ground-breaking findings that cannot be verified.

## Appendix B: Test of Scientific Literacy Skills

**Background for question 28:** Researchers interested in the relation between River Shrimp (*Macrobrachium*) abundance and pool site elevation, presented the data in the graph below. Interestingly, the researchers also noted that water pools tended to be shallower at higher elevations.

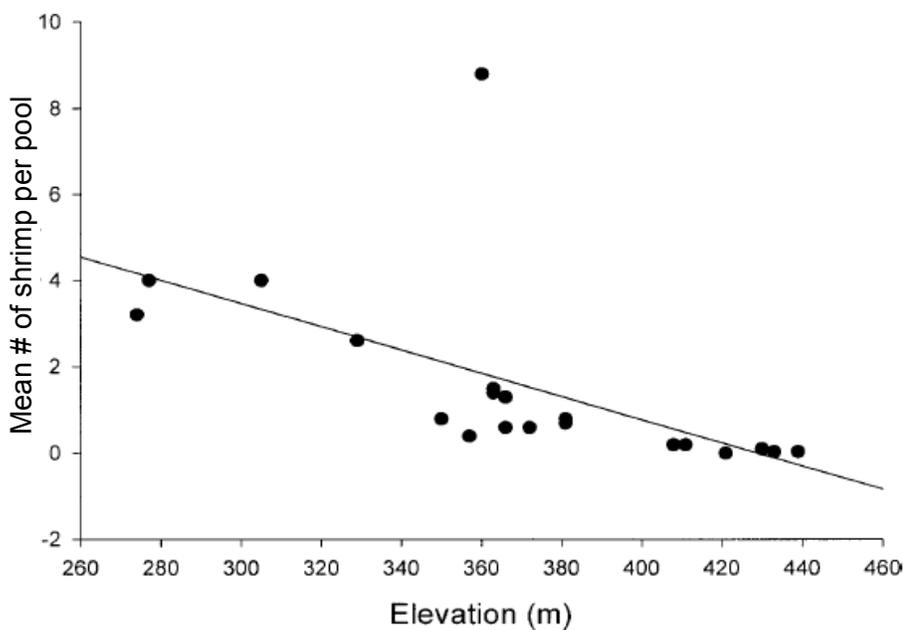


FIG. 3. Relationship between total abundance of *Macrobrachium* (1988–2002) and elevation in Quebrada Prieta.

28. Which of the following is a plausible hypothesis to explain the results presented in the graph?
- There are more water pools at elevations above 340 meters because it rains more frequently in higher elevations.
  - River shrimp are more abundant in lower elevations because pools at these sites tend to be deeper.
  - This graph cannot be interpreted due to an outlying data point.
  - As elevation increases, shrimp abundance increases because they have fewer predators at higher elevations.

### Appendix C: TOSLS Skills and Answer Key (28Qs)

SKILL	DESCRIPTION	Question	Correct Answer
<b>1</b> (3 Qs)	Identify a valid scientific argument (e.g., recognizing when scientific evidence supports a hypothesis)	1	B
		8	D
		11	B
<b>2</b> (5 Qs)	Conduct an effective literature search (e.g. Evaluate the validity of sources (e.g., websites, peer reviewed journals) and distinguish between types of sources)	10	B
		12	C
		17	B
		22	C
		26	C
<b>3</b> (3 Qs)	Evaluate the use and misuse of scientific information (e.g. Recognize a valid scientific course of action, distinguish the appropriate use of science to make societal decisions)	5	D
		9	B
		27	B
<b>4</b> (4 Qs)	Understand elements of research design and how they impact scientific findings/conclusions (e.g. identify strengths and weaknesses in research related to bias, sample size, randomization, experimental control)	4	C
		13	D
		14	C
		25	B
<b>5</b> (1Q)	Make a graph	15	D
<b>6</b> (4 Qs)	Read and interpret graphical representations of data	2	C
		6	C
		7	A
		18	A
<b>7</b> (3 Qs)	Solve problems using quantitative skills, including probability and statistics (e.g calculate means, probabilities, percentages, frequencies)	16	B
		20	B
		23	D
<b>8</b> (3 Qs)	Understand and interpret basic statistics (e.g. interpret error bars, understand the need for statistics)	3	B
		19	C
		24	D
<b>9</b> (2 Qs)	Justify inferences, predictions, and conclusions based on quantitative data	21	C
		28	B

## Appendix D: Student Interview Scoring Rubric

Skill	Correct reasoning	Question	Correct Answer
<b>1</b> (3 Qs)	Evaluation of hypothesis with experiment; empirical test; draws conclusion that is based on strong evidence; provides reasoning for evaluating evidence; Evaluates the experimental design, recognizing confounds or need for random selection, or other independent variables	1	B
		8	D
		11	B
<b>2</b> (5 Qs)	Recognize sources of bias; quoting researcher does not indicate primary source; reviews are not primary; media reports are tertiary; peer review and importance of evaluation by 3rd party experts	10	B
		12	C
		17	B
		22	C
<b>3</b> (3 Qs)	Recognize bias political or financial influences should not used to pressure findings, conclusions, reporting, or social decisions; decisions should be based on evidence; questionable ethics of publishing work that has not been verified; questionable ethics of distributing materials to bias participants; questionable ethics of rejecting studies based on controversy	5	D
		9	B
		27	B
<b>4</b> (4 Qs)	No confounding factors (e.g., differences in sample size, sample selection, sample makeup); an explanation of how controls are used to mediate confounding factors; identifying strengths and weaknesses of experimental design (e.g., random assignment to control and treatment groups)	4	C
		13	D
		14	C
		25	B
<b>5</b> (1Q)	Histogram is the best way to compare means	15	D
<b>6</b> (4 Qs)	Given data, be able to explain what the general shape of the graph would be (exponential/logarithmic vs linear); explain why the other shapes are not correct; interpret the graph and infer cause (e.g., pesticide killed the beetles which caused more tadpoles to be eaten); extract numerical information from graph and use that to make comparisons or conclusions; interpret shape of a graph to reach a conclusion	2	C
		6	C
		7	A
		18	A
<b>7</b> (3 Qs)	Solve algebraic calculations accurately	16	B
		20	B
		23	D

**Appendix D: Student Interview Scoring Rubric**

<b>8</b> (3 Qs)	Give measure of reliability such as use of statistical tests to define probability and certainty; how sample size effects certainty; Recognize that researchers use statistics to make inferences about a population using a sample of that population	3	B
		19	C
		24	D
<b>9</b> (2 Qs)	Recognize or use reasoning to explain that correlation does not imply causation; using information from a graph to explain why they chose an answer that they did (e.g., the graph showed elevation and mean number of shrimp rather than having fewer predators)	21	C
		28	B