_____ _____

NAME DATE

1. Answer whether each of the following two statements is true or false. Justify your answer in one or two sentences.
   a. "Having pelvic spines is always advantageous to a stickleback."

   b. "All mutations are bad."

2. What specific features of the environment in Bear Paw Lake, Alaska, may have favored the survival and reproduction of stickleback fish with reduced pelvises? Answer in two or three sentences.

3. In the film, Dr. Bell notes that in multiple freshwater populations and at multiple times in history, the frequency of stickleback fish with pelvic spines decreased and the frequency of stickleback fish with reduced pelvises increased. This demonstrates that:

   a. only fish with smaller pelvises migrate to freshwater.

   b. similar environments select for similar genetic changes.

   c. the pelvis of the marine fish is destroyed by freshwater.

4. Circle whether each statement below is true or false.

   True/False Evolutionary change always takes millions of years.

   True/False Stickleback fish lose their pelvic spines whenever they are in fresh water.

   True/False Dramatic changes in traits, such as the loss of limbs, can occur through mutations affecting a single gene.

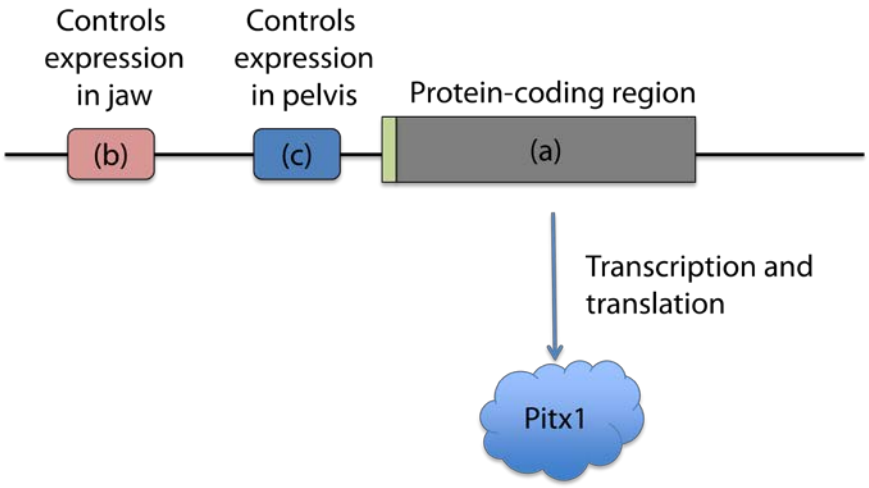
5. During a high-flood season, a lake overflows its banks and some resident freshwater stickleback fish are carried out to the ocean. For each of the following statements, circle the outcome most likely to occur.

   When they reach salt water, individual fish *will / will* not spontaneously generate pelvic spines during their lifetime.

   More fish *with / without* pelvic spines will be eaten by large-mouthed predators.

   Over many generations, the frequency of stickleback fish with pelvic spines will increase/decrease in populations that descended from the original one that spilled out from the lake .

6. Below is a simplified schematic representation of some of the genetic elements involved in the regulation of *Pitx1* gene expression. The large grey rectangle represents the protein-coding region of the *Pitx1* gene. The smaller rectangles to the left (pink and blue) are regulatory switches; each one allows a specific binding protein to interact with it and turn on the *Pitx1* gene in a particular tissue. When expressed, the *Pitx1* gene is transcribed and then translated to generate the Pitx1 protein. Read each question below and write "yes" or "no" in the blank space provided.



   a. A deletion at location (a) causes a frameshift mutation. How likely is it that a functional Pitx1 protein would be produced in the jaw?_____ in the pelvis? _____. Justify your answer in one or two sentences.

   b. If the entire region (b) was deleted, would you see a functional Pitx1 protein in the jaw? _____ in the pelvis? _____ Justify your answer in one or two sentences.

7. The function of the *Pitx1* gene was first discovered by scientists working in a different field and in a different organism. To investigate what the *Pitx1* gene did, these scientists intentionally mutated the *Pitx1* protein-coding region in mice so that the Pitx1 protein was no longer produced. These mice died before birth and had miniaturized hind limbs. Given this information, answer each of the following questions.

   a. What do you think these scientists concluded about the function of the Pitx1 protein after carrying out this experiment?

   b. How is the genetic change that occurred in stickleback fish with reduced pelvises in freshwater lakes different from the one that scientists produced in the mice?

   c. Why are stickleback fish with a *Pitx1* mutation able to survive but not the mice?

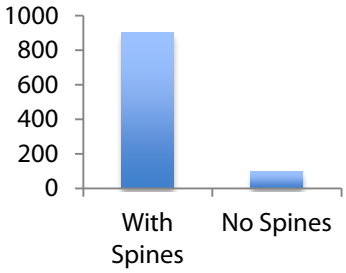
8. You are studying stickleback fossils from a newly discovered desert deposit site that was once the bottom of an ancient lake. Sediment, mineral, and topographical analysis indicate that when the lake first formed it was connected to the ocean by a river that eventually dried up, cutting the lake off from the ocean. As you sort through different rock layers in this desert deposit, you find two distinct types of stickleback fish fossils—those with no pelvic spines and those with full spines. You don't find any fossils of large predatory fish in this deposit.

Fossil stickleback without pelvic spines. (The circle shows the region where you would expect to see the pelvis and pelvic spines; the arrows point to the ectocoracoid bone, which is not part of the pelvis.)

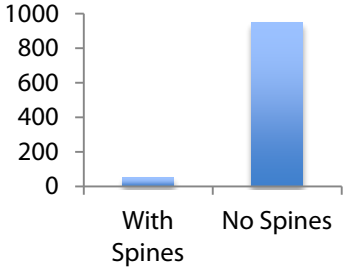
Fossil stickleback with a full pelvis, which includes pelvic spines.

The data below were collected from five different rock layers (labeled A to E) in the desert deposit. Each graph shows the number of fish belonging to each category. Place the rock layers in the most reasonable order from oldest to most recent. Justify your answer in two or three sentences.

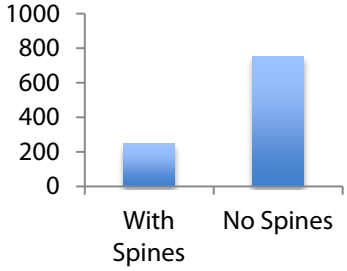
A



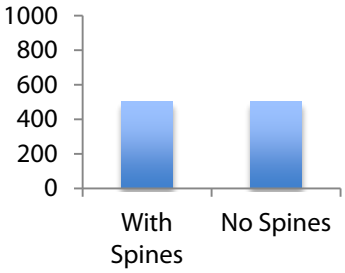
B



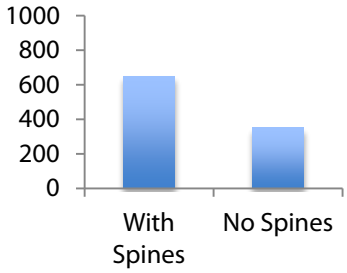
C



D



E



Oldest__, __, __, __, __Most recent