Effect of Temperature on Embryonic Development

Authors

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SUBJECT/GRADE LEVEL

Subject Area: Science

High School

Materials

- Microscope
- Petri dishes (1/student)
- Breeding fish and aquarium set up (At least a 10 gallon tank to allow for a growing population of fish.)
- Log book (Example in Exploration)
- Light timer for aquarium to initiate breeding
- Japanese Medaka (the primary fish for this unit can be purchased online. Additionally, 3 of the 5 pet shops that I checked in my area(Canton, Ohio) could order the fish for me. Local providers would be my preference. These can also be purchased on Amazon
- Embryo rearing solution Link
- Plan for a class of 30 students.

STANDARDS

Next Generation Science Standards

- HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis
- HS-LS4-5 Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species

Mathematics Standards | Common Core State Standards

- CCSS.MATH.CONTENT.S.IC.6 Make inferences and justify conclusions from sample surveys, experiments, and observational studies. S.IC.6 Evaluate reports based on data.

English Language Arts Standards | Common Core State

- CCSS.ELA-LITERACY.SL.11-12.1.A: Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

LESSON OBJECTIVE(S)

Students will be able to determine the effect of differing temperatures on the embryonic development of a fish embryo. Teacher resources to aid in breeding

Students will be able to successfully utilize a microscope to collect both quantitative and qualitative data on the development of their fish embryo from fertilization to birth

Students will be able to graph their data and make comparisons of their data to the group data

CAREER CONNECTION(S)

Mentor Background: Dr. Dylan Fudge: Dr. Dylan Fudge is a research chemist/principal investigator for the Defense Threat Reduction Agency matrixed at the U.S. Army Combat Capabilities Development Command Chemical Biological Center (CCDC CBC) in Aberdeen Proving Ground. His work focuses on evaluating emerging biological and chemical weapons of mass destruction by advancing and developing in vitro predictive toxicological systems. He earned his Ph D. in Molecular and Cellular Biophysics from the University of Denver. Prior to working for the military, he held multiple positions in academia and industry. Research involves toxicological studies utilizing organ-on-a-chip technologies and interfacing these technologies with aerosol exposure systems. Research will also include basic toxicological techniques used to characterize both biological and chemical compounds.

STEM Careers: Biochemist, Toxicologist, Research chemist, Chemical Engineer

ENGAGEMENT

Link for slides

Brief Description: The students will be asked to identify the effects temperature or environmental changes may have on animals. This can be done as a group, a whiteboard activity, an electronic feedback app where the class could add their ideas on the screen, or simply a discussion. This is designed to help students make a connection between an organism (structure and function) and their environment.

Procedures:

For each pair of pictures, ask the students to be as specific as they are able when describing the effects of the environmental change. (Changes in food sources, too hot/too cold, changes in predators, possible new challenges) This worksheet could also be utilized to encourage discussion. Engagement worksheet

EXPLORATION

Brief Description:

Students will each be given a fertilized egg in a petri dish with embryo rearing solution. Additionally they will be given a log book to be used as they observe the development of their egg. They will study the development of their embryo until it hatches. Student log book **This will be continued to be embedded in instruction of selected scientific topics based on teacher discretion.**

Procedures:
Students will observe the egg under the microscope daily. In their log book they will be expected to draw a diagram, and make at least 1 qualitative and 1 quantitative observation. (When a heartbeat is seen, the quantitative data collected is the heart rate.)
Each day the log book has an analysis question or prompts the students to develop their own question for later discussion.

Students will be paired. One of the student's eggs will be stored at room temperature and one will be stored in an area that is colder. (Set up suggestions in the teacher section) Each day, the students will make comparisons of what they see with their paired partner and record them in their log).

EXPLANATION

Brief Description: The student exploration will continue as the students carry out an embryonic study of Japanese Medaka fish to determine the effect of different temperatures. Simultaneously, relevant explanations will be carried out by the teacher as outlined below.

Procedures:
Day 1: Introduce the students to the unit and distribute log books. Address relevant vocabulary. Students can complete pages 2, 3 and 4. (If students are more comfortable with microscopy, 3 and 4 can be omitted)

Day 2: Complete the scientific question and hypothesis. Allow the students to review the protocol. Distribute the embryos to each student and allow them to complete observation #1.(Depending on their lab skill level, this day may need to be split into 2. If microscope practice is needed the extra time is encouraged.

Day 3-8 (The exact number of days is dependent on the rate of development. This is an estimate)
Students observe their embryo, record observations and consult with their partner.
After the 1st day of observation, the amount of time can be decreased to about 10 minutes.
During these classes, additional instruction can be included.
Potential topics:

1) Data Nuggets
   - Are you my species?
   - Why so Blue?
   - Salmon in hot water
2) Lessons on homeostasis
   - Homeostasis
3) Ecosystems- Structure and function
   - Ecosystems video
   - CK12 Lessons on ecosystems

EXTEND/ELABORATE

Brief Description: A possible extension could be a zebrafish investigation testing the effect of caffeine on the fish development.

Procedures: Example of an investigation testing caffeine and embryonic development
Zebrafish and caffeine investigation example
Additional protocol/investigation example
NIH research on caffeine and zebrafish

EVALUATION

Brief Description: Students will complete their log book including conclusion statements with supporting data.

Procedures:
The students' log books will be completed upon the hatching of both their embryo and their partner's. An additional evaluation could be a scientific poster presentation. This could be in a traditional printed poster format with a gallery walk or a digital presentation. Directions and Rubric contained in the link.
Digital poster presentation

REFERENCES

Help determining sex

Breeding and egg collection

Additional resources for breeding an egg collection

Raising Medaka

Rice fish basics video

PubMed

Salmon in hot water

Are you my species?

Why so Blue?