

Worms that keep the Beat

Purpose: To develop the students' understanding of circulation and blood pulsations in the closed circulatory system of an invertebrate (Phylum Annelida, Class Oligochaeta, Genus/species, *Lumbriculus variegatus*). In addition, effects of pharmacologically active chemicals are examined on pulsation rates and comparisons are made with human circulatory function.

Objectives:

1. The student will be able to observe and record the pulse rate of *Lumbriculus variegatus* (an aquatic segmented worm).
2. The student will design and carry out an experiment showing the effect of various substances on the pulse rate of *Lumbriculus variegatus*.
3. The student will present a poster session of their findings following a rubric.
4. The student will be able to compare and contrast pulse rate changes in *Lumbriculus* and humans.

Materials: per group of two students

Lumbriculus variegatus 5- 7

Glass or plastic capillary tubes 3- 5

5 plastic petri dishes

1 polyethylene bulb pipette

1 micropipet tip

5 cups or beakers (250ml)

1 graduated cylinder (50ml or 100ml)

Compound light microscope

Balance (optional)

Chemicals that have possible effect on pulse rate

- | | |
|--------------------------------------|--------------------------------|
| ○ Caffeine (No-Doze) | ethanol (pure not denatured) |
| ○ CO ₂ (Carbonated water) | Herbs (ginseng extract) |
| ○ Nicotine (tobacco product) | d-limonene (orange peel fluid) |
| ○ pH? buffers | vitamins |
| ○ Capsaicin (red pepper) | other |

Brief Description of the Activity

Students will learn the relationship between the pulse rate of a worm and various pharmacologically active chemicals using a learning cycle. The 5 E's of the learning cycle are-**Engage:** Get the students attention using a KWL with questions concerning pulse rate. **Explore:** Provide students with the techniques for measuring the pulse rate of a fresh water annelid worm using microscopes. **Explain:** The class will use Internet resources and conduct a web treasure hunt to get the facts. **Elaborate:** Students will design and conduct an inquiry lab testing the effects of various stimulants or depressants. The **Evaluation** will be based on a poster session of the student's findings.

References

Dr. Charles Drewes Iowa State University

http://www.zool.iastate.edu/~c_drewes/

http://www.zool.iastate.edu/~c_drewes/Lvgen4.htm

Carolina Tips, Carolina Biological Supply Company

<http://www.carolina.com/tips/worm/worm.asp>

Olathe USD 233 – Grading Rubric

Paula Donham, Olathe East High School – Poster Rubric

Lesiuk, N. and C. Drewes (1999) "Blackworms, Blood Vessel Pulsations, and Drug Effects," American Biology Teacher, 61:48-53.

Thomas J Conley, Frontiers in Physiology 1998 ,Cardiovascular Inquiry Using Lumbriculus variegatus, Mudworms

Suggestions for Teachers

Preparation and Procedures

Weeks prior to lab order materials (see **Quick List Buying Guide**)

Several Days prior to lab set up worm culture. See **Raising and Handling** at <http://www.carolina.com/tips/worm/worm.asp>

Photo copy-KWL, Treasure Hunt, Measuring the Pulse Rate, Student Designed Lab, 3-page Mini-poster, Mini-poster rubric

Day 1

KWL-- Use to engage students and introduce topic with suggested questions.

- What can cause a change in human pulse rate/heart rate?
- What chemicals effect pulse rate?
- How can animals be used as models for pulse rate and chemical interaction?

Web site Treasure Hunt.

Hint: If a limited number of computers are available, print and photocopy bookmarked pages.

Hint: Provide activities via your web site or shared drive that all students can access. This speeds up jumps from site to site. (Typing in exact URLs is difficult.)

Day 2

"Measuring the Pulse Rate" (Base line data)

Hint: Use plastic capillary tubes and eliminate the danger of broken glass.

Hint: White plastic deli dish (½ pint) and chilled spring water slows the worm movement.

Hint: Flex camera record on VHS if stress free demo is desired. In other words, why not pre-record close ups and microscope images rather than stress doing them live for the class.

Hint: Heat kills. Bright light makes the worms more active so try to use minimal light and still view red color of blood as it moves.

Hint: Blood flows to anterior end through the dorsal blood vessel.
anatomy is comparable to earthworms.

Day 3 & 4

Student Designed lab Complete as homework parts of lab needing signature.
Read Dr. Drew's **Biological Smoke Detectors**. It has many hints
for teachers and students.

Hint: Prepare solutions in dropper bottles so that students can add # of
drops.

Hint: Dosage is sub-lethal. The death of the worm is not acceptable
data. Effects on pulse rate numbers at various concentrations is the
best data.

Hint: Capsaicin is not water soluble and may best be administered by
contacting skin of worm on wet filter paper. Dissolving pepper
powder in alcohol and placing on filter paper. Then dried to
remove alcohol. Rewetted with spring water and then place worm
on paper. **Remember**--students need to solve these problems by trial
and error. Inquiry allows students to design and redesign
experiment just as do real research scientists.

Hint: Use multiple trials that can be averaged.

Age Level: 9th through 12th grades

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Level 5 Inquiry

National Standards: 9 -12

Science as Inquiry

- Abilities necessary to do scientific inquiry.

Life Science

Structure and function in Living Systems

Regulation and behavior

- Behavior of organisms

Science in Personal and Social Perspectives

- Personal and community health

Kansas State Standards:

STANDARD 1: Science as Inquiry

Benchmark 1: Students will demonstrate the fundamental abilities necessary to
do scientific inquiry.

STANDARD 3: Life Science

Benchmark 6: Students will understand the behavior of animals.

Benchmark 7: Students will demonstrate an understanding of structure,
function, and diversity of organisms.

Student Skills:

Basic Microscope techniques

Use capillary tubes to observe pulse rate of *Lumbriculus* .

Basic understanding of a controlled experiment.

Recommendations:

- Students should have skills in using the microscope and using the steps of the scientific method
- Take one day prior to activity to conduct baseline pulse rate for *Lumbriculus*. This is a time for students to practice lab skills.
- **Warning** – Heat kills the worms; a possible source is the microscope lamp.

Safety:

1. Warn students of dangerous nature of broken capillary tubes.
2. Provide a “sharps” disposal container. (Metal coffee cans work well.)
3. Discuss humane treatment of all life forms. Treat these animals as you would pets at home. (http://www.nabt.org/sub/position_statements/animals.asp)

Questions for Teacher to ask students:

1. What is the purpose of blood circulating in animals?
2. What is the “heart” of the worm?
3. This worm has no red blood cells, what might carry the oxygen in the blood?
4. What other variables change oxygen content of blood?

Inclusion:

- Visually impaired students can benefit from large screen viewing of microscopic work.
- Students that are uncomfortable with worms can view from a distance initially if a flex camera is used with a monitor. Next students can get closer to the worm risk free if the worm is safely placed in a closed vial and passed to students.
- Physically handicapped students may lack motor skills to carry out necessary steps. It is recommended that pairing with capable students would allow equal access

Extensions:

- Students can conduct web research of circulatory system.
- Guest Speaker
- Student Activities Handout
- Long term effect of chemicals on *Lumbriculus*
- Calculate the blood volume. (Dr. Drewes)

Measuring the Pulse Rate (Base line data)

Day 1: Microscopic Observation of Pulse rate of *Lumbriculus variegatus* (Adapted from Dr. C. Drewes, ISU)

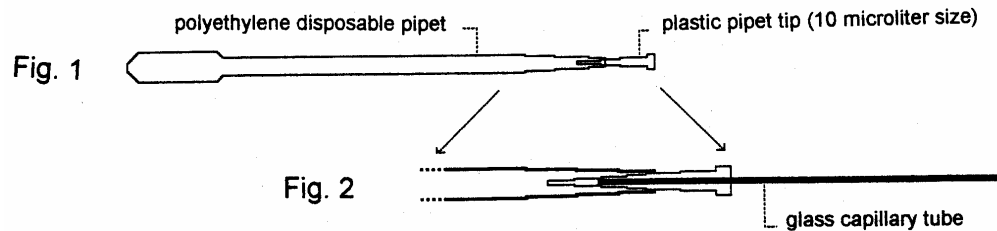
Purpose: To develop skills needed to record the pulse rate of a Worm

Materials per group: (2 students)

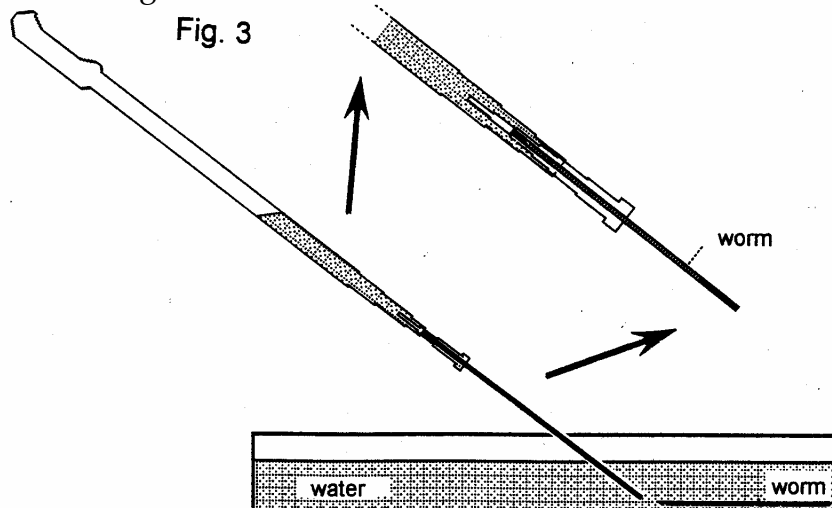
- 3 -5 *Lumbriculus variegatus* -source see appendix
- 2 glass capillary tubes (plastic capillary tubes can be used if safety is of concern)
- 1 - polyethylene bulb pipet
- 1 - micropipet tip
- Spring water/or aged tap water (aged 2 to 3 days in open container)
- Compound microscope
- 2 - 350ml beakers

Procedure:

1. Pipet 2to 3 worms 5 -7 cm in length into dish with cold spring water about 5-10 degrees Celsius.
2. Construct a device for drawing the worm into a capillary tube by:
 - a. Placing the small point of a micropipet tip into the end of a 3-5 ml plastic pipet
 - b. Carefully push the cap tube into the funnel end of the micropipettor tip. See figure 1 &2. **Caution:** broken glass capillaries are razor sharp



3. Squeeze the barrel of the plastic pipet to force air out.
4. Place the opening near the head or tail and draw the worm into the capillary tube. See figure 3.



5. Detach the capillary tube with worm from the pipettes.
6. Place the capillary tube on the stage of a **compound microscope**.
7. Locate the dorsal blood vessel at magnification of about 40 to 100x.
8. Count the number of pulses in one minute for the head – middle and tail regions.
9. Record these along with the class for a view of group data.

Data:

Pulse Rate of Lumbriculus in Different Segments

Pulses /minute	Head	Middle	Tail	Average H,M,T
Count # 1				
Count #2				
Count #3				
Average				
Class Data				

Data Analysis: Describe trends or patterns observed in the numbers.

Conclusion: Give a reason why oserved patterns can be explained using biological reasons.

Student Designed Lab investigating the effects of various biologically active chemicals on the pulse rate of the Black worms.

Student Directions:

Base on the questions you have after completing the KWL and Web treasure hunt you will design an experiment. The results of you experiment will be shared with the class as a poster. Read the guidelines that follow and complete your assignment.

If possible, consult this article about student-designed experimentation with biologically active compounds: **Biological Smoke Detectors**

http://www.zool.iastate.edu/~c_drewes/Toxweb3.htm

http://www.zool.iastate.edu/~c_drewes/Toxweb3.PDF

Materials Available:

Lumbriculus variegatus 5- 7

Glass or plastic capillary tubes 3- 5

5 plastic petri dishes

1 polyethylene bulb pipet

1 micropipet tip

5 cups or beakers (250ml)

1 graduated cylinder (50ml or 100ml)

Compound light microscope

Balance (optional)

Dropping bottles

Chemicals that have possible effect on pulse rate

- | | |
|---------------------------------------|-------------------------|
| ○ Caffeine (No-Doze) | ethanol |
| ○ Carbonated water (CO ₂) | Herbs (ginseng extract) |
| ○ Nicotine (tobacco product) | d-limonene |
| ○ Capsaicin from red pepper | other? |



by Dr. Drewes

Complete these steps and receive teacher approval before starting the experiment.

Question: What is the effect of _____

_____?

Hypothesis: (If /then)

- Independent variable _____
- Dependent variable _____

Experimental design and procedures:

Describe what is meant by each of the following items. Explain the decisions (the why and how) that need to be made regarding each.

- Control group handling and procedures

- Treatment group handling and procedures

- Exposure time to chemical (suggest 10-15 min)

- Before and after measurements in the treatment group

- Before and after measurements in the control group

- Recovery from treatment (optional)

Materials: _____

Procedure sequence:

1) _____

2) _____

- 3) _____
- .4) _____
- .5) _____
- 6) _____
- 7) _____
- 8) _____
- 9) _____
- 10) _____

Additional Steps add on separate paper

Teacher approval. _____

Data and Graphs: Construct data tables and graphs for your report.
Draw a table before you start the experiment.

Final Report is a mini-poster. Use post it notes or tape report on to the mini-poster. Follow the rubric to design a poster for presenting your experiment.

