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# Eukaryotic Extremophiles: Rotifers

Life on the Edge



# Acknowledgements

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# National Standards Correlation

## Life Science Content Standard C

### Regulation and Behavior

All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment. Regulation of an organism's internal environment involves sensing the internal environment and changing physiological activities to keep conditions within the range required to survive.



Picture of a plant adapting to its environment

### Diversity and Adaptations of Organisms

Millions of species of animals, plants, and microorganisms are alive today. Although different species might look dissimilar, the unity among organisms becomes apparent from an analysis of internal structures, the similarity of their chemical processes, and the evidence of common ancestry. Biological evolution accounts for the diversity of species developed through gradual processes over many generations. Species acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally occurring variations in populations. Biological adaptations include changes in structures, behaviors, or physiology that enhance survival and reproductive success in a particular environment.



Picture of DNA structure

## Earth and Space Science Content Standard D

### Structure of the Earth System

Water is a solvent. As it passes through the water cycle it dissolves minerals and gases and carries them to the oceans. The atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor. The atmosphere has different properties at different elevations.



Picture of Earth from space

## Teacher Manual

Prep Time: 30 minutes

Class Time: 45 minutes

### Purpose:

To find out which species of rotifers can survive an overnight desiccation.

### Common Misconceptions:

- “When mud or sediment from ponds in which rotifers live is dried, living rotifers appear after a few hours when water is added to the sediment.”---- The American naturalist, Volume 42 By Essex Institute, American Society of Naturalists, JSTOR (Organization)
  - Explanation for #1: “These living rotifers probably develop however from the winter eggs thick shelled fertilized eggs which in some cases are known to withstand prolonged desiccation.”---- The American naturalist, Volume 42 By Essex Institute, American Society of Naturalists, JSTOR (Organization)
- “Asexual reproduction produces weak offspring. Sexual reproduction produces superior offspring.” Berthelsen, B. (1999). Students Naïve Conceptions in Life Science. ---- MSTA Journal, 44(1) (Spring’99), pp. 13-19. <http://www.msta-mich.org>.
- “Organisms cannot survive without water.”

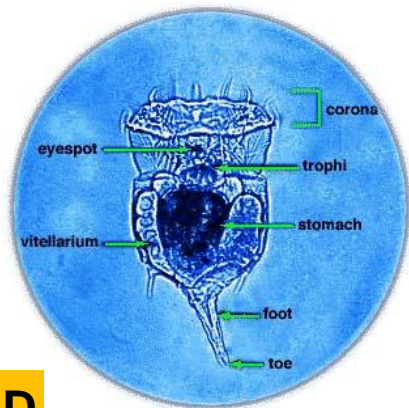
### Skills:

1. *Predicting* the outcome of an experiment
2. *Controlling* variables
3. *Conducting* an experiment
4. *Collecting, recording, and graphing* data
5. *Drawing* conclusions and *communicating* them to others

### Overview:

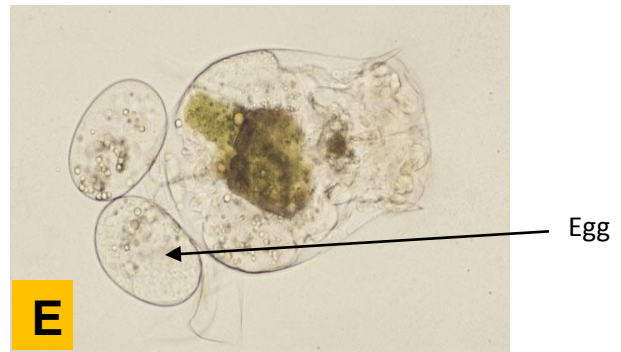
Rotifers are aquatic multicellular Eukarya organisms. The class bdelloids are the extremophilic rotifers. You will be working with two species of bdelloids: *Adineta vaga* and *Phiodina rapida*. The monogonout (another class of rotifers which are not extremophiles), *Brachionus calyciflorus*, will be used as a control.

Rotifers are microscopic animals. There are approximately 2,000 species of rotifers. Most species live in freshwater; some live in the sea; and a few live as parasites in or on other organisms. A rotifer's body consists of a head, a long middle section that holds the internal organs, and a tailpiece bearing one to four pointed projections called toes. An adhesive substance, with which rotifers adhere to surfaces, is secreted by glands in the toes. The rotifer has a two-lobed "brain" (a small mass of nerve tissue), and most species have eye spots (cells that are sensitive to light).



**D**

Parts of a rotifer



**E**

*Brachionus calyciflorus*



**F**

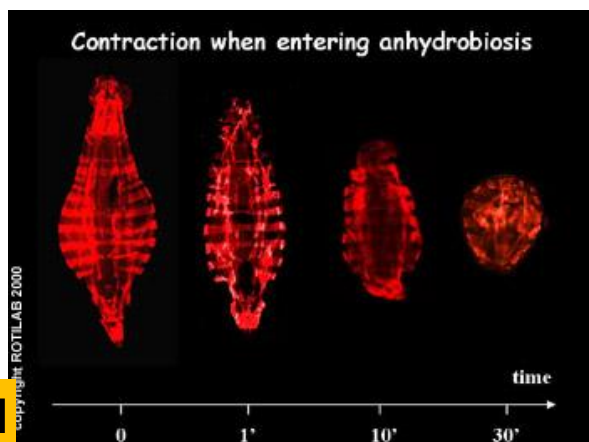
*Adineta vaga*



**G**

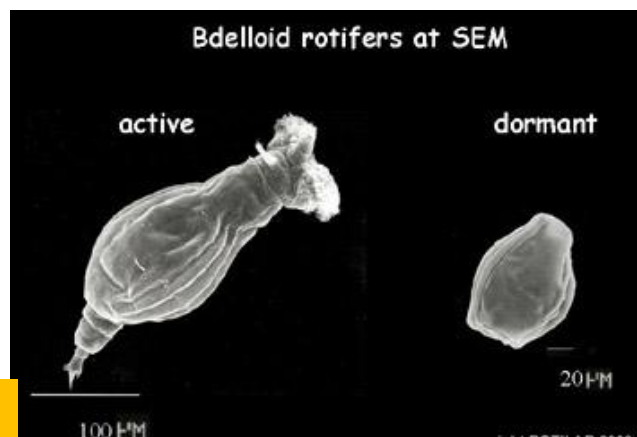
*Phiodina rapida*

The mouth is surrounded by hairlike cilia that sweep in food, which typically consists of bacteria, protozoans, and other small organisms. The cilia are also used for swimming. Female rotifers produce both summer eggs and winter eggs. Summer eggs are thin-shelled and develop without fertilization. They are not all the same size; the larger ones produce females and the smaller ones produce males. Winter eggs are thick-shelled and must be fertilized. They produce only females. Winter eggs can survive internal water loss and freezing.



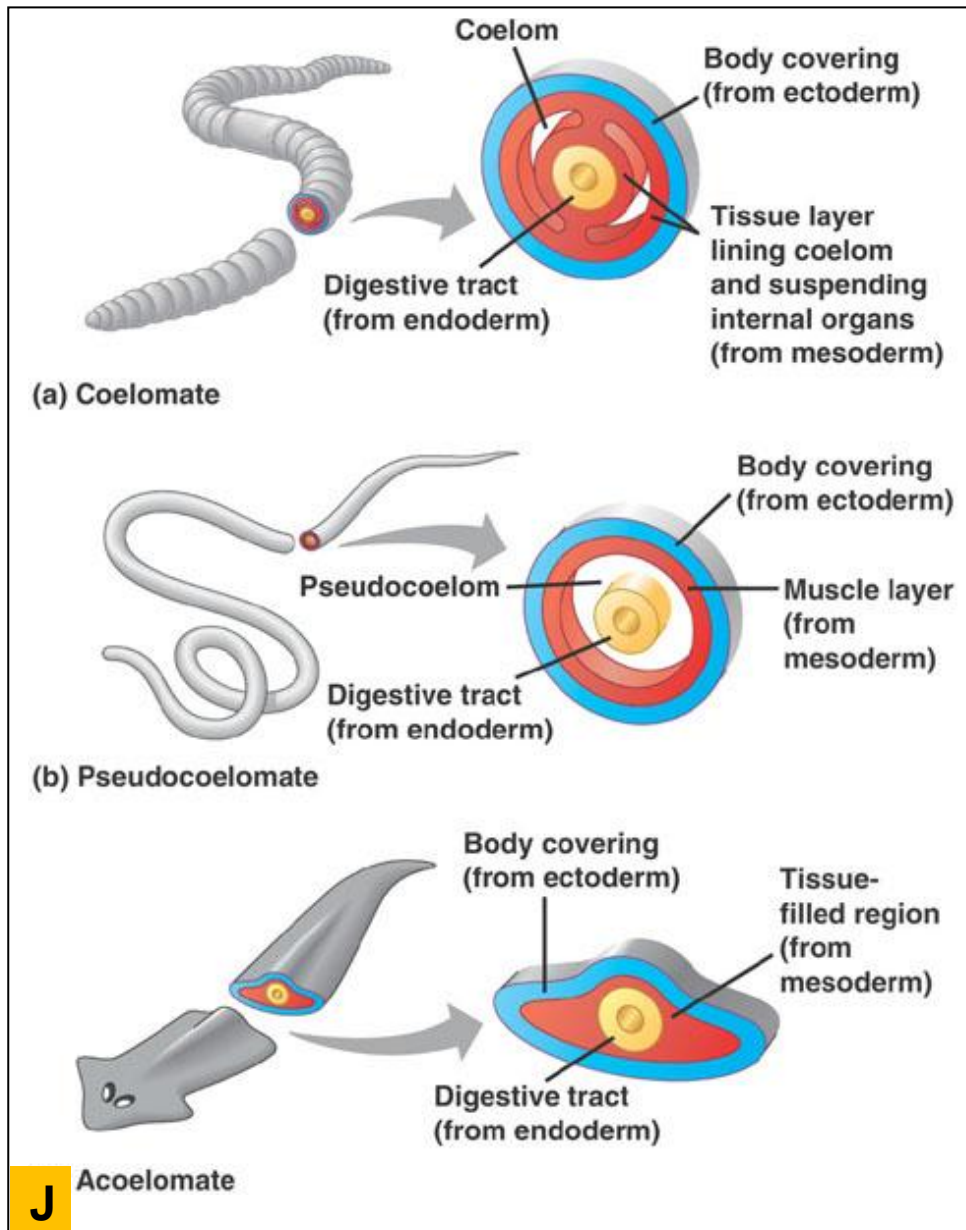
**H**

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**I**

Teacher's Notes - Explain to the students what happens during desiccation of a rotifer. Rotifers are Pseudocoelomates, meaning that they do not have a true cavity. Unlike Coelomates, their organs are held loosely. When the rotifer dries out, its entire pseudocoelom disappears, and it is reduced to 20% its original body weight. To read more about body cavities, visit: [http://www.novelguide.com/a/discover/ansc\\_01/ansc\\_01\\_00048.html](http://www.novelguide.com/a/discover/ansc_01/ansc_01_00048.html)



### Materials Needed for each Group:

1. 24 well plate
2. Twelve circles of filter paper
3. Rotifers (*Adineta vaga* (AV), *Philodina rapida* (PR), *Brachionus calyciflorus* (BC)) in a 6 well plate
4. Microscope
5. P1000 Pipette and tips
6. Forceps
7. EPA media



### Procedure:

#### Day 1

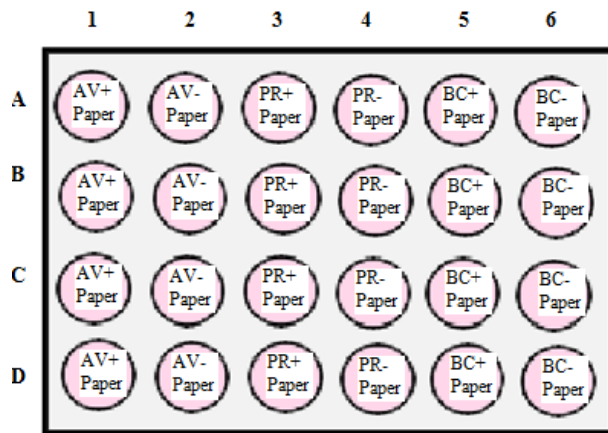
1. Label a 24 well plate with your group number.
2. Place filter paper into appropriate wells (see diagram below).
3. Pipette 60-70  $\mu\text{L}$  of rotifer culture from the 6 well plate into the appropriate wells of 24 well plate (again, see diagram); do this while looking through the microscope so you can observe the rotifers.
4. Use the microscope to verify that each well does have rotifers.
5. Leave overnight with top OFF.



#### Day 2

1. The next day observe each well under the microscope? Are they dry?
2. Rehydrate each well with 250  $\mu\text{L}$  of EPA solution.
3. Wait 30 minutes.
4. Count the number of wells with live rotifers (the exact number alive in each well is not needed).
5. Calculate the percentage of wells with survivors for each of the six treatments (this number will be 0%, 25%, 50%, 75%, or 100%).
6. Make a histogram of the data with percent wells with live rotifers on the Y-axis and the treatment on the X-axis.





Use the table below to record your observations. Mark each box with a check, indicating a successful rehydration or an X for an unsuccessful rehydration.

Student Observations- Day 2, Rehydration					
AV with paper	AV no paper	PR with paper	PR no paper	BC with paper	BC no paper
AV with paper	AV no paper	PR with paper	PR no paper	BC with paper	BC no paper
AV with paper	AV no paper	PR with paper	PR no paper	BC with paper	BC no paper
AV with paper	AV no paper	PR with paper	PR no paper	BC with paper	BC no paper

Student Questions

1) Which species had the highest survival rate?

*Adineta vaga* and *Phiodina rapida*

2) What do you think would have happened if we loosely covered the tops of the wells and allowed them to desiccate more slowly?

The rotifers won't desiccate well because there will be moisture in their wells.



## Citations

### *Pictures*

[A] Picture of Rotifer: <http://www.microscopy-uk.org.uk/mag/wimsmall/extra/rotif7.html>

[B] Picture of Rotifer: <http://discovermagazine.com/2009/jan/053>

[C] Picture taken by Aakanksha Angra

[D] Parts of a Rotifer: <http://www.ucmp.berkeley.edu/phyla/rotifera/rotifera.html>

[E] *Brachionus calyciflorus*: <http://mathnat.uni-koeln.de/10466.html>

[F] Adineta vaga:

<http://www.plingfactory.de/Science/Atlas/KennkartenTiere/Rotifers/source/Adineta%20vaga.html>

[G] Philodena rapida: <http://www.eol.org/pages/43499>

[H] Picture of diessication stages from Terry Snell

[I] Picture from Terry Snell

[J] Body Caviities <http://ryaned8.glogster.com/glog-7951/>

[K] Picture taken by Aakanksha Angra

[L] Picture taken by Aakanksha Angra

[M] Picture taken by Aakanksha Angra