



**NSDL/NSTA Web Seminar:
Discover Microbial Worlds**



Tuesday, January 8, 2008



Today's NSDL Experts:



Sarah Bordenstein
Marine Biological Laboratory
Education and Outreach Coordinator



Dr. Seth Bordenstein
Evolutionary Geneticist,
Marine Biological Laboratory



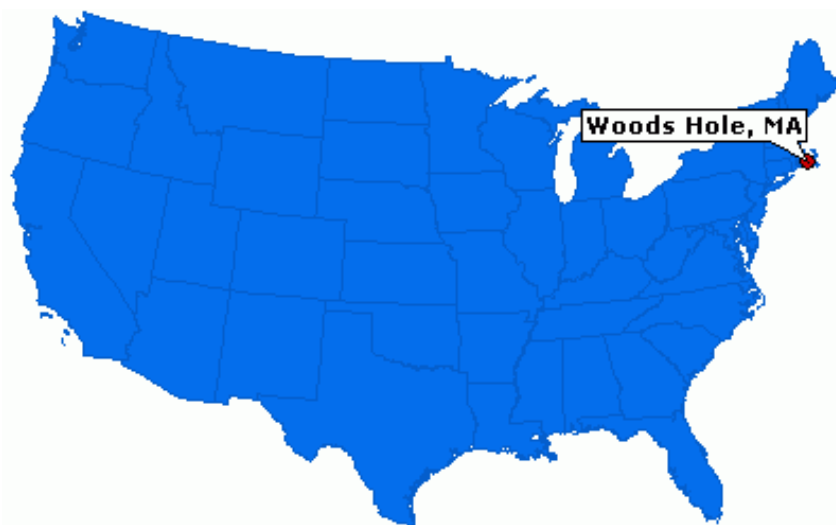
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Biological
Discovery
in Woods Hole



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MBL Biological Discovery in Woods Hole

- International center for research, education, & training in biology
- Oldest private marine laboratory (1888)
- 51 Nobel Laureates
- Microbial diversity, evolution, ecology, and genomics



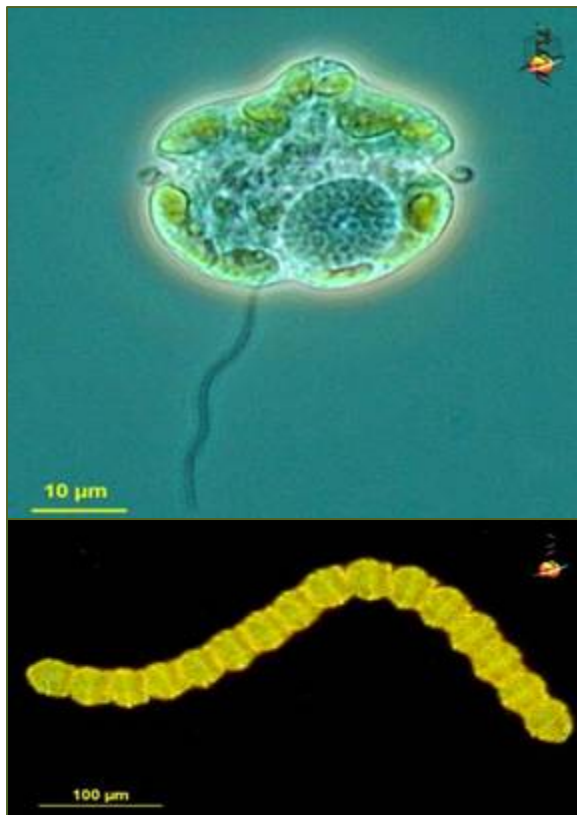
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True or False?

Most microbes cause disease.



True	False

Stamp your answer



Microbial Life

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[Marine Environments](#)

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Microbial Life - Educational Resources

Teaching and learning about the diversity, ecology and evolution of the microbial world; discover the connections between microbial life, the history of the earth and our dependence on micro-organisms.



[► Show caption](#)

This site contains a variety of educational and supporting materials for students and teachers of microbiology. You will find information about microorganisms, extremophiles and extreme habitats, as well as links to online provides information about the ecology, diversity and evolution of micro-organisms for students, K-12 teachers, university faculty, and the general public.

Microbial Life in Extreme Environments:



[► Show caption](#)

- [Find out more](#) about the extraordinary microbes that inhabit some of the most inhospitable environments on Earth.
- [Who are the extremophiles?](#)
- [Examples of extreme environments.](#)



Microbial Life

Educational Resources



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Search Online Resources

This page provides a collection of general resources including websites, PowerPoint presentations, teaching activities, data sets, and other useful materials for creating or enhancing courses related to microbiology and extreme environments. These materials can be used to support lectures, demonstrations, discussions, and class projects and activities. By narrowing the view, you may define and refine your search according to topics of your special interest.

We invite and encourage [contributions](#) to the collection, particularly new learning activities based upon the resources found here.

[Help](#)

Results 1 - 10 of **810 matches**

[Eukaryotes in Extreme Environments](#) part of SERC Web Resource

Collection

<http://www.nhm.ac.uk/zoology/extreme.html>

This article is a compilation of information about free-living eukaryotes in extreme environments. Written in summary form, it includes anaerobes, thermophiles, psychrophiles, acidophiles, ...

Topics: **Biosphere:** Biosphere:Diversity, Microbiology, Ecology

Resource Type: Scientific Resources:Overview/Reference Work

Extreme Environments: High Pressure, Anhydrous, Anoxic, Hypersaline, Extremely Cold, Acidic, Extremely Hot, Alkaline

Grade Level: Informal, General Public, Graduate/Professional, College Upper (15-16), College Lower (13-14), High School (9-12)

Narrow the View ▾

Topics: Biosphere

[60 matches](#) General/Other

Ecology [665 matches](#)

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Diversity [121 matches](#)

Biogeochemistry [130 matches](#)

Molecular Biology [137 matches](#)

Astrobiology [96 matches](#)

Microbiology [810 matches](#)

Microbiology and Health [175 matches](#)

Methods of Microbiology [180 matches](#)

Resource Type



Search Term “Symbiosis”

Narrow the View ↴

Topics: Biosphere

[60 matches](#) General/Other
[Ecology 665 matches](#)
[Evolution 139 matches](#)
[Diversity 121 matches](#)
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[Molecular Biology 137 matches](#)
[Astrobiology 96 matches](#)
[Microbiology 810 matches](#)
[Microbiology and Health 175 matches](#)
[Methods of Microbiology 180 matches](#)

Resource Type

[Activities 138 matches](#)
[Assessments 3 matches](#)
[Course Information 25 matches](#)
[Datasets and Tools 31 matches](#)
[Audio/Visual 151 matches](#)
[Computer Applications 20 matches](#)
[Pedagogic Resources 56 matches](#)
[Scientific Resources 703 matches](#)
[Biographical Resources 2 matches](#)
[Policy Resources 15 matches](#)

Extreme Environments

[Alkaline 61 matches](#)
[Acidic 66 matches](#)
[Extremely Cold 64 matches](#)
[Extremely Hot 141 matches](#)
[Hypersaline 69 matches](#)
[High Pressure 72 matches](#)
[High Radiation 29 matches](#)
[Anhydrous 35 matches](#)
[Anoxic 76 matches](#)
[Altered by Humans 75 matches](#)

Ocean Environments

[Coastal and Estuarine 201 matches](#)
[Shallow Sea Floor/Continental Shelf 34 matches](#)
[Deep Sea Floor/Abyssal 47 matches](#)
[Surface Waters 99 matches](#)
[Deep Waters 35 matches](#)

Grade Level

[Primary \(K-2\) 22 matches](#)
[Intermediate \(3-5\) 125 matches](#)
[Middle \(6-8\) 312 matches](#)
[High School \(9-12\) 485 matches](#)
[College Lower \(13-14\) 579 matches](#)
[College Upper \(15-16\) 494 matches](#)
[Graduate/Professional 424 matches](#)
[Informal 73 matches](#)
[General Public 333 matches](#)



Glow

Living Lights

Teacher's Guide

Exhibit



<http://nsdl.org>





[Grade Level](#) showing only **High School (9-12)** [Show all Grade Level](#)

Results 1 - 4 of 4 matches

[Explore the World Using Protozoa](#) part of SERC Print Resource

Collection

This book contains 28 hands-on investigations that use protozoa to model macroscopic ecological and biological processes--such as symbiosis, succession, and feeding strategies. Featuring activities ...

Topics: **Biosphere: Biosphere:Methods of Microbiology: Culturing Methods, Microscopy**, **Biosphere:Microbiology, Ecology, Education:Assessment**
Resource Type: **Activities:Classroom Activity:Jigsaw, Pedagogic**
Resources: **Overview/Summary, Activities:Lab Activity**
Grade Level: **High School (9-12), College Upper (15-16), College Lower (13-14)**

[C.S.I. on the Deep Reef](#) part of SERC Web Resource Collection

<http://oceansexplorer.noaa.gov/explorations/03max/backgr...>

In this lesson students discover the factors that are indicative of chemotrophic nutritional strategies. This NOAA lesson plan is designed to teach students about the factors that are indicative of ...

Topics: **Biosphere:Ecology:Habitats:Marine, Biosphere:Ecology:Symbiotic Relations, Habitats:Benthic, Biosphere:Ecology:Metabolism, Biosphere:Diversity, Microbiology**
Resource Type: **Activities:Lab Activity, Classroom Activity**
Extreme Environments: **High Pressure**
Ocean Environments: **Deep Sea Floor/Abyssal**
Grade Level: **College Lower (13-14), High School (9-12)**

[Glow: Living Lights](#) part of SERC Web Resource Collection

http://www.sdnhm.org/exhibits/glow/glow_guide.pdf

This 48-page Teacher's Guide accompanies the "Glow: Living Lights" exhibit at the San Diego Natural History Museum. In PDF format, the guide contains 12 lesson plans that explore the ...

Topics: **Biosphere: Biosphere:Ecology:Habitats:Terrestrial, Biosphere:Ecology:Principles, Abiotic Relations, Symbiotic Relations, Habitats:Marine, Biosphere:Ecology:Metabolism, Habitats:Water Column, Biosphere:Diversity, Microbiology, Evolution**
Resource Type: **Scientific Resources:Overview/Reference Work, Activities:Lab Activity, Classroom Activity**
Ocean Environments: **Surface Waters, Deep Sea Floor/Abyssal, Deep Waters, Shallow Sea Floor/Continental Shelf**
Grade Level: **High School (9-12), Informal, Middle (6-8), Intermediate (3-5)**

[Black Smokers: Life Forms](#) part of SERC Web Resource Collection

<http://www.amnh.org/nationalcenter/expeditions/blacksmok...>

This educational web site features life forms of deep sea hydrothermal systems. Hosted by the American Museum of Natural History, this site offers a brief introduction of the community and then ...

Topics: **Biosphere: Biosphere:Ecology:Habitats:Marine, Biosphere:Ecology:Metabolism, Symbiotic Relations, Symbiotic Relations:Mutualism, Biosphere:Ecology:Habitats:Benthic, Biosphere:Diversity, Microbiology, Ecology:Food Webs, Biosphere:Biogeochemistry**
Resource Type: **Scientific Resources:Overview/Reference Work, Computer Applications, Audio/Visual:Images/Illustrations, Animations/Video, Activities:Classroom Activity**
Extreme Environments: **Extremely Hot, High Pressure**
Ocean Environments: **Deep Sea Floor/Abyssal, Hydrothermal Systems**

Narrow the View ↴

Topics: Biosphere

- Ecology [4 matches](#)
- Evolution [1 match](#)
- Diversity [3 matches](#)
- Biogeochemistry [1 match](#)
- Microbiology [4 matches](#)
- Methods of Microbiology [1 match](#)

Resource Type [Show all Resource Type](#)

Activities

- Classroom Activity [4 matches](#)
- Lab Activity [3 matches](#)

Extreme Environments

- Extremely Hot [1 match](#)
- High Pressure [2 matches](#)

Ocean Environments

- Shallow Sea Floor/Continental Shelf [1 match](#)
- Deep Sea Floor/Abyssal [3 matches](#)
- Surface Waters [1 match](#)
- Deep Waters [1 match](#)

Grade Level [Show all Grade Level](#)

- High School (9-12)**
[4 matches](#)



<http://nsdl.org>





How many bacteria are in one gram of soil?

- A. 100
- B. 100,000
- C. 1,000,000
- D. 10,000,000



micro*scope

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- information
- contact us
- site guide
- browse organisms
- alphabetically
- by classification
- recent additions
- browse collections
- alphabetically
- by concept
- search
- this site
- glossary
- classification
- other sites
- Microbes.info (web sites)
- Protistariy
- ICoMM
- Microbial Life
- Plankton*net AWI
- Plankton*net Roscoff
- tools
- linkIT
- for developers
- web-services
- user name
- password



news

- July 2007: Micro*scope affiliates with the Encyclopedia of Life.
- Cameos: 4 sets of images for screen savers available. (1) various microbes from the Microbial Life digital library; (2) marine microbes brought to you by the International Census of Marine Microbes, (3) microbes from extreme habitats brought to you by the NASA Astrobiology Institute, and (4) microbial imagery from the Bay Paul Center. [Instructions here.](#)
- May 2006: **Ten thousandth image added to micro*scope!**



micro*scope

is a communal web site that provides descriptive information about all kinds of microbes. It combines locally assembled content with links to other expert sites on the internet. Information is assembled in collections provided by various contributors.



education

We provide special services for educational purposes. We are affiliated with the Microbial Life digital library of materials about microbial diversity, ecology and evolution. Educators and students can have their own password-protected space within micro*scope for educational projects.



Plankton*net is a communal source of information about marine phytoplankton. It is based on



taxonomic intelligence

In collaboration with the [uBio project](#), we use taxonomic principles and expertise to manage information about organisms.



our purpose

Microbes were the only living things for most of the history of the Earth. Over 3.5 billion years ago they began the process of transforming this planet, making it habitable for those of us who came later. Bacteria and protists remain the dominant players in most known ecosystems. Their numbers are staggering - a single teaspoonful of sea water contains millions of bacteria and thousands of protists. This site has images of microbes, classification schemes, descriptions of organisms, talks and other educational resources to improve awareness of the biodiversity of our microbial partners.



contributing and sharing

The content of this web site is freely available for educational and other non-commercial uses. Please acknowledge the contributor and this web site. Many components of this web site can be accessed and delivered in other web sites using our [SOAP services](#).



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search and browse

You can browse for content using the taxonomic structure, using names of organisms, or by different themes under collections. Use the box below or the menu bar to the left to search for content in our classification scheme, within our glossary, or throughout the web site.



- is our communal repository of descriptions of organisms. Register with us if you wish to add to this.

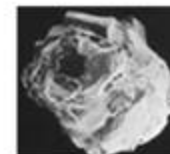


contact us

if you wish to comment, contribute or correct. We are microscope@mbl.edu.

What is this?

Click on the image to find out more ...



The latest addition



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- information
- contact us
- site guide
- browse organisms
- alphabetically
- by classification
- recent additions
- browse collections
- alphabetically
- by concept
- search
- this site
- glossary
- classification
- other sites
- Microbes.info (web sites)
- Protistariy
- ICoMM
- Microbial Life
- Plankton*net AWI
- Plankton*net Roscoff
- tools
- linkIT
- for developers
- web-services
- user name
- password



portrait

Paramecium (bursaria) (par-a-mee-see-um) is a very familiar genus of ciliates. They eat bacteria and have the mouth recessed in a buccal cavity, and the cell is often shaped with a scoop leading to the mouth. There are cilia all over the body with a caudal tuft of longer cilia at the back of the body. Usually with a layer of extrusomes (trichocysts) under the cell surface and a large oval macronucleus. Contractile vacuoles star-shaped. This species is *P. bursaria*, a species with symbiotic green algae living inside. Phase contrast. This picture was taken by David Patterson and Mark Farmer of material from freshwater sites in the vicinity of the University of Georgia in Athens, Georgia, USA) in April, 2001 and from collections of organisms maintained at the University. Image copyright: D. J. Patterson and Mark Farmer, image used under license to MBL (micro*scope).

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- classification page
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Paramecium bursaria

From the collection Athens, Georgia, USA

Description of *Paramecium bursaria*: Cell foot-shaped rather than elongate, the anterior is transversely truncated, the posterior rounded. Attains 80-150 microns long. The oral groove is very wide for most of its length. This species is easily recognised by the presence of green zoochlorellae in the cytoplasm. There are two contractile vacuoles with radiating collecting canals. There is a single, ovoid macronucleus and one elliptical micronucleus.

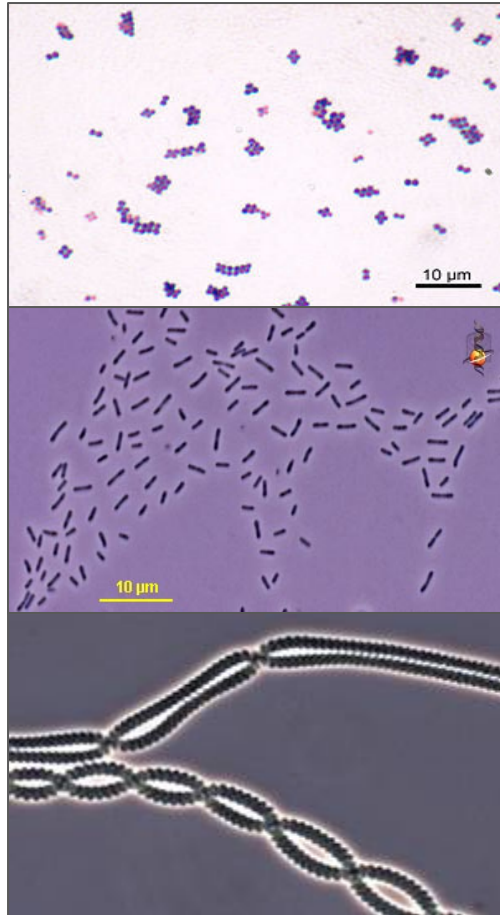
LINKOUTS

Google websites	Google images	uBio portal	PubMed Literature
NCBI molecular data	Ciliate Resource	CCAP Cultures	Tree of Life
ATCC Cultures	micro*scope more in this site	Vivissimo web sites	Planktonic ciliates
iSpecies.org	WAPPS Educational materials	WIKIPEDIA free encyclopaedia	amazon On-line store
CCCM cultures	PID images	Discover Life Discover Life	LIBRARY OF CONGRESS books

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When did bacteria evolve?



- A. 130,000 years ago
- B. 610 million years ago
- C. 2 billion years ago
- D. 3.8 billion years ago

Encyclopedia of Life - Windows Internet Explorer

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AutoLink

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Encyclopedia of Life

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www.eol.org

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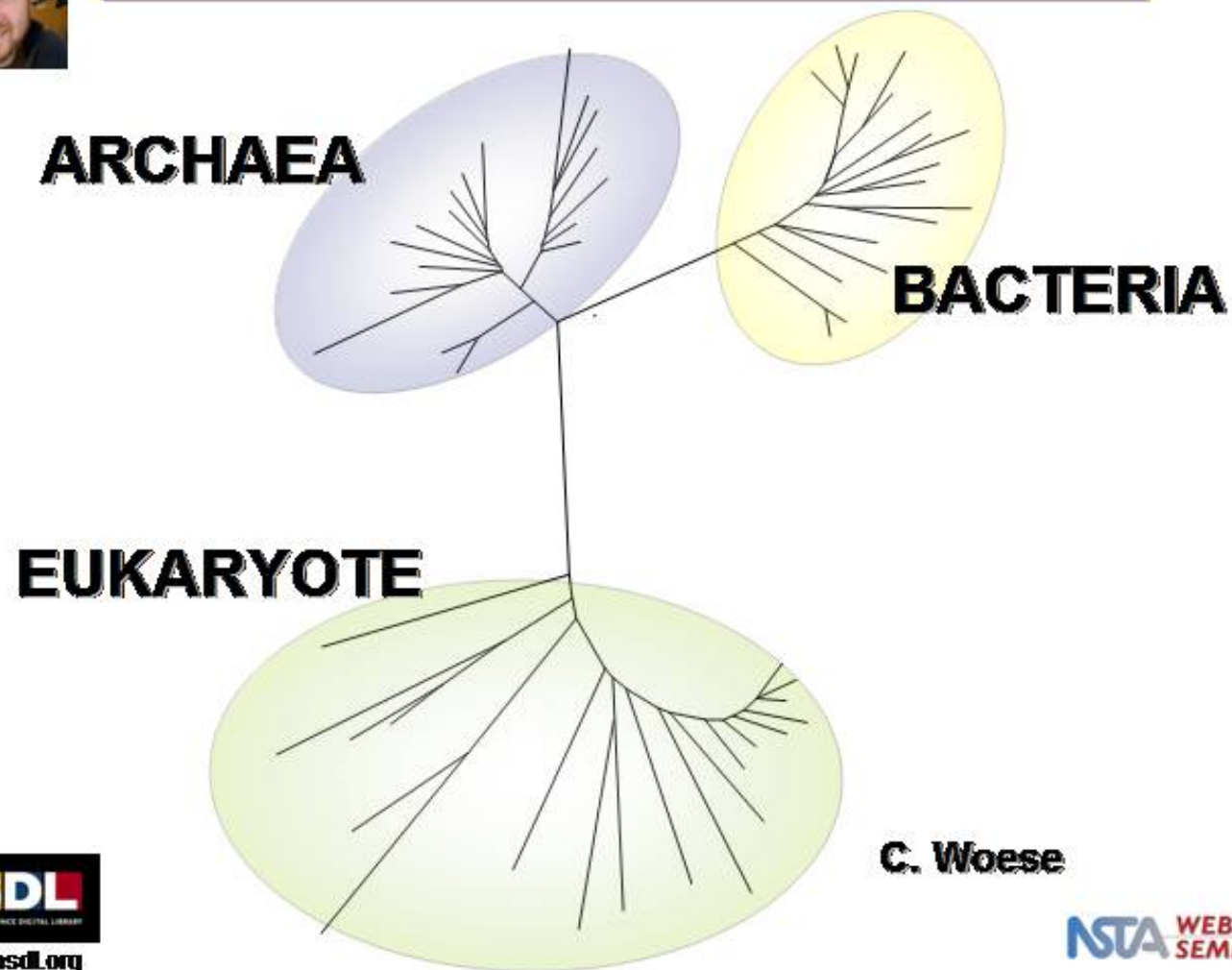
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3:37 PM



Microbes in Eukaryotic Evolution

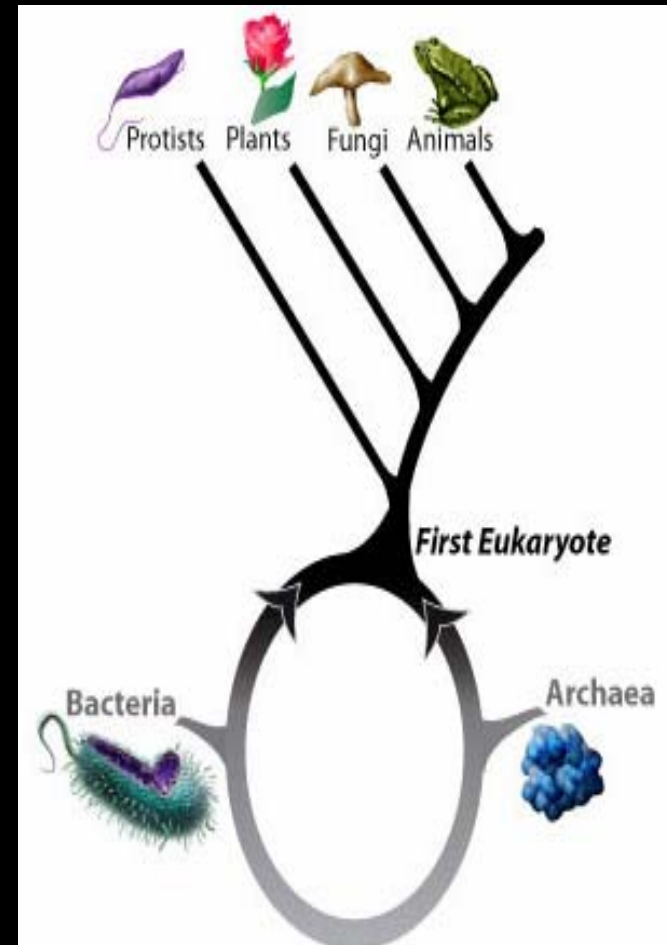


C. Woese



Evolutionary Innovations Through Animal-Bacteria Endosymbioses

- Eukaryotic cell (fusion of single celled organisms)
- Eukaryotic organelles (chloroplasts, mitochondria)
- Use of many nutrient-limited niches by animal lineages





SYMBIOSIS QUIZ

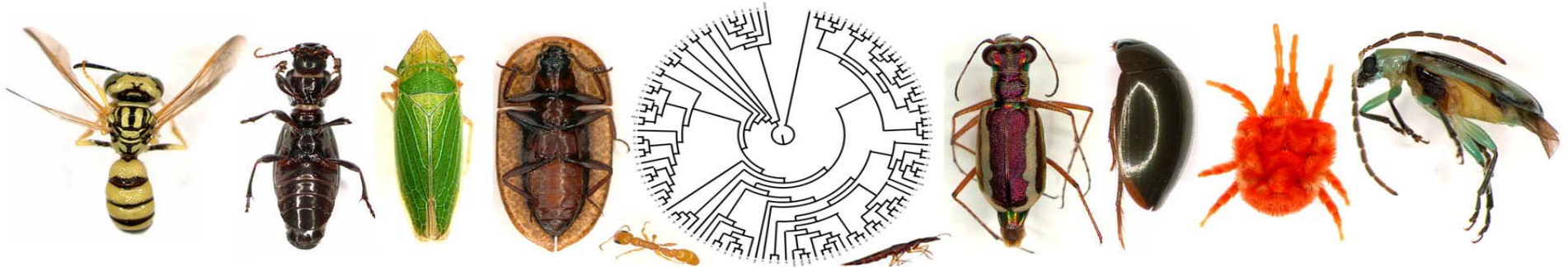
What % of the cells in your body are human?

Stamp
your
answer

10%	30%
60%	90%



Insects are excellent model systems

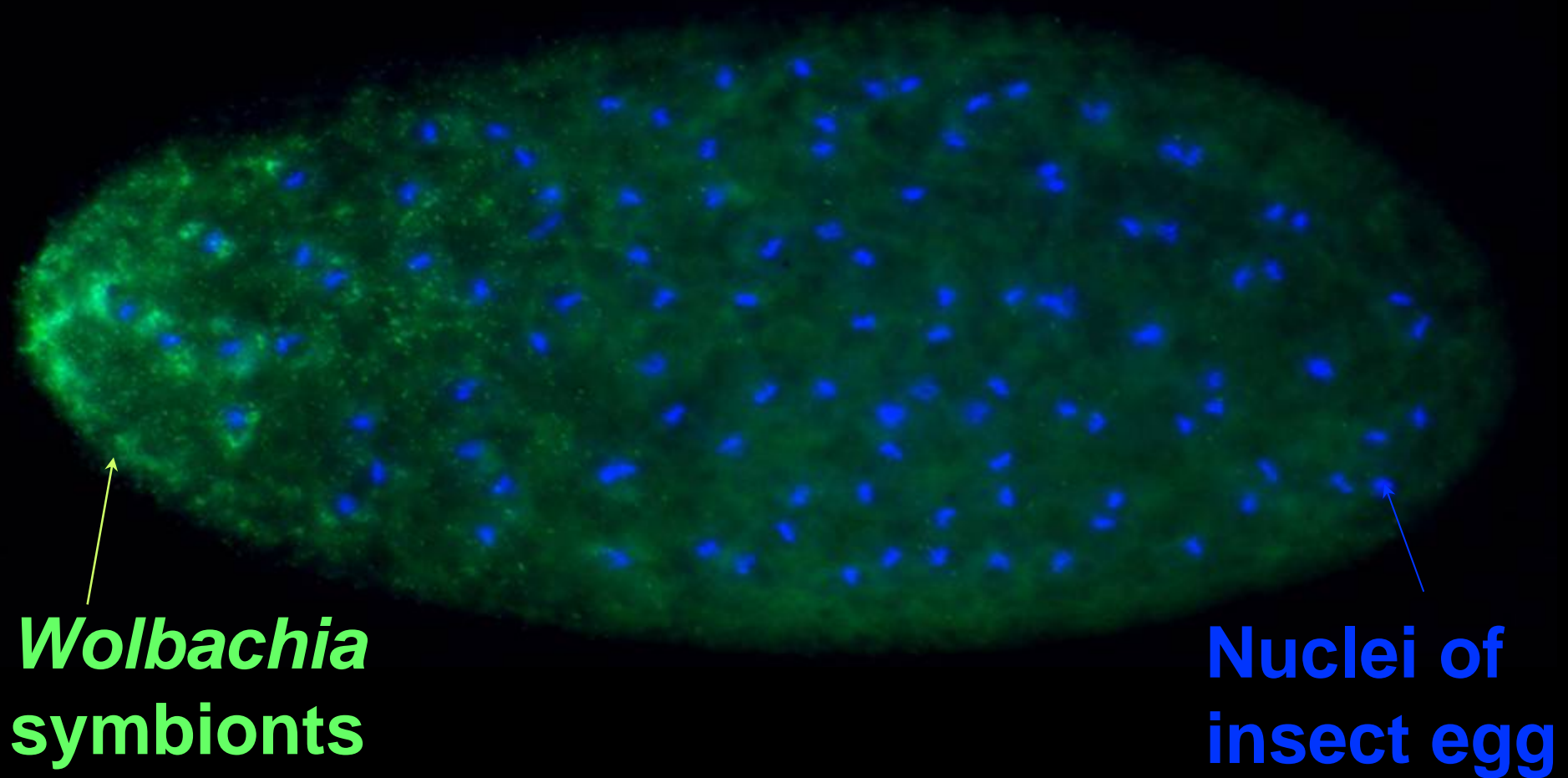


❖ Present for 350 MY

- ❖ Comprise 85% of all animal species
- ❖ 20% harbor bacteria called *Wolbachia*
- ❖ Up to 6 million species are infected
- ❖ YOU ARE OUR BIGGEST ASSET!



Discover the Microbes Within: The *Wolbachia* Project



***Wolbachia*
symbionts**

**Nuclei of
insect egg**



SYMBIOSIS QUIZ

Which of the following occur as a result of symbiosis?

- A. Parasitism**
- B. Mutualism**
- C. Commensalism**
- D. All of the above**

Wolbachia are Infectious Widowmakers!

Male-Killing



Parthenogenesis



Feminization

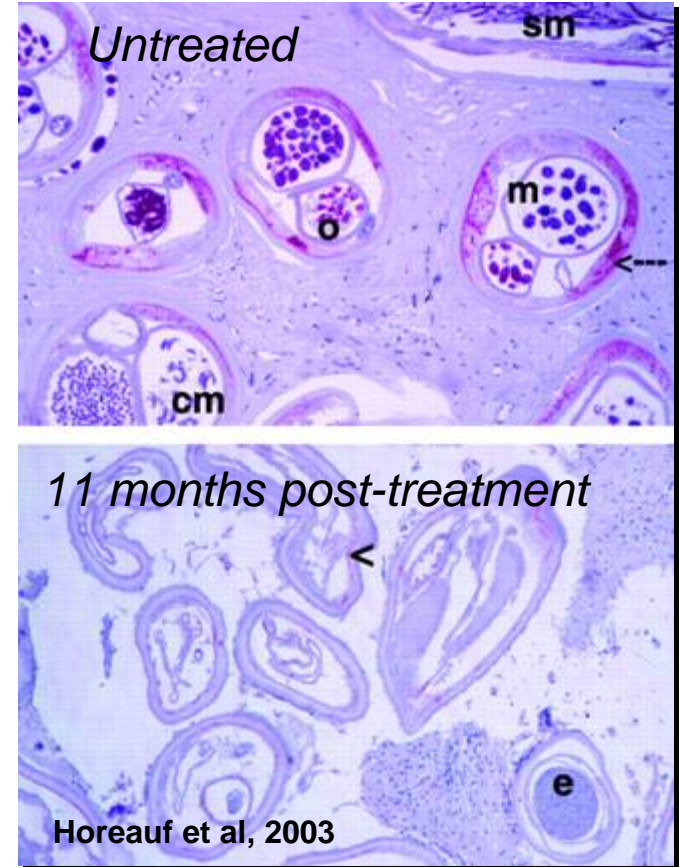




Wolbachia cause Infectious (River) Blindness



Onchocerca volvulus





What is the closest relative to *Wolbachia*?

Stamp
your
answer

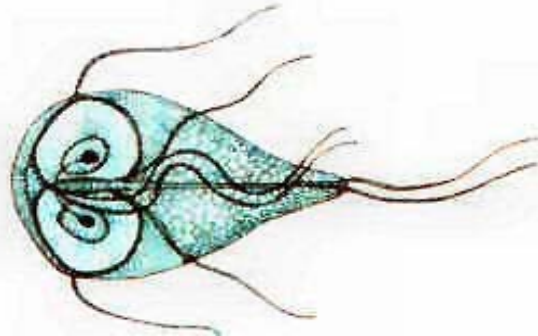
E. coli



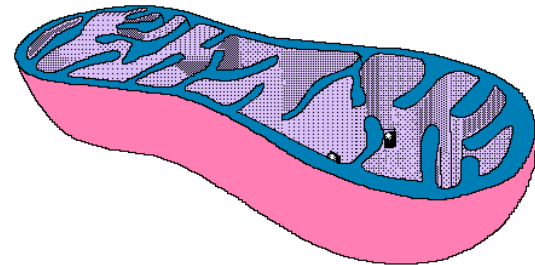
Preying Mantis



Giardia



Mitochondria





How do YOU discover the *Wolbachia* within?



<http://nsdl.org>



jbpc.mbl.edu/~sbordenstein/workshop.html

For up-to-date labs and accompanying lectures, click on the icons below. Please also visit the Education Gallery using the link above to see past events.



Lab 1: Insect Identification (Biodiversity)



Lab 1 Insect Identification Key



Lab 2: DNA Extraction (Molecular Biology)



Lab 3: Polymerase Chain Reaction (Molecular Biology)



Lab 4: Gel Electrophoresis (Molecular biology)



Lab 5: DNA Sequence Analysis (Bioinformatics)



Lab 1 Lecture: Introduction to Symbiosis and *Wolbachia*



Lab 2 & 3 Lecture (1 of 2): Biotechnology, Microbiology, and PCR Basics



Lab 2 & 3 Lecture (2 of 2): Introduction to DNA Isolation and PCR Labs

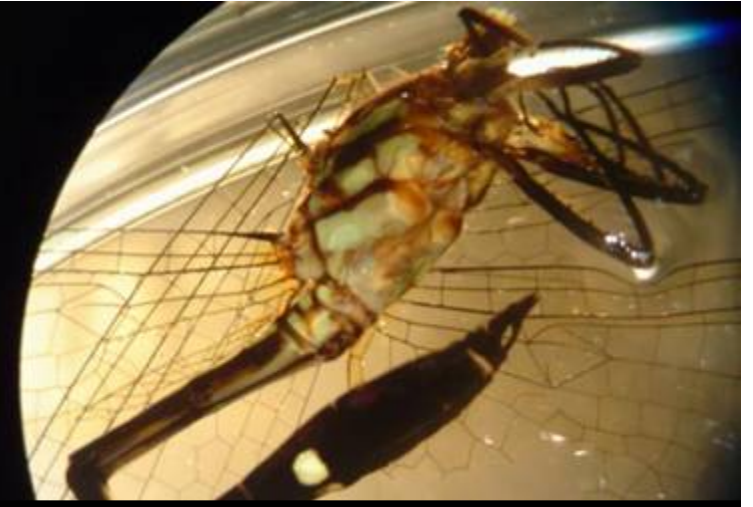


List of National Science Education Standards Aligned with this Project



MBL

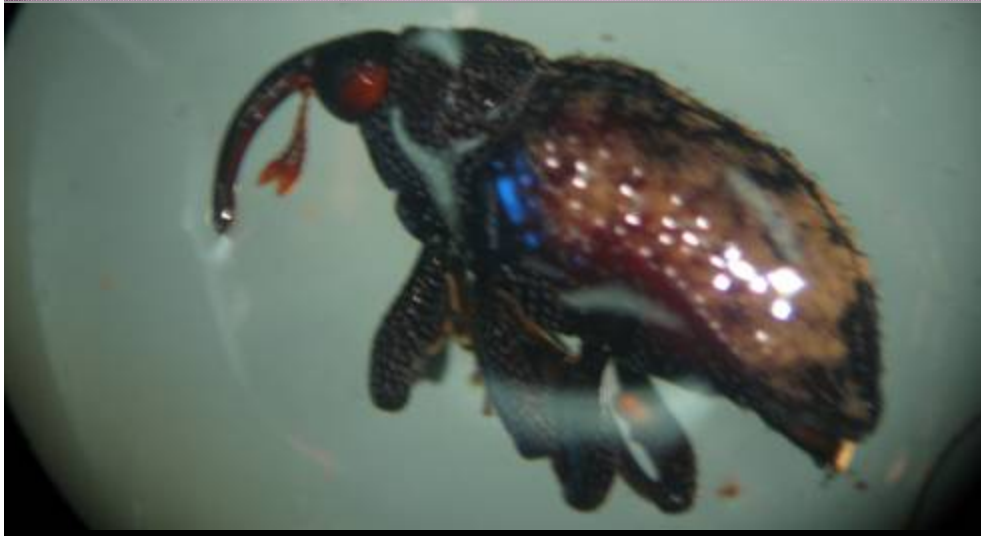
April 11-13, 2008



Your School!



When it all comes together, it looks like this!

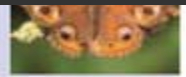


“Discover Life”

pick4.pick.uga.edu/mp/20q?guide=Insect_orders



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1. Wing number

search

7 2, fore pair reduced to small clubs

7 2, hind pair reduced to tiny clubs or absent

21 4

20 Absent



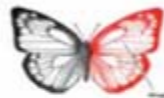
2. Wing shape

search

20 Broad, lacking a fringe of long hairs

21 Narrow, lacking a fringe of long hairs

7 Narrow, with a fringe of long hairs



3. Wing texture

search

19 Both pairs of wings membranous, of similar texture, covered in microscopic hairs

4 Forewings hard, opaque, forming close-fitting covers over abdomen

10 Forewings leathery, hind wings transparent



DNA EXTRACTION LAB



ACTIVITY AT A GLANCE

Goal:

To introduce students to DNA extraction techniques and to isolate genomic DNA from insects and *Wolbachia*, the endosymbiotic bacteria that live within the cells of over 20% of insect species.

Learning Objectives:

Upon completion of this activity, students will transition from field work and morphological classification (Lab 1) to molecular biology and biotechnology, learn about DNA as a diagnostic tool to discover unseen microbes, increase abilities in biotechnology, and understand the process of inquiry and discovery-based research. They will *isolate* total genomic DNA from morphospecies identified in the Insect Identification Lab.

Prerequisite Skills:

- Prior practice with micropipettors.

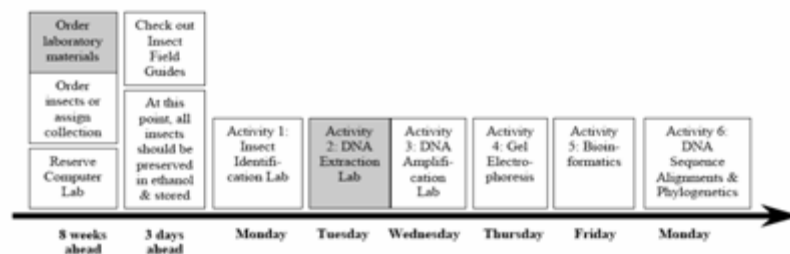
Teaching Time:

90 minutes (2 class periods - optional 45min stopping point on page 7)

National Science Education Standards Addressed:

Unifying Concepts and Processes in Science, Science as Inquiry, Science and Technology, Life Science, Science in Personal and Social Perspectives, History and Nature of Science

Timelines for Teaching *Discover the Microbes Within: The Wolbachia Project*



Agarose Gel Electrophoresis Lab



ACTIVITY AT A GLANCE

Goal:

To determine the presence or absence of PCR products and quantify the size (length of the DNA molecule) of the product.

Learning Objectives:

Upon completion of this activity, students will have integrated scientific discovery, inquiry and biotechnology. Students will understand that DNA contains hereditary information in the form of genes, how DNA samples separate-based upon different sizes, learn how to stain and visualize DNA samples. We will be using agarose gel electrophoresis to determine the presence and size of *Wolbachia 16S rDNA* amplified by our PCR.

Teaching Time:

90 minutes or two class periods of 45min each

National Science Education Standards Addressed:

Unifying Concepts and Processes in Science, Science as Inquiry, Science and Technology, Life Science, History and Nature of Science

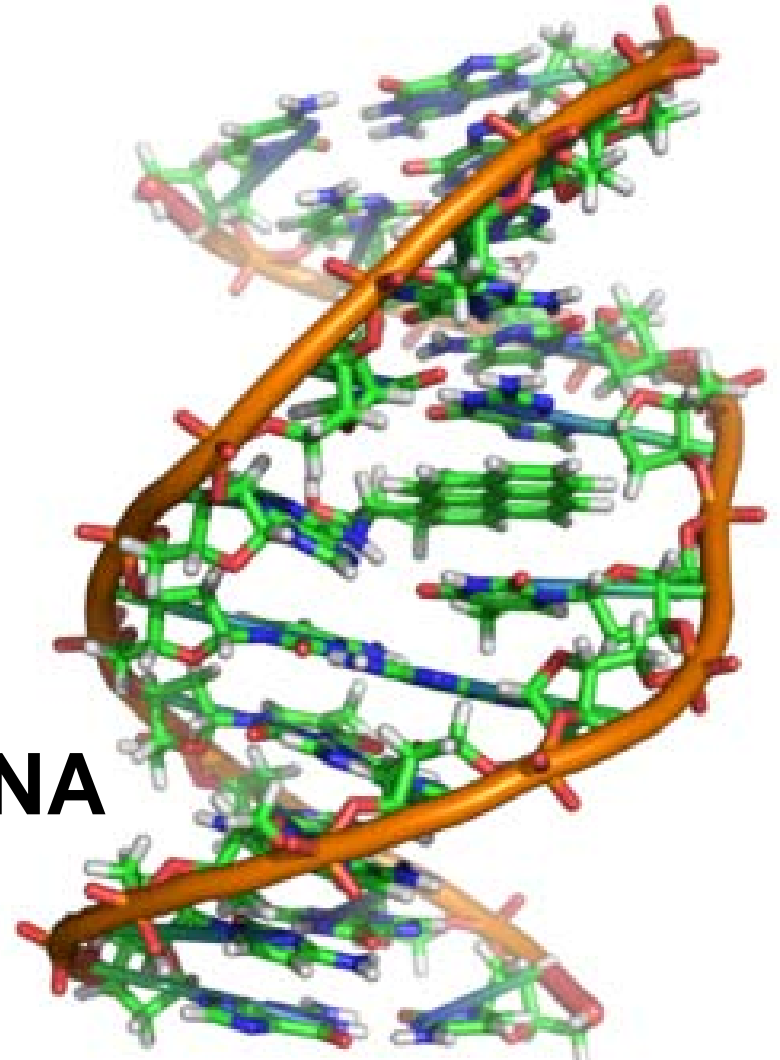
MATERIALS (per group of two students)

- Your 6 PCR products
- 4 Gloves
- 1 Micron pen or sharpie
- 1 box of P200 pipet tips
- 1 box of P20 pipet tips
- P200 and P20 pipets
- 1 rack for holding PCR tubes
- 6X Loading Buffer (Fisher TAK-9156)
- DNA ladder (Fisher PR-G3161)
- Agarose (Ward's 944 V 3700)
- Gel casting tray and combs
- QUIKView DNA stain (Ward's 38 V 9014)
- Staining trays for the class
- Electronic balance for class
- Weighing dishes or paper
- Spatula
- 500ml flask
- 100ml graduated cylinder
- Microwave for class
- Plate or water bath for class
- Oven mitt or tongs for class
- Masking tape for class
- Safety goggles

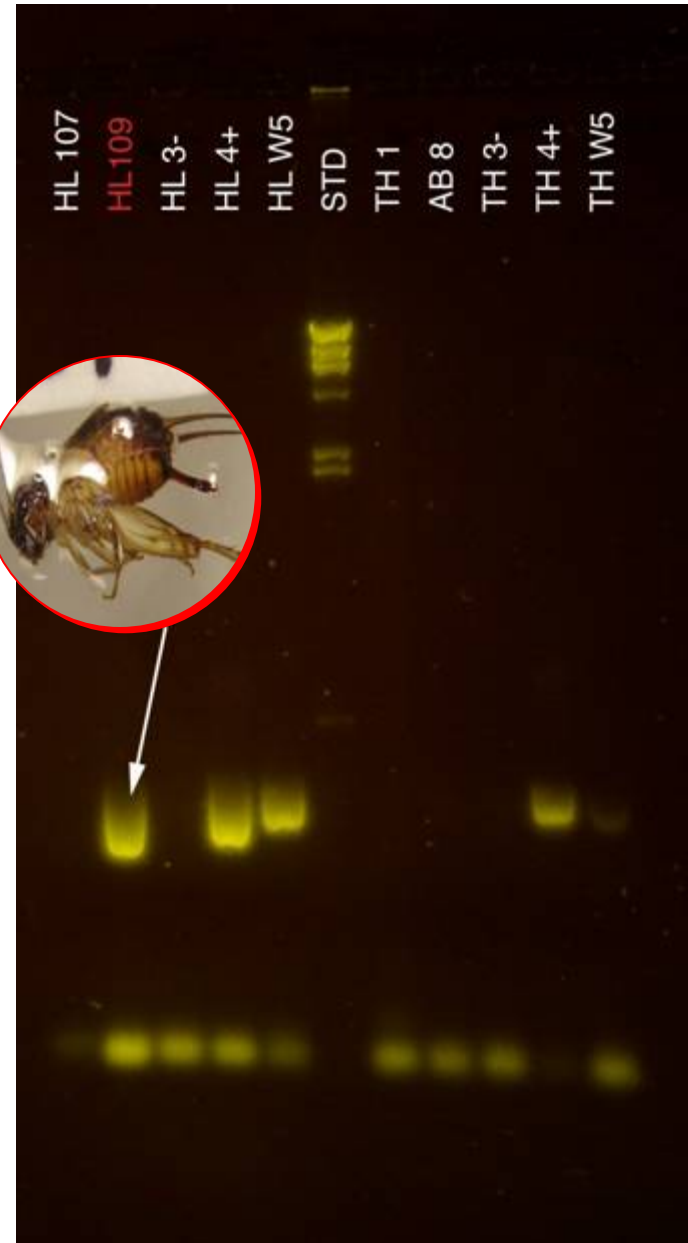
Poll Question!

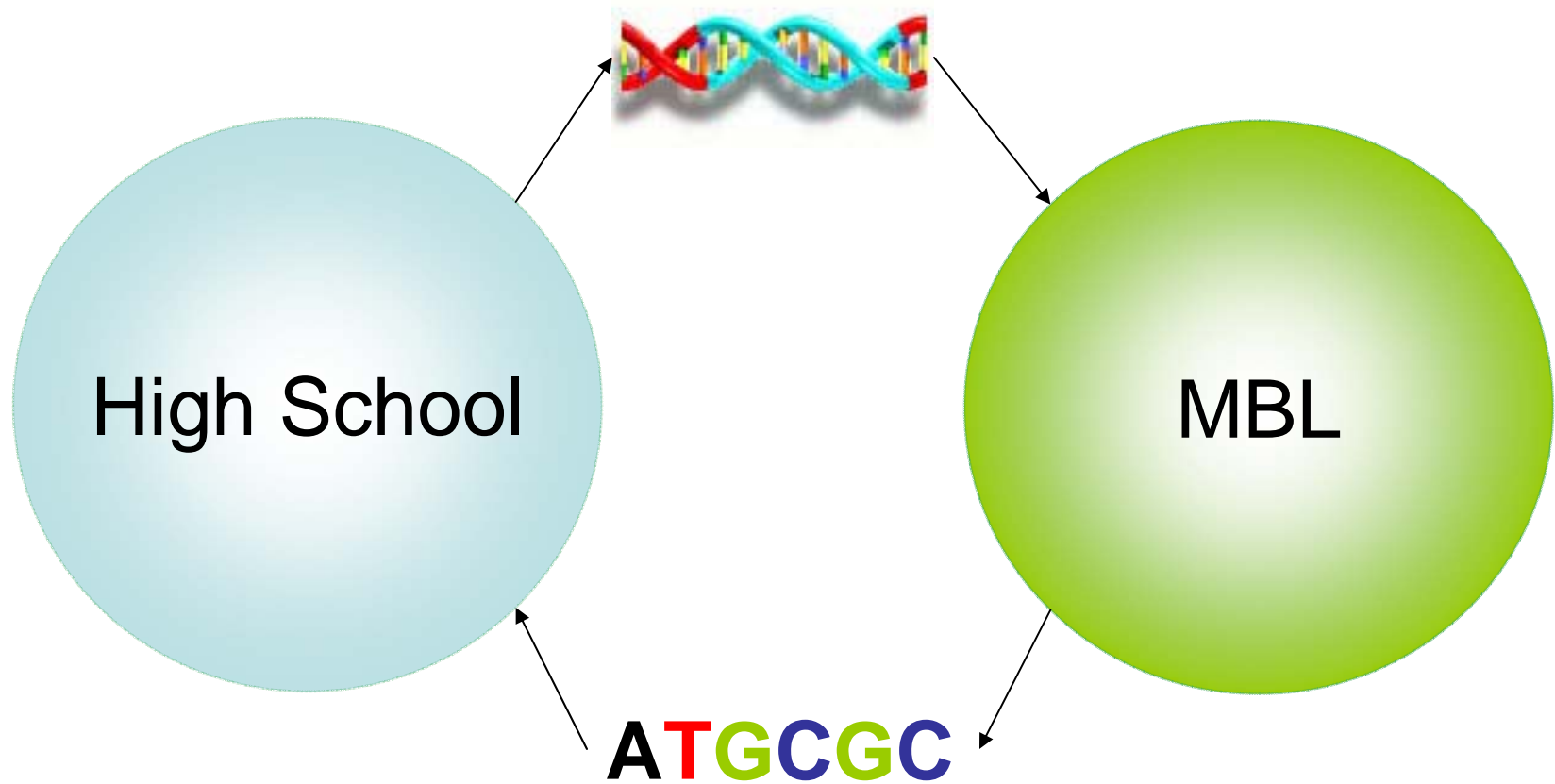
PCR is a biotechnology method that:

- a) Extracts DNA**
- b) Amplifies DNA**
- c) Sequences DNA**
- d) Expresses RNA from DNA**



Binghamton High School, NY, Dec. 2007







Lab 5: DNA Sequence Analysis

Bioinformatics is like using 'Google' for DNA sequences






http://www.ncbi.nlm.nih.gov



http://nsdl.org




National Center for Biotechnology Information
 National Library of Medicine National Institutes of Health

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 Guide to NCBI resources

About NCBI NEW
 The science behind our resources. An introduction for researchers, educators and the public.

GenBank
 Sequence submission support and software


Molecular databases
 Sequences, structures and taxonomy

Literature databases
 PubMed, OMIM, Books and PubMed Central

What does NCBI do?

Established in 1988 as a national resource for...

Draft
 Explore human the human genome

BLAST

 sequences. More

Lab 5 - BLAST tutorial:
www.geospiza.com/outreach/BLAST/index.html

BLAST Basic Local Alignment Search Tool
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NCBI BLAST Home
 BLAST finds regions of similarity between biological sequences. [more...](#)
[Learn more](#) about how to use the new BLAST design

BLAST Assembled Genomes
 Choose a species genome to search, or [list all](#)

- Human
- Mouse
- Rat
- Arabidopsis thaliana*

Basic BLAST
 Choose BLAST program to run.

- [nucleotide_blast](#) Search a nucleotide database
Algorithms: blastn, megablast
- [protein_blast](#) Search protein database using...
Algorithms: blastp, psi-blast
- [blastx](#) Search protein database using...
Algorithms: blastx, tblastx
- [tblastn](#) Search translated nucleotide...
Algorithms: tblastn, tblastx
- [tblastx](#) Search translated nucleotide...
Algorithms: tblastx

BLAST Basic Local Alignment Search Tool
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NCBI BLAST: blastn suite - BLASTN programs search nucleotide databases using a nucleotide query. [more...](#)
[blast page](#) [bookmark](#)

Enter Query Sequence
 Enter accession number, gi, or FASTA sequence Query subrange: From To

Or, upload file no file selected

Job Title
 Enter a descriptive title for your BLAST search

Choose Search Set
 Database: Human genomic + transcript Mouse genomic + transcript Others (nr etc.)

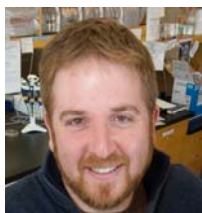
Entrez Query Optional

Program Selection
 Optimize for: Highly similar sequences (megablast) More dissimilar sequences (discontiguous megablast) Somewhat similar sequences (blastn)

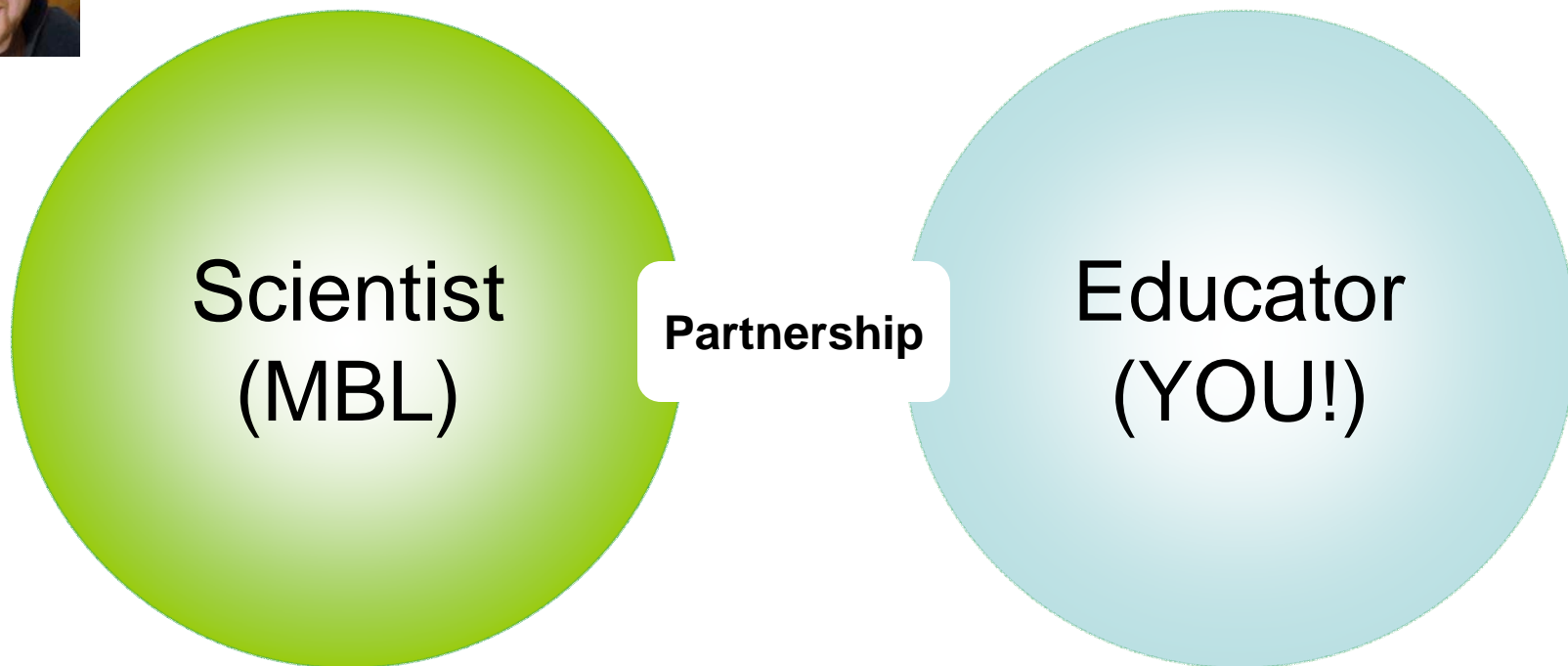
 Search database Test/gpipe/3606/allcontig
 Show results in a new window

For the BLAST activities:

1. Change the database to "Others"
2. Select "nucleotide collection" from the pull-down menu.
3. Change the program selection to optimize for more dissimilar



jbpc.mbl.edu/~sbordenstein/workshop.html



MBL Workshop, April 11-13

Thanks to:

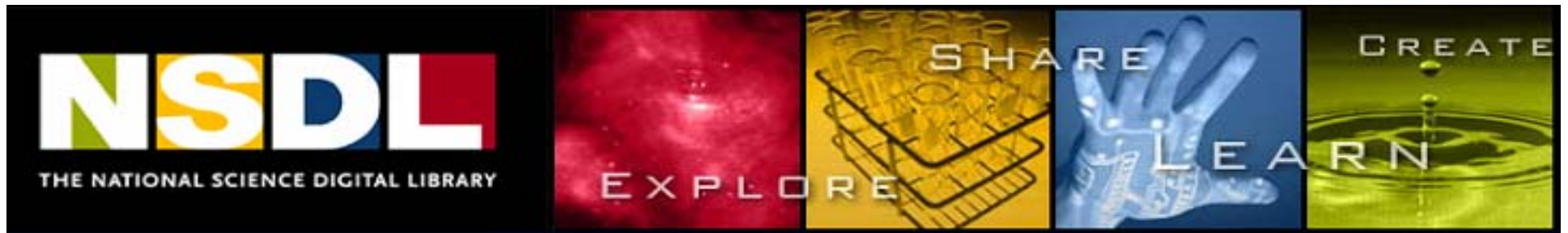


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<http://nsdl.org>





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**THANK
YOU!**

<http://www.mbl.edu/>

<http://jbpc.mbl.edu/~sbordenstein/workshop.html>



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- Utilize our blog featuring our presenters for the Fall Series sharing their insights on careers in science and science education:
<http://expertvoices.nsdl.org/2007fall-nsta-sems/>



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- More than [125 e-chapters](#) from selected books and series (40 chapters FREE of charge).
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