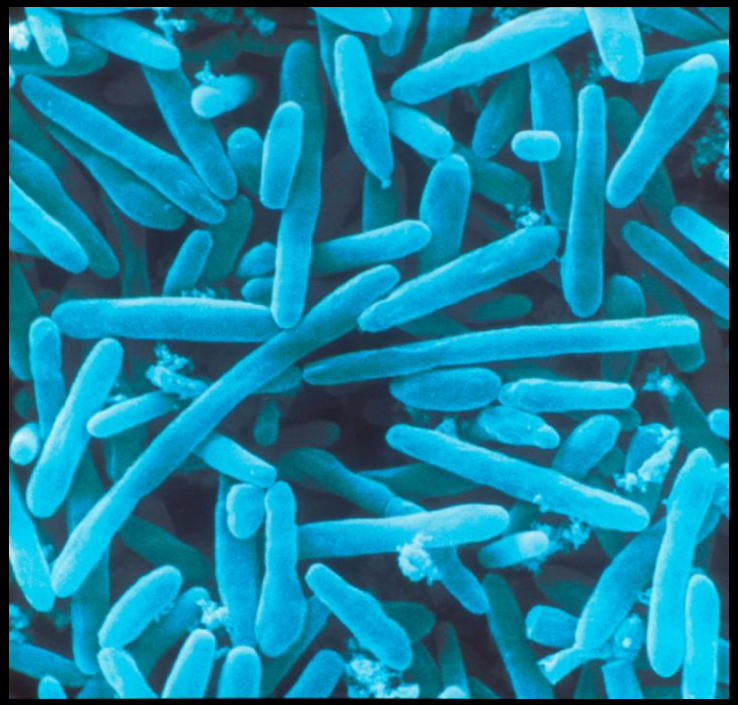

Biotechnology
CAPTIVATING SCIENCE EDUCATION
Explorer™
BIO-RAD
Professional Development

Biotechnology Explorer™ CAPTIVATING SCIENCE EDUCATION

BIO-RAD

Microbes and Health: "What causes Yogurtness"™?



Biotechnology Explorer™ CAPTIVATING SCIENCE EDUCATION

BIO-RAD

Microbes and Health

Instructors

Stan Hitomi
Coordinator – Math & Science
San Ramon Valley Unified School District
Danville, CA

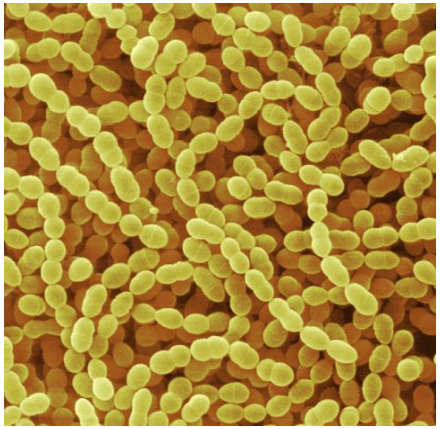
Kirk Brown
Lead Instructor, Edward Teller Education Center
Science Chair, Tracy High School
and Delta College, Tracy, CA

Sherri Andrews, Ph.D.
Curriculum and Training Specialist
Bio-Rad Laboratories

Essy Levy, M.Sc.
Curriculum and Training Specialist
Bio-Rad Laboratories

Why Teach

Microbes and Health?



- Powerful teaching tool
- Laboratory extensions
- Real-world connections
- Link to careers and industry
- Standards based

Microbes and Health Kit – Core Content Alignment	
Scientific Inquiry •Interpretation of experimental results •Use of experimental controls •Evaluation of hypothesis •Microscopy	**Cell and Molecular Biology** •Bacterial metabolism •Prokaryotic cell structure and cell division •Effects of temperature and pH on bacterial growth •Antibiotics
Chemistry of Life •Effects of pH on proteins •Enzymes •Protein structure and function	**Environmental and Health Science** •Epidemiology and disease •Microbiology
Evolution •Adaptation to environment •Bacterial defense mechanisms	**Genetics** •Variation in bacteria

Microbes and Health Kit Advantages

- Can be used in Biology, Microbiology, Health Sciences or Biotechnology
- Hands-on microbiology lab activity
- Application of Koch's Postulates
- Sufficient materials for 8 student work stations (4 students per station)
- Easy preparation
- Can be used as on its own for any microbiology experiments or for independent study.

Workshop Time Line

- **Introduction**
- **Preparation of microscope slides. Observe cultures and asses disease symptoms (pH, smell, texture)**
- **Isolate disease causing pathogens and grow in pure culture (grow on LB sugar plates)**
- **Inoculate milk samples**
- **Assess disease symptoms (pH, smell, texture) from pre-inoculated milk samples and compare to the original bacteria**
- **Laboratory Extensions**

What can you teach with the Microbes and Health Kit?

Bacterial colonies cultured from yogurt (above)
Streptococcus thermophilus (inset)

- **Practice sterile microbial techniques commonly used in research**
- **Study the role of microbes in disease and health**
- **Learn how cells metabolize nutrients to form other products**
- **Utilize Koch's Postulates to identify the causative agent for disease**
- **Your students will attempt to discover the causative agents that turn milk into yogurt**

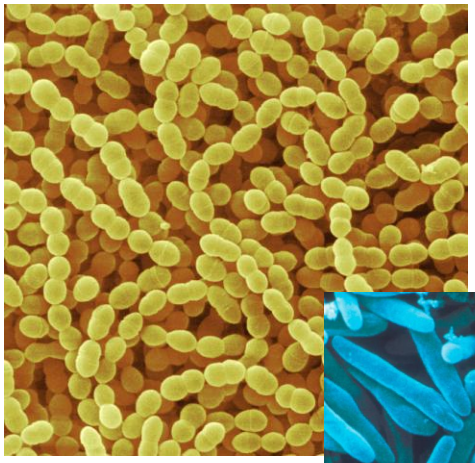
Bacteria in Yogurt

lactic acid bacteria are found in yogurt

lactic acid lowers the pH in milk causing casein (milk protein) to denature and the milk to curdle

Lactobacillus acidophilus
Lactobacillus casei
Bifidobacterium Bifidum

Streptococcus thermophillus



Lactobacillus bulgaricus

lactose → pyruvic acid → lactic acid

Robert Koch

- **Robert Koch (pronounced “coke”)**

  - German physician and bacteriologist
  - Lived 1843-1910

- **Developed a criteria for determining whether a given bacteria is the cause of a given disease:**

  Known as Koch’s Postulates

Koch's Postulates

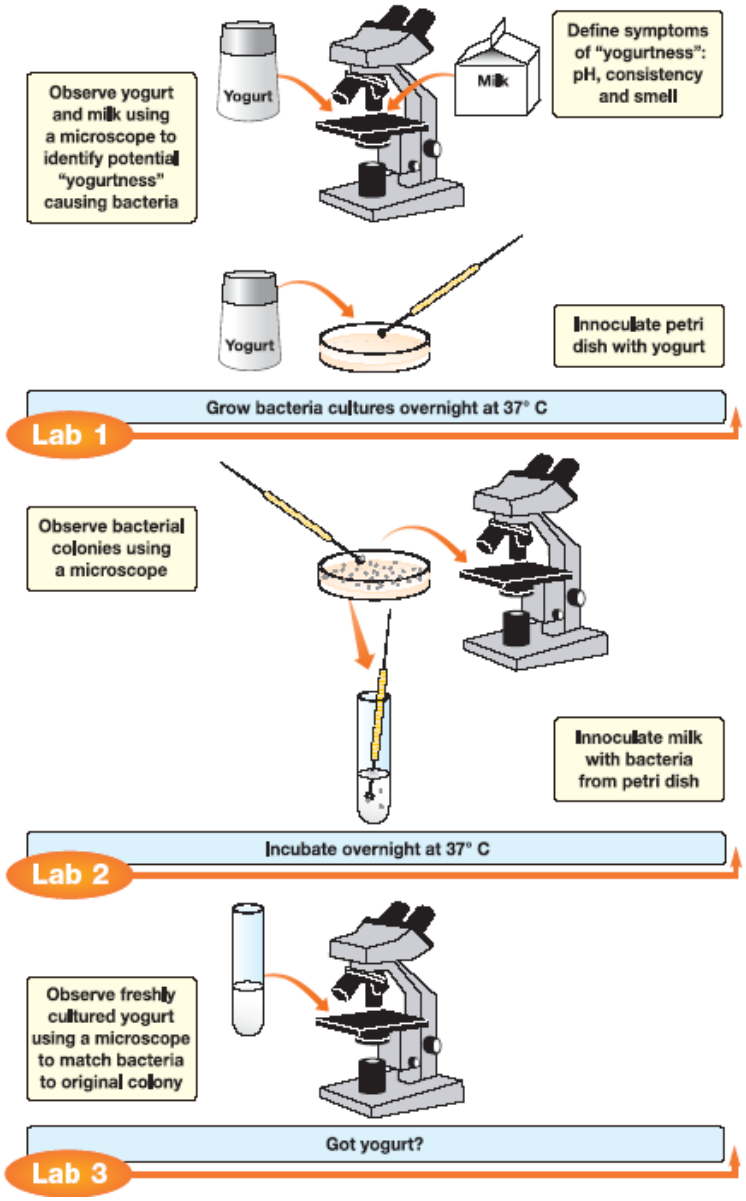
1. The microorganism must be found in all organisms suffering from the disease, but not in healthy organisms.

2. The microorganism must be isolated from a diseased organism and grown in pure culture.

3. The cultured microorganism should cause disease when introduced into a healthy organism.

4. The microorganism must be again isolated from the inoculated, diseased experimental host and identified as identical to the original specific causative agent.

Procedures Overview



Laboratory Quick Guide

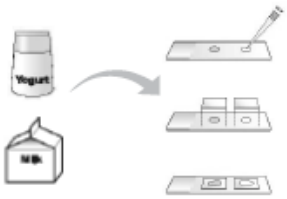
Quick Guide

Lesson 1

Postulate 1: Identify possible pathogens

1. Compare yogurt and milk with respect to appearance, smell and pH. Record observations.

2. Label left hand edge of slide "yogurt" and right hand edge "milk".



3. Dip toothpick in yogurt, mix with a drop of water on left hand side of slide and cover with cover slip.

4. Add drop of milk to right hand side of slide and cover with cover slip.

QUICK GUIDE

5. Observe yogurt and milk under the microscope. Describe and draw what you see.

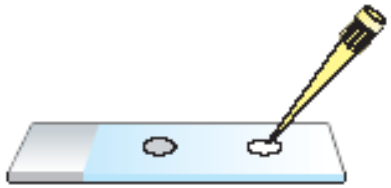
6. Repeat steps 1–5 with a different brand of yogurt.

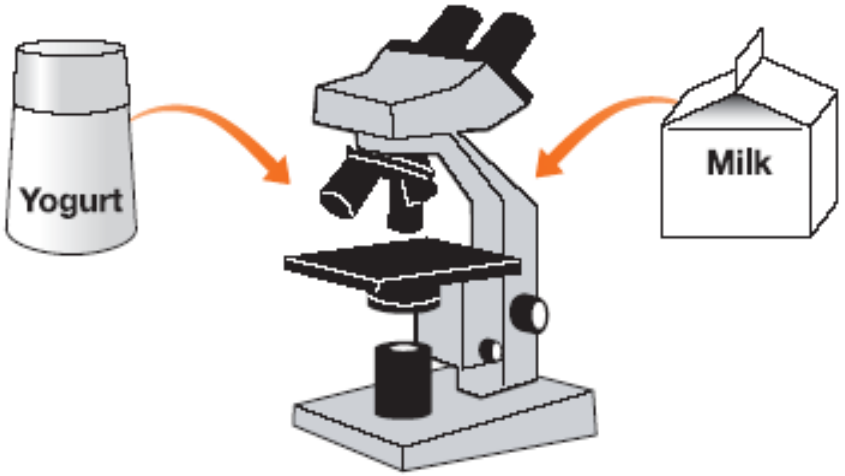
Postulate 2: Isolate and culture suspected pathogens

7. Label 3 LB sugar agar plates on the bottom (not the lid) with your initials and one as "milk", one as "yogurt" and the third as "*E.coli*".

Postulate 1

The microorganism must be found in all organisms suffering from the disease, but not in healthy organisms.





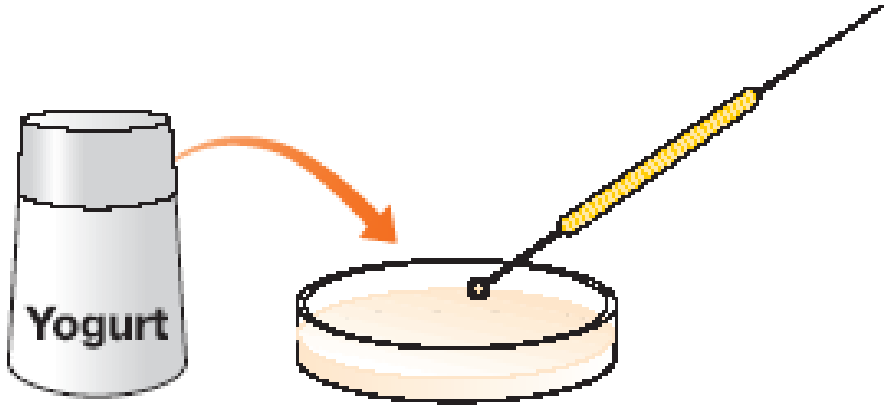
1. **Compare yogurt and milk and define the symptoms of "yogurtness":**

   - microscopic observations
   - textures, consistency
   - smell
   - pH

Milk simulates a "healthy" sample
Yogurt simulates a "diseased" sample

Postulate 2

The microorganism must be isolated from a diseased organism and grown in pure culture.



2. Observe the cultures using a microscope and compare the different types of colonies.

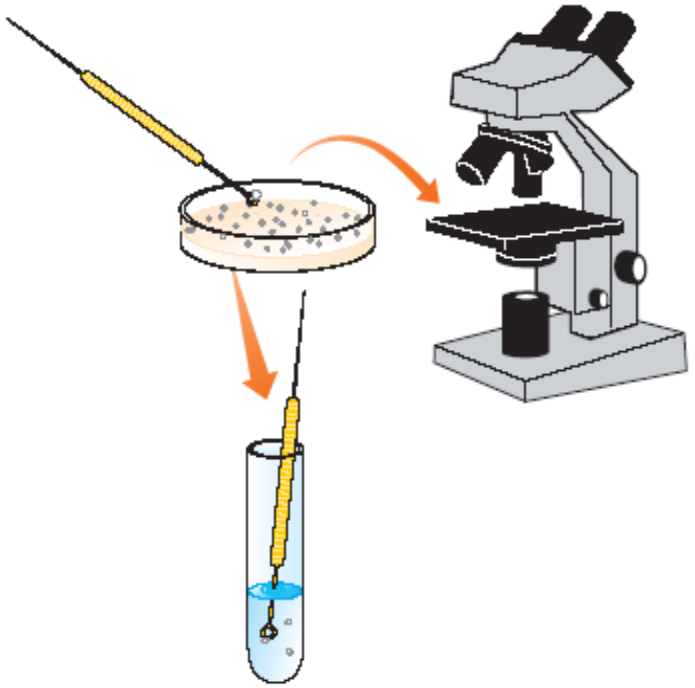
3. Inoculate 3 separate petri dishes:

Heathy individual- milk
Diseased individual- yogurt
Control bacteria- *E.coli* (control)

4. Grow cultures overnight at 37^0C

Postulate 3

The cultured microorganism should cause disease when introduced into a healthy organism.



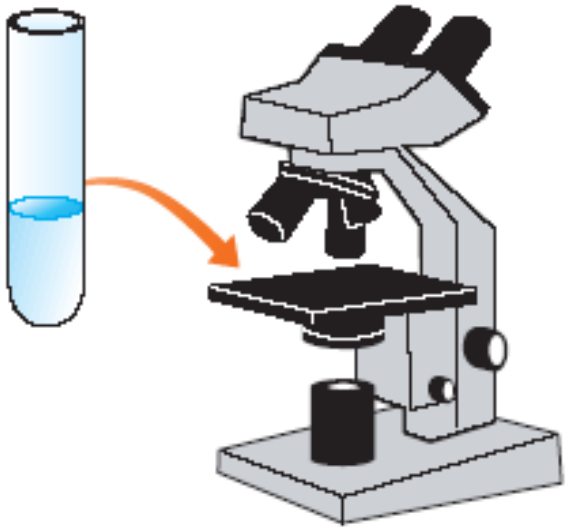
5. Inoculate fresh milk with bacteria colonies from the petri dishes

6. Incubate overnight 37^{0}C

7. Assess symptoms of the subject (pH, smell, texture). Are these the same symptoms of "yogurtness"?

Postulate 4

The microorganism must be again isolated from the inoculated, diseased experimental host and identified as being identical to the original specific causative agent



8. Observe yogurt and milk under the microscope: Can the bacteria be matched to the original culture?

Got Yogurt?

Bacteria, Bacteria, Bacteria

- **The single most successful life form on earth**
- **Prokaryotic organisms**
- **Exist in soil, water, in and on animals, plants and humans**
- **Several distinct morphologies**
  - **coccus – spherical, bacillus – rods, spiral forms**
- **Can orginize as**
  - **single units, pairs, long strings, helical shapes, twisted spirochetes**
- **Divide by binary fission (some every 20 min!)**
- **Colonies originate from one bacterial cell (clonal growth) and can have different shapes**
- **Gram's stain dye is taken up by bacteria with thick cell walls (Gram + or -)**

http://www.neatorama.com

Good Bacteria, Bad Bacteria

Salmonella typhimurium

- **Bacteria as Pathogens**

  Cholera – *Vibrio cholerae*
  Typhoid fever – *Salomonella typhi*
  Anthrax – *Bacillus anthracis*
  Tuberculosis – *Mycobacterium tuberculosis*

- **Beneficial Bacteria**

  Rhizobia – soil bateria important for nitrogen fixation
  Human bacterial flora – 500-100,00 species of bacteria live in the human body
  Lactobacillus species – convert milk to lactic acid
  Digestion of oil spills -
  Marine bacteria: *Acinetobacter calcoaceticus RAG-1*
  Genetic engineering – use of *E.coli* in industry and reasearch

http://www.accessexcellence.org/AE/AEC/AEF/1994/brown_oil.html

Antibiotics and Drug Resistance

http://www.cdc.gov/drugresistance/community/#campaign

- **Anti-bacterial antibiotics are one of the main theraputic tools to control and treat many bacterial infectious diseases. These may be:**
  - **Bactericidal – Kill bacteria**
  - **Bacteriostatic – prevent bacteria from dividing**
- **Antibiotics have various modes of action**
  - **May inhibit important bacterial enzymes**
  - **May destroy cell wall components**
- **Antibiotic Resistance**
  - **Due to overuse/misuse of antibiotics**
  - **Some bacterial strains develop resistance as an outcome of natural selection pressures**

Laboratory Extensions

- **Culture microbes from anywhere**
  - **Surfaces**
  - **Pets**
  - **Homes**
  - **School**
  - **Water**
- **Study the use of antibiotics**
- **Grow liquid culture to teach**
  - **Bacterial growth curves**
  - **Serial dilutions**
  - **Counting bacteria**
  - **Spectrophotometry**