HOTT Activities

Project Name: Microbe Math **Date**: 9-1-07

Grade Level: 3-5

Standard:

3.S.1.2	4.S.1.1	5.S.1.1
3.LVS.1.1	4.LVS.1.1	5.S.1.2
3.W.1.1	4.W.1.2	5.LVS.1.1
		5.W.1.1

Professions: Laboratory Technician

All HOTT lesson plans are designed with the purpose of increasing students' awareness of the variety of health careers that are available to them. If possible, invite the corresponding health professional into your classroom to discuss his/her occupation. If this is not an option, use the attached sheet(s) to share this/these career(s) with your students.

Purpose: Students will use clay to illustrate bacterial multiplication rates while calculating the enormous astronomical potential reproductive growth of just one bacterium in a single day. Students will apply math skills to learn about optimal conditions for bacterial growth, learn about the exponential speed at which bacteria can multiply, learn about the role of bacteria in promoting decay.

Materials Needed: Modeling clay, one or two colors, ½ inch grid chart paper, graph sheets (one per student) magnified images of common germs (either one sheet per student or transfer onto an overhead transparency)

Duration: 50 minutes

Instructions:

- Prior to the start of the activity divide clay into a fist-sized piece for each group of four students.
- Ask students for examples of decay they have seen, such as food left in the refrigerator too long or a dead animal in the yard. Explain that bacteria and fungi cause most of the decay.
- Go through the Vocabulary words:
  - **Antibiotic** – agent that destroys bacteria
  - **Antibodies** – protein that fights infections
  - **Bacteria** – microscopic life form
  - **Exponential growth** – growth that increases at an ever accelerating rate.
  - **Fungi** – a single-celled or multicellular organism without chlorophyll that reproduces by spores and lives by absorbing nutrients from organic matter. Fungi include mildews, molds, mushrooms, rusts, smuts, and yeasts.
  - **Microbe** – a microscopic organism, especially one that transmits a disease

- **Microorganism** –any organism (animal or plant) of microscopic size
- **Optical microscope** – a magnifying instrument that uses transmitted or reflected light to obtain an image.

- Explain that an individual bacterium is far too small to be seen by our eyes alone; most are about 1/1000 of a millimeter in diameter. Pass out copies of common germs sheet (or show transparency) and review the magnified images of germs. (NOTE: These images have been taken from a variety of sources and do not necessarily reflect what a student would see looking through an optical microscope.)
- Divide the class into groups of four. Give each group a fist-sized piece of clay that represents a single bacterium. Every 30 to 60 seconds, have each group divide its "bacteria": first two, then four, then eight, then 16, then 32. Track the bacterial growth on the class graph sheet. (Example attached)
- Explain that real bacteria — including strains that make us sick — divide every 20 minutes under optimal conditions. The real bacterium would have gone from one to 32 in 100 minutes. Now ask them to calculate how many bacteria there would be after two hours, three hours and four hours at this fission rate.
- Ask them to consider why such unchecked growth does not actually happen. *[Finite food supply, limits of suitable living space, propensity for crowded bacteria to poison themselves with their own waste, antibiotics that are created by competing fungi, ability of humans and many animals to produce antibodies.*]
- **Interesting Fact** In just 12 hours, one bacterium could multiply to over 8.5 billion under perfect conditions. After three days, with no bacteria dying, there would be enough of them to cover the entire earth.

Check for Understanding:

- Have students graph an exponential multiplication rate with a specified time period and rate at which that number doubles, then redoubles again and again. Example: if an organism doubles every hour, how many hours must pass for there to be over one million of them? [*20*]
- Ask students how their model bacteria are different from real life. [*Size, structure, dividing bacteria do not get smaller and smaller with each generation and growth rates are not limitless*.]

In essay form, have students answer the following questions:

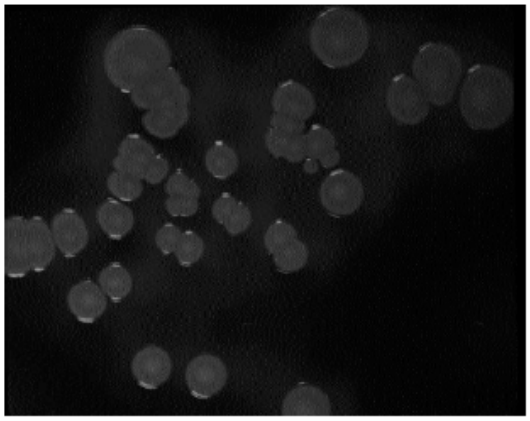
- What are other examples of rapid species growth in the natural world?
- Does this sort of growth apply to humans?
- What sort of environmental and biological factors limit that growth?

Adaptations: None

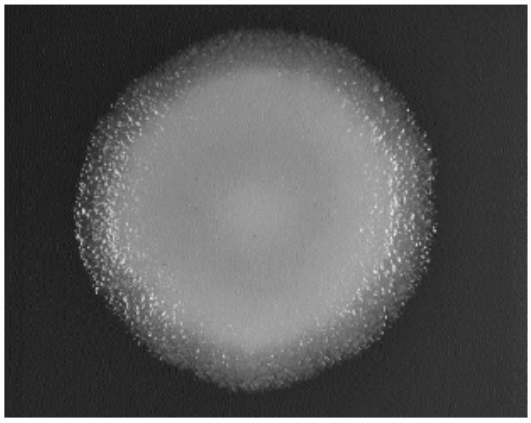
References:

- www.healthyhands.com

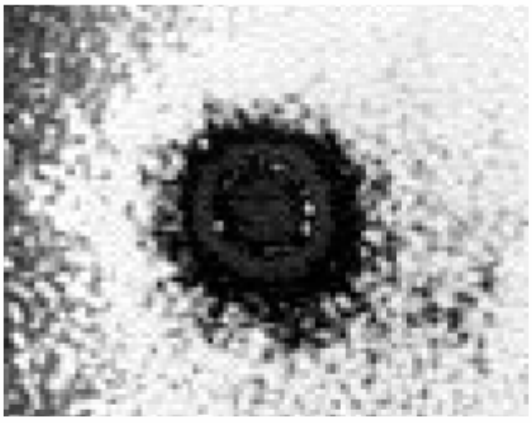
Magnified Images of Common Germs



Staphylococcus aureus (bacteria)

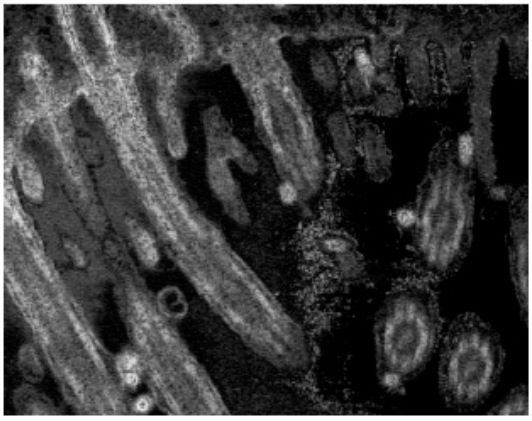


Bacillus cereus (bacteria)

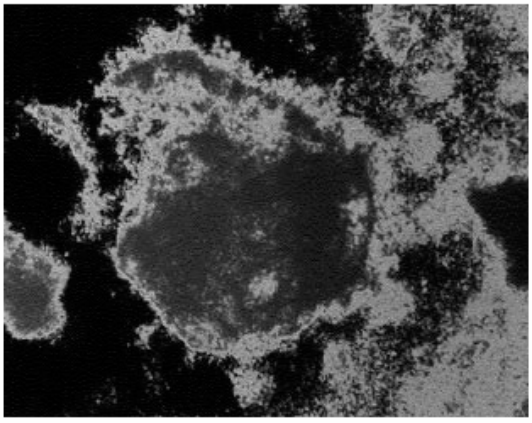


Rhinovirus (Type 1A)

Bacteriophage T4 (virus)

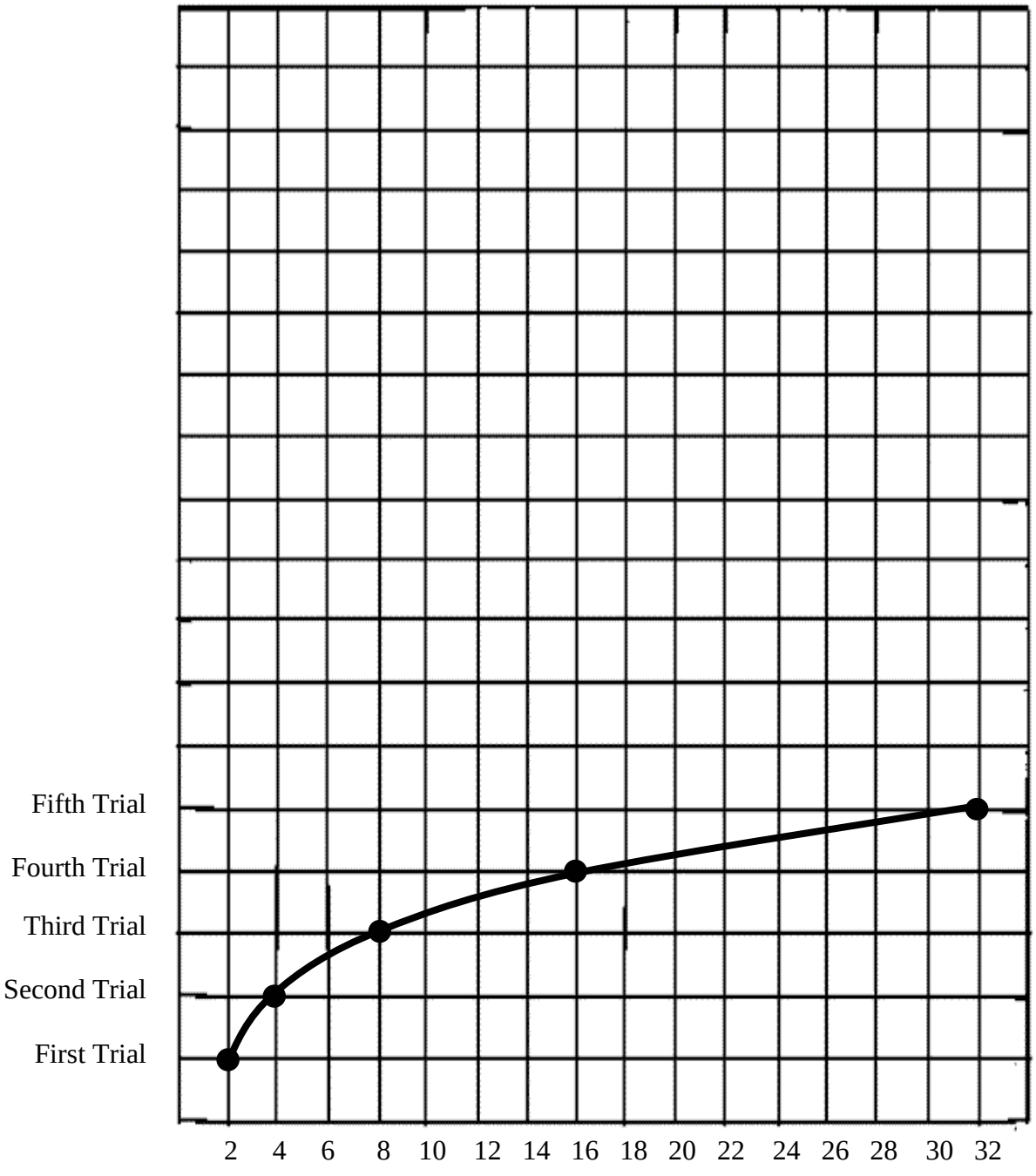


Influenza A virus



Rubella virus

Example of Bacteria Growth Graph



Training, Other Qualifications, and Advancement

The usual requirement for an entry-level position as a clinical laboratory technologist is a bachelor's degree with a major in medical technology or in one of the life sciences; although it is possible to qualify through a combination of education, on-the-job, and specialized training. Universities and hospitals offer medical technology programs.

Bachelor's degree programs in medical technology include courses in chemistry, biological sciences, microbiology, mathematics, and statistics, as well as specialized courses devoted to knowledge and skills used in the clinical laboratory. Many programs also offer or require courses in management, business, and computer applications. The Clinical Laboratory Improvement Act requires technologists who perform highly complex tests to have at least an associate degree.

Medical and clinical laboratory technicians generally have either an associate degree from a community or junior college or a certificate from a hospital, a vocational or technical school, or one of the U.S. Armed Forces. A few technicians learn their skills on the job.

The National Accrediting Agency for Clinical Laboratory Sciences (NAACLS) fully accredits 469 programs for medical and clinical laboratory technologists, medical and clinical laboratory technicians, histotechnologists and histotechnicians, cytogenetic technologists, and diagnostic molecular scientists. NAACLS also approves 57 programs in phlebotomy and clinical assisting. Other nationally recognized accrediting agencies that accredit specific areas for clinical laboratory workers include the Commission on Accreditation of Allied Health Education Programs and the Accrediting Bureau of Health Education Schools.

Some States require laboratory personnel to be licensed or registered. Information on licensure is available from State departments of health or boards of occupational licensing. Certification is a voluntary process by which a nongovernmental organization, such as a professional society or certifying agency, grants recognition to an individual whose professional competence meets prescribed standards. Widely accepted by employers in the health care industry, certification is a prerequisite for most jobs and often is necessary for advancement. Agencies certifying medical and clinical laboratory technologists and technicians include the Board of Registry of the American Society for Clinical Pathology, the American Medical Technologists, the National Credentialing Agency for Laboratory Personnel, and the Board of Registry of the American Association of Bioanalysts. These agencies have different requirements for certification and different organizational sponsors.

Clinical laboratory personnel need good analytical judgment and the ability to work under pressure. Close attention to detail is essential, because small differences or changes in test substances or numerical readouts can be crucial for patient care. Manual dexterity and normal color vision are highly desirable. With the widespread use of automated laboratory equipment, computer skills are important. In addition, technologists in particular are expected to be good at problem solving.

Technologists may advance to supervisory positions in laboratory work or may become chief medical or clinical laboratory technologists or laboratory managers in hospitals. Manufacturers of home diagnostic testing kits and laboratory equipment and supplies seek experienced technologists to work in product development, marketing, and sales. A graduate degree in medical technology, one of the biological sciences, chemistry, management, or education usually speeds advancement. A doctorate is needed to become a laboratory director; however, Federal regulation allows directors of moderately complex laboratories to have either a master's degree or a bachelor's degree, combined with the appropriate amount of training and experience. Technicians can become technologists through additional education and experience.

Employment

Clinical laboratory technologists and technicians held about 302,000 jobs in 2004. More than half of jobs were in hospitals. Most of the remaining jobs were in offices of physicians and in medical and diagnostic laboratories. A small proportion was in educational services and in all other ambulatory health care services.

Job Outlook

Job opportunities are expected to be excellent, because the number of job openings is expected to continue to exceed the number of job seekers. Employment of clinical laboratory workers is expected to grow faster than the average for all occupations through the year 2014, as the volume of laboratory tests continues to increase with both population growth and the development of new types of tests.

Technological advances will continue to have two opposing effects on employment. On the one hand, new, increasingly powerful diagnostic tests will encourage additional testing and spur employment. On the other hand, research and development efforts targeted at simplifying routine testing procedures may enhance the ability of nonlaboratory personnel—physicians and patients in particular—to perform tests now conducted in laboratories. Although hospitals are expected to continue to be the major employer of clinical laboratory workers, employment is expected to grow faster in medical and diagnostic laboratories, offices of physicians, and all other ambulatory health care services.

Although significant, job growth will not be the only source of opportunities. As in most occupations, many openings will result from the need to replace workers who transfer to other occupations, retire, or stop working for some other reason.

Earnings

Median annual earnings of medical and clinical laboratory technologists were $45,730 in May 2004. The middle 50 percent earned between $38,740 and $54,310. The lowest 10 percent earned less than $32,240, and the highest 10 percent earned more than $63,120. Median annual earnings in the industries employing the largest numbers of medical and clinical laboratory technologists in May 2004 were as follows:

General medical and surgical hospitals	$46,020
Medical and diagnostic laboratories	45,840
Offices of physicians	41,070

Median annual earnings of medical and clinical laboratory technicians were $30,840 in May 2004. The middle 50 percent earned between $24,890 and $37,770. The lowest 10 percent earned less than $20,410, and the highest 10 percent earned more than $45,680. Median annual earnings in the industries employing the largest numbers of medical and clinical laboratory technicians in May 2004 were as follows:

Colleges, universities, and professional schools	$32,410
General medical and surgical hospitals	31,830
Offices of physicians	29,620
Medical and diagnostic laboratories	29,220
Other ambulatory health care services	28,130

According to the American Society for Clinical Pathology, median hourly wages of staff clinical laboratory technologists

and technicians in 2003 varied by specialty and laboratory type as follows:

	Hospital	*Private clinic*	*Physician office laboratory*
Cytotechnoligist	$24.70	$24.07	$25.66
Histotechnologist	19.88	19.22	20.50
Medical technologist	20.40	19.00	18.00
Histotechnician	16.97	16.13	20.00
Medical laboratory technician	16.12	15.00	14.75
Phlebotomist	11.13	10.57	10.50

Related Occupations

Clinical laboratory technologists and technicians analyze body fluids, tissue, and other substances, using a variety of tests. Similar or related procedures are performed by chemists and materials scientists, science technicians, and veterinary technologists and technicians.

Sources of Additional Information

For a list of accredited and approved educational programs for clinical laboratory personnel, contact:

➤ National Accrediting Agency for Clinical Laboratory Sciences, 8410 W. Bryn Mawr Ave., Suite 670, Chicago, IL 60631. Internet: **http://www.naacls.org**

Information on certification is available from:

➤ American Association of Bioanalysts, Board of Registry, 906 Olive St., Suite 1200, St. Louis, MO 63101-1434. Internet: **http://www.aab.org**

➤ American Medical Technologists, 710 Higgins Rd., Park Ridge, IL 60068.

➤ American Society for Clinical Pathology, 2100 West Harrison St., Chicago, IL 60612. Internet: **http://www.ascp.org**

➤ National Credentialing Agency for Laboratory Personnel, P.O. Box 15945, Lenexa, KS 66285. Internet: **http://www.nca-info.org**

Additional career information is available from:

➤ American Association of Blood Banks, 8101 Glenbrook Rd., Bethesda, MD 20814-2749. Internet: **http://www.aabb.org**

➤ American Society for Clinical Laboratory Science, 6701 Democracy Blvd., Suite 300, Bethesda, MD 20817. Internet: **http://www.ascls.org**

➤ American Society for Cytopathology, 400 West 9th St., Suite 201, Wilmington, DE 19801. Internet: **http://www.cytopathology.org**

➤ Clinical Laboratory Management Association, 989 Old Eagle School Rd., Suite 815, Wayne, PA 19087. Internet: **http://www.clma.org**