This chapter contains background information for establishing a biotechnology club, definitions of basic biotechnology concepts and experiment ideas. Sections include

- Definitions
- Background materials
- Internet simulations
- Simple experiments
- Local contacts

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the NSF Award # 0401988
LSC-Montgomery Biotechnologyy Institute

Introduction to Biotechnology Clubs

Why a biotechnology club?

Professional clubs in high schools, such as Future Farmers of America (FFA) and Health Occupations Students of America (HOSA), can help students become acquainted with possible careers in a fun and exciting way. They encourage students who are on-level (but not necessarily straight-A, Advanced Placement students) to participate in activities that will help them make career decisions. Clubs are a great way to introduce new fields and to encourage participation by students from a variety of backgrounds.

What is Biotechnology, and why should I (or my students) care?

Although the field of biotechnology has exploded in importance over the last 25 years, many people – even highly educated, professional people – still don’t know it exists! One of our jobs as science educators is to move towards the future when nobody asks us “What is Biotechnology?”

The PowerPoint presentation, *Biotechnology – Unlocking Your Future*, was written to help people understand what Biotechnology is and why it’s really important to our society. It can be found on the LSC-Montgomery Biotechnology Institute’s web page, [http://wwwappsnc.nhmccd.edu/biotechnology/index.htm](http://wwwappsnc.nhmccd.edu/biotechnology/index.htm). In addition, you can request a copy of a short, 12-minute presentation, *Biotechnology -- Making the Connection*, on the importance of biotechnology (see address below).

Here are the important take-home messages, in FAQ format.

What is Biotechnology? Biotechnology is the use of living organisms or parts (like proteins or DNA) to make useful products.

Why is Biotechnology important? Because biotechnology processes are being used in so many fields. Biotechnology is responsible for huge advances in health care, including new medicines, vaccines and test-kits. But it is also important in other areas such as agriculture, the development of alternative fuels, discovery of new fibers to make clothing, and forensic criminology.

Is Biotechnology new? NO! Biotechnology is one of the oldest technologies. For example, biotechnology has been used for thousands of years to make bread and cheese.

Then why haven’t we heard much about it? The field started to grow explosively after the 1970’s when discoveries in biology made the techniques used today possible. Many adults today finished their education before this biotechnology revolution occurred and so are unaware of the importance of this field.
Why are some people afraid of biotechnology? People are often afraid of things they don’t know much about. Not so long ago, many people were afraid of computers too.

How will biotechnology affect my students? Because of the great jobs available in biotechnology! The field is growing explosively and there are many more jobs than applicants in many sectors. This is certainly true in the southeast Texas region where LSC-Montgomery is located. Our program has enjoyed 100% placement of its students for many years.

How much education will my students need? Some jobs are available with just a high-school diploma or GED. Many entry level positions are available with an associate’s degree. Others require higher degrees.

Will they be able to continue their education? YES! Our program, for example, is accepted for credit towards several different B.S. degrees. Many companies pay for their employees to continue their education, too. This will vary somewhat depending on where you go to school.


How do I get started?

Convinced? Then the next thing to do is get a club going. Here are things you might want to do.

(1) Get a copy of this handbook – SEE! You’re already started!
(2) Target your population. Do you need a new club? Is there an existing science club, or one in a related field like Health Occupations (HOSA), that might like to branch out a bit? If so, volunteer to add some activities to the existing club.
(3) If not, then you can start a biotechnology club specifically. The activities in the handbook are more than enough for a full school year! Find out what you need to do at your school (get listed as a new club, get student activities funding, etc.).
(4) Find a partner and sponsors! Find out if there are any community colleges or high schools in your area that are already involved in biotechnology education. Call them up! Locate any biotechnology companies in your area. Here’s an important website to help you get started: http://www.biolink.org/.
(5) Put together a budget. Student activities funds may help and your partner organizations may be able to contribute funds, supplies, equipment, speakers, etc.
(6) Pick your meeting time and frequency. There are easily enough activities suggested for once or twice a month meetings.
Advertise, advertise, advertise! The bigger the sign, the better. Don’t count on a few 8 ½ by 11 announcements getting the job done.

Offer food if you can. Snacks fill rooms.

Identify a core of interested students, make them officers.

Get a copy of Shoestring Biotechnology. This is a terrific source of interesting, inexpensive experiments in biotechnology. (http://www.biotechnologyinstitute.org/resources/shoestring_biotechnology.html).

Pick your units and schedule your activities. ROTATE units and activities. Find out what interests your students and emphasize those units, but still try to mix up activities. Guest speakers, labs, field trips, videos, computer activities, parties—all have a role in a good pre-professional club.

Questions? Lean on your mentors. Or contact us—we’ll be glad to try to help you out!

**Handbook Organization**

The activities in this handbook are designed for students who have shown an interest in the biological sciences. Typically they will have taken biology at the high school level. Some will have taken an advanced course in biology, but some may only have a general science course.

Each section in this handbook is organized similarly.
- a short introduction with some internet websites to provide background information
- suggested classroom activities: some are internet simulations, many can be done with supplies available in a grocery store, and some require access to a laboratory
- other suggested activities: these include possible guest speakers (local contacts) and field trips

**Who are we?**

LSC-Montgomery is located in Conroe, TX about 30 miles north of Houston. The college is located in the middle of a thriving biotechnology incubator, called the Research Forest. We offer an Associate of Applied Science Degree program and an Advanced Training Certificate in Biotechnology. In the fall of 2000, we initiated clubs in area high schools as a way of publicizing careers in biotechnology and introducing our college’s program. We have worked with local high schools since then to sponsor biotechnology clubs and help existing clubs offer biotechnology-based activities. These activities have been supported by the college, local industry, and grant funding (NSF Grant: Biotechnology SUCCESS -- ATE401988).

The Biotechnology Institute at LSC-Montgomery has a staff of three people. The biotechnology coordinator, Nancy Prejean, wrote most of the material in this handbook and researched the vast majority of the websites. The biotechnology outreach specialist, Janet Varela, has implemented most of the contacts with the high schools, helping to start up new clubs and keep existing ones running. The director,
Dr. Larry Loomis-Price, edited the materials and acquired the funds necessary to keep sponsoring clubs and to write this handbook.

**BIOS**

Dr. Larry Loomis-Price studied biology and chemistry at MIT and received his PhD in biological chemistry at the University of California at Berkeley. He worked as a medical researcher for almost 15 years, first at the Walter Reed Army Institute of Research and then at the Henry M. Jackson Foundation in Washington DC. His research involved development and initial testing of vaccines for the prevention of malaria, hepatitis C, and HIV. Concurrently, he taught in the biotechnology graduate program at Johns Hopkins University in Baltimore. He took his current position as director of the LSC-Montgomery Biotechnology Institute in 2002. He is the chair of the Spring Independent School District Career and Technology Education advisory board and also serves on a similar board for the Conroe ISD Academy of Health Sciences. Dr. Loomis-Price is the Primary Investigator on a National Science Foundation Grant entitled “Biotechnology-SUCCESS: Outreach to Underserved Populations” which is testing recruitment programs to attract students from diverse populations to study biotechnology. The funding for development of this handbook was largely obtained from this grant.

Nancy Prejean serves as Biotechnology Specialist for the LSC-Montgomery Biotechnology Institute. She received a Bachelor of Science degree from the University of Southwestern Louisiana and a Masters of Science degree from Florida State University. She has 34 years of teaching experience with her most recent employment being in the Deer Park ISD school system where she taught physical education, math and technology. As a specialist, Nancy works closely with Dr. Loomis-Price as they advance the goals of the MCBI. They work with industry partners to keep the curriculum current and with high school students and teachers to promote awareness of the need for biotechnology graduates in the future.

Janet Varela serves as Outreach Coordinator for the LSC-Montgomery Biotechnology Institute. She received a BS degree in Biology from Sam Houston University. She is currently working for Kelly Scientific as a recruiter for businesses needing biotechnology employees. For the MCBI, she visits local schools, assists with biotechnology high school competitions, arranges field trips and works with teachers to set up biotechnology clubs in their schools to promote the field of biotechnology to potential students.
Biotechnology General Background and Vocabulary

**DNA** – Deoxyribonucleic Acid. This is the molecule found in every cell in a living organism. The DNA contains all the information necessary for the cell to survive, perform its functions and reproduce itself.

**Nucleic Acids** – these are the components of DNA. Each nucleic acid consists of a sugar, a phosphate group and one of four possible organic base molecules. The nucleic acids are linked into a long chain through the sugar and phosphate groups. The four different bases (symbolized A, C, T, and G) code the information that is carried on the DNA molecule.

**Double-helix** – DNA in cells is arranged with two long strands curled around each other and twisted. The two strands are loosely chemically bonded between the bases on each strand. In this structure, which resembles a twisted ladder, A always bonds to T and C bonds to G. The two strands can be separated by simply heating the solution containing the DNA; this process is called ‘melting’ the DNA.

**Proteins** – the biological molecules that carry out most of the functions in cells and make up the structure of the cells themselves. The information coded by DNA in cells serves to make specific proteins. Proteins are made up of linear strands of molecules called amino acids (the same as DNA is made up of linear strands of nucleic acids). Proteins form complex three-dimensional shapes that are specific to the linear sequence and serve to carry out their specific functions.

**Genome** – the sum total of all DNA in an organism. Many complete genomes have been solved, including those from bacteria, yeast, fruit flies, and mammals including a common strain of mouse, and humans.

**Human Genome Project** – The sequencing of all DNA in a human being. This project involved a large consortium of businesses and governments from several countries. The project is still on-going, but the rough draft of the human genome was published in 2003.

http://www.ornl.gov/sci/techresources/Human_Genome/home.shtml

**Searchable index of terms:** There are MANY more terms that you may come across while exploring biotechnology. Here is a good site:

http://biotechnologyterms.org/.

**Talking glossary of genetic terms:** This is a wonderful site with the term’s pronunciation, audio information, images and additional links to related terms. In addition, the site is available in Spanish – both in print and orally. (Click here for web snapshot in English) (Page 30) or here for web snapshot in Spanish (Page 31)

http://www.genome.gov/10002096 (English)

http://www.genome.gov/sglossary.cfm (Spanish)
Supplemental materials:

**Biotechnology – Making the Connection:** request a copy of the DVD from
Larry Loomis-Price, Director of MCBI
3200 College Park Dr.
Conroe, TX  77384

**Biotechnology – Unlocking Your Future:** PowerPoint available at
http://www.appsmc.nhmccd.edu/biotechnology/index.htm

**Posters and Handouts:** BioTrek has developed a number of handouts on bioscience topics. Many are available as large files suitable for printing as 3 by 4 foot posters.  
(Click here for web snapshot) Page 28
www.biotechnology.wisc.edu/outreach/handouts.html

**National DNA Day:** National DNA day is held in April of every year and the web site below has great activities, speaker presentations, and curriculum supplements for the current year as well as activities from prior years. The webcasts are very visual and interesting to listen to.  
(Click for web snapshot) Page 29
http://www.genome.gov/10506367

**Internet background:**

**DNAi:** An amazing site sponsored by the Dolan DNA learning center. Teaching resources, free programs, unbelievable graphics, interviews with the scientists that made the biotechnology revolution happen.  
(Click for webpage snapshot) Page 10
http://www.dnai.org/index.htm

**DNA from the Beginning:** An animated primer on the basics of DNA, genes, and heredity. Each concept is explained by: animation, image gallery, video interviews, problems, biographies, and links.  
http://www.dnaftb.org/dnaftb/

**Internet simulations:**

**Tour of the Basics:** Wonderful site with graphics and activities.  
(Click here for webpage snapshot) Page 11
http://gslc.genetics.utah.edu/units/basics/tour/

**Build a DNA Molecule:** Click and drag nucleotides into position.  
(Click here for webpage snapshot) Page 12
http://gslc.genetics.utah.edu/units/basics/builddna/

**Transcribe and Translate a Gene:** An activity for students to do themselves.  
(Click here for webpage snapshot) Page 13
http://gslc.genetics.utah.edu/units/basics/transcribe/
**Gel Electrophoresis**: Sort and measure DNA strands by running your own gel electrophoresis experiment. ([Click here for webpage snapshot](http://gslc.genetics.utah.edu/units/biotechnology/gel/)) Page 14

**DNA Workshop**: In this activity, the student is placed within the cell and is involved with the processes of DNA replication and protein synthesis. ([Click here for webpage snapshot](http://www.pbs.org/wgbh/aso/tryit/dna/)) Page 15

**Biotechnology Adventure**: An educational web site designed to present the factual information regarding biotechnology in a way that will entertain both students and adults. Very colorful and animated. ([Click here for webpage snapshot](http://biotechnology-adventure.okstate.edu/)) ([Click here for outline of topics](http://biotechnology-adventure.okstate.edu/)) Page 21

**The Gene School**: A variety of genetic games presented in PDF format and ready to be printed out. ([Click here for webpage snapshot](http://library.thinkquest.org/19037/games.html)) Page 22 ([Click here for sample game](http://library.thinkquest.org/19037/games.html)) Page 23

**Genome: The Secret of How Life Works**: Many great animations and links to lesson plans. This site is also in Spanish. This site is information displayed at the Smithsonian. ([Web intro snapshot](http://library.thinkquest.org/19037/games.html)) Page 24 ([Click here for Spanish web snapshot](http://library.thinkquest.org/19037/games.html)) Page 25 ([Click here for lesson plan snapshot](http://library.thinkquest.org/19037/games.html)) Page 26

**Understanding Genetics**: An online exhibit from The Tech Museum of Innovation: Zoom Into DNA; use an interactive eye color calculator; have a Geneticist at Stanford University answer questions about DNA; keep up on the latest Genetics news and much, much more! ([Click for web snapshot](http://library.thinkquest.org/19037/games.html)) ([first site](http://library.thinkquest.org/19037/games.html)) ([more recent link](http://library.thinkquest.org/19037/games.html))

**The Gene Scene**: An informal, interactive site for independent exploration of genetics. OLogy, the American Museum of Natural Science’s Web site for kids ages seven through twelve, is designed as a place for kids to explore, ask questions, get answers, meet OLogists, and play games. The site also has age-appropriate content in archaeology, astronomy, biodiversity, marine biology, paleontology, and physical science, OLogy makes science learning rich and engaging. Educators can find suggestions and tips on how to use the OLogy Web site in the Educator's Guides. ([Click for web snapshot](http://library.thinkquest.org/19037/games.html)) Page 27

([http://www.ology.amnh.org/genetics/index.html](http://www.ology.amnh.org/genetics/index.html))
Experiments:

Using micropipettes and the spectrophotometer: Skill development with goal of determining the amount of protein in a set of unknown solutions. A PowerPoint, training module and reference to TEKS skills is included in the documentation.

http://www.panam.edu/dept/biotechnology/modules.html

DNA isolation: Two activities: smoothie DNA and cheek cell DNA protocols. (Click here for webpage snapshot of protocol 1) Page 16 (Click here for webpage snapshot of protocol 2) Page 17
http://www.life.uiuc.edu/hughes/footlocker/Activities/index.html

DNA smoothie: (Click here for webpage snapshot) Page 18
http://matcmadison.edu/biotechnology/resources/activities/dna/teacher.htm

Candy DNA and Replication (no lab required)

DNA Sequencing (no lab required)

Genes in a Bottle: students extract DNA from their cheek cells and then transfer them to a glass vial and create a necklace. The kit can be ordered from Bio-Rad. (Click here for webpage snapshot) Page 19
www.bio-rad.com

Local Contacts:

Ken Coker
Lexicon Genetics
8800 Technology Forest Place
The Woodlands, TX 77381
281-364-0100

HARC
4800 Research Forest Dr.
The Woodlands, TX 77381
Tour of the Basics

Are you confused by all the talk about DNA and genes?
We can help.
Take the Tour of the Basics!
To start the Tour, choose a topic from the six listed above.
You can also download the tour to run on your computer without an Internet connection.
Read the instructions below this screen to learn how.

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Build a DNA Molecule

The structure of DNA is a double helix, much like a ladder that is twisted into a spiral shape. The bases of the DNA are found in pairs, which make up the rungs of the ladder. The uprights of the ladder are the structural backbone of the DNA. They don't carry information, they just hold the bases in their proper order. DNA bases characteristically pair G with C, and A with T.

Use these pairing rules and the nucleotides below to build a DNA strand containing five base pairs.

Click and drag each nucleotide into position.

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Transcribe and Translate a Gene

The DNA that makes up the human genome can be subdivided into information bytes called genes. Each gene encodes a unique protein that performs a specialized function in the cell. The human genome contains more than 25,000 genes.

Cells use the two-step process of transcription and translation to read each gene and produce the string of amino acids that makes up a protein. The basic rules for translating a gene into a protein are laid out in the Universal Genetic Code.

To see how this works, look over the diagram at the right. Then try it yourself in the activity below!

Are you ready to transcribe a DNA sequence and translate it into a protein?

Having problems with an animation on this page?
Try downloading the latest version of the Macromedia Flash player.

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Go directly to **DNA Workshop Activity** (92K - requires Shockwave)

An embryonic cell divides again and again. Where there was one cell there are two, then four, then eight,... Each holds all the genetic information needed to create a human being. How, exactly, do these cells make copies of themselves?

Hair grows from your head, nonstop, day in and day out. The cells of your hair follicles somehow generate all of the protein that make up this hair. How is this protein created?

The answers to these questions are DNA replication and protein synthesis.

Knowledge of the structure of DNA began with the discovery of nucleic acids in 1869. That genes control the synthesis of enzymes was understood in the 1940s. In 1953, an accurate model of the DNA molecule was presented, thanks to the work of Rosalind Franklin, James Watson, and Francis Crick.

The activity in this section places you within the cell, involving you with the processes of DNA replication and protein synthesis.

- **DNA Workshop Activity** (92K - requires Shockwave)
  
  text version of activity

If you're interested in finding out more about DNA and protein synthesis, check out the other sections:

- DNA Replication
- All Wound Up
- Protein Synthesis
- Glossary

Related **People and Discoveries** entries

- Francis Crick
- Rosalind Franklin
- Drugs developed for leukemia (relevant research)
- Watson and Crick describe structure of DNA
- Amino acids are created in laboratory

http://www.pbs.org/wgbh/aso/tryit/dna/  
5/17/2006
Biotechnology in a Lunchbox: Extract DNA from fruit & make a smoothie!!

Materials Needed (per group):
- Clear shampoo (such as Suave Daily Clarifying)
- 1 clear film container or other small container
- Water (tap or bottled)
- Table salt (non-iodized)
- Meat tenderizer (not seasoned)
- Two 10 oz. plastic cups
- Fruit (blueberries, strawberries-fresh or frozen, nectarines, bananas, kiwis, etc.)
- 91% Ice cold Isopropyl Rubbing Alcohol (NOT 70% - you may need to search several stores to find this) or Absolute Ethanol (best)
- Blender or fork for puréeing fruit
- Toothpick or swizzle stick
- 1 Cone-shaped #4 size coffee filter
- Ice
- 2 teaspoons (one for measuring and one for mixing)

Materials for Smoothie (optional):
- 10 oz. bag frozen strawberries
- 1 extra banana
- 1 c. orange juice
- 4 - 8 Tablespoons honey

DNA EXTRACTION DIRECTIONS:
DNA is found in the cells of all organisms. DNA is a very long, stringy molecule that has a negative charge. Each chromosome in a cell is made of a single long DNA molecule, which may have millions of nucleotide bases. [FYI: If the 46 DNA molecules from the chromosomes of one of your cells were placed end-to-end, they would be approximately 6 FEET LONG, but so thin that you couldn't see them! In this laboratory, we will extract DNA from a variety of fruit cells.

(NOTE: All measurements and times are approximate. Feel free to experiment with other methods!)

1. Measure 2 teaspoons (10 ml) of shampoo into a small cup.
   The lipid bilayer of the cell membrane and nuclear membrane are broken down by soaps, such as lauryl or laureth sulfates found in shampoo and dish soap. [FYI: When you wash dishes, the fats (grease) are removed from your dishes by the dish soap.] Shampoo also contains EDTA (ethylene diamine tetraacetic acid), which binds to cations such as Mg³⁺. Cations are sometimes used as cofactors that help enzymes work properly - without the cofactor, the enzyme can't function. One enzyme that is detrimental to DNA is nuclease, which breaks down the DNA. EDTA binds to Mg³⁺ and prevents it from assisting nucleases in their destruction of DNA.

2. Add 2-3 pinches of salt (NaCl) to the shampoo.
   The positively-charged sodium ions (Na⁺) are attracted to the negative charge of the DNA. This creates a shield around the DNA molecules and causes them to stick together (coalesce). This enables the DNA to precipitate out of the solution when added to alcohol in a later step. Salt also causes proteins in the fruit mixture to denature and precipitate out of the solution.

Carolyn A. Zants, UUC-Hughes Biotechnology Education and Outreach Program (www.life.uiuc.edu/hughes/footlocker) (activity modified from Iowa State University Biotechnology Center)
WIND YOUR WAY AROUND YOUR OWN DNA!!!

DNA contains the instructions for making an organism, including YOU! Your DNA determines how you look, what blood type you have, even your tendency to get some diseases. Almost every cell in your body contains the same DNA and same genes (some cells such as gametes have half as much DNA and mature red blood cells don’t have any DNA). Each chromosome is made of a single, long strand of DNA. If the DNA from the 46 chromosomes in one cell of your body could be laid out end-to-end, it would measure 6 feet!

In this activity, you will isolate your very own DNA from your cheek cells. First, you will break away the membranes surrounding the cells and nuclei, and then you will precipitate the DNA so you will be able to see your DNA!

MATERIALS NEEDED:
• clear Gatorade OR 0.9% salt water (NaCl) (approx. 1/2 teaspoon in 8 oz. water)
• small cup (4-8 oz.)
• 30 - 50 ml test tube or other small container (such as a clear film canister)
• 25% soap solution (1 teaspoon dish soap or shampoo + 3 teaspoons water)
• ice cold alcohol (95% ethanol/ethyl alcohol is best; 91% isopropanol/rubbing alcohol also works) - keep in freezer or on ice until use
• Teaspoons for measuring

PROCEDURE:
1. Swish 2 teaspoons (10 ml) of the Gatorade or salt water from the small cup in your mouth vigorously for 30 seconds. Your goal is to slough off as many cheek cells as possible. Your instructor will time you to make sure you have swished long enough.
2. Spit the water with cheek cells back into the small cup.
3. Pour this solution into a tube containing 1 teaspoon (5 ml) of soap solution;
4. Gently mix this solution for 2-3 minutes. Try to avoid creating too many bubbles. The soap solution breaks the cell membranes that are made up of fats - just like soap breaks down grease on your dishes!
5. Tilt the tube of soap solution/cells. Pour 2-3 teaspoons (10-15 ml) of ice cold alcohol (EtOH) down the side of the tube so that it forms a layer on top of your soapy solution. DO NOT MIX THIS!
6. Let the tube stand for 1 or 2 minutes,
7. The white clump that you see is YOUR DNA!!! Research laboratories use a similar procedure to isolate and study DNA from different organisms.

Geryl A. Zanta, UIUC-Hughes Biotechnology Education and Outreach Program (www.life.uiuc.edu/hughes/footlocker)
This activity is a modification of a procedure developed by the Museum of Science and Industry, Chicago.
INSTRUCTOR PROTOCOL

DNA FROM FRUIT SMOOTHIES

INSTRUCTOR

• Place one banana (fresh or frozen) and one pound of frozen strawberries into a pitcher (for edibles).

• Add a little honey and orange juice to approximately double the volume of the fruit (400-
Genes in a Bottle Kit

Click for: | Ordering Information | Related Information | Literature |

Bottle Your DNA!

Whether it’s being cloned, sequenced, fingerprinted, mapped, or genetically engineered, DNA has become an everyday topic in the media and the classroom. Introduce your students to the molecular framework of biology — with their own DNA!

How do scientists separate pure DNA from cells composed mainly of lipids, proteins, carbohydrates, and salts? Membranes are first ruptured with detergents to release DNA into a solution; then proteins and other organic molecules are digested and separated while retaining intact DNA. The DNA is finally collected by precipitation in a form that can be manipulated as desired.

With this simple laboratory activity, students gain practical knowledge by conducting a real-world laboratory procedure that is used to extract DNA from many different sources.

Welcome to BioTech-Adventures, an educational web site designed to present the factual information rega in a way that will entertain both students and adults.

Faculty expertise in teaching biology (Dr. Meredith Hamilton), animal biotechnology (Dr. Rodney Geisert), (Dr. Jonathan Shaver), wildlife genetics (Dr. Ronald Van Den Bussche), veterinary science (Dr. Jerry Male medicine (Dr. Lee Rickards) brings together a unique group of scientists to develop materials for teaching Mary Lou Sheffer, School of Journalism and Broadcasting, working with undergraduates in video develop production of accurate and entertaining films depicting real applications of biotechnology today.

Educators be certain and look through our teacher resources where you can download the illustrations an animations from the site for use in your teaching program.

The younger crowd, or just young at heart, will enjoy the entertaining computer animations found in the H:

ATTENTION: If you cannot see the above animation you need to update your shockwave plug-in. You can download the newest version from Macromedia.

Questions, Comments or Suggestions

http://biotech-adventure.okstate.edu/
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Games

There are a variety of genetic games here for you to try, all with the answers included on a separate page. The games here are in PDF format (if you don't have it already, be sure to get the free Adobe Acrobat Reader) and are ready to be printed out. If you have trouble viewing them online, shift-click (IBM) or option-click (Mac) to download them.

- Alphabet Soup (24K)
- Crossword (33K)
- Crypto-Groups (25K)
- Heads and Tails (25K)
- Keywords (23K)
- Matching (23K)
- Match Game (23K)
- Name Falls (26K)
- Pyramid (23K)
- Secret Word (23K)
- Word Maze (22K)
- Word Search (156K)

Experiments
Quiz
Games
Message Board
Polls
Teacher Links
PYRAMID

Using only the letters in the word TOE, complete the words in the pyramid. Words read across only. Every word contains each letter of TOE at least once.

TOE

Z Y G _ _ _
P R _ _ _ I N
P R M _ _ _ R
G _ N _ _ Y P _
C Y _ _ S I N _
A U _ _ S _ M _
P H _ N _ _ Y P _
_U K A R Y _ _ _ S
N U C L _ _ _ I D _
C _ N _ R _ M _ R _
R _ C _ M _ B _ I _ N _
H _ _ _ _ _ _ _ _ Y G _ U S
R _ C _ M _ B _ I _ N _ A _ I _ N
B _ _ _ _ _ C H _ N _ L _ G Y
_L _ _ _ _ _ _ C _ R _ P H _ _ _ R _ S _ I _ S
¡El futuro está aquí! Los científicos han trazado el mapa del genoma humano conjunto completo de sus genes. Los genes son los códigos secretos o las fases de quiénes somos y qué influyen quiénes podríamos ser. Su ger un enorme recetario y al decodificarlo se abren nuevas posibilidades.

¿Se ha preguntado alguna vez...

- ¿qué tienen usted en común con una mosca de la fruta?
- ¿cómo son los sus hijos?
- ¿cómo los genes controlan el crecimiento y el envejecimiento?

¡Deje de preguntarse y comience a explorar!

Esta sitio web ofrece un contenido informativo e interactivo para cualquiera que tenga un genoma: alumnos, maestros y padres. Visite la Exposición del Genoma, prueba su conocimiento y aprenda más!

La exposición del genoma, patrocinada por Pfizer Inc., fue producida por Clear Channel Exhibitions en colaboración con el Human Genome Research Institute (NHGRI), una división del National Institutes of Health (NIH), y el Department of Health al Services y Whitehead Institute/MIT Center for Genome Research.
Teacher's Activity Guide and Lesson Plans

Here are a variety of Genome classroom resources. You will need Adobe Acrobat or Acrobat Reader in order to view the complete Teacher's Activity Guide and the .pdf versions of the lesson plans. If you would like to download Acrobat Reader, click here. (It's free and easy).

Lesson plans are also available as Word documents (.doc) and as Web pages (Web).

- Teacher's Activity Guide (complete) .pdf
- Table of Contents .pdf
- Introduction .pdf
- Elementary School Lesson Plans
  - Lesson 1: Variety is the Spice of Life .pdf
  - Lesson 2: Outrageous Offspring .pdf
  - Lesson 3: Cell City .pdf
  - Lesson 4: Ladders of Life .pdf
  - Lesson 5: Genetic Hall of Fame .pdf
  - Lesson 6: Genetic Mistakes .pdf
  - Lesson 7: Whose Genes Are These, Anyway? .pdf
  - Lesson 8: And The Verdict Is... .pdf
- High School Lesson Plans
  - Lesson 1: A Unique Individual .pdf
  - Lesson 2: How You Became a Unique Individual .pdf
  - Lesson 2 (handout): Genetics of Parenthood .pdf
  - Lesson 3: The Structure of DNA .pdf
  - Lesson 4: Proteins, Proteins .pdf
  - Lesson 5: Disproving the Proof .pdf
  - Lesson 6: Genome's Greatest Hits .pdf
  - Lesson 6 (reproducible) .pdf
  - Lesson 7: Where can we go from here? .pdf
  - Lesson 8: Understanding DNA Fingerprinting .pdf
  - Lesson 8 (handout): The Case of Gerald Walker .pdf
- Glossary .pdf
- Acknowledgements .pdf

Related Links
- Access Exellence BioTech
- Biotechnology Info
- Department of Energy Genome Institute
- DNA From the Big
- DNA Learning Center
- Genetics: Decodin
- Human Genome C
- Lawrence Livermore Laboratory Genome
- National Human Genome Research Institute
- Student Guide to 1 Genome Project
- The Human Genome
- The Student Genio
- U.S. Department c Human Genome F
- Whitehead Institute
- YourGenome.org
BioTrek has developed a number of handouts on bioscience topics. You can use these handouts to illustrate how science approaches research problems. You can download these files and print the handouts for your own use.

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<td>Most of these handouts are available as large files suitable for printing as 3 by 4 foot (or larger) posters on a large format printer. Click on the link.</td>
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National DNA Day: April 25, 2006

National DNA Day is a unique day where students, teachers and the public can learn more about genetics and the discovery of DNA's double helix. National DNA Day commemorates the completion of the Human Genome Project in April 2003, and the discovery of DNA's double helix in 1953. Take part in the activities available on this page from this year's DNA Day and from DNA Day celebrations in the past.

Give Us Your Feedback on National DNA Day Activities!
Please take a few moments to share your experience with National DNA Day activities, the webcast and the online chat.

National DNA Day Webcasts and Podcasts
The National Human Genome Research Institute (NHGRI) has produced these webcasts to help students and teachers learn more about genetics, genomics, and the impact of the Human Genome Project. Some of these webcasts are available in RSS feed.

- Genomics: Towards a Healthier You
  NHGRI Researcher Barbara Biesecker talks about genomics and your health.

  Dr. Francis S. Collins and Dr. Elaine A. Ostrander are featured.

- Life in the Lab
  Learn what it is like to choose the career of a scientist from three young and very different individuals who work in research.

- DNA - The Next Generation
  Nobel laureate James Watson and NHGRI Director Francis Collins discuss the history and future of human genomics.

National DNA Day Online Chatroom Transcripts

- 2006 Online Chatroom Transcript
  View the questions our experts answered about genetics and genomics on National DNA Day, April 25, 2006.

- 2005 Online Chatroom Transcript
  View the questions our experts answered about genetics and genomics for April 25, 2005.
Talking Glossary of Genetic Terms

The National Human Genome Research Institute (NHGRI) created the Talking Glossary of Genetic Terms to help people without scientific backgrounds understand the terms and concepts used in genetic research. Simply click on the term of interest to open a page with a wealth of information, including the term's pronunciation, audio information, images and additional links to related terms. Students, teachers and parents will find the glossary an easy-to-use, always available learning source on genetics.

For more information go to the Guide to the Talking Glossary.

Enter a word or phrase:

Term:  

abcdefghijklmnopqrstuvwxyz

A

- adenine
- adenosine deaminase deficiency (ADA)
- adenovirus
- Aicardi syndrome
- allele
- amino acids
- animal model
- antibody
- antisense
- apoptosis
- ataxia-telangiectasia
- Autoimmune Lymphoproliferative syndrome (ALPS)
- autosomal dominant
- autosomal

B

- bacteria
- bacterial artificial chromosome (BAC)
- base pair
- birth defect
- bone marrow transplantation
Glosario de Términos Genéticos

El Instituto Nacional de Investigación del Genoma Humano (NHGRI) ha creado el Glosario hablado de términos de genética para ayudar a las personas que no tienen conocimientos científicos a entender los términos y conceptos utilizados en la investigación en genética. Simplemente haga clic en el término que le interesa y se abrirá una página con amplia información, incluida la pronunciación del término, información de audio, imágenes y enlaces con términos relacionados. El glosario será un recurso de aprendizaje de genética siempre disponible y de uso sencillo para estudiantes, maestros y padres.

Para más información, consulte la Guía del Glosario hablado.

Escriba una palabra o frase:

Termino:  [Buscar]

A B C Ch D E F G H I J K L I M N Ñ O P Q R S T U V W X Y Z

A
- Ácido desoxirribonucleico (ADN)
- Ácido ribonucleico (ARN)
- Adenina
- Adenovirus
- ADN mitocondrial
- ADN no codificador o no codificante
- ADN recombinante
- Alelo
- Aminoácidos
- Amplificación génica
- Anticuerpo
- Antígeno
- Apoptosis
- ARN mensajero (ARNm)
- Ataxia-telangiectasia
- Autosoma
- Autosómico Dominante

B
- Bacteria
- Biblioteca
- Biblioteca de ADNc