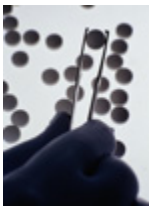
CHAPTER 5

DRUGS OF THE FUTURE



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Background | **Classroom Applications** | **Internet Resources** | **Appendices**

BACKGROUND

New understanding of human genetics will not only make it easier to diagnose diseases, it will also change how diseases are treated. Scientists and drug companies are using knowledge from the **Human Genome Project** to find cures for everything from **cancer** to **obesity**. This new medicine is called "**genomic**" medicine. This chapter will address the following questions:

- How is genomic medicine different from traditional medicine?
- What diseases are scientists studying?
- How will people take these new drugs?
- What are the practical and ethical issues of gene-based medicines for modern medicine and human society?

This chapter examines the procedures used to develop gene-based treatments and drugs. It also looks at several cases in which genomic medicine was successful where traditional medicine had failed. Teachers can use the lesson plans and materials to acquaint students with the basic concepts genomic medicine, to give them an opportunity to discuss the possible effects of these improvements in medical treatment, and to encourage them to think about how their own future may change as a result of genomic medicine.

BACKGROUND INFORMATION

As scientists complete the sequencing of the human genome, they are using this information to create new ways of fighting disease-especially life-threatening diseases such as cancer, **Alzheimer's**, obesity, and **heart disease**. Until now, doctors really haven't been able to cure these diseases using drugs; they could only treat and control the **symptoms**. In the case of heart disease, physicians have been treating high blood pressure

with one of six different medicines. But first they have to decide which of the six drugs to use; the first one they choose might not successfully control the disease. If the drugs are successful, the symptoms decrease; however, the high **blood pressure** itself is not cured.

Future drug therapy will be very different. **Genomic** medicine, which is still experimental, will allow doctors not only to treat the symptoms but also to cure the disease itself. Using drugs that have been developed with knowledge of the human genome, doctors will be able to identify and kill sick cells while not hurting healthy cells. They will do this by "turning on and off" **proteins**, the body's building blocks. In other words, they will use genomic drugs to help good proteins within the body fight the bad cells. Doctors hope to be able to treat patients with genomic drugs even before they become sick. They will also be able to customize drugs to treat a disease in an individual patient.

To create drugs for individual patients, it has been necessary for scientists to locate only a few useful genes hidden among billions of other genes, similar to finding a needle in a haystack. This has required international research teams and very advanced technology. Scientists have already begun using their new knowledge to create anticancer drugs. " **Smart bombs**," which contain **antibodies** that already exist in the human body, are one type of new anticancer drug.

Researchers believe that smart bombs are able to hunt and kill cancer cells without killing the healthy cells that surround them. But before they could create these smart bombs, they had to find the genes related to these antibodies. To do this, they took genetic fragments from gene sequences they had already identified. They then looked through the human genome database to find DNA that matched these fragments and found 7000 possibly responsible genes. Then, using a sophisticated computer, they compared these gene fragments to those in cancer cells stored in a laboratory. Only 200 genes matched those active in all cancer cells. To narrow the possibilities even further, scientists next compared these 200 genes with cells from patients who currently have cancer to see which genes were found most often. This entire process narrowed the number of genes most frequently found in cancer patients from possibly thousands to only several dozen.

Once the small number of genes has been found, the process of developing a drug begins. To do this, scientists test the antibodies they have located in laboratory animals such as mice. Later, they begin to study the effects of these antibodies on humans who suffer from cancer. Once this process has been completed, the drug is reviewed by a government agency. If approved, the drug can then be sold.

Research on smart bombs has created drugs now being tested on patients with colon, head, and neck cancer to prevent the growth and spread of cancer cells. One such experimental drug has successfully reduced or eliminated head and neck tumors in 8 out of 30 cases of patients who took it along with chemotherapy. Scientists are also working on creating drugs that carry small amounts of radioactive isotopes, or poisons, that will kill cancer cells without destroying healthy cells in other parts of the body. Such research may lead to newer and better drugs that can be used to fight and even cure different types of cancer.

Not only will the types of drugs that people take in the future be very different, but also the ways in which people receive treatment may change. Big needles may be replaced by other methods of injecting drugs into the body. Some drugs (including antibiotics) may be taken using **inhalers**, which are now used mostly by people with asthma. To replace many drugs that are now taken in pill or liquid form, scientists are now experimenting with **skin patches** and **ultrasonic** devices.

The ultimate objective of the scientists who are working on new genomic drugs and on new ways of administering them is to produce a "magic" cure. Such a miracle drug would be smart enough to direct itself to the source of the problem in the human body, figure out what it needed to do, and cure the problem.

CLASSROOM APPLICATIONS

Medicine is changing at a rapid rate as a result of the new knowledge of the human genome. It is important for students to know how drugs and treatments are changing and will continue to change. The following lesson provides a basic introduction to this topic.

PRELIMINARY LESSON PLANNING

Materials:

- Prepare copies of the student handouts as follows: for Appendix B, one handout for each group of students; for Appendix C, one copy of Handouts 2 and 3 for each student in the class; and for Appendix D, one handout for each pair of students.
- If available, bring relevant visuals to assist student comprehension (for example, photos of pills, hypodermic needles, laboratory rats, the brain, the heart, or other suitable items).
- For the Cool Down Activity, bring enough overhead transparencies or large sheets of paper and pens for each group in the class.

Student Grouping:

- Decide on procedures for pairing or grouping students for each activity (see suggestions below). It is recommended that groups have no more than six participants.
- For most activities, you should group students heterogeneously-either by language proficiency level or, in those activities where language is less of an issue, by expertise (i.e., how much group members know about the topic). In other activities, you may wish to group randomly. In classes where students have varied first language backgrounds, it is important to mix students from different backgrounds in the same group.

Vocabulary:

- Before teaching the lesson, preview the glossary items and select those items that need to be taught before you begin the lesson (that is, those that are absolutely essential for introducing and understanding the topic). These will probably include synonyms for words such as drugs (medicine, treatment, pills, tablets, shots); disease (illness, sickness, condition); cure (make better, help, improve); and experiment (test, trial, try out).

WARM UP ACTIVITY

(approximately 20 minutes)

Purpose:

- To encourage students to think creatively
- To allow students to discuss ideas from other sources (e.g., television, movies, science fiction)
- To provide an opportunity for students to speak in pairs or small groups

Procedures:

1. Tell students that they will be creating a futuristic, science fiction method for curing a disease.

2. To set the scene, ask students if they have ever seen a science fiction movie or TV program, or read a science fiction novel or short story, in which people are cured using methods from the future.

3. Divide the class into groups of three to five students. The total number of groups will depend on the number of students in the class. Give each group an overhead transparency or large piece of paper and a marker. Have each group appoint a secretary and a spokesperson.

4. Have students brainstorm both the disease they will cure and the futuristic method of treatment. Tell them to illustrate their cure on the transparency or a large piece of paper.

5. Ask for student groups to volunteer to present their imaginary cures for real diseases. Ask the spokesperson for each group to explain in more detail the disease and the procedure for the cure.

Transition from Warm Up to Activities

Explain to students that, having imagined futuristic cures, they are now ready to learn about differences between traditional medicine and cures based on scientists' knowledge of the human genome.

ACTIVITY 1

(approximately 20 minutes)

Purpose:

- To activate students' background knowledge about traditional medicine
- To provide new information about genomic medicine
- To allow students to organize information using a compare/contrast format

Procedures:

1. Divide the class into groups of two to five students. The total number of groups will depend on the number of students in the class. Give each group a copy of Handout 1 (see Appendix B).

2. Explain to students that their task is to match the information in column 1 about traditional medicine with the corresponding information in column 2 about genomic medicine.

3. When all groups have completed the task, ask for volunteers to talk about their answers (see Appendix B for the answer key.)

ACTIVITY 2

(approximately 60 minutes)

Purpose:

- To promote students' speaking ability
- To provide students with various viewpoints on an issue

Procedures:

1. Divide students into groups of three or six.

2. Distribute Handout 2 (see Appendix C). Tell students that they will be participating in a role play about a patient who could be treated with experimental genomic drugs to cure a life-threatening disease.

3. Ask students to read the two scenarios and select one for their role play.

4. Distribute Handout 3 (see Appendix C). Have students assign each member of their group a role in either Role Play 1 or Role Play 2.

5. Allow students 15-20 minutes to discuss and prepare their role play.

6. Ask for volunteers to perform the role play for the class. If the class is very large and time is limited, have only the volunteers perform the role play. If the class is smaller and time is available, all students can be asked to perform.

7. Read aloud the actual outcomes of the two scenarios (see Appendix C) and allow time for students to comment.

ACTIVITY 3

(approximately 30-40 minutes)

Purpose:

- To familiarize students with genomic treatments and drugs
- To give students an opportunity to read for key information about new genomic treatments
- To expose students to topic-related vocabulary
- To promote exchange of key information

Procedures:

1. For this jigsaw reading activity, divide students into four "expert" groups. The total numbers in each group will depend on the total number of students in the class. Assign each group a letter designation (A, B, C, or D). With a large class, you can create multiple groups for each letter.

2. Give each group a copy of Handout 1 (see **Appendix D**) that corresponds to their letter designation. Instruct students to do the following:
   a. Have one person in your group read aloud the information about the new genomic treatment. Take notes on important information.
   b. Agree as a group on the important pieces of information. Add any additional information to your notes.

3. Regroup students into new groups that contain four students, one from each of the previous expert groups. If the total number of students in class is not divisible by four, distribute the remaining students evenly among the groups.

4. Distribute copies of Handout 2 for Activity 3 (see **Appendix E**).

5. Have students share the information from their notes to fill in the grid.

6. Elicit responses from the group on the blackboard (see **Appendix E** for sample answers).

7. As a whole class, consider the cases of smart pills and fat pills. Together, brainstorm the advantages and disadvantages of these new genomic drugs.

COOL DOWN ACTIVITY

(approximately 10 minutes)

Purpose:

- To review applications of genomic medicine
- To elicit student reactions to the best uses of this new medical technology
- To provide an open-ended speaking activity

Procedures:

1. On the blackboard, draw a chart listing diseases and their rankings (see Appendix F for a sample blackboard layout).

2. Divide the class into groups of four or five students. Explain that they will be deciding as a group the most important and least important uses of genomic medicine.

3. Ask students to copy the blackboard chart into their notebooks.

4. Have each student individually assign a ranking (1 = most important; 12 = least important) to each disease listed. If they wish, they can add two other diseases that they personally believe to be important.

5. Have group members discuss their individual rankings and arrive at a collaborative agreement on the top five diseases they believe to be most important.

6. Ask one member from each group to list their top five on the blackboard. Group members should be prepared to provide reasons for their choices.

7. Make a blackboard tally of the diseases students think are top priorities for genomic researchers.

POSSIBLE EXTENSIONS TO LESSON

1. For the Warm Up Activity, if students have done the activity on large sheets of paper, these drawings can be posted on the walls of the classroom. Have each group write a short explanation of their treatment and post this written explanation with the illustration. As an alternative, instead of preparing a written explanation, a spokesperson for each group can stand next to the group's drawing. All other students circulate around the room, asking the spokespersons to explain the groups' futuristic treatments.

2. As homework for Activity 1, assign students to find an article or an Internet site on genomic medicine, locate one additional fact about genomic medicine, and write a short paragraph about this fact.

3. As an in-class writing activity following Activity 2, ask students to do a "quickwrite" in which they discuss whether they would be willing to undergo an experimental medical treatment. Allow about 15-20 minutes for students to put their ideas on paper.

4. A second alternative for Activity 2, as homework, is to have students write a dialogue between the different parties in the role play that they participated in.

5. For the cool down activity, divide the class into 10 equal groups, assigning each group a disease to defend. Each group should spend several minutes discussing reasons why the cure for their disease should be given top priority. They are then given the chance to present their reasons in a debate format.

Refer to the websites listed in the next section of this chapter for more information and lesson planning ideas.

INTERNET RESOURCES AND REFERENCES

Internet Applications (Web sites with prepared lesson plans and activities)

Human Genome Project Internet Exercise
http://www.kumc.edu/gec/lessons.html
This Web site has links to lessons on DNA and genetic research and treatment developed by teachers and health care professionals.

Think Quest: Biotechnology
http://library.thinkquest.org/04apr/00217/en/biotech/index.html
Think Quest challenges students to create Web sites that teach about different topics in science. At this site, enter keywords such as "genomic medicine" and "gene therapy" to find sites about medicine created by students in different countries.

Exploitable Content (Web sites with information about the topic, but without any prepared lessons)

Access Excellence. About Biotech: Biotech Applied.
http://www.accessexcellence.org/AB/BA/
This site has numerous articles readings and case studies related to biotechnology. Check under the link "Revolutions in Medicine".

The Discovery Channel: Discovery Health
http://health.discovery.com/
This Web site covers a wide range of topics in health and medicine, including some of the diseases and conditions discussed in this chapter.

Discover magazine
http://discovermagazine.com/
The Web site of this science magazine allows you to read articles from past issues. Search "gene therapy" in the links to recent issues and archive for articles about new treatments in medicine.

Millennium Pharmaceuticals
http://www.mlnm.com/
This U.S. research institute, which is involved in research on smart bombs, hopes to "transcend the limits of medicine" by building the biopharmaceutical company of the future. Click on "science and technology" to read about their specific goals.

RT Magazine: The Journal for Respiratory Care Professionals
http://www.rtmagazine.com/
This journal article, "Aerosolized Administration of Drugs," was written for health care professionals. It discusses the administration of medicine to the respiratory tract via aerosol.

The New England Journal of Medicine
http://content.nejm.org/cgi/content/full/347/19/1512
http://content.nejm.org/cgi/content/short/348/1/50
These two technical articles, "Genomic Medicine-A Primer" and "Population Screening in the Age of Genomic Medicine" are written by doctors for doctors. They may be helpful to teachers and students especially interested in medicine.

Mad Sci Network
http://www.madsci.org/
A staff of science experts is available to answer nearly any question you may have. At this link, simply enter a "key term" for a question you have and you will see what answers have already been provided.

http://www.madsci.org/info/class.html
This link gives instructions for how this site can be most effectively used in your classroom and provides links to lessons.

The Human Genome Project
http://genome.pfizer.com
This is the official Web site for the Genome Exhibit, an exhibition at the Smithsonian Institution in Washington, D.C. marking the fiftieth anniversary of the first model of DNA.

Official Documents

Centers for Disease Control & Prevention (CDC)
http://www.cdc.gov/genomics/
This Web site provides links to information about CDC activities and projects that integrate advances in human genetics into public health research, policy, and programs.

National Center for Biotechnology Information (NCBI)
http://www.ncbi.nlm.nih.gov/
Sponsored by the U.S. National Library of Medicine and National Institutes of Health, this site gives background information and updates on genetic science.

American Society of Gene Therapy (ASGT)
http://www.asgt.org/
This site offers information about the latest developments in gene therapy. The link to media information includes a list of important facts, a glossary, and copies of press releases (at the link to Media Information).

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APPENDICES

APPENDIX A

Glossary

AIDS: Acquired Immunodeficiency Syndrome. First reported in 1981, it has since become a major global epidemic, killing over 10 million people and infecting tens of millions more. The disease is caused by HIV, a virus that destroys the body's ability to fight infections and certain cancers. Go to the **NHGRI glossary** for more information.

Alzheimer's: A mental disorder that gradually destroys vital nerve cells in the brain. Symptoms include loss of memory, judgment and reasoning, and changes in mood and behavior. It is not a normal part of aging.

Antibiotics: Drugs that fight infections.

Antibodies: Protein molecules produced by the body to fight infection or disease.

Artery: Blood vessel carrying blood away from the heart.

Arthritis: An inflammatory condition that often causes pain, swelling, and stiffness in the joints, often making even minor movements uncomfortable or painful.

Blood pressure: The pressure caused by the blood moving against the walls of the blood vessels, especially the arteries. It varies with the strength of the heartbeat, the flexibility of the arterial walls, the amount of the blood, and a person's health, age, and physical condition. Normal adult blood pressure is 120/80. If a person has high blood pressure, medication is often prescribed to lower the pressure.

Cancer: A general term for more than 100 diseases that are characterized by uncontrolled and rapid growth of abnormal cells. Cancer cells can spread locally or through the bloodstream to other parts of the body.

Chemotherapy: The treatment of cancer using specific chemical agents or drugs that harm fast-growing cells. This treatment kills fast-growing cancer cells, but often harms other fast-growing cells as well, such as the cells for hair and fingernails.

Cholesterol: A white substance found in many foods that is an important element in cell walls in the body. An unusually high level of cholesterol in the blood is often a symptom of heart disease.

Colon: A section of the large intestine, in the digestive tract. The total length is approximately 5 feet (approx. 150 centimeters) in the adult. It is responsible for forming, storing, and expelling waste.

Diagnose: To identify a person as having a certain disease or condition.

Genomic: (adj.) (medicine, treatment, drugs, researchers) Using genetic material or research.

Heart disease: A problem that prevents the heart from working normally. This problem can be with the heart's shape or how the heart works, or with the blood vessels supplying the heart.

Human Genome Project: An international research project to map each human gene and to completely sequence human DNA. (See **NHGRI glossary** for more information.)

Hypodermic needle: A hollow needle used to inject medicine or drugs directly into the blood.

Immune system: The body system, made up of many organs and cells, that defends the body against infection, disease and foreign substances. The immune system is often stimulated in specific ways to fight cancer cells.

Inhaler: A hand-held device used to take medicine by breathing in through the nose or mouth. Also called inhalator.

Leptin: A hormone produced by fat cells for regulation of appetite. It controls how much you want to eat, how much of the food your body stores, and how much is used for energy.

Liver: A large organ in animals that is important for digesting food and removing waste products.

Mental illness: Any of various conditions which cause problems with a person's normal thinking, feeling, or behavior, and caused by social, psychological, biochemical, genetic, or other factors, such as infection or head trauma. Also called emotional illness, mental disease, mental disorder.

Microchip: An extremely small piece of semiconducting material, which can contain a very large amount of information.

Neuron: A cell that sends electrical signals across distances. Neurons receive input from sensory cells or other neurons and send messages to muscles or other neurons.

Obesity: (n), **Obese** (adj.) (1) Having too much body fat.

Parkinson's: A problem with the central nervous system. A neurological disease that continues to get worse. Symptoms include uncontrolled shaking of the body and difficulties with muscular coordination.

Poison: A substance that causes injury, illness, or death

Protein: Essential components of all living cells that allow a body to function work well (including enzymes, hormones, and antibodies). Proteins are essential in the diet of animals for the growth and repair of tissue.

Radioactive isotope: Elements with an unstable nucleus that act as poisons, killing cancer cells without destroying other parts of the body.

Skin patch: A small piece of material put on the skin. It contains medicine that gradually enters the body through the skin.

Smart bomb: A genomic drug that contains natural antibodies targeted directly at cancer cells.

Swallow: (v) To cause (food or drink, for example) to pass through the mouth and throat into the stomach.

Symptom: An indication of disorder or disease that signals a change from normal function, sensation, or appearance.

Trophic compounds: The body's natural substances that help cells grow and develop.

Tumor: A mass of abnormal cells that are the result of rapid cell division. Tumors perform no useful body function. They may be either benign (non-cancerous) or malignant (cancerous).

Ultrasonic: (adj.) (1) Sounds that the human ear cannot hear. (2) Of or relating to acoustic frequencies above the range that the human ear can hear, or above approximately 20,000 hertz.

Vaccine: Weakened or dead poisonous cells injected into the blood in order to stimulate the production of antibodies.

Handout 1 for Activity

Conventional Medicine	Genomic Medicine
a. Traditional drugs cannot tell whether a cell is healthy or sick. They therefore kill both types of cells. For example, chemotherapy, which is used to treat cancer patients, kills both healthy and unhealthy cells. This is why patients are often very ill and lose their hair after receiving this treatment.	1. Using this technology, doctors will be able to cure the causes of diseases.
b. Doctors are unable to treat patients until they show symptoms. Only at this point can they diagnose the disease and prescribe drugs.	2. Only one drug will be needed to treat a disease in any patient.
c. Using traditional medicine, doctors are only able to treat the symptoms of the disease. If these drugs are successful, the symptoms go away but the disease remains. For example, people suffering from diabetes can take insulin to keep their blood sugar levels stable. But they still suffer from diabetes and will have to take insulin for the rest of their lives.	3. Genomic drugs will be able to find and kill sick cells (for example, in cancer patients), leaving healthy ones.
d. Today, most drugs are taken by pill or hypodermic injection.	4. In the future, doctors will be able to treat patients before they even become sick.
e. Different types of medicines are used to treat the same condition. For example, six drugs are used to treat high blood pressure. The drug used depends on the patient and his/her symptoms.	5. To take these drugs, people will use inhalers, skin patches, and even ultrasonic devices or microchips inside their bodies.

Answer Key for Activity 1

Traditional Medicine	Genomic Medicine
c. Using traditional medicine, doctors are only able to treat the *symptoms* of the disease. If these drugs are successful, the symptoms go away but the disease remains.	1. Using this technology, doctors will be able to cure the *causes* of diseases.
e. Different types of medicines are used to treat the same condition. For example, six drugs are used to treat high blood pressure. The drug used depends on the patient and his/her symptoms.	2. Only one drug will be needed to treat a disease in any patient.
a. Traditional drugs cannot tell whether a cell is healthy or sick. They therefore kill both types of cells. For example, chemotherapy, which is used to treat cancer patients, kills both healthy and unhealthy cells. This is why patients are often very ill and lose their hair after receiving this treatment.	3. Genomic medicines will be able to find and kill only sick cells (for example, in cancer patients), leaving healthy ones.
b. Doctors are unable to treat patients until they show symptoms. Only at this point can they diagnose the disease and prescribe drugs.	4. In the future, doctors will be able to treat patients before they even become sick.
d. Today, most drugs are taken by pill or hypodermic injection.	5. To take these drugs, people will use inhalers, skin patches, and even ultrasonic devices or microchips inside their bodies.

APPENDIX C

Handout 2 for Activity 2

Scenario 1: A 58-year-old man from the United States was suffering from bone cancer. His cancer was not cured by traditional drugs such as chemotherapy. He was weak and even shrank several centimeters in height. His doctors knew about an experimental genomic treatment that involved taking cells from the patient's blood and mixing them with cancer cells. This new mixture would be injected into his body to help his immune system fight the cancer.	**Scenario 2:** A 61-year-old woman from Germany had a tumor the size of an egg in her kidney. German scientists could create a special vaccine just for her. To do this, they would take some cancer cells from her and mix them with cells from a healthy person's immune system. They then would inject this cell mixture into her.

Handout 3 for Activity 2

Role Play 1

Participants: Patient, Doctor, Relative of the patient (spouse, parent, aunt or uncle, sibling)

Situation: A patient goes to the doctor to receive test results. The doctor tells him/her that the disease he/she has is not treatable with traditional drugs. The patient then asks about other ways to treat the disease. The doctor explains that there is an experimental treatment available. The patient, the relative, and the doctor discuss this option. The doctor wants to convince the patient to try the experimental treatment. The relative wants to convince the patient not to try it.

Role Play 2

Participants: Patient cured using experimental treatment; Genomic medicine scientist who devised the treatment; Television talk show host

Situation: Following a "miracle cure," a genomic scientist and his/her patient are invited to appear on a local television talk show. The patient is reluctant to appear on television. The scientist who helped cure the patient and the talk show host try to convince the patient to appear on the show to help publicize the potential of genomic medicine.

Actual Results of Scenarios in Handout 2

Scenario 1: Two weeks after his experimental treatment, the patient was strong enough to return to work and within two months, his cancer was in remission.

Scenario 2: Within three months, the patient had only a few side effects (such as pain in the tumor area and mild fevers) and the tumor had disappeared.

APPENDIX D

Handout 1 for Students in Group A

Case 1: Smart Pills

Scientists have used genetic engineering to create fruit flies with high levels of memory protein. This protein makes memorizing easier and helps fruit flies remember what they have memorized longer. Now that the scientists know this works in fruit flies, they are trying to find this memory protein in humans. This protein could be put into pills. Such "smart pills" would last a few hours. They would allow people to remember facts almost instantly and without the effort of repetition.

Handout 1 for Students in Group B

Case 2: Repairing Damaged Neurons

Parkinson's disease is a disease that damages a person's brain. Over time, the patient's brain becomes filled with a harmful protein substance. This substance destroys or damages neurons that transmit signals from the brain to the body. Scientists have not found a way to stop this substance from forming. However, to protect healthy neurons and to repair damaged nerve cells, genomic scientists are looking into using trophic compounds, the body's natural substances that help cells grow and develop. They are currently testing a trophic compound that can travel into the brain and act like a bath, covering and protecting both healthy and damaged cells.

Handout 1 for Students in Group C

Case 3: Fat Pills

Genomic scientists are currently identifying the genes that are involved in obesity. The hormoneleptin was discovered in 1994, when scientists noticed that this hormone was absent in especially fat laboratory rats. Further research showed that certain obese children who also lacked leptin lost as much as 4 pounds a month when they were given this hormone. Subsequent trials with the leptin hormone have shown, however, that not all people lose weight when they receive this hormone. Scientists and drug companies are trying to find other chemicals in the body that are related to obesity.

Handout 1 for Students in Group D

Case 4: Combating Heart Disease

Doctors are currently using drugs called "statins" that stop the body from making too much cholesterol. These drugs do not work for everyone, however, so drug companies are trying to create a new cholesterol removing drug. Instead of stopping the body from making cholesterol in the cell, this drug will remove cholesterol from cells. The cholesterol would go first to the liver and then eventually leave the body. This new drug, taken with statins, would remove all harmful cholesterol from the body.

APPENDIX E

Handout 2 for Activity 3 (

Problem	Name of the Drug/Treatment	Effects of the Drug/Treatment

Answer Key for Activity 3

Problem	Name of the Drug/Treatment	Effects of the Drug/Treatment
Memorizing information	"Smart Pills" (memory proteins)	♦ Accelerates the pace of memorization ♦Improves the retention of memorized information ♦Makes memorization of facts almost instant
Parkinson's disease	Trophic compound	♦Helps the body's cells grow and develop faster ♦Allows the growth of new and undamaged neurons in the brain ♦Acts like a bath covering both healthy and damaged brain cells
Obesity	Leptin (hormone)	♦Helps control weight and weight gain ♦ Allows obese individuals to lose weight more easily
Heart disease	Cholesterol extracting drug	♦ Extracts harmful cholesterol from the cells ♦ Prevents cholesterol from remaining in the heart or arteries ♦ Virtually eliminates harmful cholesterol from the body when taken with statins (a drug that stops the body from manufacturing excess cholesterol)

APPENDIX F

Sample Blackboard Layout for cool down activity

Diseases Ranking

1. AIDS
2. cancer
3. mental illness
4. obesity
5. arthritis/other immune system diseases
6. Alzheimer's
7. heart disease
8. Parkinson's
9. obesity
10. memory loss
11. _____ (your choice)
12. _____ (your choice)

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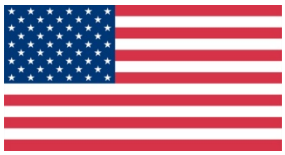

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