Eat an Apple – Call Me in the Morning: Agricultural Biotechnology's Role in Tomorrow's Health Care

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Recall the old adage: "An apple a day keeps the doctor away." The purpose of this unit is to identify the role of agriculture, specifically agricultural biotechnology, in health care of the future.

INTRODUCTION

We expanded our agricultural science and technology curriculum at Cesar E. Chavez High School this past year to include a course in Food Technology. Students have been learning a great deal about the traditional methods used in the food processing industry to deliver the highest quality and safest foods possible to consumers. Students in this course have also previously completed a course in agricultural biotechnology. Students will be able to combine information learned in both of these courses to move on to a higher level of thinking when they are challenged to explore the possible ways these two areas of agriculture can work together to address health challenges of the 21st century.

With the advances agricultural scientists are making today through genetic engineering to improve the foods we eat, could eating an apple a day really serve as a viable complement to preventative medicine? Could the same technology used to extend the shelf life of certain fruits such as the "Flavr Savr Tomato" also be used to create new vaccine-enhanced foods to deliver routine vaccinations to the general public?

The answer is yes, and an example is the way genetic engineering has already successfully been used to manufacture human insulin. Insulin to treat diabetes is harvested from the pancreases of slaughtered cattle. This process is extremely expensive since only a very small amount of insulin can be extracted from each animal. In addition some people also have allergic reactions to this insulin. To solve this problem, scientists were able to isolate the part of the gene that regulates production of insulin. By splicing this segment into the gene of the E-coli bacteria, it was discovered the bacteria that produces insulin multiply and pass the capability to the next generation. This bacterium is grown under closely monitored conditions, and once an adequate amount of bacteria is produced the insulin is extracted and purified for use. The bacteria are then destroyed (Herren 329-332).

It is important that we bring this technology to the classroom given the incredibly fast rate at which biotechnology is growing. If future production agriculturists are going to be ready to meet the demands of world dependency on American farm products to feed the hungry, there is little doubt biotechnology will have great impact on the success of these efforts. Products that are more disease resistant and pathogen free are just two concerns that researchers are actively working on. There is also little doubt that the career outlook in biotechnology is promising and worth further exploration.

BACKGROUND

For years it has been common practice in the animal industry to provide medicated feeds to livestock to guard against disease. The medications used in these feeds have been mixed into the feeds as additives and not actually a part of the grain(s) used in the mix. However, once the feed has been absorbed into the blood stream of the animal, the medications are also absorbed and become part of the animal tissue (muscle) that eventually finds its way to the dinner table. Strict FDA regulations clearly define withdrawal time from the point the medicated feeds are no longer fed to livestock to be slaughtered. Without this precaution, individuals who are allergic to medications such as penicillin are vulnerable to possible adverse reaction if they ingest products that still contain the medication.

Although this unit is primarily directed to students in my agricultural biotechnology class, students in biology might also find the unit challenging and useful. In this unit students will first research the different childhood diseases (measles, diphtheria, etc.) all of us have received traditional vaccinations by either oral vaccine or needle injection into muscle tissue. An introductory lesson on *Proper Research Techniques* is included in the unit to provide students with clear expectations of what is involved in scientific research. Other lessons will include *Genetic Engineering, Addressing Public Concern over Genetic Engineering,* and *Research and Development*. Another area students will research is functional foods and nutraceuticals. Functional foods can best be defined as foods that have been enhanced by additives to make them better. Functional foods have been available since the 1920s when iodine was added to salt to prevent goiters. Nutraceuticals are functional foods with potentially disease-preventing and health-promoting properties. Some of the nutraceutical products that are marketed today include St. John's Wort, Echinacea, Ginko Bilboa, Saw Palmetto, and Ginseng. It should be noted that manufacturers of these products are not required to prove their safety or efficacy before marketing them. Another problem that must be addressed as well is the fact that the quality of the raw source and the plants used are not regulated.

In the first lesson students will identify childhood diseases which currently offer both injection and oral delivery of a vaccine. One of the complaints often voiced by the young patient is the pain associated with the injection of the needle. Oral vaccinations generally have an unpleasant odor and taste bad. Students will review when (at what age) and how vaccines are currently administered. Students will then research what is being done, if anything, to develop oral vaccines that do not taste bad without the need of masking the taste through artificial flavoring. Students will then identify which fruits and/or vegetables would be the best candidates for development into products to be used for delivering vaccinations to the general public. Students should also look at moral and ethical issues as they conduct their research. Once students have completed their initial research, students will complete a lesson on genetic engineering in order to understand the role of genetic engineering in the development of new foods to serve as alternative modes of delivery of vaccinations to the targeted group. Students will work in teams to develop a formal presentation that they will use to "pitch" their idea to a research and development firm. Students will be provided samples of R&D proposals as a guide to developing their own. Students will have the option of entering their project in the Texas FFA Agricultural Science Fair. The finished product should include current data collected about the selected disease in terms of the rate of occurrence of the disease in the Houston/Harris County area, how health officials are administering vaccinations, tracking recipients of vaccinations, and identifying ways to reach those not currently receiving vaccinations. Students should incorporate the use of charts, graphs, and if possible samples. The proposal should also request funding for their project. Students will write letters to various government and private corporations to request information about the current status of research and development of foods already being considered for this purpose. Presentation could be in the form of display board, power point, multimedia presentation (to include animation) or combination of all three.

Students also need to understand that there is considerable public concern over genetic engineering. A lesson will be developed to address public conceptions about genetic engineering and ways scientists and the agricultural industry should address these concerns in a non-confrontational manner.

PROPER RESEARCH TECHNIQUES

To fully understand the potential impact that biotechnology will play in developing biomedical foods of the future students must first research what advances have already been made. This will require extensive research. Although the primary focus of this part of the unit is aimed at agricultural research, the principles defined below apply to all other areas of scientific research as well. Students should follow the scientific approach when conducting this research, which includes:

Identify the Problem
Research Materials on the Problem
Developing a Theory or Hypothesis
Test the Theory
Report on the Theory

A closer look and further explanation of five of these steps that should help students be successful in their research is provided here.

Step #1 – Identify the Problem

Before beginning any type of research you must first determine an area that needs improvement. By keeping up with what goes on in agriculture, researchers can find out what changes are needed.

Example: *There is a global need for delivering safe, effective vaccinations to massive numbers of people at the lowest possible cost.*

Step #2 – Research Materials on the Problem

Once you identify the problem you find out what has already been done to address the problem. Some of the information we uncover may help us solve the "new problem."

Example: *The researcher finds several newspaper and health magazine articles that describe the current problems the World Health Organization is facing with global health issues. From these readings the researcher gathers information to solve the problem.*

Step #3 – Develop a Theory or Hypothesis

At this point of the research task it is time to give one's own ideas for solving the problem. These ideas or theories must be things that can be tested, and should be written in the "if --- then" format.

Example: *If bioengineered foods can be developed as vaccines, then the problem of vaccinating large masses of people in the traditional method can be eliminated.*

Step #4 – Test the Theory

This step will of course be tricky, if not impossible to actually perform. For this application students will report on test results that have already been recorded.

Example: *Students will be encouraged to compile complete findings that were reported by research scientists for at least one fruit or vegetable of their choice.*

Step #5 – Report on the Theory

At the conclusion of the student's research, a report will be presented to the rest of the class to inform the class whether or not the theory was correct. Since many of the studies that students will be looking into are ongoing, this may not be able to be answered.

IMMUNIZATION

There is little argument that immunization against infectious diseases is important to our society. Immunization begins at birth and continues on into adulthood. Some vaccinations contain living microbes in harmless form and provide lasting protection. Other vaccines (those made from dead microbes or toxins they produce) have to be administered several times throughout one's life. After receiving a vaccination, the body begins the defensive action of producing antibodies to fight the disease. Immunization also helps prevent the spread of disease to others. Most vaccinations are low risk and adverse reactions are rare. However, if there is a family history of negative response to specific vaccines, they may need to be avoided. Parents should consult their doctor when planning the immunization course that is to be followed.

Some parents, especially first-time parents, fear that vaccines may cause the illness the vaccination is supposed to guard against. Some "shots" may lead to soreness at the point of injection or even a mild fever, but serious reactions are rare. There are numerous sources to find vaccination schedules for infants, but the best source for parents to choose should probably be the pediatrician responsible for the child's care.

There are four different types of vaccines currently available. Those are:

1. Attenuated (weakened) live viruses, which are used in some vaccines such as in the measles, mumps, and rubella (MMR) vaccine.
2. Killed (inactivated) viruses or bacteria are used in such vaccines as in IPV (polio).
3. Toxoid vaccines contain a toxin produced by the bacterium. For example, the diphtheria and tetanus vaccines are toxoid vaccines.
4. Biosynthetic vaccines (Hib) contain synthetic substances.

Immunizations are also important for those who travel to other countries and there is specific information available form the Centers for Disease Control and Prevention (CDC) of those requirements. One should consult the doctor before embarking on extended travel and should also remember to take a copy of the child's immunization record when travelling internationally. It should also be noted that typically immunizations should be administered one month before a person travels.

Speaking of immunization records, we as teachers are fully aware of the mandatory immunization of children who attend public school. It is the responsibility of the parent to make sure their children have the proper immunizations and provide records to the school nurse. It seems that on an almost daily basis at the beginning of each school year I am asked to give students in my advisory class immunization update reminders that must be taken care of in order to remain enrolled in school.

GENETIC ENGINEERING

Genetic engineering is the newest form of biotechnology. Simply put genetic engineering is the altering of the genetic makeup of organisms. Scientists have developed plants that are resistant to herbicides through genetic engineering. Herbicides are chemicals that are used to control numerous weeds and other unwanted plants. In order to eradicate those undesirable weeds in the field selective herbicides (broadleaf or narrow leaf) must be used to make sure no harmful effects are imposed on the crop plant. By producing crops that are tolerant of all herbicides this concern would be eliminated. Scientists are working on many different applications of genetic alteration in both plants and animals. Scientists may one day be able to alter the bacteria in the stomach of ruminants that allow for the digestion of large amounts of fiber to expand dietary choices to include fiber from woody sources that now go to waste (Herren 332-333). Corn plants could be developed that would produce their own nitrogen, with other crops being altered to produce larger and higher quality oils.

Genetic engineering is also often referred to as recombinant DNA technology or gene manipulation. Genes and/or sections of DNA can be transferred from on organism to another to improve the production of desired proteins. Genetic engineers understand and use the unique properties of DNA for gene manipulation. Animal DNA works essentially the same as DNA in plant cells. This simplifies the transfer of DNA from one organism to another.

Two major techniques are used in genetic engineering. First, genes are engineered into organisms such as microbes for mass-production of rare or valuable gene-products for medicine, agriculture and industry. This process is known as tissue culture. It should be noted that although the idea is attractive, it can be difficult to grow cells of higher organisms such as animals and plants in the laboratory, not to mention costly. It is easier to insert copies of the gene for the valuable protein into bacteria and express the gene in that way. Microbes are easy and economical to grow in large quantities.

The other area of gene manipulation covers the insertion of selected genes into plants and animals to improve their genotype. If genes are inserted during the embryonic stages of an animal's development, all the cells in the animal will carry the new gene. These animals are called transgenic because they have a copy of a new gene in all of their cells. Transgenic animals can give a copy of the new gene to their offspring.

PUBLIC CONCERNS ABOUT GENETIC ENGINEERING

There is of course a great deal of concern for the long-term effects of genetic alteration of organisms. The purpose of this unit is not to equip students with quick answers to common questions or misunderstandings about genetic engineering; nevertheless, students need to be aware of what some of these concerns are. The main concerns expressed by many include concerns about cross species gene transfer, genetic pollution, and food and product safety. Perhaps the best way to address this dilemma is through regulation of genetic engineering. Research must be done under controlled laboratory conditions to prevent the possible escape of newly engineered organisms into the environment.

Students will also conduct a mini-survey of their community to determine the attitudes of their family, friends, and neighbors regarding biotech foods. This survey will consist of six questions to determine respondents' knowledge of biotech produced foods, opinions on some of the techniques used to create new foods, shopping preferences and how they think these products should be labeled.

Students are encouraged to do further research to identify the major human health concerns raised by the introduction of genetically altered foods. Students should specifically look at the following broad areas in their quest for additional information on this issue.

Marker Genes/Antibiotic Resistance

There is concern among some that when biotechnologists modify a plant or insert a gene to produce a transgenic plant, they often also insert a marker gene that will select the plants that are successfully transformed. The most widely used markers make developing plants resistant to antibiotics. The possible results are as follows:

- ***Some Antibiotics Could Lose Effectiveness***
  The concern here is that if foods with antibiotic resistant genes are eaten with meals, the interaction could reduce the ability of these antibiotics to fight disease.
- ***Resistance Genes Could be Transferred to Human or Animal Pathogens***
  Microorganisms that are able to take up antibiotic resistance genes could become impervious to antibiotics.

Allergens, Toxins, Unknown Substances

Public interest groups also raise concern about these areas as well. Some feel that we rush too quickly in releasing genetically altered foods to the consumer without enough research to determine all possible outcomes. Some of these unknowns are:

- ***Hidden Allergens***
  Foods that have been genetically altered may contain genes from a variety of sources, some of which are bacterial, while others may be from plants or animals. These new substances could cause allergic reaction by some who consume these items not knowing they are present.
- ***Increase of Natural Toxins, Production of New Toxins***
  Genetic changes to foods could possibly also alter pathways that regulate the production of natural toxic substances in the plant, leading to increases in natural toxins.
- ***Unknown Substances***
  The fear of the unknown has always been a challenge for scientists to overcome. I'm pretty sure that when pasteurized milk first made its way onto the shelves of the supermarket there was a lot of fear of "what will happen if I drink this?" But the real issue raised here is among vegetarians and religious groups with dietary rules who could unknowingly eat foods with an animal gene, or certain foods that should not be eaten together.

The Need for Labeling

Some feel that any product that is placed before the consumer should be clearly labeled to identify that food as one that has been genetically altered.

WHERE WE ARE NOW

Students should begin their research by looking further into what has been done with certain fruits that have been genetically altered to deliver safe, effective and inexpensive vaccines, as well as vegetables that can provide additional vitamins or medicine to fight certain illness or physiological deficiencies. Some of the fruits and vegetables (as well as grains) and the diseases presently being researched are briefly described below.

Bananas

This common fruit has been looked at as a potential vehicle for a vaccine against hepatitis B. Hepatitis B (HBV) affects more than 2 billion people worldwide. This strain of hepatitis is 50 to 100 times more infectious than AIDS. There is no cure for hepatitis B. A vaccine (available since 1982) utilizes recombinant-DNA technology to bioengineer yeast is currently used. The vaccination program consists of a series of three intramuscular injections over a six-month period. The vaccine requires refrigerated storage, and the administration of the injection must be made by a medical professional. Total estimated cost for the delivery of this traditional vaccine ranges between $100 and $150 per person. The additional cost of transportation and distribution, especially to Third World countries, make mass immunization virtually impossible. Initially researchers at the Boyce Thompson Institute for Plant Research Inc. looked at the potato for the first edible vaccine. It was determined that since most people do not eat potatoes raw, transgenic potatoes might not fit the bill. Dr. Yasmin Thanavala of the Roswell Park Cancer Institute's department of immunology believes the banana would be a more likely choice. After all, bananas are consumed worldwide and require no processing before eating. Ideally the genetically engineered fruits would be grown locally, eliminating the need for transportation. Further, with this technology the cost factor of the vaccination would be reduced to pennies per person because one banana plant can produce 100 pounds of bananas (Tafoya, Tyler, & Slutter).

Tomatoes

Genetically altered tomatoes have been looked at as edible vaccines for many different types of illnesses. One virus, respiratory syncytial virus (RSV), is currently being researched by University of Illinois professor Schuyler Korban and colleagues. RSV causes pneumonia and bronchialitis. These diseases severely affect newborns and infants. The UN has placed RSV on its list of the top 12 most important viruses that need newly developed vaccines. Initial research began with apples. The notion behind this fruit of choice was the commonality of the fruit and the many different forms that are available, some which can be easily eaten by babies. However, given the lengthy growing season of apples, researchers turned their attention to tomatoes. Researcher Korban, Dennis Buetow, and post doctoral assistants Dr. Sergei Krasnyanski and Dr. Jagdeep Sandhu isolated one of the major proteins on the coat that envelops the virus and injected the gene codes for that protein into what is called a plant expression vector. This expression vector was then transferred into tomato cells, which resulted in tomato cells containing the antigen protein, or the protein that produces the antibody. Once developed, testing the capabilities of the fruit to act as a vaccine began. Test conducted on mice revealed that those that ate the engineered tomatoes had higher levels of antibodies in their blood after 30 days than those who did not. Additional testing completed by the research team showed that when mice were injected with a live form of RSV, those who had eaten the engineered tomatoes showed a significant antibody response. The next step involves the use of cotton mice, which respond similarly to humans. If those tests go well, human testing will soon follow. It should be noted that genetically altered tomatoes (or any other altered food) would not be sold in the supermarket. After all, they will be medicines, and not intended to use in your salad (Korb).

Potatoes

Genetically engineered potatoes show tremendous promise as an edible vaccine for hepatitis B. Researchers at Roswell Park Cancer Institute (RPCI) and their colleagues at Arizona State the vaccine, consisting of only one protein from the virus, appears to be safer than other oral vaccines.

The results of a placebo-controlled, double blind, Phase 1 study revealed some interesting data. In the study 42 adult healthcare workers, who had previously responded to a licensed, injectable vaccine, received an oral booster dose delivered in transgenic potatoes that expressed the hepatitis B surface antigen. The findings indicated that blood serum antibodies increased in 10 of 16 volunteers (62.5%) who ate three doses of potatoes and 9 of 17 (52.9%) volunteers who ate two doses of transgenic potatoes. There was no increase in volunteers who ate the non-engineered potatoes ("Genetically Engineered Potatoes").

Rice

Rice has long been and continues to serve as the most important food crop of the developing world. Rice feeds more than two billion people worldwide and is the number one staple food in Asia, where it provides 40-70% of the total food calories consumed (Datta). It would be difficult to create new strains of rice to deliver vaccine to those who depend heavily on rice in their daily diet (remember cooking could have an adverse effect and lessen the potency of the vaccine). Scientists have developed rice with high iron and beta-carotene qualities through genetic engineering. Farmers now have the ability to plant Bt or Xa21 rice in their fields, with reduced pesticide use.

LESSON PLANS

Lesson I: Ouch! That Hurts!

Traditionally most vaccinations are still given in the form of injection. This experience can be painful to say the least, and for some small children traumatic. Oral vaccines are available for some diseases, but may not be administered unless requested. The purpose of this lesson is to identify how different vaccines are administered to the public, both children and adults.

Materials Needed

Copy of Immunization Worksheet (Appendix A)
Answer Key for Immunization Worksheet (Appendix B)
Copy of recommended Immunization Schedule

Objectives

The Learner Will Be Able To (TLWBAT):

1. Identify how specific vaccines are given to the public.
2. At what age specific vaccinations are administered.
3. Identify which vaccines are given in combination form.
4. Identify their most recent vaccination(s).

Procedures

1. A few days before beginning this lesson ask students to review their personal immunization record to make sure they are up to date. Due to privacy issue, students will not share this information. Inform students that this is for their information only, and you just want them to be aware of their record.
2. On the day of the lesson provide each student with a copy of the immunization worksheet (Appendix A).
3. Instruct students to search for the recommended immunization schedule for children and adults for the area in which they live. Possible sources for this information include local health agencies, school district health services department, personal doctor, school nurse, and the Internet.
4. Once students find this information they will complete the missing information on the Immunization Worksheet and answer all other questions on the worksheet.
5. Completed worksheets will be turned in at the end of the period.

Lesson II: Banana Split Anyone?

As described in the narrative, bananas show great promise as a fruit that will one day be used to deliver vaccinations for Hepatitis B. It would be impossible for students to actually create a genetically altered banana in a school setting for many reasons. What students can do however in this lesson is extract DNA form a banana. This lab is designed for a class of 30. Be sure to follow all lab safety rules.

Materials

- 1 banana
- 100 ml buffer
- 50 ml protease solution
- 150 ml of ICE COLD ethanol (95%)
- 30 test tubes
- 30 Pasteur pipettes
- Blender
- Funnel
- Cheese cloth or nylon hose for filters
- Bag of Ice
- Lab Journals

Preparation

- Before you begin you will need to prepare the buffer, protease solution, and slurry.
- Buffer Mix (Prepare the day before.)
- 1.5 g non-iodized salt
- 10 ml of liquid dishwasher detergent
- 150 ml distilled water
- Protease Solution (Prepare prior to class.)
- 3 g meat tenderizer
- 50 ml distilled water

Teacher Procedures

Slurry Preparation (Prepare at the beginning of the lab.)

1. Cut ends off of the banana. Do not peel.
2. Cut the banana into chunks and place into blender.
3. Add 100-150 ml of chilled buffer.
4. Mix until well blended. (About 1 minute)
5. Filter mixture with funnel and cheese cloth into a beaker which is on ice
6. Distribute approximately 4 mls solution into each test tube for students. Keep solution chilled if possible.

Student Procedures

1. Secure a test tube with banana filtrate from the teacher.
2. Add 2 ml of the Protease Solution. Note the appearance of the filtrate in your journal.
3. Mix filtrate slightly with your pipette.
4. Tilt the tube and slowly add up to an equal volume of cold ethanol down the side of the tube. You should see a distinct layer of clear ethanol over the filtrate layer.
5. Notice the whitish layer that forms between the darker banana filtrate and the ethanol layer.
6. Gently swirl a Pasteur pipette at this interface. You should see white, gelatin type material begin to spiral at the tip of the pipette. That material is the DNA.
7. Students should record their observations in their lab journals.

To make this lab really fun for the students, ask them each to bring a banana to class and place them to the side. Once they finish the lab breakout the ice cream and other goodies and make banana splits. Ask the question, "Which had you rather do, get a shot or eat a banana split to get that next vaccine?"

Lesson III: Surveying Your Community

There have been several surveys of this type done in the past, but it should be interesting to determine the awareness level of people in the local community about biotech foods. Students should attempt to survey ten people. If the students in a class of 20-30 interview 10 people each, they will have data from 200-300 people. This of course is not a scientific survey, but should give students a general view of the community's knowledge and attitudes.

Materials

10 copies of the survey worksheet for each student (Appendix C)

Clipboard for each student with extra paper to record comments

Objective

The Learner Will Be Able To (TLWBAT):

Interpret and report on survey results

Procedures (During the Survey):

1. Teacher should discuss each question on the survey with students prior to beginning the survey to make certain they understand the questions.
2. Locate 10 people to survey. Make an effort to find people of different ages, gender, and backgrounds, so you will have a variety of opinions.
3. Student should read the questions and answer choices aloud and circle the answer the respondent gives to each question. (Do not ask the respondent to fill out the form.)
4. Ask the question the same way each time, to compare the responses from different people. (Try not to show any expressions that might reflect your own opinion and do not tell the respondents how you would answer the questions.)
5. If someone adds other opinions, write them down on a separate sheet of paper. These comments will be discussed with classmates later.

Procedures (After the Survey):

1. Tally the answers from your own survey. Graph the answers, using a pie chart or bar graph. What was the most common response, if there was one for each question?
2. What question would you have asked if you could have added one to the survey? Phrase your question so that it informs the person being surveyed well enough so they can answer the question. Provide 5 answer choices to fit your question.
3. Combine your results with results from the rest of the class. Use a pie chart for each question. Label the charts so that people can understand what they are seeing.
4. Summarize the results of the survey in your own words, in terms of the respondents' knowledge, opinions and interest in the subject.
5. Display the results somewhere outside the classroom so others can see it. This should stimulate curiosity and raise questions from students not in your class.

APPENDIX A

IMMUNIZATION WORKSHEET

Name ____ Date ____________________

Period __________________

Use the recommended immunization schedule you located during your search to complete the missing information in the chart and to answer the questions below the chart.

Typical Immunization Schedule

Age	**Disease**	**Method of vaccination**
Birth	Hepatitis B	Injection/Oral
	Diptheria, tetanus, pertussis (DTP) *Haemophilus influenzae* type b (Hib) Hepatitis Poliomyelitis	
	Diptheria, tetanus, pertussis (DTP) *Haemophilus influenzae* type b (Hib) Poliomyelitis	
	Diptheria, tetanus, pertussis (DTP) Hepatitis *Haemophilus influenzae* type b (Hib)	
	Measles, mumps, rubella (German measles) *Haemophilus influenzae* type b (Hib)	
	Diptheria, tetanus, pertussis (DTP) Poliomyelitis	
	Diptheria, tetanus, pertussis (DTP) Poliomyelitis	
	Measles, mumps, rubella	
	Diptheria, tetanus Booster needed every ten years throughout life	

Questions:

1. Which vaccines are administered by injection only?

2. Which vaccines are administered orally?

3. Which vaccines are combined injections?

4. At what ages should the vaccine for DTP be given?

5. At what ages should the vaccine for Poliomyelitis be given?

6. When should the first inoculation for measles be administered?

7. Which vaccines are recommended at age 6 months?

8. Which vaccines should one receive every 10 years after the age of 16?

9. Which vaccination(s) are recommended for your current age?

10. Describe your most recent vaccination experience. Was it administered by injection or orally?

APPENDIX B

IMMUNIZATION WORKSHEET

Name ____ Date ______________________

Period ____________________

Use the recommended immunization schedule you located during your search to complete the missing information in the chart and to answer the questions below the chart.

Typical Immunization Schedule Answer Key

Age	Disease	Method of vaccination
Birth	Hepatitis B	Injection/Oral
2 months	Diptheria, tetanus, pertussis (DTP) *Haemophilus influenzae* type b (Hib) Hepatitis Poliomyelitis	*Combined Injection* *Injection* *Injection* *Oral*
4 months	Diptheria, tetanus, pertussis (DTP) *Haemophilus influenzae* type b (Hib) Poliomyelitis	*Combined Injection* *Injection* *Oral*
6 months	Diptheria, tetanus, pertussis (DTP) Hepatitis *Haemophilus influenzae* type b (Hib)	*Combined Injection* *Injection* *Injection*
15 months	Measles, mumps, rubella (German measles) *Haemophilus influenzae* type b (Hib)	*Combined injection* *Injection*
18 months	Diptheria, tetanus, pertussis (DTP) Poliomyelitis	*Combined Injection* *Oral*
4-6 years	Diptheria, tetanus, pertussis (DTP) Poliomyelitis	*Combined Injection* *Oral*
11-12 years	Measles, mumps, rubella	*Combined Injection*
14-16 years	Diptheria, tetanus Booster needed every ten years throughout life	*Combined Injection*

Questions/Answers:

1. Which vaccines are administered by injection only?

   Hepatitis B, Haemphilus influenzae type b (Hib), Hepatitis

2. Which vaccines are administered orally?

   Poliomyelitis

3. Which vaccines are combined injections?

   Diptheria, tetanus, pertussis (DTP), Measles, mumps, rubella (German measles)

4. At what ages should the vaccine for DTP be given?

   2 months; 4 months; 6 months; 18 months; 4-6 years; 14-16 years

5. At what ages should the vaccine for Poliomyelitis be given?

   2 months; 4 months; 6 months; 18 months; 4-6 years

6. When should the first inoculation for measles be administered?

   15 months

7. Which vaccines are recommended at age 6 months?

   DTP; Hepatitis; Haemophilus influenza type b (Hib)

8. Which vaccines should one receive every 10 years after the age of 16?

   Diptheria, tetanus

9. Which vaccination(s) are recommended for your current age?

   Answers will vary

10. Describe your most recent vaccination experience. Was it administered by injection or orally?

    Answers will vary

APPENDIX C

What Do You Know About Biotech Foods?
Read the questions and answers choices aloud. Circle the answer the respondent gives you. Write any extra comments on a separate sheet.
1. Some food plants are now being produced that use new technique, often called *biotechnology*. One form of biotechnology is called "genetic engineering." To genetically engineer a plant, breeders change it by putting in a gene that can be taken from anywhere – another kind of plant, a bacterium, or even an animal. How much have you heard about these new plants (such as corn, tomatoes, and bananas)? **1) a lot 2) a fair amount 3) a little 4) almost none 5) none**
2. Some new corn plants have a gene from a soil bacterium built into them that makes the plants resist corn borers. How likely would you be to buy corn in the supermarket that had been grown on plants such as these? **1) very likely 2) somewhat likely 3) don't know 4) not too likely 5) not likely at all**
3. Scientists are currently working to develop a genetically engineered banana that would be used to vaccinate people against hepatitis by simply eating the banana. Do you think this is a good idea? **1) definitely 2) I think so 3) not sure 4) probably not 5) definitely not**
4. If you saw two kinds of tomato for sale in the supermarket that both cost the same, that looked the same, but you knew that one of them had been produced using genetic engineering, how likely would you be to buy the biotech tomato? **1) very likely 2) somewhat likely 3) don't know 4) not too likely 5) not likely at all**
5. What if the genetically engineered tomato cost 10% less than the conventional one; how likely would you be to buy it? **1) very likely 2) somewhat likely 3) don't know 4) not too likely 5) not likely at all**
6. Do you think consumers should be told, by the use of some kind of labeling, whether a tomato they buy at the supermarket has been genetically engineered? **1) yes, definitely 2) probably should 3) not sure 4) probably not 5) definitely not**

ANNOTATED BIBLIOGRAPHY

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