Appendices

APPENDIX A

Timeline and Helpful Hints

CHAPTER 1. DNA: THE HEREDITARY MOLECULE

SECTION A. What is DNA?

1. **An Introduction to DNA**
   10-15 minutes preparation time; 15 minutes class time*

2. **DNA in the News**
   10 minutes preparation time; 15 minutes class time*
   This is a good way to reinforce what students should already be aware of—that DNA, biotechnology, and genetics are such important topics in their lives that there is a wealth of information printed about them in the press. The purpose of this exercise is to begin the collection of information that can be used to help them throughout the unit, especially in the bioethics portion in Chapter 4.

SECTION B. What Does DNA Look Like?

1. **Spooling Purified DNA**
   60 minutes preparation time;15 minutes class time
   Although this is an easy exercise to prepare, it does take a little time. The preparation of the DNA may take several days to get the dehydrated DNA to go back into solution. Begin the prep work four or five days before you actually need the solution and all will work well. You will need a magnetic stirring plate to prepare this solution. Once the components of the solution are added to your mixing container, place the container on the magnetic stir plate and turn the plate on. The solution is finished when the liquid is completely clear and no clumps are visible.

2. **Extracting DNA from Calf Thymus**
   30 minutes preparation time; 30 minutes class time
   The hardest part of this activity is finding the calf thymus. Experience has shown that if you request the thymus from your grocery's meat department they can get it for you, but it will often take several days to a week to acquire. Once acquired, the thymus can be cut into chunks and frozen for years with no loss of quality for this lab experience. In an emergency, chicken livers can be used, but the amount of DNA should be less.

*photocopy time

SECTION C. What is the Structure of DNA?

1. **The Puzzle of DNA Structure and Replication**
   *120 minutes preparation time (one time only)**; 20 minutes class time*
   Have the puzzle pieces copied on colored paper and laminated. Cut them out and store them in envelopes or plastic bags. The laminated pieces can be kept and reused for years. Remember to have extra sheets of the puzzle pieces made and laminated, so that when pieces are lost or damaged, you will have replacements for them. Cutting the pieces can be done either by you or the students. Experience shows that teachers are more careful in this than most students.

2. **"The Spiral Staircase" from *The Cartoon Guide to Genetics***
   No preparation time; 10 minutes class time

3. **What is a Model? And What is it Good For?**
   No preparation time; 10 minutes class time

4. **Building a Three-Dimensional DNA Model**
   No preparation time; 20 minutes class time

5. **DNA Model Questions**
   10 minutes preparation time; 20 minutes class time*

6. **DNA Word Search**
   10 minutes preparation time; 20 minutes class time*

SECTION D. What Does DNA Do?

1. **DNA Codes for Proteins**
   No preparation time; 10 minutes class time

2. **"How DNA Codes for Proteins" from *The Cartoon Guide for Genetics***
   No preparation time; 10 minutes class time

3. **The Gene Expression Dance**
   *30 minutes preparation time (one time only)**; 15 minutes class time*
   Since this is a whole class role-play, you really need only one set of puzzle pieces. Have the puzzle pieces copied on colored paper and laminated. Some of the puzzle pieces will be two-sided, and care should be used to insure that the proper front and back sheets are laminated together. Cut them out and store them in envelopes or plastic bags. The laminated pieces can be kept and reused for years. Remember to have extra sheets of the puzzle pieces made and laminated, so that when pieces are lost or damaged, you will have replacements for them. Cutting the pieces can be done either by you or the students. Experience shows that teachers are more careful in this than most students.

*photocopy time **cutting out paper models; could be done in class

4. **Paper Proteins: Models for Simulating Gene Expression**
   *120 minutes preparation time (one time only)**; 30 minutes class time*
   Have the puzzle pieces copied on colored paper and laminated. Cut them out and store them in envelopes or plastic bags. The laminated pieces can be kept and reused for years. Remember to have extra sheets of the puzzle pieces made and laminated, so that when pieces are lost or damaged, you will have replacements for them. Cutting the pieces can be done either by you or the students. Experience shows that teachers are more careful in this than most students.

5. **Using the Genetic Code to Translate an mRNA**
   10 minutes preparation time; 15 minutes class time*

SECTION E. How Does DNA Determine a Trait?

1. **An Introduction to the Connection Between Genes and Visible Traits**
2. **Shine On!**
   a. How to Read a Micropipettor
   b. Practicing Microbiological Techniques
   Bacteria for this section can be streaked onto plates several days to a week before needed and then kept in the refrigerator. Strive to get plates with single colonies so that your students can pick a single colony to start their liquid cultures.
   c. Engineering Glow-in-the Dark Bacteria
   It is essential that the *E. coli* cultures used in this activity be freshly grown and no more than 24 hours old. The day before they are needed, you will need to streak enough plates so that each lab group will have a culture of bacteria to work with. It is best to have plates with individual colonies growing on them, so that the point can be made that all of the cells from a single colony come from a single bacterium. If your plates have few or no colonies, but a lawn or large masses of bacteria on them, the protocol will still work well. NOTE OF CAUTION: After the completion of the transformation protocol DO NOT incubate these plates at 37ºC. Use a 30ºC incubator or room temperature. The inserted glow-in-the-dark genes will not express themselves properly under the warmer conditions.

CHAPTER 2. PASSING TRAITS FROM ONE GENERATION TO THE NEXT

SECTION A. What is Inheritance?

1. **An Introduction to Inheritance**
   10 minutes preparation time; 15 minutes class time*

*photocopy time **cutting out paper models; could be done in class

SECTION B. How Does a New Generation Get Started?

1. **Model Systems for Studying Heredity and Development**
2. **Starting a New Generation: Sea Urchin Fertilization**
   If you order the urchins from Carolina Biological, **you must order them at least three weeks before you need them.** They will be harvested on the Monday of the third week and shipped the same day. The urchins will arrive by Wednesday or Thursday at the latest. You will need to make your receiving department aware that you are expecting the urchins so that you will be notified about their arrival and can deal with the urchins quickly. To accomplish this, you will also need to have the aquaria prepared ahead of time. Experience has shown that setting up the aquaria on Monday or Tuesday gives time for the water temperature to stabilize and for you to get the salts in balance before adding the urchins. **Note:** when cleaning the aquaria after use, do not use soaps or detergents—the residue can harm the urchins you get next year.

3. ***The Miracle of Life***
   No preparation time; 60 minutes class time

SECTION C. If All the Kids Have Mom and Dad's Genes, Why Don't They All Look Alike?

1. **Really Relating to Reebops**
   20 minutes preparation time; 45 minutes class time
   For this laboratory to work well, the marshmallows need to be stale. (When they are too fresh, they are mashed by the addition of the various parts–legs, eyes, extra body segments, etc.) Simply open the bag of marshmallows, spread them out on a tray and keep them in a cool dry place for about a week. The marshmallows will be ready for use when they do not compress too much when squeezed between the thumb and forefinger.

2. **Determining Genetic Probabilities with a Punnett Square**
   5-10 minutes preparation time; 20 minutes class time*

3. **Exploring Human Traits: Create-a-Baby**
   10 minutes preparation time; 30 minutes class time*
   Bring coins for the students to use.

4. **Using a More Complicated Punnett Square**
   10 minutes preparation time*; 20 minutes class time

*photocopy time

SECTION D. How are Genetic Experiments Actually Performed?

1. **A Colorful Experiment in Yeast Genetics**
   120 minutes preparation time; 30 minutes class time each for two days
   This laboratory exercise is wonderful for showing the expression of dominant and recessive alleles as well as a very graphic review of Punnett squares. Producing YEAD culture plates takes no longer than preparing or pouring regular plates. However, you must allow them to dry completely so that condensation will not fall on the growing yeast and flow from one growth area to another, causing cross contamination of cultures on the plate. Make the plates at least one full week before they are needed. Check through the plates daily, removing and bagging those whose lids are free of condensation. The condensation-free plates are ready to use and can be kept in the refrigerator for four to six weeks. Some of the plates that you have poured may have condensation on the lids for up to two weeks. When the students inoculate the YEAD plates with yeast, make sure they are very careful of contamination by airborne spores. The yeast will grow best at 30ºC, but can be grown at room temperature. The Reds will be at their peak of color in three days of 30ºC incubation or five to seven days at room temperature. The extra time is worth the effort for the results obtained.

2. **Experimenting with Wisconsin Fast Plants**
   180 minutes preparation (one time only); 45 minutes class time for the first day, 10 minutes for other days
   This exercise is good for teaching constants and variables in experimental design as well as reinforcing the skills of graphing and data collection. The most difficult part of this exercise is the preparation of the plant lighthouses and the film-can growth systems. Once the lighthouses and growth systems are constructed, they can be used year after year with good results. There is no quick way to make the plant lighthouses or the film-can growth systems, so follow the directions and take your time and you will get great results.

SECTION E. How are Genetic Results Evaluated Statistically?

1. **Introduction to Using Statistics to Evaluate Genetic Explanations**
   10 minutes preparation time; 15 minutes class time*

2. **Too Many White Kittens? Using Chi Square (χ^2) to Find Out**
   10 minutes preparation time; 20 minutes class time*

3. **How to Perform a Chi-Square Test on Any Data Set**
   10 minutes preparation time*; 20 minutes class time

*photocopy time

CHAPTER 3. HOW GENES AND THE ENVIRONMENT INFLUENCE OUR HEALTH

SECTION A. How Stable and How Powerful Is DNA?

1. **DNA Paradoxes**
   10 minutes preparation time; 10 minutes class time*

SECTION B. How Do Heritable Changes in Genes Occur?

1. **Inducing Mutations with UV Light**
   60 minutes preparation time; 45 minutes class time for day one, 20 minutes class time for day two

SECTION C. Is it Nature, or Is It Nurture?

1. **Albino Plants: A Model for Gene-Environment Interaction**
   45 minutes preparation time; 20 minutes class time for each of two days
   Here you will again prepare agar plates. This time you will not need to sterilize the agar because there are no nutrients present that bacteria or fungi can use for food. The difficult part of this preparation comes when the charcoal powder is added. The trick is to get the agar completely dissolved, add the charcoal powder and then get everything thoroughly mixed and poured before the whole mixture cools too much. The black agar that is produced is an excellent background for showing the phenotypes of the sprouting tobacco seeds. This exercise is a great one, not only for the 3:1 ratio portrayed but also for showing how the environment affects the expression of the pigment genes in the tobacco.

2. **Heart Disease: A Personal Gene-Environment Interaction**
   10 minutes preparation time; 30 minutes class time*

SECTION D. What Are Some of the Features of "Simple" Genetic Diseases?

1. **Some "Simple" Heritable Defects**
   10 minutes preparation time; 20 minutes class time*

2. **Phenylketonuria (PKU) Illustrates the Complexities of Some "Simple" Genetic Diseases**
   10 minutes preparation time; 20 minutes class time*

3. **The Special Inheritance Patterns of Sex-Linked Mutations**
   10 minutes preparation time; 20 minutes class time*

4. **Investigating Human Genetic Diseases**
   10 minutes preparation time; 20 minutes class time*

*photocopy time

SECTION E. How Does a Genetic Counselor Detect Mutant Genes?

1. **Detecting the Duchenne Muscular Dystrophy (DMD) Mutation**
   See note for preparation time; 45 minutes class time
   This exercise is a great simulation of how scientists detect specific alleles in someone suspected of having them. If the agarose gels for the electrophoresis simulation are pre-cast and your students work the entire period, you can get this investigation finished in one normal class period. Either you or your students can cast the gels the day before and then store them overnight in a plastic bag with water for the next day's class. Casting the gels will take 20-30 minutes for your students. However, you will have to cast as many gels as you have gel boxes for, remove them to plastic bags and then repeat for each of your classes. This process can take several hours. Making the dyes may take up to an hour but, if made in large quantities, the dyes for this investigation can be stored for years. While the dyes are running on the gels, there is a block of time that could be used in class to do other work.

SECTION F. How Can I Become a Genetic Counselor?

10 minutes preparation time; 20 minutes class time*

CHAPTER 4. CONTROLLING OUR GENETIC FUTURES

SECTION A. Biotechnology: Panacea or Pandora's Box?

1. **Video–Promise & Perils of Biotechnology: Genetic Testing**
   10 minutes preparation time; 45 minutes class time*
   The pre-video worksheet questions take five minutes. Twenty five minutes are required to show the video and fifteen minutes are needed for the post-video worksheet questions and discussion.

2. **Worksheet for Promise & Perils of Biotechnology: Genetic Testing**
   10 minutes preparation time; 20 minutes class time*
   See section A-1 above.

SECTION B. Resolving Genetic Testing Issues: An Introduction to Group Decision Making

1. **A Value-Based Approach to Group Decision-Making**
   10 minutes preparation time; 35 minutes class time*
   The reading for this can be done in class, and will take from five to ten minutes. It will then take another five to ten minutes to complete the individual work. When the individual sheets are completed, fifteen to twenty more minutes will be needed to come to a group decision on "The Class List" worksheet.

*photocopy time

2. New Genetic Tests Lead to Difficult New Questions

10 minutes preparation time; see below for class time*

Experience has shown that this section can take anywhere from a few minutes to a few days to complete. Student are interested in many of the ideas incorporated in this section. You might think of having a group discussion about each item or allow the students to pick three or four items to cover. Encourage the group to decide which way to go based on the criteria expressed in "The Class List" worksheet from the previous section.

SECTION C. Genetic Testing: Two Case Studies

1. Roger Patton's Dilemma

10 minutes preparation time; 30-40 minutes class time*

Class time will vary based on whether you assign this reading for homework or have it done in class. It should take you from five to ten minutes to give and overview. It should take another five to ten minutes for the students to fill out the work sheet. After completion of the work sheet, there will need to be time allotted to discuss student ideas from their work sheets.

2. Carol and George Face a Tough Decision

10 minutes preparation time; 30-40 minutes class time*

Class time will vary based on whether you assign this reading for homework or have it done in class. It should take you from five to ten minutes to give and overview. It should take another five to ten minutes for the students to fill out the work sheet. After completion of the work sheet, there will need to be time allotted to discuss student ideas from their work sheets.

SECTION D. DNA in the News

Depending on how you have chosen to use the news articles collected, this section could take several days to complete. The key element of this section is to let students know early in this unit what you expect them to do with the articles. You may choose to have students prepare and present a poster of articles collected on specific genetics related topics; you may choose to have students use the collected articles as a basis for a term paper. You may want your students to use the information as background for a panel discussion of genetics issues. Some teachers have even had groups of students prepare arguments that could be used in a debate. Or you may choose all or none of these ideas.

*photocopy time

APPENDIX B

Some Frequently Used Suppliers

Carolina Biological Supply Company
2700 York Road
Burlington, NC 271215-3398
Tel: (800) 334-5551
Fax: (800) 222-7112
www.carolina.com

Fisher Scientific
(Many addresses throughout USA)
Tel: (800) 766-7000
Fax: (800) 926-1166
www.fishersci.com

Fisher Scientific Education
485 South Frontage Road
Burr Ridge, IL 60521
Tel: (800) 955-1177
Fax: (800) 955-0740
www.fisheredu.com

Nasco Science
901 Janesville Ave.
Fort Atkinson, WI 53538-0901
Tel: (800) 558-9595
Fax: (920) 563-8296
www.eNASCO.com

Sigma
P.O. Box 14508
St. Louis, MO 63178
Tel: (800) 325-3010
Fax: (800) 325-5052
www.sigma-aldrich.com

Ward's Natural Science Establishment
P.O. Box 92912
Rochester, NY 14692-9012
Tel: (800) 962-2660
Fax: (800) 635-8439
www.wardsci.com

APPENDIX C

Some Presumably Simple Heritable Human Traits

MANY ITEMS LISTED in this table are considered tentative, because the heritable basis for some of these traits has not been fully resolved. Others are somewhat misleading, because (as noted for some entries) certain traits have a different genetic basis in occasional individuals than they do in most other affected persons.

A. HAIR

DOMINANT	RECESSIVE
Curly	Straight
Dark	Light blond
Light red	Intensely red
Red tint to blond or brown	No red pigment at all
White forelock	No white forelock
Prematurely gray (white before age 30)	No premature graying
Widow's peak	Straight hairline
Clockwise whorl	Counterclockwise whorl
Male-pattern baldness in men	Male-pattern baldness in women

Despite the fact that male pattern baldness is much more common in men than women, is not a sex-linked condition. It is an example of an autosomal condition that is sex-limited, which means that symptoms are strongly influenced by the sex hormones. Thus, male-pattern baldness is a dominant trait in men, and also in women who are taking testosterone for medical purposes, or in women who have a deficiency of female sex hormones for some reason. But it is a recessive trait in women with normal hormone levels.

Excessive facial hair in women	No excessive facial hair in women
Hair on middle segments of fingers	Middle segments of fingers hairless

B. EYES

DOMINANT . . . . . .RECESSIVE

Brown . . . . . .Grey

Contrary to earlier opinion, blue eye color is not a simple autosomal recessive trait; it is a multigenic trait.

One eye dominant . . . . . .Two eyes used equally

Only about 5 percent of the population use both eyes equally; about 65 percent favor their right eye, and about 30 percent favor their left eye.

Normal vision . . . . . .Severe nearsightedness in childhood

Autosomal-dominant and sex-linked forms of nearsightedness (myopia) are also known.

Astigmatism . . . . . .Normal vision

Red-green color blindness in men . . . . . .Red-green color blindness in women (sex-linked)

Normal blue-yellow color vision . . . . . .Blue-yellow color blindness

Blue-yellow color blindness is much less common than red-green color blindness, and although it is usually transmitted as an autosomal recessive condition, autosomal dominant and sex-linked forms are also known.

Extremely long eyelashes . . . . . .Normal eyelashes

Sudden bright light causes sneezing . . . . . .No sneezing triggered by light

C. EARS

Free earlobes . . . . . .Attached or missing earlobes

Rim of ear rolled . . . . . .Rim of ear flat

Pointed on top . . . . . .Round on top

Ears can be wiggled without touching them . . . . . .Ears cannot be wiggled this way

Tone deafness . . . . . .Normal tone discrimination

Normal hearing . . . . . .Born deaf

Only about 30 percent of the cases of childhood deafness can be clearly attributed to genetic causes, about 40 percent are the result of known non-genetic causes (such as ear infections), and about 30 percent have unknown causes. A number of different autosomal recessive mutations can result in deafness, but an autosomal dominant form is also known.

D. FINGERS AND TOES

DOMINANT	RECESSIVE
Extra fingers and/or toes	Normal number of digits
Fingers numb and cold from poor blood flow	Normal blood flow in fingers
Thumb permanently flexed	Thumb can be flexed or straightened
Thumbs and big toes stubby and broad-ended	Normal thumbs and toes
All fingers and toes short and stiff	Normal fingers and toes
Second toe longer than big toe	Big toe longer than second toe

E. TONGUE

Can be rolled up from the sides	Cannot be rolled up from the sides
Tip cannot be folded backward	Tip can be folded backward
Taster (thinks PTC tastes bitter)	Non-taster (thinks PTC has no taste)

PTC = phenylthiocarbamide. For reasons that are not at all understood, tasters have a higher incidence of thyroid cancer than non-tasters do, whereas non-tasters have hyperactive thyroid glands more frequently than tasters do.

F. TEETH

Present at birth	Emerge weeks later
Extra teeth	Normal number
Develop normally	Baby teeth OK; no permanent teeth develop
Peg-shaped	Normally shaped
Protuberant upper front teeth	Normal upper front teeth
Many fail to emerge from gum (sex-linked)	Emerge normally

G. NOSE

DOMINANT . . . . . .RECESSIVE

Normal . . . . . .Turned up at tip

Wide nostrils . . . . . .Normal nostrils

No polyps . . . . . .Nasal polyps

Cannot smell skunk . . . . . .Can smell skunk

Cannot smell musk . . . . . .Can smell musk

Can smell chemical from asparagus in urine . . . . . .Cannot smell this compound

Cannot smell cyanide (sex-linked) . . . . . .Can smell cyanide

Generally deficient sense of smell . . . . . .Normal sense of smell

A sex-linked version of the deficient sense of smell also exists.

H. SKIN

Freckles . . . . . .No freckles

Dimple on cheek . . . . . .No cheek dimples

Dimple in middle of chin . . . . . .No chin dimple

Dimple on back of shoulder . . . . . .No shoulder dimples

Stretch marks around lower back . . . . . .No such marks

Excessive, painful calluses on hands and feet . . . . . .Normal calluses

Multiple pigmented moles . . . . . .Few or no moles

Chilblains . . . . . .No chilblains

Exposure to cold causes red or blue discoloration and swelling of skin, accompanied by intense itching and/or burning sensations. Most common in young women.

Hypersensitive to cold . . . . . .Normal cold sensitivity of skin

Differs from the above. Exposure to cold causes skin wheals, pain and swelling of joints, chills and fever.

Spicy foods cause prolific sweating . . . . . .No such effect

Varicose veins . . . . . .No varicose veins

I. NIPPLES

DOMINANT . . . . . .RECESSIVE

Inverted . . . . . .Normal (protruding)

Inverted nipples are more common in women than men; may be sex-limited.

Extra (sometimes with extra breasts) . . . . . .Two

Extra nipples are more common in women who are identical twins.

J. URINE

Normal color after eating beets . . . . . .Red after eating beets

Foul smelling after eating asparagus . . . . . .Normal smelling after eating asparagus