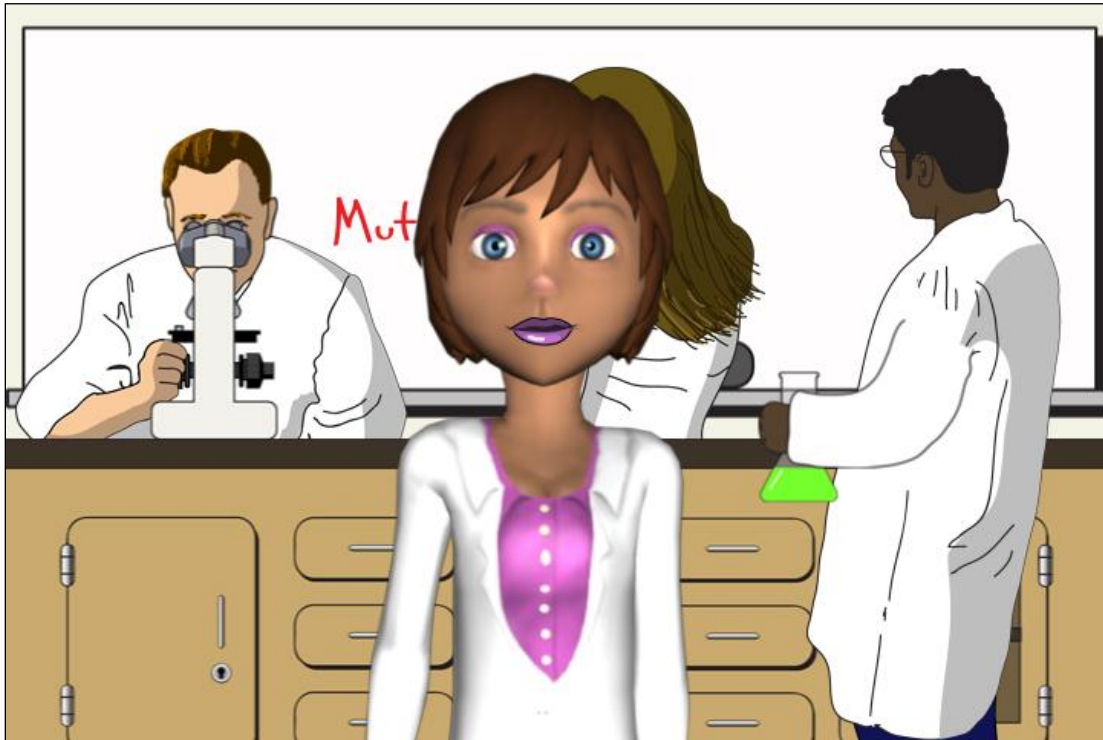


# Genetic Mutations Science Suitcase

## Teacher's Instruction Manual



An Educational Science Module Created With the Generous Support of



Welcome.

Thank you for selecting the STARS Genetic Mutations Science Suitcase for use within your classroom. This suitcase has been created through the collaboration of the Biomedical Communications Graduate Program and the University of Texas Southwestern Medical Center Graduate School, produced for the Science Teacher Access to Resources Southwestern (STARS) Science Triathlon, with support from the Dallas Museum of Nature and Science, the Dallas Interdependent School District (DISD) and Advanced Placement Strategies (APS) program. Funding was provided by the Howard Hughes Medical Institute with additional support by the University of Texas Southwestern Graduate School and the O'Donnell Foundation.

This instructional guide has been created with the educator in mind, providing instruction for utilizing the components within the science suitcase.

The Genetic Mutations Science Suitcase should contain the following:

- Genetic Mutations Animation CD/DVD
- Mutations! Card game, with cards, boards and game guides
- Nucleosome model, a flexible physical hands-on model
- Genetic Posters, a series of 3 large wall posters
- Guide DVD, a storage DVD loaded with all guides, manuals and instructions
- Two carrying cases: A central storage case where all small-sized components are found, and a large carrying tube for the storage of the Genetic posters and card game team boards

### Index

Genetic Mutations Animation DVD.....	4
Mutation! Card game.....	8
Nucleosome Model.....	13
Genetic Posters.....	18
Guide DVD.....	24
Cases.....	26

### Genetic Mutations Animation DVD

The Genetic Mutation DVD included in the scientific suitcase contains several components that may be freely utilized in a Biology classroom (Figure 1-1). The primary component of the CD is a short form animation that is over twenty five minutes long. The animation is divided into several primary sections that may be shown together or separately. The principal purpose of the DVD is to serve as a resource tool that shows students basic genetic concepts, such as DNA, nucleotides and codons. It also explains more advanced concepts, such as nucleosomes and their function in both supercoiling and epigenetics. And finally, the DVD covers in detail the concepts of genetic mutations, their causes and the basic forms of genetic mutations found in nature. It is suggested that the DVD be shown first, as an introductory course into genetic mutations. It will provide students with information that they may use subsequently in the other activities presented in the science suitcase.



Figure 1-1. Genetic Mutations Animation DVD.

**To utilize the DVD, follow these steps:**

- Insert the DVD into your computer drive or DVD player
- Animation DVD should start automatically and lead you to the Main Menu
- Open DVD drive and make certain disk is right-side up. Labeled side should be facing upward.
- If it does not automatically begin and you are on a computer, right click on “My Computer,” go to your DVD drive, right click and select “Open with” and choose program to view DVD

The Genetic Mutation DVD should begin automatically and take the educator to the Main Menu. From here, the educator has several choices (Figure 1-2).

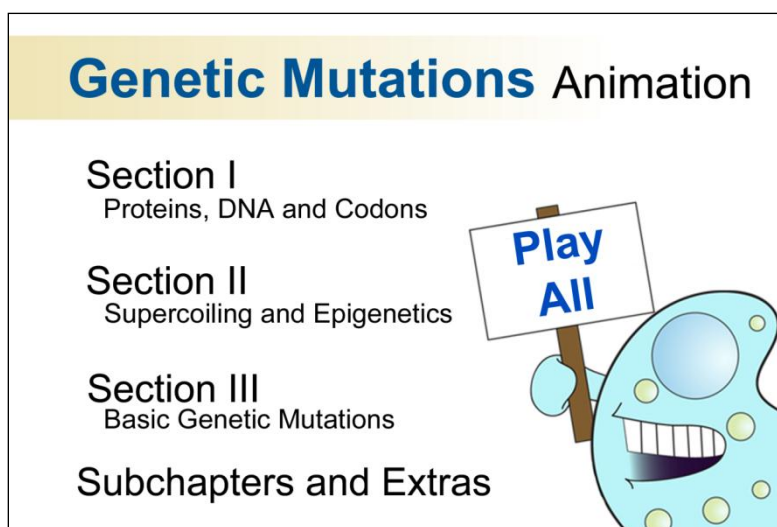


Figure 1-2. Genetic Mutations Animation Main Menu.

**Play All**

Starts the animation from the very beginning, and will run through the entire animation

**Section I: Proteins, DNA and Codons**

- Proteins, section that explains their functions and how they are formed
- DNA, section that describes Deoxyribonucleic Acid, the phosphate-deoxyribose sugar backbone and nucleotides
- Codons, section that describes codons and a basic review of formation

## **Section II: Supercoiling and Epigenetics**

- Supercoiling, section that explains histones, nucleosomes and the mechanism by which they allow for compacting of DNA
- Epigenetics, section that explains how nucleosomes help determine what kind of specific cell type a pluripotent cell should turn into

## **Section III: Basic Genetic Mutations**

- Basic traits of genetic mutations, section that describes shared characteristics
- Deletion, section that describes the Deletion mutation
- Insertion, section that describes the Insertion mutation
- Frame-shift, section that describes Frame-shift mutation
- Point mutation, section that describes Point mutation and its different varieties
- Duplication, section that describes the Duplication mutation
- Inversion, section that describes the Inversion mutation
- Translocation, section that describes the Translocation mutation

## **Subchapters and Extras**

This link provides access to the Subchapters and Extras menu (Figure 1-3). This submenu gives access to specific subsections of each primary section found on the Main Menu. This allows an educator to target a specific topic found in the animation. Also, it gives access to extra features, such as:

- Nucleosome Model leads to a video demonstration for the hands-on nucleosome and its use
- Posters leads to a short video animation for the Genetic Posters, showing how they relate with one another
- Credits leads to funding, creator and participants for the animation

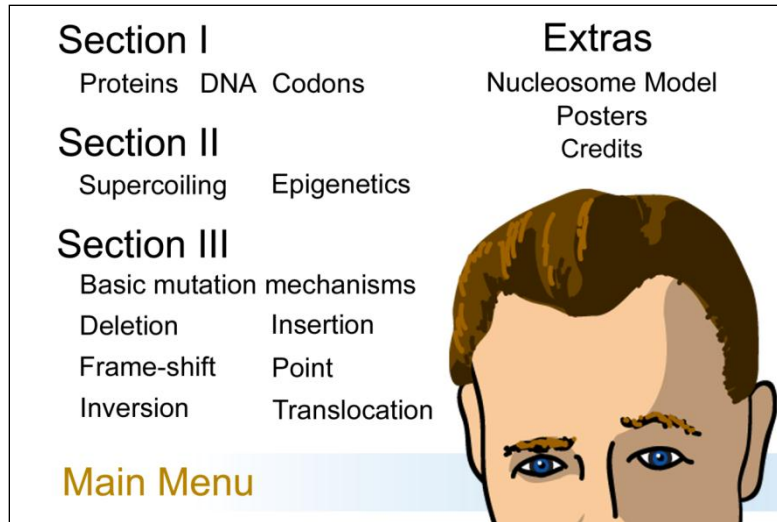


Figure 1-3. Subchapters and Extras Menu.

### Mutations! Card Game

The suitcase has a card/board game hybrid titled “Mutations! Card Game”. This card game has one primary purpose, which is to teach students the basic types of genetic mutations and how these mechanisms may alter a DNA strand. This educational process is carried out in two stages of the game, where each team of students must first successfully build a DNA strand. And then, navigate their team token to the end of the strand while repairing or surviving mutations inflicted on their game board strand by the opposing team. Teams will both suffer and inflict mutations in all stages of this game. The card game should have the following components:

- Two Team Boards, one for Team A and one for Team B
- Two Student Quick Reference Guides
- One Educator Quick Reference Guide
- One Mutations! Card Game Instruction Manual
- One Deck Board
- Over 200 hundred individual cards
- Two Team Tokens
- Three carrying cases for the cards

This instruction manual will not explain the game mechanics since that portion is covered by the card game's own instruction manual (Figure 1-4).



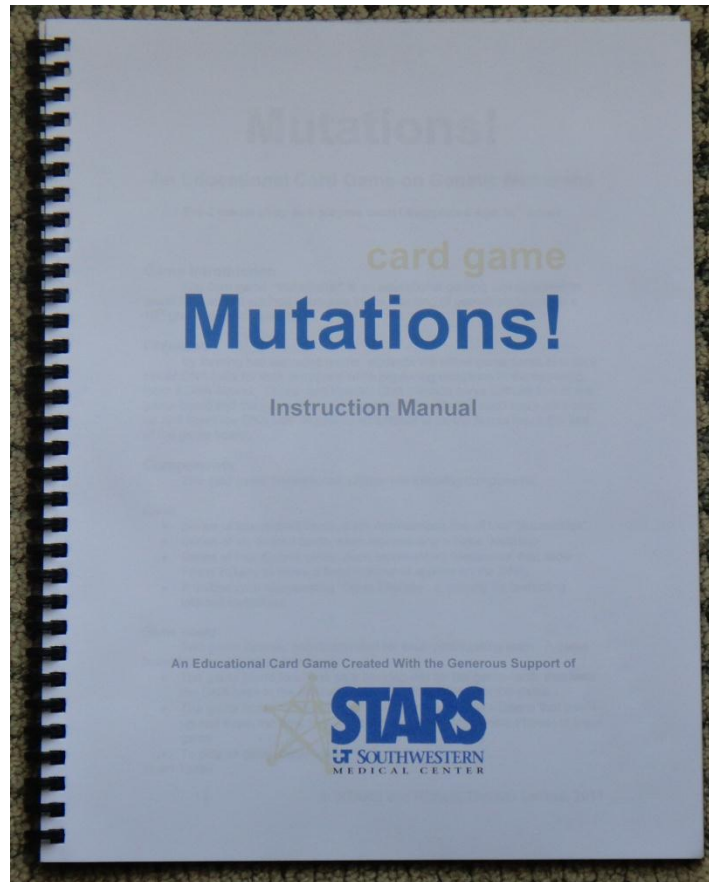


Figure 1-4. Mutations! Card Game Instruction Manual.

The game cards are found in multiple card cases, one case for each card type. Cards fit within each case snugly, and each is labeled for easy identification. There is one case for Nucleotide cards, one for Mutation cards and one for Movement cards, with support cards being held any of the three cases (Figure 1-5). The Team Tokens are seen here with the cases. They are red plastic blocks that are easy to replace. If the educator wishes it, any item may be substituted for the Team Tokens. Team Tokens have a small Styrofoam strip to hold them in place during packing and transit within the suitcase.



Figure 1-5. Card Cases With Team Tokens in Front.

The Deck Board, game instruction guide, both Student Quick Reference Guides and the Educator Quick Reference Guide may be found with the card cases in the central storage case for the science suitcase. The Team Boards may be found in the carrying tube. It is recommended that the Team Boards be rolled and stored with the face of each board oriented outward.

Set up of the board may look like the following example (Figure 1-6). Team Boards for each side are easy to identify. The name of each team may be found in the upper right, with a blue color band for Team A and an amber color band for Team B. Team boards may be set up next to each other, or facing on another. It is recommended that each Team Board be set on its own table because of their large size.

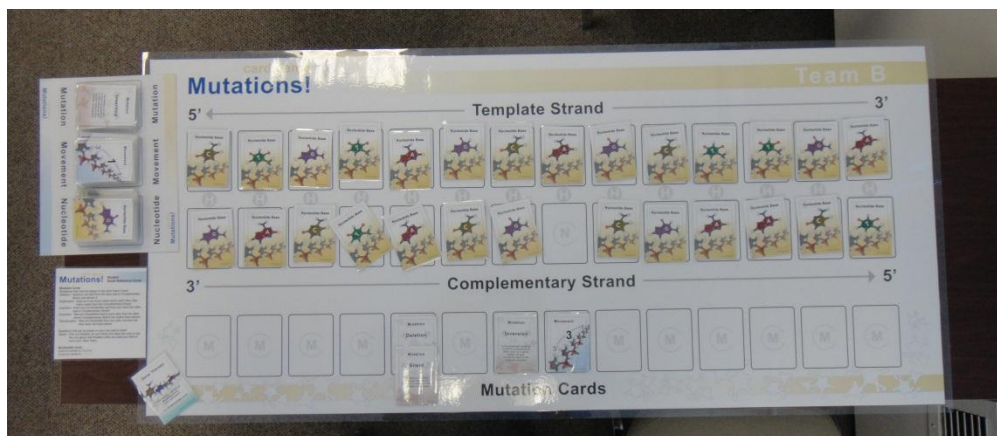


Figure 1-6. Mutations! Game Card Team Board for Team B.

The Student and Educator Quick Reference Guides are meant to be used for referral material by students and/or teachers at any time. So the guides may be held or set down anywhere for easy access (Figure 1-7).

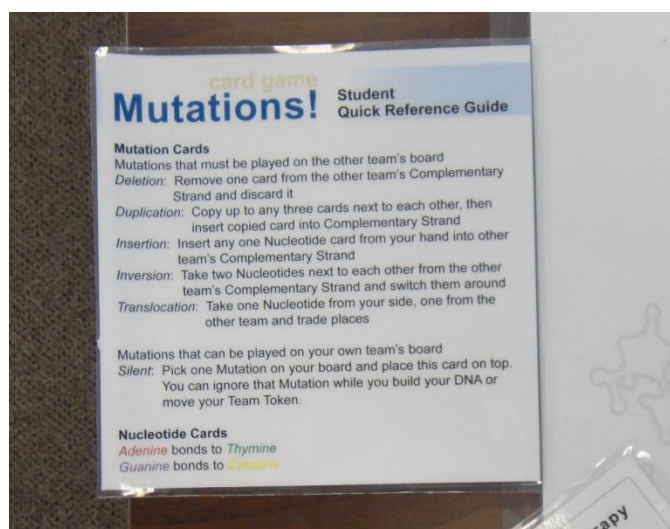


Figure 1-7. Student Quick Reference Guide.

The Deck Board is designed to hold all three kinds of card types for the game. The board is meant to be shared between both teams, so placement of the Deck Board depends on the placement of the Team Boards and the orientation of each team. The Deck Board is roughly the size of a regular sheet of paper with a hard coating. There is a space on the Deck Board reserved for each card type, labeled for easy identification (Figure 1-9). In the image below we see examples of each card type used in the game.

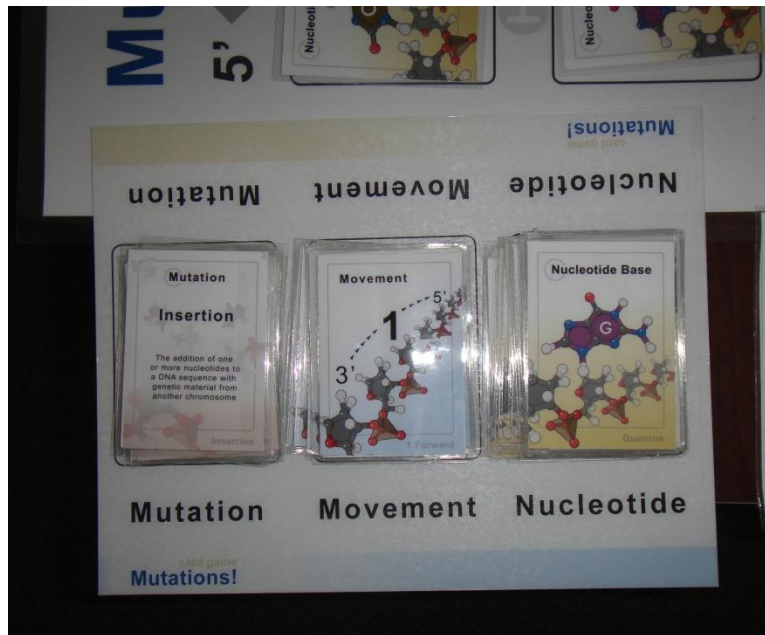


Figure 1-9. Deck Board.

### Hands-on Nucleosome Model

The suitcase comes with a hands-on physical model of a nucleosome. This model is based off of the actual molecular structure of a nucleosome, making it an accurate representation. The nucleosome has two purposes.

The first is to show students the theoretical interaction between histone tails and the DNA helix wrapped around the nucleosome. This interaction may cause the DNA wrapped around the nucleosome core to either tighten or loosen. If it tightens, then the DNA cannot be used in protein synthesis. If it loosens, then enzymes may reach the DNA strand and use it to create a new protein. This is essential in epigenetics, where different synthesized proteins can lead to the development of different kinds of cell types from pluripotent cells.

The second purpose of the nucleosome is to show students that DNA wraps around a histone core, a process that allows DNA to become tightly compacted and fit within a cellular nucleus. This is known as supercoiling, and is an essential function of nucleosomes, since without this process a DNA strand would be too big to otherwise fit inside a cell.

A five minute demonstration video on how to use the nucleosome model is found on the Genetic Mutations Animation DVD, under the Subchapters and Extras menu.

The nucleosome model has two components:

- A flexible, bendable physical nucleosome roughly 10 inches in length along its longest axis that is very lightweight (Figure 1-10).
- A three foot cord of derby rope used as representation of a DNA helix. The cord is colored blue-white, very lightweight and resistant to wear (Figure 1-10).

The flexibility of the nucleosome allows for illustrating how histone tails interact directly with DNA, while the derby cord serves not just for this function, but also to illustrate that a DNA strand wrapped around a nucleosome allows for shortening of the same strand. This shortening over a grand scale allows for an important step in supercoiling to occur.





Figure 1-10. Derby Rope and Nucleosome Model.

The nucleosome's construction is light memory foam coated in a rubberized color-coat that helps identify the individual histones that make up the nucleosome model (Figure 1-11). There are a total of 8 histones in the model, so 8 different tones are represented. The foam and rubberized coating allows for extreme rotation and compression of the model (Figure 1-12).

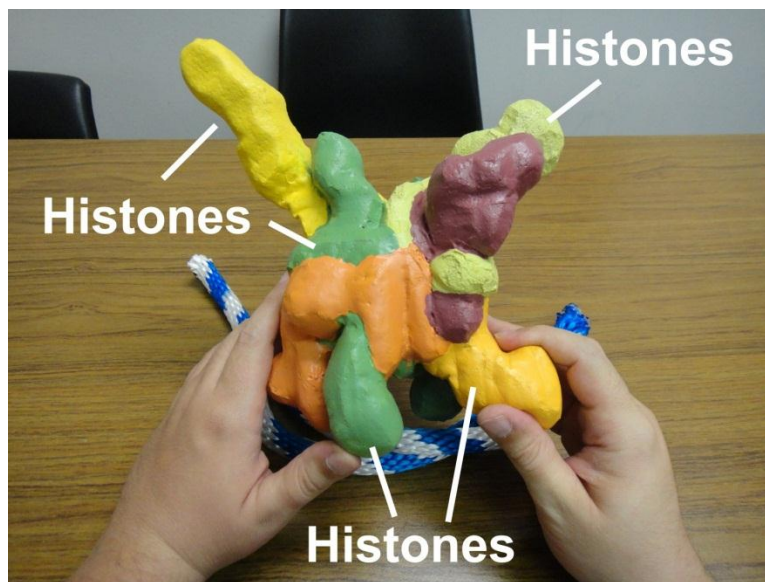


Figure 1-11. The Individual Histones of the Nucleosome Model.



Figure 1-12. Nucleosome Being Compressed.

Theoretical interaction between the histones and DNA occurs through the histone tail. Each histone has its own tail, so a total of 8 tails may be seen in this model. The tails, like the rest of the nucleosome model, may be compressed, twisted or bended. Tails may be identified as the outcroppings that emerge from the central portion of the nucleosome, such as the ones identified in the picture (Figure 1-13).

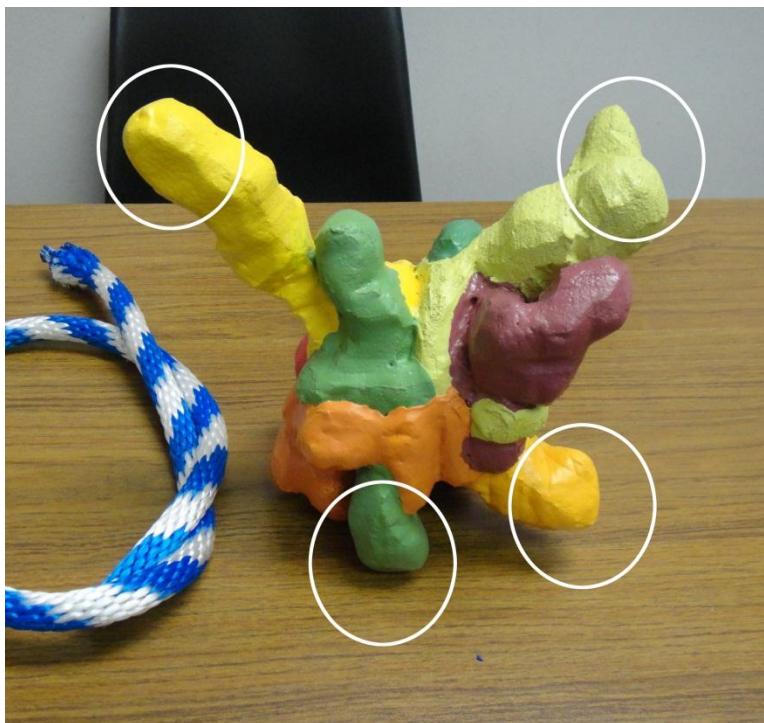


Figure 1-13. Circles Identifying Several Nucleosome Tails.

The purpose of the derby rope is to symbolize a DNA helix. It may be loosened or tightened around the central portion of the nucleosome. Though the nucleosome has no clear up or down orientation, the wrapping of the derby rope around the nucleosome can be done in any direction to facilitate the process. A suggested orientation of the rope may be seen below (Figure 1-14).



Figure 1-14. Derby Rope Around Nucleosome.

Below are two sample images of the derby rope being loosened or tightened around the nucleosome core. The first image represents the effect that a histone tail has on a DNA strand after it directly interacts with it, causing it to loosen its hold on the nucleosome core (Figure 1-15) so it may be used as a template in protein synthesis. The second image shows the effect that a histone may have on DNA, causing it to tighten so much that it no longer can serve as a template for protein synthesis (Figure1-16).





Figure 1-15. DNA Loosened Around a Nucleosome Core.



Figure 1-16. DNA Strand Tightened Around Nucleosome Core.

### Genetic Posters

The suitcase provides a series of three posters utilized to show the great size differential that exists between genetic structures. Since a chromosome is roughly 50,000 times larger than a nucleotide, a difference akin to that of a 1 millimeter ink line and the height of a fifteen story building, these posters emphasize the grand difference in scale between them and the structures that lay between. This is done by illustrating the process of supercoiling.

A short demonstration video on how the posters relate to one another can be found in the Subchapters and Extras menu on the Genetic Mutations Animation DVD.

The science suitcase should have the following:

- Three posters of the same size, 6 x 4 feet.

All three posters are stored within the carrying tube that accompanies the case. Posters may be folded length-wise to allow entry into the carrying tube.

Poster 1 represents the formation of DNA from nucleotides, the way DNA begins to wrap around histones to form nucleosomes, and the tightening of these nucleosomes to form a tetramer coil at the bottom of the poster (Figure 1-17).

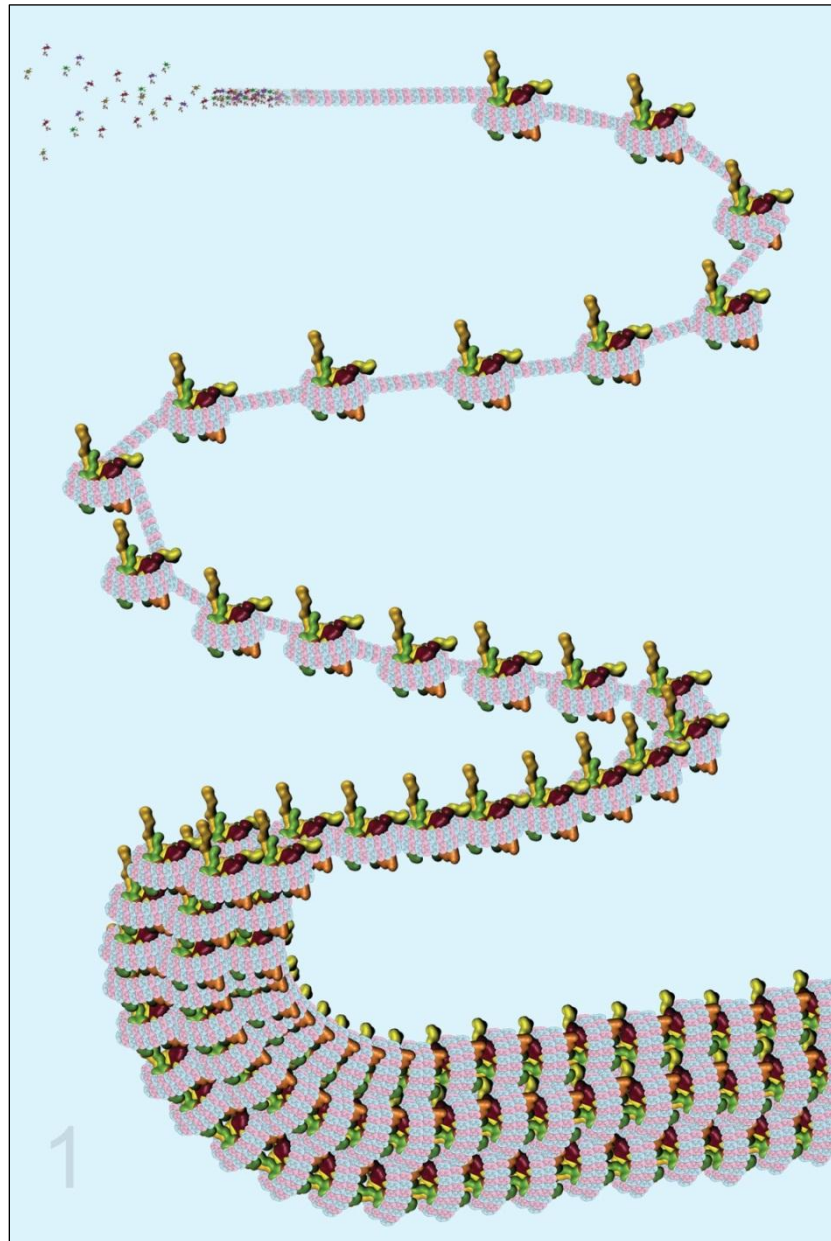


Figure 1-17. Poster 1.

Poster 2 shows the mid-stage of supercoiling, where a DNA helix becomes very kinked, twisted and compacted (Figure 1-18).

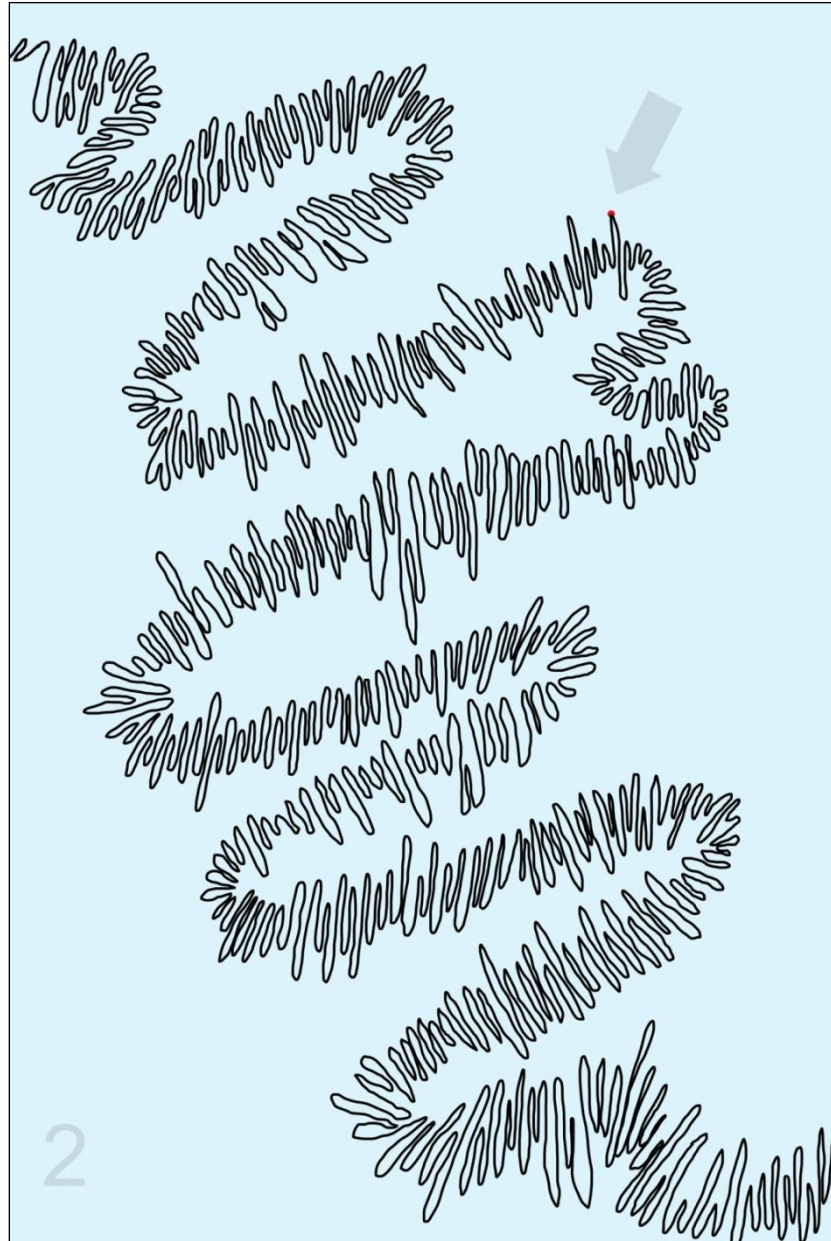


Figure 1-18. Poster 2.



Poster 3 shows the final stage of supercoiling, the chromosome (Figure 1-19).

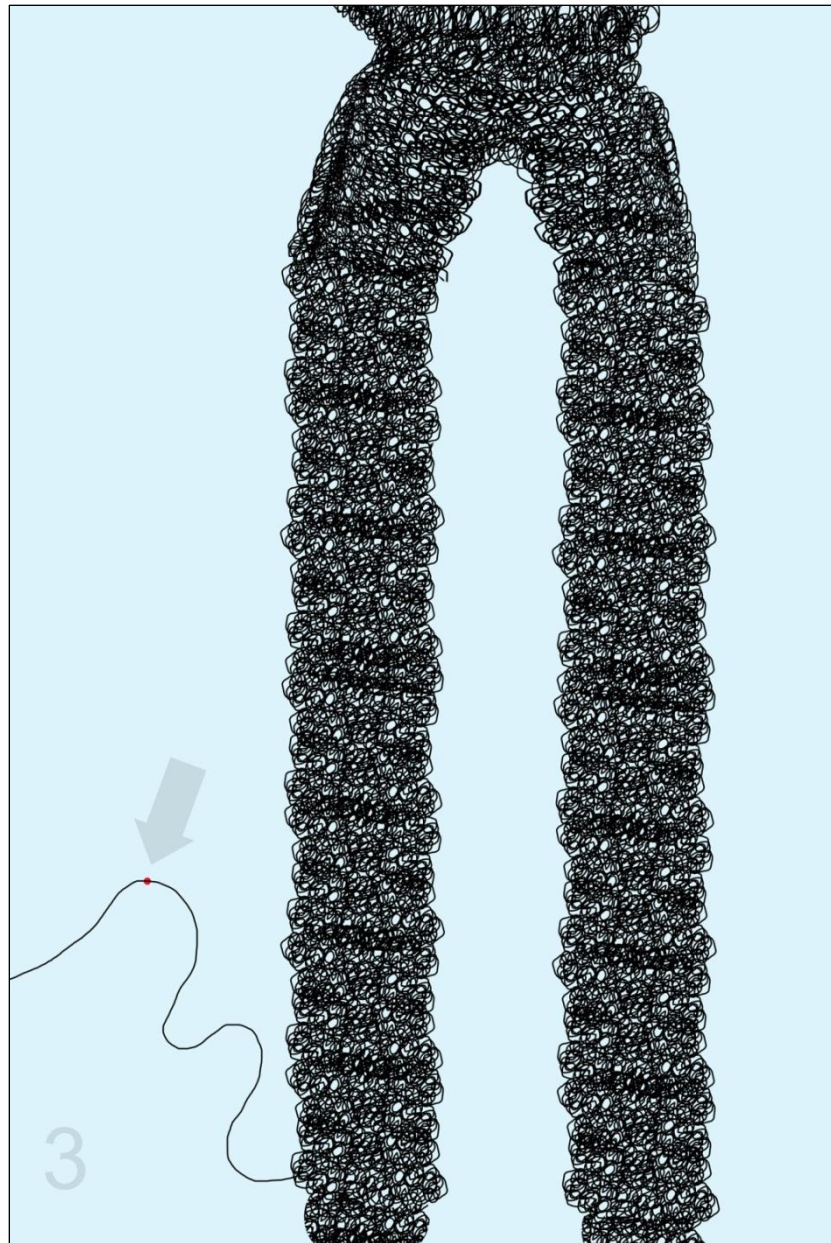


Figure 1-19. Poster 3.

The recommended manner in which to show the posters is to hang them side by side (Figure 1-20). A small, greyed out number may be found on the bottom left corner of each poster. These allow for quick identification of the posters and denote the order they should be put in (Figure 1-21).

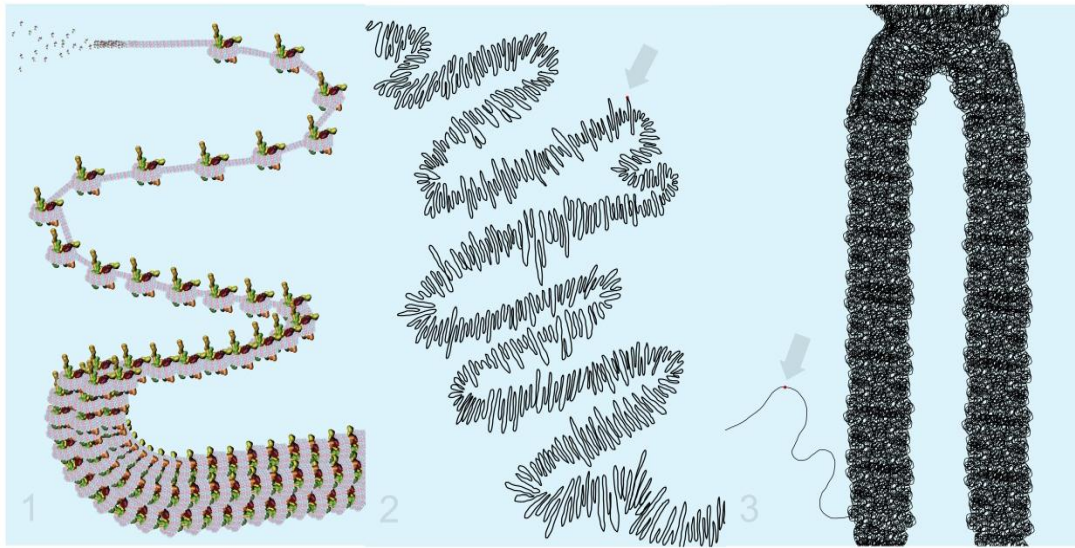


Figure 1-20. Correct Order of Posters.



Figure 1-201. Circled Location of Numbers on Posters.

Posters 2 and 3 both have a small red dot with greyed out arrows pointing to their location (Figure 1-22).

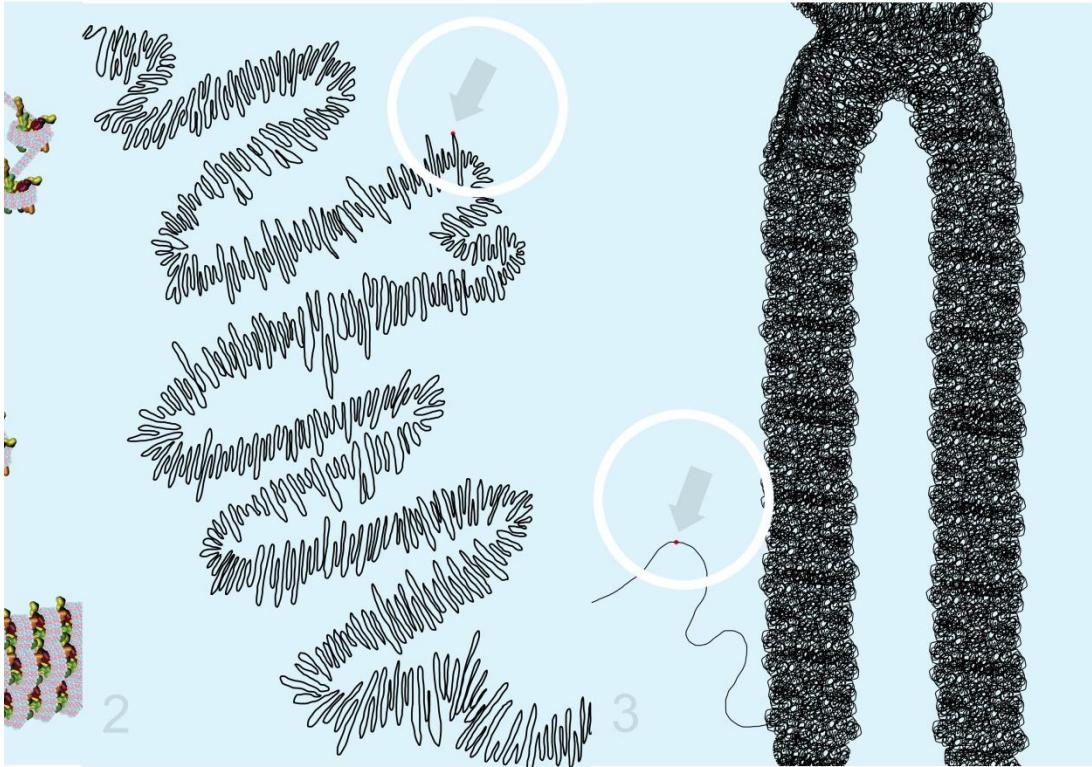


Figure 1-22. Circled Red Dots and Arrows on Posters 2 and 3.

These red dots represent the entirety of the previous posters. The dot on poster 2 represents the area covered by poster 1, while the red dot on poster 3 represents the entire area covered by poster 2. As such, each previous poster theoretically fits into a small space on the following poster. This should assist the student's in understanding that despite seeming to be equal size at first, the events of the first poster are incredibly small when compared to the events depicted in the second poster. And that the events on poster 2 are just a small fragment of what is perceived on poster 3.



### Guide DVD

The suitcase comes with a Guide DVD, a data DVD with all the manuals, guides and instructions in a PDF format, as well as animations or demonstrations videos. The files you will find specifically are:

- The Mutations! Card game instruction book
- The Teacher's Instruction Manual
- The Nucleosome demonstration video in Quicktime® format
- The Genetic posters animation
- Digital copies of the Genetic posters in .jpeg format

The Guide DVD may be found in the central storage case where most other suitcase components are also located. The Guide DVD is labeled for easy identification (Figure 1-23).



Figure 1-23. Guide DVD.



**To utilize the DVD, follow these steps:**

- Insert the Guide DVD into your computer DVD drive
- If your computer is set to automatically run CDs or DVDs, then the DVD with all files should open in a new window.
- Choose the file you wish to review
- If the Guide DVD does not open automatically, go to the My Computer tab option and double click on it
- Open your DVD drive by double clicking on it. This should take to you an opened window with all the available files on Guide DVD. Choose the file you wish to review.

### Carrying Cases

This science suitcase is contained within two separate storage devices.

- A 16 x 12 x 6 inch hard plastic carrying case that is extremely lightweight, durable and resistant to spills, but not including total immersion in a body of water (Figure 1-24). This case functions as the primary storage unit where the majority of the suitcase components are carried. This includes all manuals and instructions, all DVDs and CDs, the game cards and their respective cases, game tokens and the Nucleosome model with derby rope.
- A solid, thick cardboard tube 3 inches in diameter with a length of 24 inches (Figure 1-25). This case carries the Genetic posters, and Team Boards from the card game.



Figure 1-24. Primary Carrying Case.



Figure 1-25. Carrying Tube.

Storage in the primary case is simple. First locate the upper lid of the case. The upper lid has both the handle on it and two Styrofoam strips on the inside of the lid on the right side (Figure 1-26).



Figure 1-26. Upper Lid of Carrying Case.

The Deck Board and Quick Reference Guides from the card game are placed at the bottom of the case. (Figure 1-27).

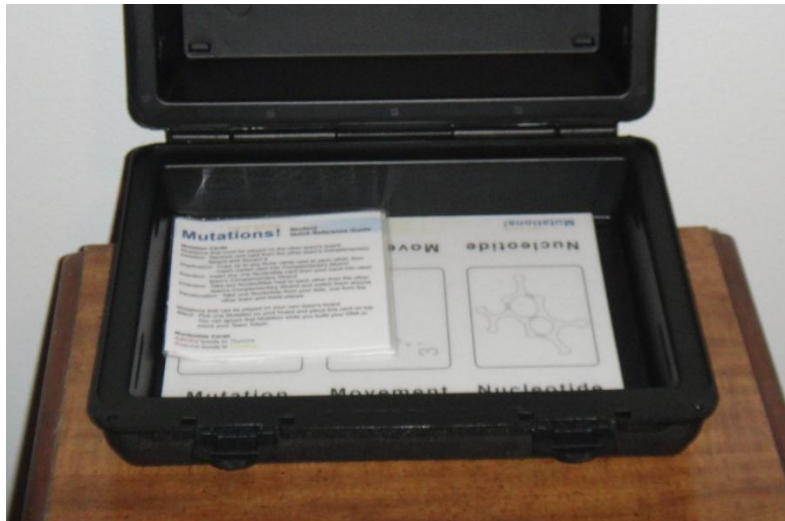


Figure 1-27. Deck Board and Reference Guides at the Bottom of Carrying Case.

Next, the Genetic Mutations Animation DVD and Guide DVD are put down, one next to the other (Figure 1-28).



Figure 1-28. Genetic Animation DVD and Guide DVD Set Within Carrying Case.

The instruction manuals are put in next at the bottom of the case (Figure 1-29).



Figure 1-29. Instruct Manuals are Set Within Carrying Case.

Next the next, the card game Team Tokens are put flush against the upper edge of the case. The Team Tokens are held in place with a cut, rectangular piece of Styrofoam (Figure 1-30).



Figure 1-30. Team Token Located in Carrying Case.

Next, the three card carrying cases are set flush up against the lower edge of the Styrofoam holding the Team Tokens, stacked on top of the other (Figure 1-31).





Figure 1-31. Card Cases Set Within Carrying Case.

Finally, the Nucleosome model with derby rope tied around it is set into the case, right next to the card cases (Figure 1-32). The rope may be just tied around itself and set between the model and the card carrying cases, if the educator wishes.

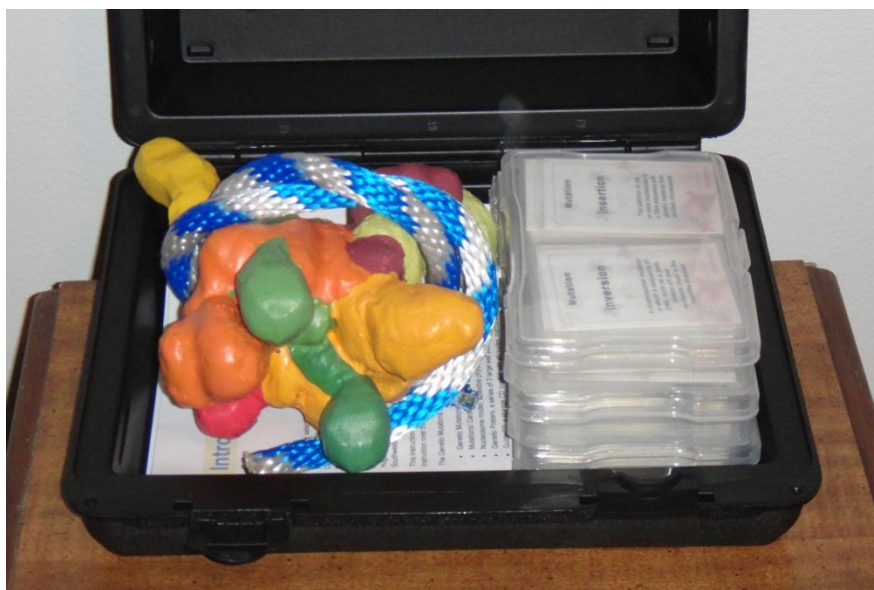


Figure 1-32. Nucleosome Model With Derby Rope Within Carrying Case.

The case is easily carried (Figure 1-33). The lid may present with some resistance when lowering due to the Styrofoam strips on the lid and the flexibility of the Nucleosome model. If the lid presents strong resistance or stops suddenly, reopen the case and organize components once more. All elements should fit comfortably without much resistance to the lid closing if they are stored correctly. Once closed, the case weighs only 6 pounds with all elements in place. There is relatively little shifting of items due to the closeness of the packing, so items are securely in place.



Figure 1-33. Carrying Case Sealed.

In regards to the carrying tube, the card game Team Boards and Genetic posters should fit comfortably within. Due to their size, the Genetic Posters may be folded length-wise and then introduced into the carrying tube. Since the Team Boards may present some rolling with long term storage, it is recommended that they be rolled and inserted facing outward. The total weight of the carrying tube once filled is 4 pounds.

