The Dynamic DNA Model User Guide

Inside the Color-Coded, Flexible Ladder with Epigenetic Switches

We invite you to contact us through our website, dnaandbeyond.org. You will see the greeting from our CEO, James Huhta, M.D., a world renowned perinatal cardiologist. To learn more about our teaching system, contact us at twoodward@trinitycollege.edu, or call 727-642-8574.

Welcome to the *"Dynamic DNA Model"!* This 38-inch long colorful, sturdy, flexible plastic ladder of DNA has 21 rungs. Each rung is made up of a pair of DNA letters (nucleic acids) held together by magnets. These 21 rungs, known to biologists as "**nucleotide pairs,**" are not only a series of chemical letters. They actually spell out **seven DNA words**, with each word having three letters. Since DNA words are called "**codons**," our sequence of 21 letters is displaying **seven codons of DNA**, which is somewhat shorter than the **smallest gene ever discovered**! See the briefing page, "Not Smurfs but smORFs" at dnaandbeyond.org. There we share more information on the newly discovered "midget genes."

Let's Do the Twist: Our model of a super-short gene is designed to be flexible enough to allow one holding it to give a "twist" at the end of the solid handle. This provides a picture the twisting-ladder or "double helix" structure of the DNA molecule. The inset picture is taken of a happy owner, a college graduate in Copenhagen, Denmark, who posed with his new twisting-gene model.

When placed flat on a table or counter, our model can also show DNA's ability to open and close. It shows how DNA unzips, then zips back together. This takes place through the embedded magnets at the tips of each pair of letters. As a result, the middle of each rung of the ladder "breaks open" when tugged. DNA's opening enables the gene to be copied into a string of RNA while unzipped. DNA also unzips when it's time for replication. One DNA is thereby turned into two duplicates of the original!

How long are normal or typical-length genes? Actually, the length of a gene can vary quite widely. Typical average-length proteins (built by DNA's embedded code) are 500 amino acids long or longer. Since each amino acid is specified by a 3-letter codon in the DNA, the gene sequence for such a protein would have 1500 letters, the equivalent

of taking seventy of our models and joining them end to end. This would go three quarters the length of a football field. The longest known gene, "titin," or "TTN," is found in our muscle cells. Its length is truly staggering: well over 100,000 DNA letters! That would make the total gene length at this scale (the scale of our model) the equivalent of placing about 5,000 of our models end to end. It would stretch out for a length of more than three miles!

Color System: Our model teaches the seven basic building blocks of DNA using a seven-color code system. The Norwegian biology teacher pictured here with her brother is using this color code in her high school class. *Here's how the code works...*

Four Nucleic Acid Colors: Each rung is made up of two color-coded nucleic acid half-rungs: either **C**rimson with **G**reen, or **A**zure/**A**zul with **T**angerine /**T**iger. (Biochemists use the abbreviation of "A" for adenine, "T" for thymine, "C" for cytosine, and "G" for guanine.) Note: the colors and color-names here were chosen to remind anyone studying DNA of the A/T and C/G complimentary pairing. One possible help: think of "Crimson/Green" as Christmas colors, and think of "Azure/Azul" and "Tiger/Tangerine" as the team colors of the University of Florida and other universities, including Illinois, Auburn, Virginia, Wheaton, Syracuse, and Boise State! In Florida where the model is produced we call these the "Gator colors"!

Three Other Color-codes: Each half rung is equipped with **white** outside sections signifying the **deoxyribose sugar**. (Sugar cubes and processed sugar are white, so that inspired the choice of white.) Between rungs are pairs of ball-shaped connectors with nooks; these are the "phosphate" molecules. For the "**P**" of **phosphate**, we use the color **purple**. The last member of the team is a pair of **methyl tags**, which we color **magenta**. Methane, a basic hydrocarbon, is CH_4; the methyl molecule is slightly different: it has a central carbon with three hydrogens—making it look like a Mickey Mouse with three ears. Methyl tags can be added or removed. This is the on/off switching mechanism of the epigenetic control system. Tags are attached to switch the gene off, and plucked away to turn the gene on.

Quick Review: Manipulating the Model

Each A/T or C/G rung, with its two half dowels, is held together as one rung by the action of magnets. Yet the rungs can break open, so the action of those same embedded magnets allow the half-rungs to break open when tugged on. This works best by far on a flat surface, and the handle which splits in two can be pulled apart first, followed by the rest of the ladder. To twist the model, you have a few options. The ladder-chain has robust flexibility, so it can be laid out flat on a display table and twisted into a spiral. It also can be held vertically, or suspended horizontally in mid-air, and then twisted into the famous double-helix.