The Stuff of Life - DNA

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Background:

Phosphate plays an important role in our everyday life. We need it to make DNA (or deoxyribonucleic acid): "the stuff of life." What is phosphate? Phosphorus (P) occurs in nature as phosphate. The phosphate ion combines with various atoms and molecules within living organisms to form many different compounds essential to life. Phosphorus is required by every living plant and animal cell. Phosphorus is one of the primary nutrients essential for plant growth and crop production.

It is a non-renewable resource that must be mined from nature. It cannot be artificially produced. We do not, however, mine phosphorus. We mine phosphate minerals. Most of the phosphate we mine – about 90% – is used to produce phosphate fertilizers. Another 5% is used to make animal feed supplements. The remaining 5% goes into making a variety of products from soft drinks to toothpaste to metal coatings. Plants get phosphate from the soil along with nitrogen, potassium and a number of other nutrients they need to live. Fertilizer is added to nutrient-deficient soil to replenish these vital chemicals. Animals get phosphate from their food.

When animals (including humans) get phosphate from their food, it plays several roles in their bodies. Phosphate plays a role in the way living matter provides energy for biochemical reactions in cells. The compound ATP stores energy that living matter gets from food (and from sunlight in plants) and releases it when it is required for cellular activity. Phosphate also helps with the forming and strengthening of bones and teeth. Living organisms use phosphate to give shape to their DNA, which is a blueprint of genetic information contained in every living cell.

As stated in the textbook *Modern Biology* (Holt, 2006, p. 197), "Deoxyribonucleic acid (DNA) is the material that contains the information that determines inherited characteristics. The most commonly known structure of DNA is the double helix. DNA is a nucleic acid made of two long chains or strands of repeating subunits called nucleotides. Each nucleotide consists of three parts: a five-carbon sugar, a phosphate group, and a nitrogenous base. The phosphate group consists of a phosphorus (P) atom bonded to four oxygen (O) atoms. The sugar and the phosphate form the sides or the "handrails" of DNA. Without them, the DNA molecule would fall apart. The diagram below shows a DNA double helix. The activity today will allow you to see your DNA."

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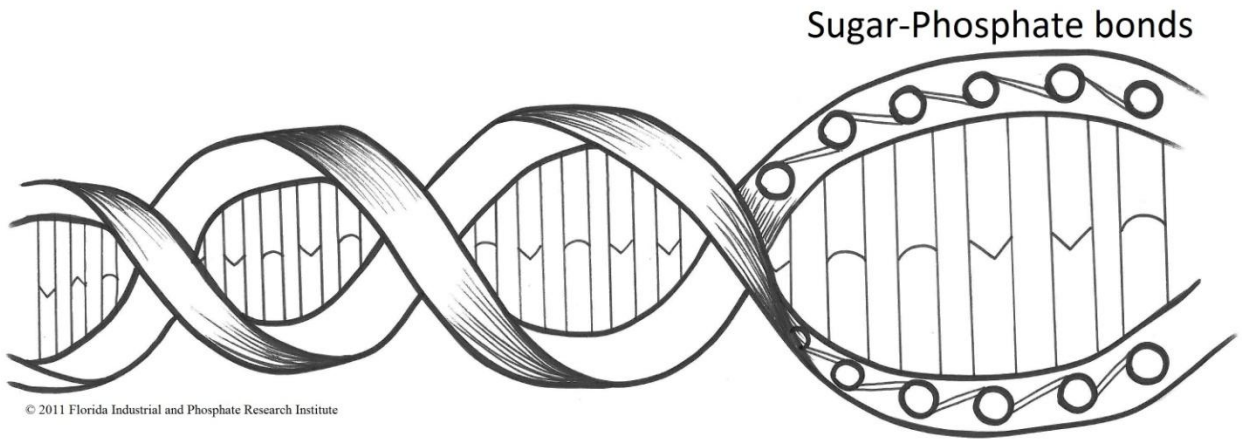

Standards:

SC.F.1.3.5	SC.G.1.3.5	SC.7.L.16.1	SC.8.L.18.2
SC.912.L.16.9	SC.912.N.3.5		

Objectives:

- Students will be able to visualize their DNA
- Students will have a better understanding of the role of phosphate in DNA structure
- Students will be able to draw the structure of DNA

Vocabulary:

deoxyribonucleic acid (DNA)
phosphate
double helix
adenosine triphosphate (ATP)
heredity
nucleic acid
nucleotide
nitrogenous base
deoxyribose (5-carbon sugar)

Materials:

2 clear plastic cups (6 to 8 ounces)
1 plastic spoon (all you need is ONE)
clear Gatorade
bottle of dish soap
water (distilled or drinking)
teaspoon of salt
ice-cold rubbing alcohol (90%, 71% is okay if 90% is not available)
pipette
methylene blue

Procedure:

1. With a DRY spoon, place a teaspoon of salt into one of your clear plastic cups (cup #1).
2. Dilute the salt by filling cup #1 one-fourth (1/4) full of water and adding 2 ounces of Gatorade. Dissolve the salt by stirring with your spoon.
3. Put 3 teaspoons of water in cup #2, then add 1 teaspoon of dish soap into cup #2 and stir.
4. Swish the salty water from cup #1 in your mouth for 30 seconds.
5. Gently spit the salt water into cup #2 with the diluted dish soap.
6. Stir the soap/spit mixture for 2 to 3 minutes.
7. (NOTE: this stage requires great concentration and it is important that you have a demarcated water/alcohol boundary – this means that the water and alcohol should not mix. One should sit on top of the other. **DO NOT MIX!**)
   With a pipette full of cold rubbing alcohol, gently pour the alcohol down the **side** of cup#2. The rubbing alcohol should form a separate layer on top of the salt/spit mixture.
8. Wait a few minutes and you should see spindly, white threadlike clumps starting to form in the alcohol. This is your DNA.
9. Once your DNA has formed you can drop a few drops of the Methylene Blue in the alcohol to see your DNA better.

Data/Observations: Draw and color what you see in your cup.

Analysis/Conclusion:

Grades 6-8

1. Why do we study DNA?
2. How can you describe the structure and function of DNA?
3. What role does phosphate play in the structure of DNA?
4. What would happen to the DNA if there was an absence of phosphate?
5. What would happen to the organism if there was an absence of phosphate?

Grades 9-12

1. Why do we study DNA?
2. How does DNA impact life?
3. What influence does DNA have on the function of the cell? Of the entire organism?
4. How can you describe the structure and function of DNA?
5. What role does phosphate play in the structure of DNA?
6. What would happen to the DNA if there was an absence of phosphate?
7. What would happen to the organism if there was an absence of phosphate?
8. How does the phosphate in DNA relate to the phosphate in ATP?
9. Explain the reaction in this activity. What role do the materials play (salt, Gatorade, alcohol, soap)?
10. How are you able to see your own DNA?

Extension:

This lesson is a great introductory activity for students to visualize DNA. This can lead into more in-depth understanding of DNA, heredity, and DNA technology.

Grades 6-8

1. Create models of DNA molecules using craft supplies such as toothpicks, pipe cleaners, paper clips, construction paper, etc. Students need to label all of the key structures of the model.
2. Use graphic organizers to chronologically explain the cell cycle and describe what is happening to the DNA within the cell in each stage.
3. Have students explore DNA's influence on heredity. Have the class take an inherited traits inventory of common characteristics.
4. Students can draw their family's pedigree to better understand the concepts of genotypes and phenotypes by visualizing their relatives. Students will be able to relate dominant, recessive, homozygous, and heterozygous traits in the people they know by observing trends over generations.

	ME		CLASS	
TRAIT				
I can see the colors red and green				
I have dimples				
I have a widow's peak				
I am right-handed				
I have detached earlobes				
I have a cleft chin				
I have naturally curly hair				
I have mid-digit hair				
Second tow is longer than big toe				
I have allergies				
I can roll my tongue				
I have freckles				
I have a hitchhiker's thumb				
I can taste PTC paper*				

*PTC paper can be purchased from a lab supply company or vendor

Grades 9-12

1. Students can use graphic organizers to explain the relationship between DNA and RNA.
2. Students can research major causes and effects of DNA mutations as well as the different types of mutations. With this information, they can make models of "normal DNA" and common mutations in order to have visual explanations of mutations.
3. Students can make a foldable to understand protein synthesis that helps them through the steps of DNA replication, transcription, and translation.
4. Have students do creative projects on how they think DNA technology will impact the future. Give them a "futuristic" genetic concept (Human Genome project, gene therapy, cloning, etc.) and have them write an illustrated story, make a movie, perform a skit, or some other type of creative project depicting what they think the future will look like due to advancing DNA technology. While the projects should be creative, students need to use current scientific data as the basis for their project.