IMHOTEP'S LEGACY ACADEMY

7.1 Why are we all so different? DNA Extraction

Grade 7 Activity Plan

Reviews and Updates

7.1 Why Are We All So Different?

Objective:

1. To show students the basic components and structure of deoxyribonucleic acid (DNA).
2. To show how the information stored in DNA is used to by the cell.

Keywords: Deoxyribonucleic acid, nucleus, gene, chromosome, nucleotide, codon, base, amino acid, protein

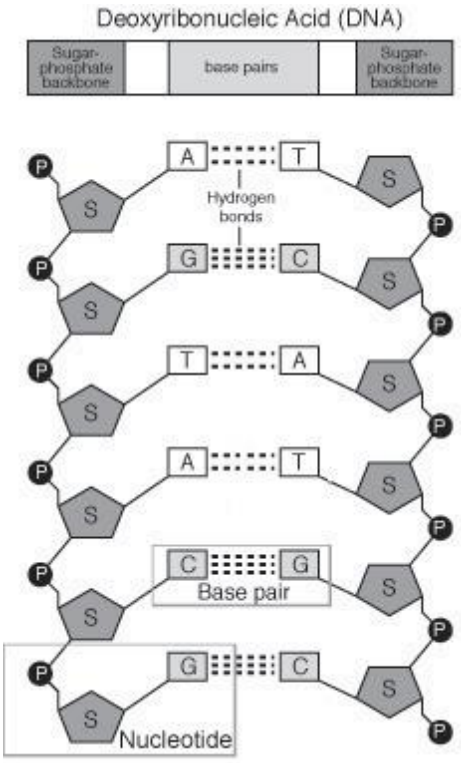
Take-home product: DNA bracelet, edible DNA molecule

Segment	Details
African Proverb and Cultural Relevance (5 min.)	"Only the knife shows what inside of the coco yam looks like." **West Africa**
Pre-test/ Background (20 min.)	Introduce keywords and concepts. Show DNA Structure video to reinforce concepts: http://www.eyeondna.com/2007/05/23/dna-structure-packaging-and-replication-videos/
Activity 1 (10 min.)	Have the students construct an edible model of DNA from a given nucleotide sequence.
Activity 2 (20 min.)	Discuss the relation of nucleotide sequences to amino acids and proteins. Pass out Alias Worksheets, and have the students make a bracelet using their names as the DNA Alias. Compare and contrast the differences in DNA codes.
Activity 3 (30 min.)	Explain DNA extraction from fruits and vegetables. Have students work in pairs to conduct DNA extraction from bananas.
Post-test (5 min.)	DNA Crossword

Suggested interpretation of the proverb: In order to fully understand something in life, we must study it and to do so we must *be able* take it apart/cut into it, as only the knife can cut into/take apart the yam. Today, we will be sharp like knives, and dive into an investigation of DNA.

BACKGROUND INFORMATION

DNA provides the instructions for building and operating all living things. The DNA instructions are divided into segments called genes. Each gene provides the information for making a protein, which carries out a specific function in the cell. A molecule of DNA (DeoxyriboNucleic Acid) is composed of two backbones and four types of chemical bases. The backbone is formed by a chain of alternating phosphates and sugars. Each sugar molecule in the backbone provides an attachment site for one of the chemical bases. The four types of chemical bases are: adenine, thymine, cytosine and guanine. They usually are represented by their first letters: A, T, C and G. The bases form pairs in a very specific way: A always pairs with T, and C always pairs with G. A pair of bases is connected by hydrogen bonds. Each base in the pair is also connected to a sugar compound in the DNA backbone. A DNA molecule is often compared to a ladder, with the two backbones forming the sides of the ladder and the base pairs forming the steps, or rungs. However, instead of a straight ladder, DNA looks like a twisted ladder, known as a double helix ("double" for the two backbones). The DNA sequence is the consecutive order of bases on one side, or strand, of the twisted ladder. The other strand has a complementary sequence determined by the base pairing rules.



Activity 1: DNA Composition

Source: http://teach.genetics.utah.edu/content/begin/dna/eat_DNA.html

Purpose: To understand the basic components and structure of deoxyribonucleic acid (DNA).

Item	**Quantity (10 students)**
Twizzlers	20
Toothpicks	100
Mini colourful marshmallows (at least four different colours)	400g (1 bag)
Paperclips	50
Masking Tape	1 roll

Procedure:

1) **Choose** one of the sequences below.
Sequence 1: T A C G T A T G
-or-
Sequence 2: T G G T T T A G

Assign a particular color to each nucleotide. For example your four colours are pink, yellow, green and orange. You can use the following table

Pink = Adenine (A) Yellow = Thymine (T) Green = Guanine (G) Orange = Cytosine (C)

2) **Assemble** one side of your DNA molecule. Place toothpicks down the length of the liquorice (the backbone), and put the correct colour marshmallow on each toothpick (depending which sequence you chose). For example, if you choose sequence 1, then the first 3 colours would be yellow, pink and orange representing T A C.

3) **Match** the base pairs. Place the colour marshmallow for the matching base on the other end of each toothpick. Remember that A always pairs with
T and C always pairs with G! For example, if you choose sequence 1, then the first 3 colours would be pink, yellow and green representing A T G.

4) **Complete** your DNA model. Attach the other backbone so your model looks like a ladder. **Twist** your DNA model.

5) **Label** your model. Make flags to label the parts of your DNA out of paper clips and tape. Label one of each of the following: Adenine, Thymine, Cytosine, Guanine, and Backbone. Make sure your base pairs are correct!

Activity 2: DNA Alias (with worksheet)

Source: http://nature.ca/genome/05/051/0511/0511_m205_e.cfm

Purpose: To understand how the information stored in DNA is used by the cell.

Item	**Quantity (10 students)**
Fasteners	10
Elastic Cords	10 cords
Beads (4 diff. Colours)	50 (5 of each)
Alias Code Sheets	10
Scissors	5

Procedure:

1) Use the **codon table** to convert each letter in your name to the corresponding codon (three-letter sequence) in order to find the "DNA sequence". For example, if the students name is TOM then the DNA sequence or alias will be ACTGATATG.

Letter	Codon	Amino acid
T	ACT	Threonine
O	GAT	Asparagine
M	ATG	Methionine

2) Cut the elastic cord into a 10 cm-long piece. Knot one end of the cord in order to prevent the beads from sliding off.
3) Using the codon code of the student's name, **replace** each base with the corresponding coloured **bead**
4) Tie ends of bracelet together with **fastener.**

Additional online activities:
Transcribe DNA: http://learn.genetics.utah.edu/content/begin/dna/transcribe/
Build a DNA molecule: http://learn.genetics.utah.edu/content/begin/dna/builddna/

Activity 3: DNA Extraction from Fruits

Purpose: To extract DNA from fruit cells

Suggested format: Students can work individually

Item	**Quantity (10 students)**
Bananas	5
Salt	5 tsp
100 mL Beaker	10
Cold Isopropyl Alcohol/Ethanol (70-95%)	1 bottle (400mL)
Liquid Dishwashing Detergent	10 Tbsp (150mL)
Cheese cloth or Coffee Filter	3
Hot Water	5 cups
Stir Sticks	10
Gloves	11 pairs
Resealable Ziploc Bags	10
Toothpick or Skewers	10

Procedure:
NOTE: Put the Isopropyl Alcohol/Ethanol into the freeze prior to the activity

1) Mush half of a banana in a Ziploc bag until all of the lumps are gone and it looks similar to pudding
2) Fill a cup with ½ cup of hot water and 1 tsp of salt. Mix together.
3) Pour the salt water mixture into the Ziploc bag and gently mix the saltwater and banana together for about 30-45 seconds
4) Add ½ tsp of liquid detergent into the bag and mix gently. Try to avoid making too much foam
5) Filter the solution through the cheese cloth into the 100 mL beaker
6) Tilt the beaker and slowly pour the cold alcohol down the side of the beaker so that it forms a layer on top of the banana mixture. Pour until the amount of alcohol in the tube equals the amount of banana mixture
7) DNA will rise into the alcohol layer from the banana mixture

NOTE: The DNA can be quite hard to see so look for thin strands attached to the tiny bubbles that begin to rise into the alcohol. Use a toothpick to pick out some of the strands of DNA.

Additional resources:
http://learn.genetics.utah.edu/content/labs/extraction/howto/index.html
http://library.thinkquest.org/19037/dna_extraction.html
http://www.sciencenetlinks.com/lessons.php?DocID=98
https://askabiologist.asu.edu/activities/banana-dna
This video gives an idea of what the DNA should look like

Suggested Variations:

- Experiment with other DNA sources. Which source gives you the most DNA? How can you compare them?
- Try Human DNA extraction (Refer to Activity 4)
- Experiment with different soaps and detergents. Do powdered soaps work as well as liquid detergents? How about shampoo or body scrub?
- Experiment with leaving out or changing steps. We've told you that you need each step, but is this true? Find out for yourself. Try leaving out a step or changing how much of each ingredient you use.
- Do only living organisms contain DNA? Try extracting DNA from things that you think might not have DNA

Activity 4: Human DNA Extraction **(OPTIONAL)**

Source: http://nature.ca/genome/05/051/0511/0511_m204_e.cfm

Purpose: To extract DNA from human cells and see DNA molecules

Suggested format: This activity produces less clear results than plant DNA extraction, so it is an additional option if there is enough time left over

Item	**Quantity (10 students)**
Salt	10 Tbsp
Tap Water	~ 5 cups (1250mL)
Clear Plastic Cup	10
Isopropyl Alcohol/Ethanol	1 bottle (400 mL)
Stir Sticks	10
Food Colouring	1bottle of any colour
Detergent	150 mL
Gloves	11 pairs

Procedure:

1) **PRIOR TO ACTIVITY, MENTOR ONLY:** Add salt to water, stir until grains have dissolved. Pour 3 Tbsp into each of ten plastic cups.
2) **Gargle** and swish all the salty water (3 Tbsp water, 1 Tbsp salt) from the cup around your mouth. Do not swallow the water! Spit it back into the cup.
3) Dip the stir-stick in the **dishwashing detergent** and gently stir it in the cup. Less froth in the cup is better so stir only two or three times.
4) Add two or three drops of **food colouring** to the rubbing alcohol, stir well.
5) Hold the spoon with its back facing upwards just above the surface of the water, with its tip touching the side of the cup. **Dribble the alcohol** onto the back of the spoon so that it slides gently off the spoon, down the side of the cup, and onto the surface of the water. Pour enough rubbing alcohol to create a 2 cm-high layer on top of the water.
6) **Watch** the thin strands of DNA collect together in the alcohol to form nets or webs of DNA.

Note: If the alcohol is cloudy, try the experiment again and add the alcohol more slowly.

Worksheet – Activity 2 DNA Alias Codon Table

Write each letter of your name on the lines below:

____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

Use the codon table below to help you convert your name into its DNA Alias.

Step 1: Find each letter of your name.

Step 2: Look at the Simplified Codon column to find the codon for each letter.

Step 3: Replace each letter of your name with its three-letter codon:

___,___,___ ___,___,___ ___,___,___ ___,___,___ ___,___,___

___,___,___ ___,___,___ ___,___,___ ___,___,___ ___,___,___

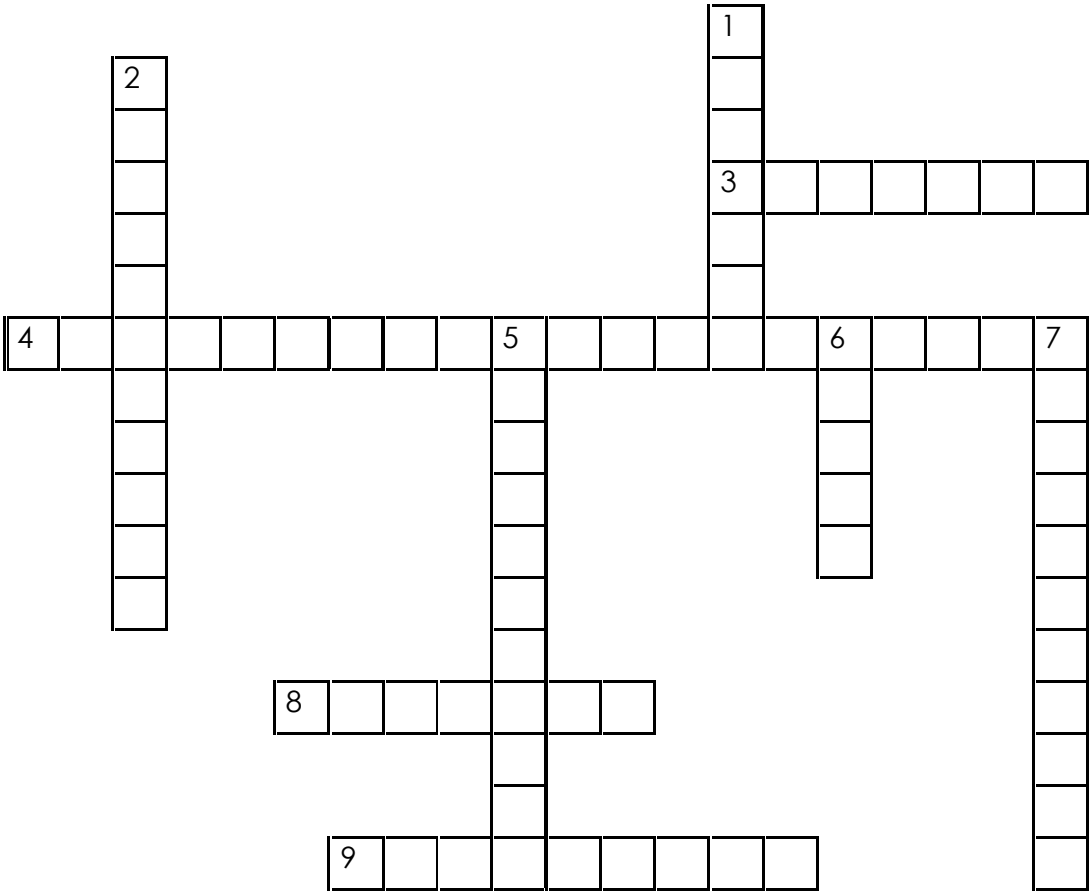
___,___,___ ___,___,___ ___,___,___ ___,___,___ ___,___,___

Our Alphabet	Amino Acid Name	Simplified Codon
A	Alanine	GCT
B		GCA (Alanine)
C	Cysteine	TGC
D	Aspartic acid	GAT
E	Glutamic acid	GAG
F	Phenylalanine	TTT
G	Glycine	GGG
H	Histidine	CAT
I	Isoleucine	ATA
J		ATC (Isoleucine)
K	Lysine	AAG
L	Leucine	CTC
M	Methionine	ATG
N	Asparagine	GAC
O		GAT (Asparagine)
P	Proline	CCC
Q	Glutamine	GAG
R	Arginine	CGT
S	Serine	TCA
T	Threonine	ACT
U		ACG (Threonine)
V	Valine	GTC
W	Tryptophan	TGG
X		GTA (Valine)
Y	Tyrosine	TAC
Z		TAT (Tyrosine)

Base Colours:
A = green
T = red
C = blue
G = yellow

Post-test (Copy Only): Using terminology learned today, complete the following crossword puzzle.

DNA: The Building Blocks of Life



ACROSS
3 I am home to DNA
4 I am the full name of DNA
8 I pair with cytosine
9 I make DNA negative

DOWN
1 I pair with thymine
2 We have 46 of these
5 I am the monomers of DNA
6 I am a triplet of nucleotides
7 I am the shape of the DNA molecule

Answers

ACROSS
3 nucleus
4 deoxyribonucleic acid (no space)
8 guanine
9 phosphate

DOWN
1 adenine
2 chromosomes
5 nucleotides
6 codon
7 double helix (no space)