

# NTTI Media-Rich Lesson

Pauline B. Washington

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## NAME

DESIGNER GENES: SAFE, DANGEROUS OR ENEMIES

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## LESSON TITLE

Tenth Grade Honors Biology

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## GRADE LEVELS

90 Minutes

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## TIME ALLOTMENT

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## OVERVIEW

These lessons are designed to study the genetic aspects of the DNA molecule to the proteins and how these molecules orchestrate the chemistry of life and their applications to human life and health (disorders and diseases – mutations). DNA is information rich; it is chemically simple and homogeneous. Proteins, by contrast, are chemically complex and diverse. Proteins are where the action is. Proteins are motors, signals pumps, chemical catalysts, detectors, gateway keepers and they regulate cell replication, survival and death.

Understanding the complex living systems and the human genome are defined by research and knowledge from DNA sequence, amino acid sequence and protein expression. Due to research, the students will associate the societal problems (ESL) resulting from the human Genome Project.

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## SUBJECT MATTER

Tenth Grade Honors Biology

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## LEARNING OBJECTIVES



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Students will be able to:

- Identify and characterize the molecular machines of life, the multi-protein complexities that execute cellular functions and govern cell forms.
- Parallel and compare the causes of genetic disorders in humans from identification of DNA fragments.
- Explore the growing ethical, social, and legal impact of the results of the human genome project.

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## STANDARDS

### 2. Topic: Research

Standard: Demonstrates appropriate use of references to access, analyze, evaluate, and present information related to research problems

2.1 Uses media resources such as print, audiovisual, and online services to find information

### 3. Topic: Nature of Biology

Standard: Explain the significance of biology (impact on our daily lives)

3.2 Explains the use of biology in daily life

### 8. Topic: Biochemistry (Protein Synthesis)

Standard: Explains the structure of DNA and RNA, and their role in protein synthesis

### 10. Topic: Genetics (Mendelian Genetics)

Standard: Explains the use of the basic Mendelian genetic principles

### 11. Topic: Genetics (Patterns of Inheritance)

Standard: Describes the patterns of inheritance and genetic engineering

11.1 Relates normal patterns of inheritance and genetic engineering

Relates abnormal patterns of genetic inheritance to genetic variation

11.2 Relates abnormal patterns of genetic inheritance to genetic disorders and diseases

11.3 List significance contributions of genetic engineering to agricultural and medical practices

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## MEDIA COMPONENTS

### Video

- Video #104 – Biology: The Science of Life – DNA: The Master Molecule of Life



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### Other Instructional Resources

These references contain background information on the DNA molecule, DNA replication, transcription and translation (from the DNA molecule to protein synthesis).

Cracking the Genome by Kevis

Myers, Richard, The Genetic Resource, Vol. 8, No. 1194, Direct Testing for Huntington's Disease

Periodical: Science 82, Nov. 1982, pp. 35-89

### Cornell Notes

<http://www.cssdesigns.com/learningtoolbox/cornell.htm/>

This reference helps students take organized notes for video websites and discussions and to identify keywords and concepts.

### Websites

1. <http://www.accessexcellence.org/AB/GG/structural.html>  
Graphics and structure of the DNA molecule are revealed at this site
2. <http://www.accessexcellence.org/AB/GG/dnamolecule.html>  
This site will help students recognize mutations and chromosomes
3. <http://www.accessexcellence.org/AB/GG/genetic.html>  
This site reveals the genetic codes
4. <http://www.cstl.nist.gov/biotech/strbase/glossary.htm>  
<http://www.accessexcellence.org/AE/AEC/CC/DNA-glossary.html>  
These sites give explanations of glossary of commonly used terms
5. <http://www.accessexcellence.org/AB/IEGeneticTesting.html>  
This site addresses genetic testing and health care issues
6. <http://www.accessexcellence.org/AE/AEPC/BEO2/zanko/gencoun2.html>  
This site addresses genetic counseling
7. <http://www.accessexcellence.org/AE/AEPC/BEO2/zanko/huns3.html>  
Huntington's Disease is addressed at this site
8. <http://www.ascaa.org>  
American Sickle Cell Association's Website  
<http://www.sicklecelldisease.org>  
An historical sickle cell disease website
9. <http://www.accessexcellence.org/AB/IE/Intro.thehumangenome.html>  
This site explains the why of identifying your genetic instructions  
<http://www.accessexcellence.org/AB/IB/ethicalissuesoftheHGP.html>  
This site identifies ethical issues of the Human Genome Project

10. <http://www.accessexcellence.org/AB/GG/pedigree.html>  
This site shows pedigree graphics and information
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## MATERIALS

25 5x7 envelopes  
2 packages of black twister candy  
2 packages of red twister candy  
Typing paper  
Computer designed alphabets for the nitrogenous bases found in DNA/RNA  
List of commercial movies dealing with bioethics  
VCR  
Computer/LCO Projector  
Overhead Projector  
Transparencies  
Human Genome Project Chart  
Computer designed gene cards simulating homozygous and heterozygous genes for  
Huntington's disease and sickle cell trait and disease  
Poster (H, h, S, s) signs for the sickle cell session and Huntington's counseling session  
Blood cells  
Cornell note paper for students  
Designer genes response cards for all students

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## PREP FOR TEACHERS

Before teaching this lesson, make certain all websites are bookmarked on the computers in the classroom. Cue video to the first segment to use in learning activity. Make sure that all materials are available for distribution to the students.

1. Obtain a classroom set of 5x7 envelopes.
2. Purchase 2 packages of strawberry and 2 packages of black twisters candies
3. Place 2 pieces of twisters candy of the same color in a plastic baggy. Place in envelope.
4. Prepare cards with the alphabets A, T, C, U, and G for the bases prior to class.
5. Prepare 10 copies of each alphabet – use different colors for each base
6. Laminate cards for future use.

7. Prepare designer gene cards (H, h, S, s). Prepare at least 15 copies of each gene. Laminate for future use. Place all materials listed above in envelope. All other materials should be available for students' use during the lesson.
8. Make available KWL charts, several Cornell note pages, and designer genes response cards for all students.
9. Class copies of commercial movies dealing with bioethics  
 Class copies of KWL charts  
 Class copies of Huntington's Disease – Family History  
 Class copies of Human Genome Chart

**STUDENT MATERIALS**

Pencil, paper, computer, and Cornell note pad

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**INTRODUCTORY ACTIVITIES: SETTING THE STAGE**

**LEARNING ACTIVITIES (ENGAGE)**

These activities will allow the student to apply the prior knowledge learned about the structure of DNA and the coding of proteins for genetic expressions. This knowledge can be used to understand some mistakes in nature (DNA) that occur and cause human suffering and death. This information can be applied through card games and role play using meaningful, relevant, and useful information connected to real-life experiences. The card game can be analyzed to determine which genes in this activity are safe, dangerous or enemies to us.



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## Introductory Activity – DNA Twisters

**Time Allotment:** 15 Minutes

### **Purpose**

These activities are designed to review the structure of the DNA molecule and sensory activities used to address different modes of learning.

### **Directions**

- Step 1 Ask students to remove the plastic bag containing the twister candies.
- Step 2 The teacher will model how the twisters candies can be used. Candies can be used as a visual representation of chromosomes and the double helical structure of DNA. After answering questions and giving definitions to related terms to promote continuous learning and stimulate thinking, the students can eat the candy.
- Step 3 Check for comprehension. The teacher will ask students to give explanations for terms (Section I) using the Cornell note taking strategies.

This activity will help the student to revisit and redefine the purpose of the lesson.

### **Vocabulary**

#### Section I

deoxyribonucleic acid  
ribonucleic acid  
nitrogenous bases  
adenine  
thiamine  
cytokine  
guanine  
uracil

#### Section II

amino acids  
genetic coding  
replication  
transcription  
translation  
mitochondria  
mRNA  
tRna

#### Section III

rRna  
genetics  
mutation  
double helix  
chromosome  
autosome  
sex chromosome  
human genome

## Introductory Activity #2

### LET'S GET TOGETHER / BASES GET TOGETHER

#### Purpose

This activity is designed for students to correctly pair the complimentary base pair in the DNA/RNA molecule.

#### Steps

- Step 1 Allow students to pull one alphabet representing a nitrogenous base from the envelope.
- Step 2 Students will stand and find complimentary base and join hands with that person. Allow students to observe the formation of base pairs of the DNA molecule. Have students form the bases for the RNA molecule.
- Step 3 Provide students with a FOCUS FOR MEDIA INTERACTION by saying: "DNA is the code of life for all living things." DNA has the same structure in the rat, snake, mold, and man. We will watch a video clip from "The Science of Life: DNA – The Master Molecule of Life, #140. As you observe the structure of DNA, pay close attention to the base pairing, replication, transcription, translation, and the genetic codes for proteins. PLAY THE VIDEO at the cue beginning with Evolution – Genetics – Mutation.
- Step 4 Students will take notes (Cornell Technique). PAUSE THE VIDEO after 1 minute and check for comprehension. Students will return to vocabulary, Section II / Section III. Students will give explanations of these terms using Cornell note taking technique. The teacher will walk around and check for student participation in assignment.
- Step 5 To further enhance learning, the teacher will provide a FOCUS FOR MEDIA INTERACTION using the Internet to show the universal structure of the "DNA molecule as the CODE OF LIFE." The teacher will direct the students to these websites showing graphics of the molecule.

DNA Molecules: Graphics. Students may work in groups to complete assignment.  
<http://www.accessexcellence.org/AB/GG/structural.html>  
<http://www.accessexcellence.org/AB/GG/genetic.html>  
These websites will challenge students to extend learning and creates shared learning.

Other sites that can be used to complete explanations of the vocabulary list include:  
<http://www.cstl.nist.gov/biotech/strbase/glossary.htm>  
[http://www.accessexcellence.org/AE/AEC/CC/DNA\\_glossary.html](http://www.accessexcellence.org/AE/AEC/CC/DNA_glossary.html)

All vocabulary should be completed on Cornell note sheets for evaluation by the teacher.



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## Learning Activity #2

### **DESIGNER GENES CARD GAME**

(Designed by P. B. Washington, Science MTL/F)

#### Objectives

- Demonstrate inheritance patterns in select human genetic (metabolic pathways) disorders (safe, dangerous or enemies)
  - (1) Sickle Cell Anemia Disease – 100 Cards
  - (2) Huntington's Chorea – 100 Cards

#### Teacher Preparation

1. \*The cards should be of different colors and on cardstock paper.
2. \*Cut cards out prior to class; 100 per metabolic disorder.
3. \*Place all sickle cell alleles in plastic bag in envelope.
4. Place all color-coded Huntington's allele cards in plastic bag in envelope.

#### Directions

**Step 1** Students will select two cards from the envelope. The alleles selected will determine the student's designer genes for the disorder.

**Step 2** Discussion of homozygous and heterozygous alleles and carrier/trial alleles in humans - compile in Cornell notes.

**Step 3** Students will be directed to then proceed to the corresponding counseling session – simulated Sickle Cell or Huntington's disease by saying, "DNA designs your life. DNA is the blueprint for life." You are who you are because of your genes. Sometimes there are mistakes in the DNA translation via the genetic code (base pairs). These are mutations and some mutations cause disorders such as hemoglobin disorders such as sickle cell disease or neurological diseases such as Huntington's disease. Today, because you have selected your specific genes, we will learn: (1) the genetic causes of the disease, (2) the symptoms, and (3) treatments.

**Step 4** Go to your specific counseling session (signs will be available for each disorder) and use these websites to learn about the three specific items stated above.

**Step 5** Students will use the Cornell note taking technique to complete this assignment.

**Step 6** Students and genetic counselor will go to these sites. These sites will allow students to extend technology activity to enhance knowledge on errors in metabolic pathways.

#### Huntington's Disease:

<http://www.accessexcellence.org/AE/AEPC/BEO2/zanko/huns3.thml>.

### **Learning Activity #3**

#### **SIMULATED GENETIC SESSION FOR HUNTINGTON'S DISEASE**

“Safe, Dangerous or the Enemy”

#### **Role Playing Classroom Activity**

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Adrian Epps, M.S., CGC

Genetic Counselor – Member of the National Society of Genetic Counselors (NSGC)

Crawford Long Hospital, Atlanta, Georgia

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#### **Target Audience:**

10<sup>th</sup> Grade Honors Biology

#### **Objectives:**

- To demonstrate the complexity of the metabolic error of Huntington's disease and genome for the impact (ELS) of the disease on individuals
- Exploration

#### **Time:**

30 - 60 minutes

#### **Materials**

Huntington's Genetic Cards, Cornell notes, paper, pencil, four to six students, one counselor, hard copies of Human Genome Map, Internet connection, computers

This session will stimulate inquire and can be used for effective questioning and probing.

#### **Description**

1. Simulation of a counseling session with charts with Huntington's alleles on the human genome map.
2. Ask genetic counselor to take her/his position at the designated spot in the classroom. A person will be selected who has done extensive research on Huntington's disease and has been pre-approved for this position by the teacher. This activity involves role-playing.
3. Students (in teams of 4 – 6) with alleles (HH, Hh, hh) will assemble at the designated spot for Huntington's disease counseling.

#### **Step 1 Begin Session**

The counselor will introduce herself/himself and meet the clients. The counselor will review the allele cards and ask the class to review the website with her/him on the hunt for Huntington's disease.

#### **Content:**

Genetic principles and concepts, inheritance patterns, allele analysis, genetic condition(s), genetic counseling, human genome project, and societal issues

**Step 2** Focus for Media Interaction

Students and designated counselor will assemble at the site on Huntington's disease and locate the website listed for the disease.

- Step 3** Counselor and students will discuss metabolic errors and the causes of mutations. The teacher will use effective questioning and probing activities to check for comprehension. Students will use Cornell note pads to record discussion activity.

Focus for Media Interaction

The counselor will ask the students about their knowledge of the Human Genome Project. After a discussion for understanding, the counselor will direct them to the website: The Why of Identifying Your Genetic Instructions  
The Human Genome.htm1

- Step 4** Pause for comprehension. The counselor will ask, "Why is the HGP important? Who does the HGP effect?" Note ESL concerns about the HGP.

**Step 5** Viewing Activity: Questioning for understanding/comprehension

The counselor displays a hard copy of the human genome map to the clients, points to chromosome #4 and identifies this site on chromosome where research proves that the erroneous DNA exists. The enemy designer gene exists here, and the gene is autosomal.

- Step 6** The counselor reminds her/his clients that genes are expressed through proteins. The counselor tells his clients that Huntington's is the first completely dominant human genetic disease to come to light. You do not have to have two copies of the mutant gene, one from each parent, to suffer the symptoms. Just one copy of the mutation will do. The disease seems to be worse if inherited from the father and seems to be more severe in the children of progressively older fathers. The gene contains a single word...CAG, CAG, CAG, CAG... The repetition continues sometimes just six times, sometimes thirty, sometimes more than a hundred times. Your destiny, your sanity and your life hang by the thread of this repetition. If the word is repeated thirty-five times or fewer, you will be fine. If the word is repeated thirty-five times or more, you will encounter the disorder.

Focus for Media Interaction

The counselor might return to the site for Huntington's disease for tutorial purposes

Website: <http://www.accessexcellence.org/AE/AEPC/BEO2/zanko/huns3.html>

- Step 7** The counselor identifies symptoms of the disorder for the clients. In mid life, one slowly begins to lose his balance and slowly begins to become incapable of taking care of himself. The decline begins with a slight deterioration of the intellectual faculties, is followed by jerking limbs, and the patient descends into deep depression. There is no appeal and the disease is incurable. This gene is your *ENEMY*.

- Step 8** The counselor reinforces the discussion by identifying additional clinical aspects and the bioethics and legal ramifications of the disorder by referring to the following.



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Focus for Media Interaction

The counselor will advise the clients of the ethical, societal and legal aspects of having Huntington's disease. To reinforce these aspects, the counselor will direct the clients to these websites for further clarification.

<http://www.accessexcellence.org/AB/IB/ethicalissuesoftheGHP.html>

<http://www.accessexcellence.org/AB/IF>

**Step 9** Clients will be asked to identify specific social, ethical and legal concerns related to Huntington's disease using Cornell note pad. The counselor will check clients' participation in activity.

**Step 10** The session ends when the counselor thanks the clients for participating and gives them response cards to complete for the culminating activity.



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## Learning Activity #4

### **SIMULATED GENETIC COUNSELING SESSION FOR SICKLE CELL ANEMIA**

#### Classroom Activity

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Neva Rose, Genetic Counselor – Certified by the American Board of Genetic Counseling (ABGS)  
Emory University – Genetic Education Center

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**Grade Level:** 10<sup>th</sup> Grade Honors Biology; Genetics

#### Objective

- To assist students understand the characteristics of sickle cell anemia disease and the impact of the trait and disease on individual lives. This activity will involve role-playing and will allow the student to think holistically about the disorder. This activity promotes communication skills.

**Time:** 30 minutes

#### Supplies

Sickle Cell gene cards, Cornell note paper, pencil, four to six students and one genetic counselor, blood cell chart; Human Genome Map; Internet connection; computers

#### Content

Genetic principles and concepts, inheritance patterns, pedigree analysis, genetic conditions, genetic counseling

#### Description

- Step 1** Genetic counselor: student appointed by the teacher and who has previously done extensive research on the sickle cell disease. This session's goal is to understand the genetic inheritance process and the societal impact of sickle cell not the diagnostic process.
- Step 2** Students who have played the Sickle Cell Anemia Allele Playing Cards Game may receive counseling. Students with SS, Ss, or ss cards will come to the section of the class identified for sickle cell anemia disease counseling.
- Step 3** Begin Session  
Counselor introduces himself/herself to genetics clients, interview clients and reviews cards for safe genes (SS), dangerous genes (Ss), and enemy genes (ss).
- Step 4** The counselor provides the students with a Focus for Media Interaction by saying, "DNA designs your life. DNA is the blueprint for life." You are who you are because of your genes. Sometimes there are mistakes in the DNA translation via the genetic code (base pairs). These are mutations and some mutations cause disorders such as Hemoglobin (blood) mistakes such as sickle cell anemia. Today, because you have

selected your specific genes, we will learn (1) the genetic cause, (2) the symptoms, and (3) treatment and care of sickle cell anemia disease.

**Step 5** We will visit an Internet site to find out about sickle cell. Use your Cornell notes to summarize your discovery.

Sickle Cell Disease

<http://www.ascaa.org> - American Sickle Cell Association Website

<http://www.sicklecelldisease.org> - Historic Sickle Cell Disease Website

**Step 6** The counselor explains the health effects of a person with the trait and with the disease. The sickle cell mutation, which causes the blood cells to collapse in the absence of oxygen, is frequently fatal to those with two copies of the recessive genes. But those with one copy are largely resistant to Malaria and have the sickle cell trait. Sickle cell anemia disease is more common among African descendents and persons from the Mediterranean and Southeast Asia. The counselor uses the Human Genome Map to show where the alleles for the disorders are located.

**Step 7** Websites are available to observe specifically which chromosome we can locate the alleles for sickle cell.

<http://www.accessexcellence.org/AB/IE/Introtothumangenome.html>

**Step 8** A hard copy of the HG Map is available for observation by the clients. A copy of normal blood cells and sickle cells is present for each client to view, critique, and compare.

**Step 9** After observing the website, hard copies of blood cells and the HG Map, the counselor will check for comprehension by asking specific questions about sickle cell disease disease/trait. The counselor will do this to check for understanding.

**Step 10** The counselor will draw a pedigree chart showing and explaining how the disorder is passed from parent to offspring.

**Step 11** The counselor asks the clients to trace their family history back three generations for the disorder.

Focus for Media Interaction may result from this assignment. View this website for tutorial on pedigree graphics and information:

<http://www.accessexcelence.org/AB/GG/Pedigree.html>

**Step 12**

- The counselor discusses societal concerns of a person who inherits the trait and/or the disease.
- The counselor states that the SS alleles are safe, the Ss alleles are dangerous, and the ss alleles are deadly enemies.
- The counselor discusses the bioethical, legal and societal issues associated with the disorder with the clients. The counselor allows the clients to ask important questions about these societal issues.

The insurance issue emerges; lack of job prospects, offspring and prenatal testing are discussed with the patients. "Timeouts" are frequent for questions. The counselor

refers attendees with the trait and disease to see Dr. Faith Washington, a sickle cell specialist, at the Hematology Department at Emory University Hospital. Additional time is available for family questions and concerns. Additional written material and websites are given to patients.

**Step 13** This discussion will lead to Focus for Media Interaction. The counselor will direct the students to the websites for further clarifications on these concerns.

Websites

<http://www.accessexcellence.org/AB/IB/ethicalissuesoftheGHP.html>

Clients are advised to list questions for further discussion on Cornell notes.

**Step 14** The counselor ends the session and thanks for participating.

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## CULMINATING ACTIVITY

These activities will allow students to:

1. reinforce concepts learned
  2. improve note-taking skills
  3. journaling
  4. reflections
- Complete Report: Prepare for Classroom Discussion

### Culminating Learning Activities

DESIGNER GENES – RESPONSE CARDS  
KWL CHART – COMPLETE THIS CHART  
HUNTINGTON'S DISEASE, A FAMILY HISTORY (SEE ATTACHED SHEET)

### Materials

Pen, paper, KWL chart and attached article (hand-out); commercial movies dealing with bioethics – view – written critique

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## CROSS CURRICULAR EXTENSIONS

### **Sociology and Law**

Research bioethical questions related to genetic disorders

Health / Medical Results

Research other genetic disorders



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## Language Arts / English

Complete reports on select disorders; do journal writings from research due to using the Internet and other resources.

Art (complete all signs/symbols for activities)

Students will complete a pedigree chart on Huntington's disease Sickle Cell disease/trait

Listed are topics for additional research. Use websites to research these topics. These sites will give information on gene therapy, other usages of gene science, and tell students about biomedical ethical issues, and genetic engineering. Use the KWL chart before beginning the research on these topics and complete the chart as your report. Follow through by using the Cornell note-taking method and giving your reflections.

After reports are turned in, the teacher will select one student to be counselor at the future genetic counseling sessions

1. Gene Therapy
2. Stem Cell Controversy
3. The Impact of Behavioral Genetics on the Law and Courts
4. Genes, Dreams, and Reality. The Promises and Risks of the New Genetics
5. Biotechnology
6. Cloning

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## COMMUNITY CONNECTIONS

1. Students will invite a bioengineer to class to discuss the scientific implications of the HGP on human life.
2. Students will invite a licensed genetics counselor, a medical doctor and a lawyer to class to discuss the bioethical issues generated due to the advancements resulting from the HGP.
3. Students can plan a field trip to the State Bureau of Investigation to observe how DNA fingerprinting is done.
4. Students will invite a hematologist to class to discuss blood diseases.

# Sickle Cell Anemia

## Questions and Worksheet

Section A.

Microscopic Observations

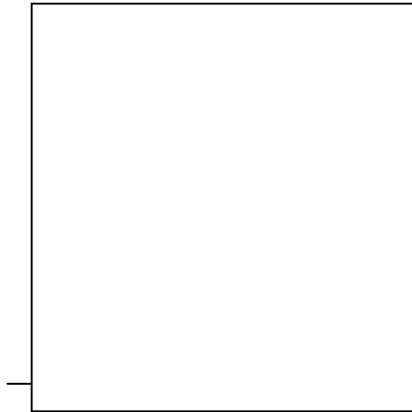


LP

normal hemoglobin

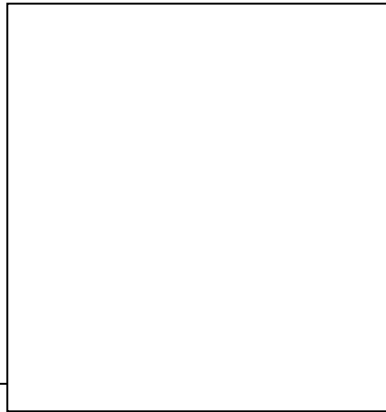


HP

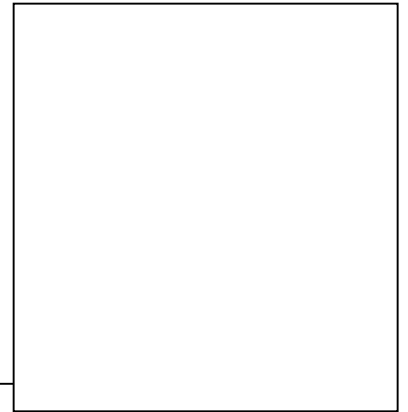


LP

Sickle Cell Anemia



HP



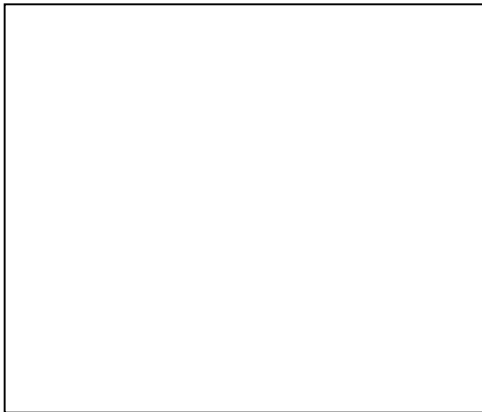
P/one cell

# Sickle Cell Anemia

## Questions and Worksheet

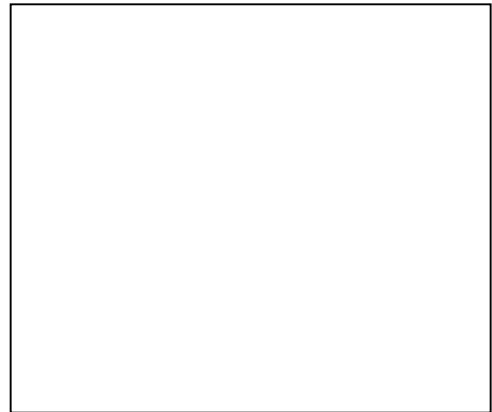
Section A.

Microscopic Observations



LP

normal hemoglobin

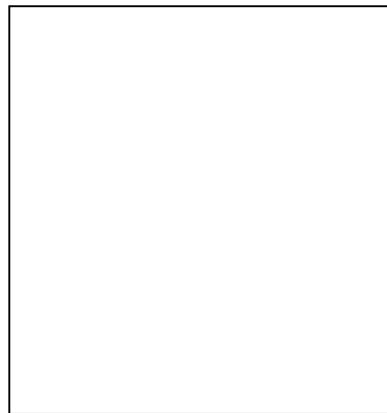


HP

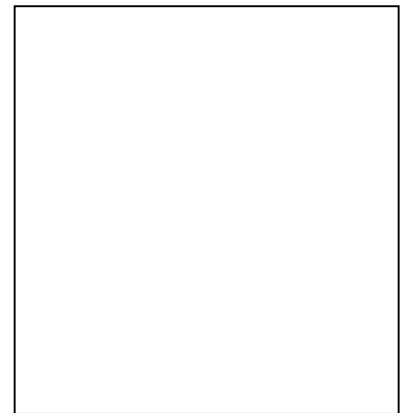


LP

Sickle Cell Anemia



HP



P/one cell

GGA	GUA	AGA	UAG	CAC	UGG	AAC	UAC	GAA	CCA	UUA	AGC
GGC	GUC	GGG	UUU	UUC	GCA	AAU	UAU	GAG	CCC	AGU	ACG
GGG	GUG	GGA	AAU	GUG	GCC	CGU	CGG	CGU	CCU	ACU	GAG
GGU	GUU	CGC	CAG	GUU	GCA	GUC	AGG	GCC	AAU	CAG	CUU

### Known portion of an Amino Acid Sequence



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GGA	GUA	AGA	UAG	CAC	UGG	AAC	UAC	GAA	CCA	UUA	AGC
GGC	GUC	GGG	UUU	UUC	GCA	AAU	UAU	GAG	CCC	AGU	ACG
GGG	GUG	GGA	AAU	GUG	GCC		CGG	CGU	CCU	ACU	GAG
GGU	GUU	CGC	CAG	GUU	GCA	GUC	AGG	GCC	AAU	CAG	CUU

**- Unknown Portion -**

Identify the shown type of genetic mutation #1 \_\_\_\_\_

Compare this portion with the known portion of an Amino Acid sequence.

Group Names: \_\_\_\_\_  
 \_\_\_\_\_



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GGA	GUA	AGA	UAG	CAC	UGG	AAC	UAC	GAA	CCA	UUA	AGC
GGC	GUC	GGG	UUU	UUC	GCA	AAU	UAU	GAG	CCC	AGU	ACG
GGG	GUG	GGA	AAU	GUG	GCC	CGU	CGG	CGU	CCU	ACU	GAG
GGU	GUU	CGC	CAG	GUU	GCA	GUC	AGG	GCC		CAG	CUU

- Unknown Portion -

#2 Type of Mutation \_\_\_\_\_



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GGA	GUA	AGA		CAC	UGG	AAC	UAC	GAA	CCA	UUA	AGC
GGC	GUC	GGG	UUU	UUC	GCA	AAU	UAU	GAG	CCC	AGU	ACG
GGG	GUG	GGA	AAU	GUG	GCC	CGU	CGG	CGU	CCU	ACU	GAG
GGU	GUU	CGC	CAG	GUU	GCA	GUC	AGG	GCC	AAU	CAG	CUU

**- Unknown Portion -**

Mutation Type #3 \_\_\_\_\_



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GGA	GUA	AGA	UAG	CAC	UGG	AAC	UAC	GAA	CCA	UUA	AGC
GGC	GUC	GGG	UUU	UUC	GCA	AAU	UAU	GAG	CCC	AGU	ACG
GGG	GUG	GGA	AAU	GUG	GCC	CGU	CGG	CGU	CCU	ACU	GAG
GGU	GUU	CGC	CAG	GUU	GCA	GUC	AGG	GCC	AAU	CAG	CUU

- Unknown Portion -

Mutation # 4 \_\_\_\_\_



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GGA	GUA	AGA	UAG	CAC	UGG	AAC	UAC	GAA	CCA	UUA	AGC
GGC	GUC	GGG	UUU	UUC	GCA	AAU	UAU	GAG	CCC	AGU	ACG
GGG	GUG	GGA	AAU	GUG	GCCCCCGU		CGG	CGU	CCU	ACU	GAG
GGU	GUU	CGC	CAG	GUU	GCA	GUC	AGG	GCC	AAU	CAG	CUU

- Unknown Portion -

Mutation # 4 \_\_\_\_\_



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