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Introduction to DNA

9th/10th grade Biology 2013-2014

Unit Overview

Day/Lesson	Main Topic	Concepts
1 ◊ ●	Strawberry DNA Lab – Day 1	Where is DNA?
2 ¤ ◊ ●	Strawberry DNA Lab – Day 2	What does it look like to the naked eye?
3 ◊	History of DNA, structure and function of DNA	What is the history and basics of the structure and function of DNA?
4 ◊ ϖ	Structure and function of DNA, continued in detail	How do base pairs connect to the function of DNA?
5 ◊ ϖ	Relationship between DNA, genes, and chromosomes	How are chromosomes, genes, and DNA related?
6 ¤ ● Δ	DNA replication	How and why does DNA make a copy of itself? Basics of replication
7 ◊ ϖ ●	DNA replication (cont.)	Nuances of replication
8 ¤ ◊	Review	ActivExpression and Q&A session
9 ¤	Unit Test	Summative Assessment

¤ = Assessment ϖ = Differentiation ◊ = M.I. ● = Inquiry Δ = Argumentation

Lesson 1: Strawberry DNA Lab – Day 1

Essential Questions:

- Where is DNA?
- How could you collect DNA?

Measurable Objectives:

- Identify where DNA is located in the cell.
- Explain how to isolate DNA from a cell.

Do Now:

● **[4 min + 6 min class discussion]**: Discuss with your partner; How could you collect DNA from a cell? Write down a minimum of 2 ideas that are important to consider in order to do this. *[To introduce the unit we want students to be able to extract and visualize DNA in person. Students will begin this lesson by working with their partner to apply their previous knowledge of cell structure and multicellular organisms to determine important considerations they should take in order to separate DNA from an entire strawberry. We are doing this to intentionally bring students prior knowledge into the laboratory experiment and implement teacher-initiated inquiry.]*

Body:

◊ **[5 min]**: Introductory discussion to show a broad overview of the topic DNA. The overview will be interactive with students by asking them to apply prior knowledge concepts of cell. This will be associated with a presentation that supports the discussion with text and visual representations of the range of purposes of DNA. The presentation will focus students attention on the process of DNA replication. *[This presentation will serve the purpose of providing students with a multimodal introduced to the variety of functions DNA serves in a living organism. Incorporating visual, aural, and text during the presentation into the overall introduction, with a specific direction and focus of the unit, will support multiple intelligences. This will serve as a preview of DNA so students can orient their prior knowledge to where we are ultimately going with the process of DNA replication.]*

● **[30 min]**: Students will work with their lab group to complete the pre-lab questions before conducting the laboratory activity. Students will then spend the rest of the period constructing their own procedure for extracting DNA from a strawberry. They will be given the different materials available and teacher guided questions to direct them in what they should take into consideration. *[This teacher-initiated inquiry will allow students to plan their own procedure and formulate their own results. By incorporating their prior knowledge on cell structure and the location of DNA students will be able to preview the materials they have access to and design their own plan and data collection method.]*

Lesson 1: Supplemental Materials

Strawberry DNA Lab - Day 1

Pre-Lab Questions:

1. What type of eukaryotic cell is a strawberry cell (animal, protist, plant, fungi)?
2. What are the general characteristics of this type cell?
3. Where is the DNA located in eukaryotic cell?
4. Do you think you could use this equipment to extract DNA from a strawberry? Explain why or why not.

Equipment:

1. Strawberry
2. Ziplock bag
3. 2 beakers
4. 1 plastic funnel
5. 1 square cheesecloth
6. 1 50 mL conical tube
7. 5 mL of 70% Isopropyl Alcohol
8. Disposable pipette
9. Microcentrifuge tube
10. 20 mL extraction solution
    a. 900 mL water
    b. 100 mL shampoo
    c. 2 tsp salt

What you must consider:

1. What steps will you follow in order to collect DNA from your strawberry?
    - Write each step down in order.
2. What materials will you use in each step?
    - Write down the material and amount of that material for each step.
3. At which steps will you collect data?
4. What type of data will you collect?
5. How will you organize and record the data?
    - Create a space and way to organize the data you will be collecting.

Lesson 2: Strawberry DNA Lab – Day 2

Essential Questions:

- What does DNA look like to the naked eye?

Measurable Objectives:

- Explain what DNA looks like to the naked eye.
- How can DNA be extracted from a plant cell?

Do Now:

◊ ¤ ● **[3 min]**: Predict what DNA look like when you collect it from the strawberry. Explain the reasoning for why you think it will look this way. *[With the basic introduction to the history, structure, and function of DNA from yesterday students will predict what they expect DNA will look like after they extract it from the strawberry. This will allow students to apply their prior knowledge of cell size and how it relates to DNA size. This do now will also serve as an assessment to show the teacher whether they are making these connections between yesterday's introductory overview and past unit information.]*

Body:

◊ ● **[30 min]**: Students will be carrying out the procedure they created from yesterday's class in their groups. *[Students will be able to implement the procedure, data collection method, and use of materials they planned. This teacher-initiated inquiry will allow students to extract DNA from common items, such as the strawberry and soap/salt/water solution.]*

● **[7 min]**: Students will compare their sample of DNA with other groups and the teacher. Students will be able to compare their procedure with other groups during time. *[This will give students the ability to see what other students were able to produce and how they went about doing it. By comparing their results with other groups they will be able to engage with the material in more social interaction and discuss the different procedures they created. By comparing their samples with the teachers they will see what the teacher procedure produced so when they complete their post-lab write up they have a reference point. This will allow groups that may not have had a very successful procedure the opportunity to see the DNA sample.]*

¤ **[5 min]**: Students will write an exit ticket explaining if their prediction of what DNA would look like to the naked eye was correct and if not they must explain why it was incorrect. *[This exit ticket will allow students to look back on their prediction after completing the lab. After they observe their DNA, other groups DNA, and the teacher's, they will return to their prediction and identify whether their prediction was accurate in this exit ticket. This exit ticket will act as an assessment for the teacher to gauge students understanding and ability to apply knowledge of cell size, structure, and the previous days mini-lecture on the introduction to DNA.]*

Lesson 2 – Supplemental Materials

Strawberry DNA Lab - Day 2

Post-Lab Questions:

1. Did your procedure allow your group to successful reach the goal of this lab?
   - Explain why or why not.
2. How did your sample of DNA compare to the teacher's sample?
3. Compare your procedure to the teacher's.
   a. How are they different?
   b. How are they similar?
4. Would you change any steps in your procedure to make it more successful?
   - If yes, write the changes you would make and what you think they would do to make your experiment better.
   - If no, explain why you think there is no way of improving your procedure.
5. What is the purpose of mashing the strawberry in the extraction solution?
6. What is the purpose of using the cheesecloth?
7. What is the purpose of using the isopropyl alcohol?
8. Read your Do Now from today. Was your prediction accurate to what you observed?
   - Explain.

Teacher's Protocol:

1. Place ½ strawberry in a ziplock bag
   Observations of your ½ strawberry:
2. Pour 20mL extraction solution into bag
3. Seal bag tightly, removing as much air as possible
4. Gently mash the strawberry in the extraction solution, 5 min
   Observations of your mashed strawberry:
5. Place funnel into the 50mL tube and filter contents of bag through the cheesecloth
6. Gently squeeze cheesecloth until all liquid has passed through the cloth.
7. Add 5 mL isopropyl alcohol to the tube
8. Hold tube to eye level and observe beautiful DNA precipitate.
9. Remove DNA from tube using the pipette and place in microcentrifuge tube.
   Observations of strawberry DNA:

Lesson 3: History and Basic Structure and Function of DNA

Essential Questions:

- What is the history and basics of the structure and function of DNA?

Measurable Objectives:

- Identify when and by who the modern model of DNA was discovered.
- Describe the basic structure and function of DNA.

Do Now:

[3 min]: Get into groups of 2-3 around one desk. Clear off your desk except for your notebook and something to write with. *[Students will get physically prepared to embark on their own data collection activity. They will work in small groups to allow for student interaction in condensing the information into their own timeline.]*

Body:

◊ **[27 min]**: Guided computer information collection. Small groups complete the DNA timeline history activity. *[This computer group work activity will get students to collect their own data about the basic history, structure, and function of DNA. They will each be constructing their own timeline. This will allow them to preview and learn this information from multiple forms and sources before having the teacher summarize and review the material.]*

◊ **[15 min]**:Co-constructed presentation in which the teacher compiles information from students in a timeline on the board, elaborates/adds necessary details, and discusses significance of the information. *[This presentation allows students to provide their own data to contribute to the entire class's collective information. The teacher will direct students attention to the key ideas and help them model note taking by extenuating key concepts and terms on the board, as well as model for them how to take large quantities of information into more concise phrases. Students will be making additions to their timelines as the teacher the class goes through this presentation. This will act as an assessment to determine students overall engagement with the activity and ability to collect information.]*

Lesson 3 – Supplemental Materials

DNA Timeline Activity

Directions: On a piece of graph paper construct a timeline that includes the following information. Show the dates spread out so that the time in-between each even is shown by the correct gap in time. Utilize the resources below to find this information.

When was:

Entire human genome is sequenced.

What did they do & When?

James Watson and Francis Crick
Gregory Mendel
Miescher
Sutton
Griffith
Avery, Macleod, McCarty
Hershey and Chase
Franklin and Wilkins
Chargraff
Phoebus Levene

Add **two extra** events or scientists for extra credit!

Resources:

1. Textbook: Chapter 9
2. http://www.pbs.org/wnet/dna/timeline/
3. http://www.brighthub.com/science/genetics/articles/99840.aspx
4. http://www.learner.org/interactives/dna/history.html
5. http://www.youtube.com/watch?v=M3zqxM8gcew

Lesson 4: Structure and Function of DNA

Essential Questions:

- How do base pairs connect to the function of DNA?

Measurable Objectives:

- Describe and draw the structure of DNA.
- Explain the function of DNA.

Do Now:

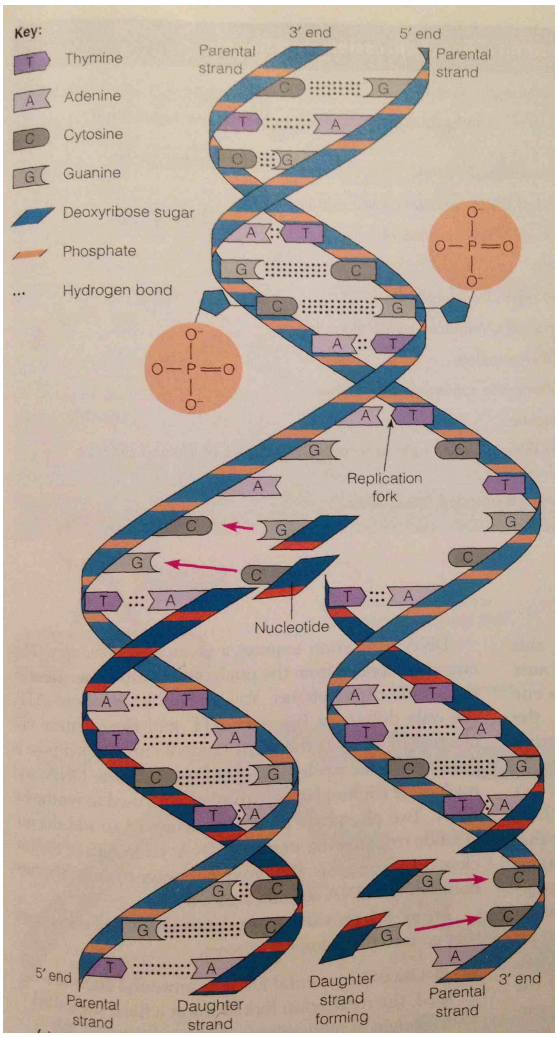
◊ **[3 min + 7 min review]**: Draw the structure of DNA & key terms to describe its structure. Direct instruction will begin with an overview of the do now that presents the idea of base pairs with an image and have students compare it to their drawings. *[This Do Now will support multiple intelligences by allowing students to show their understanding with a drawing and applying the key terms or vocabulary to describe their drawing. The direction instruction will begin with the teacher explaining base pairing with the support of an image that represents this. Students will be able to compare their Do Now with the image and build on their basic knowledge of DNA structure and function.]*

Body:

◊ ɷ **[30 min]**: Direction instruction with simultaneous video and diagraming. The teacher will interchange between showing the video, pausing it for explanation and directing students attention to key concepts, and diagraming on the board for students the more detail information of the structure and function of DNA. Video: DNA Structure and Replication: Crash Course Biology #10 https://www.youtube.com/watch?v=8kK2zwjRV0M&list=SP3EED4C1D684D3ADF. *[This multimodal direct instruction will support multiple intelligences and differentiate for students different methods of note taking that unit the vocabulary, text, and concept explanations.]*

◊ **[5 min]**: Exit Ticket; Draw a DNA double helix model. Label the different sets of base pairs (use both sets!). Your drawing should be 5 base pairs long. *[This will continue to support multiple intelligences with students building upon their drawing of the double helix with the added detail of base pairing.]*

Lesson 4 – Supplemental Materials



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Lesson 5: Relationship between DNA, genes, and chromosomes

Essential Questions:

- How are chromosomes, genes, and DNA related?

Measurable Objectives:

- Explain where DNA, genes, and chromosomes are located.
- Describe the relative size differences between DNA, genes, and chromosomes.
- Explain the relationship between DNA, genes, and chromosomes.

Materials:

- Pipe cleaners, Tape (color coded), Markers (color coded)

Do Now:

[3 min]: Read the instructions for the activity and copy the steps into your notes. *[This Do Now will allow students to be more independent during the activity as they will not rely solely on the teachers step by step verbal instruction.]*

Body:

◊ **[10 min]**: Using your Exit Tickets from yesterday construct an 8 base pair long DNA strand with your partner. *[Students will be able to build their own pipe cleaner DNA with the materials above in order to create a more hands on and kinesthetic experience with DNA and the process of replication.]*

◊ **[10 min]**: Students will watch a video on heredity and construct a short summary on the video with a partner. Video: Heredity: Crash Course Biology #9: https://www.youtube.com/watch?v=CBezq1fFUEA&list=SP3EED4C1D684D3ADF

◊ ɷ **[20 min]**: Read Section 2 of Chapter 9 and write down key words and phrases from the reading. *[This reading will address multiple intelligences with a text that supports the visual and kinesthetic aspects of the early tasks in this class period. This task will be differentiated by requiring the students who have a difficult time writing summaries from text to be responsible for defining and explaining the relevance of the the bold words of the reading. Other students will be responsible for providing an small paragraph explanation for each subsection in this section of the chapter.]*

Homework given:

Students write 4 questions: 2 simple/vocab questions, 2 critical thinking/application questions such as to define, identify, apply, analyze, etc. They will switch their questions with their partner and begin answering the questions during the end of class and complete them for homework. *[This homework will support higher level thinking and student inquiry about the reading and topics covered in this lesson. It will provide students with opportunity for peer assessment and investigation into questions that their peers created that can push students thinking on this topic.]*

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Lesson 6: DNA Replication – Day 1

Essential Questions:

- How does DNA replicate itself?
- How does one strand of DNA become two strands of DNA?

Measurable Objective:

- Explain and model the BASIC mechanism of DNA replication, step by step.

Materials:

- ◊ (S) - Pipe cleaner DNA helices, list of replication vocabulary words, flow chart of replication steps; (T) - Simple replication video, presentation

Do Now:

¤● Δ **[10 min planning/working with pipe cleaners + 5 min writing explanation]**: Make a prediction: How do you think DNA makes a copy of itself so that one strand becomes two? Demonstrate with your pipe cleaners and write your explanation in your notes. There is no right or wrong answer at this point. Work with your partner.

[There will be a timer on the board at the beginning of class to help keep students on task. We wanted the students to actively engage with the material and to work with their hands, so we are having them use their DNA models from the previous lesson in order to continue to think about how DNA works. This activity and model is especially relevant for students who are visual and/or kinesthetic learners. The inquiry-based component of this lesson is the do now, where we want students to access prior knowledge about the structure of DNA and try to extrapolate and predict HOW the DNA molecule replicates. Additionally, because students must work with their partners, they will engage in informal argumentation because they must defend their reasoning to their partner.]

Body:

[In this lesson we are introducing the idea that DNA must copy itself in order for the organism to continue to survive. We also cover the mechanism of DNA replication.]

[15 min]: Students share ideas from do now with the whole class and teacher uses student models to verify and explain (verbally, briefly) the true mechanism of DNA replication.
[Student-teacher co-constructed knowledge]

◊ **[5 min]:** Show video (Simple DNA replication video - http://www.youtube.com/watch?v=zdDkiRw1PdU)
[This is the formal introduction of the mechanism of DNA replication. Today we are solely covering the basics of replication and we are omitting these details: details of the leading vs. lagging strand (which is which), primers, helicase, polymerase, Okazaki fragments, 5' -> 3' replication.]
Guided notes - list of terms; flow chart of steps of replication [only basic terms/steps today]
[Students follow along in the video with their guided notes and flow chart. Again, this targets multiple modalities for learning.]

◊ **[10 min]:** Teacher models replication by drawing and explaining the process and having the students copy along in notes.
[3rd and final representation of the mechanism by which DNA replicates. It is important for students to see a process occurring multiple times and in multiple ways in order to fully understand it.]

Steps of DNA replication
1. The DNA double helix unwinds (by helicase)
2. DNA polymerase works down the leading strand and up the lagging strand to add nucleotides in the correct order. This creates a complementary strand.
3. Finally, the DNA strand is "sealed up" by telomeres, the terminal ends of the DNA molecule.

Lesson 7: DNA Replication – Day 2

Essential Questions:

- How and why does DNA replicate.

Objective:

- Explain and model the ENTIRE mechanism of DNA replication, step by step.

Materials:

- ◊ ϖ (S) - List of replication vocabulary words, flow chart of replication steps, guided notes; (T) - Detailed replication video , presentation

Do Now:

● **[5 min]** Why is DNA replication necessary?

[Students should think, write, then share with their table partner. Then, we will designate a "spokesperson" from each table to tell the whole class what they and their partner came up with. The spokesperson should not just say what they wrote, they are required to talk to their partner and agree upon an answer to share. We will put students' ideas on the board. The purpose of this do now is to connect DNA replication to growth and development, which are familiar ideas to the students. Additionally, tie in students' prior knowledge of mitosis/meiosis and remind them the goal of understanding DNA replication - to understand how genetic information is passed from generation to generation and, more specific to this situation, from cell to cell.]

Body:

ϖ **[15 min]** Discuss replication in more detail: show 2nd video
http://www.youtube.com/watch?v=OnuspQG0Jd0 (0:34 - 3:37)

[Again, videos Today we will show the more complex DNA replication video and we will make sure these topics are covered: leading vs. lagging strand, primers, helicase, polymerase, Okazaki fragments, 5' -> 3' replication. We will stop along the way and]

◊ **[20 min]** Return to drawings from yesterday and fill in missing information

[Today, we will re-draw or return to the old drawing of the DNA double helix and we will fill in the appropriate details. Students should follow along in their notes.]

Homework Assigned:

Write down a minimum of three concepts/terms that are confusing to you or that you would like reviewed further.

Lesson 8: Unit Review

Essential Questions:

Measurable Objectives:

- Explain the history, structure & function of DNA.
- Relate DNA, genes, & chromosomes.
- Explain DNA replication.

Materials:

- ActivExpression Clickers

Procedure:

Answer & review ActivExpression questions

[Each pair of students will receive one ActivExpression clicker, unless we know a particular student to work poorly with others, in which case they have their own clicker. The students have signed out the clickers so we know who has which one at all times. One point is awarded toward their class participation grade for answering the question, and two points for answering correctly. After all students have voted, we will display a graph on the screen that says what percentage of people voted for which question. Then, we will save another graph to the flipchart that we will look at later that tells us who answered what, and how long it took them to come up with the answer.

Students must engage in informal argumentation because they must reach an agreement with their partner about which answer to select. This requires them to defend their responses to each other. Students who work alone are gradually being taught to work with others (one question together, three alone, etc.)]

Review HW - teacher collects HW at beginning of the period and then chooses a few questions/concepts to review for the whole class.

[This HW assignment ensures students are building appropriate study skills by deciding what they have and haven't mastered. Additionally, it gives them a space in which they can voice their concerns anonymously.]

Lesson 9: Unit Test

Name: _____ Date: _____
Unit 7 Test: DNA Score: _____

Multiple Choice: Circle the best answer for each of the following questions. (2 points each)

1. Okazaki fragments are used to elongate (make longer)
    a. The leading strand toward the replication fork
    b. The lagging strand toward the replication fork
    c. The leading strand away from the replication fork
    d. The lagging strand away from the replication fork

2. How many DNA strands exist after the parent strand has been replicated?
    a. 1
    b. 2
    c. 3
    d. 4
3. Multiple replication forks or bubbles along the DNA strand
    a. Correct replication errors
    b. Reduce the time it takes to replicate the strand
    c. Ensures the new and old DNA strands are complementary
    d. Signal DNA polymerase to stop

4. Which of the following is not found in DNA?
    a. Carbon
    b. Nitrogen
    c. Sulfur
    d. Hydrogen

5. Replication of DNA requires
    a. Unwinding
    b. Hydrogen bonding
    c. Pairing
    d. All of the above

6. In DNA, the 5-carbon sugar is called
    a. Uracil
    b. Adenine
    c. Deoxyribose
    d. Ribose

7. The double helix structure of DNA was described by
    a. Watson & Crick
    b. Mendel

c. Chargaff
d. Obama

8. The discovery of Okazaki fragments suggests that DNA replication is sometimes
a. Continuous
b. Semiconservative
c. Discontinuous
d. Conservative

9. DNA is made up of subunits called
a. lipids
b. proteins
c. nucleotides
d. RNA

10. The base-pairing in DNA occurs between
a. A & G
b. C & A
c. T & C
d. A & T

False statements: Each of the following statements is false. **Replace the underlined word(s)** with the word(s) that will **make that statement true**. (2 points each)

1. Polymerase unzips the parent DNA molecule and splits it in two.

2. Okazaki fragments are made on the lagging DNA strand.

3. DNA replicates in the 4' → 6' direction.

4. Helicase builds new DNA strands by matching nucleotides to their base pairs.

5. During semiconservative replication three new DNA molecules are formed.

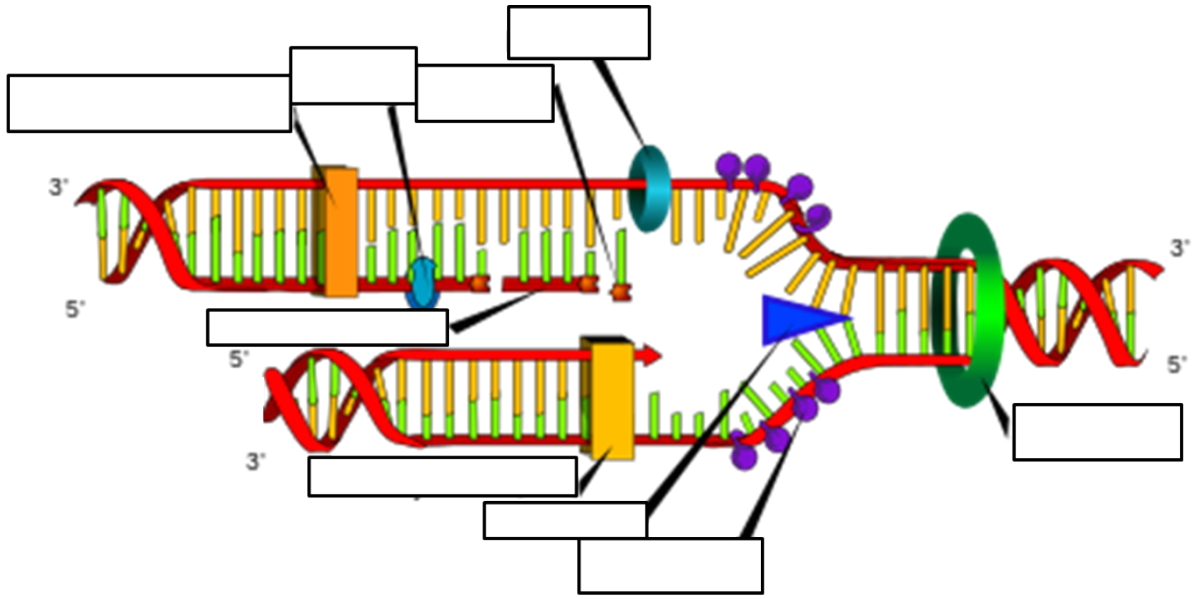
6. The elongation of Okazaki fragments progresses towards the replication fork

7. After DNA replication is complete the daughter strands <u>do not</u> look exactly like the parent stand.

8. Formation of a leading strand but not a lagging strand does not require a primer.

<u>Label & Draw</u>: Using the word blank below complete each box.

DNA-Polymerase	Helicase	DNA primase	DNA-ligase
RNA-primer	Single strand Binding protein		
Topoisomerase		Okazaki fragment	



<u>Short Answer</u>: Answer the following questions with complete sentences. (5 points each)
1. Explain what DNA looks like to the naked eye.

2. Give two reasons why DNA replication is important.

3. Explain the three parts of a DNA nucleotide.

4. What are two functions of DNA polymerases during replication?

5. Distinguish between DNA, genes, chromatids, and chromosomes.

6. Describe the four events that are occurring in the image below. Be sure to **include at least 4** of the following vocabulary in your description: DNA-Polymerase, Helicase, DNA primase, DNA-ligase, RNA-primer, Single strand, Binding protein, Okazaki fragment, Topoisomerase.