The task[217]

Student groups were asked to design and build models representing DNA molecules. The models were to include details such as base pairs and nucleotide components, and to illustrate the overall double-stranded and helical nature of DNA.

Circumstances of performance

This sample of student work was produced under the following conditions:

	alone	√	in a group
	in class		as homework
√	with teacher feedback		with peer feedback
	timed	√	opportunity for revision

This work sample illustrates a standard-setting performance for the following parts of the standards: [218]

S2b Life Sciences Concepts: Molecular basis of heredity.

S4a Scientific Connections and Applications: Big ideas and unifying concepts.

S8c Scientific Investigation: Design.

What the work shows

S2b Life Sciences Concepts: The student produces evidence that demonstrates the molecular basis of heredity, such as DNA….

(A) The students illustrate complementary base pairs; alternate sugar-phosphate side chains, and appropriate placement of the nucleotide components. The model also shows the double stranded and helical nature of DNA. It includes an illustrated key [not shown]. The students attempted to illustrate the dynamic nature of the molecule with a crank handle that turns the model that is not visible in the photo.

(B) The students had an opportunity to revise their initial submission (A). They more accurately depict the sugars and they added the phosphates. An attempt was made to illustrate more clearly the spatial relationship between these nucleotide components. In further revising the model, the hydrogen bonds between the nucleotide base pairs could be illustrated along with a more accurate depiction of accurate base pair size.

(C) The students illustrate complementary base pairs, hydrogen bonding, alternate sugar phosphate side chains, and appropriate placement of the nucleotide components. The model also shows the double stranded nature of DNA and the process of the unzipping and formation of replicated strands. However, this model does not illustrate the helical nature of DNA, an omission that should be corrected in a revision.

S4a Scientific Connections and Applications: The student produces evidence that demonstrates understanding of big ideas and unifying concepts, such as order and organization….

(A) (B) (C) The students demonstrated in model form the organization of the DNA molecule.

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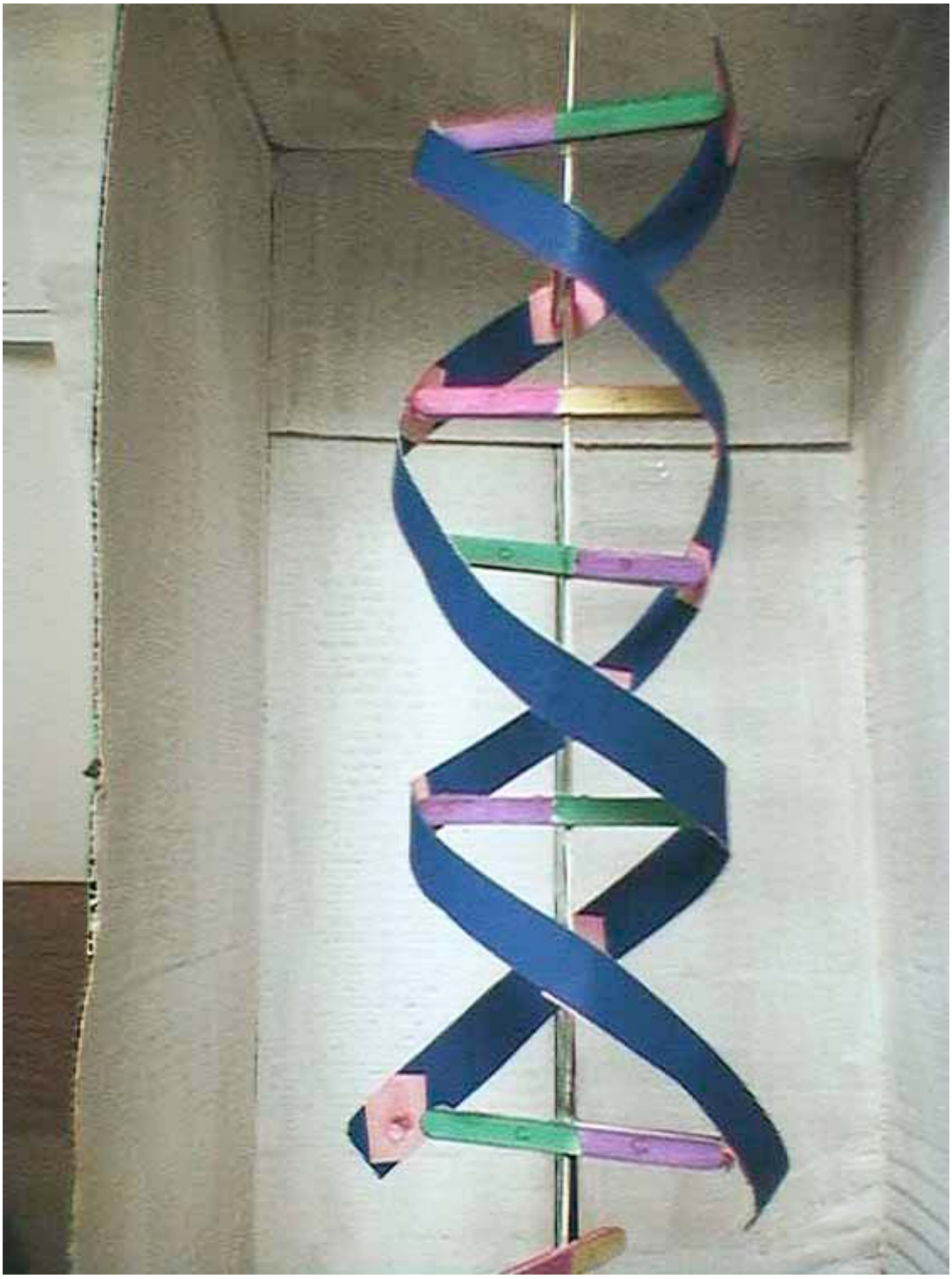
[217] For related work on Reproduction, see "Butterflies", page 89, and "It's All in the Genes", page 249.
[218] The quotations from the Science performance descriptions in this commentary are excerpted. The complete performance descriptions are shown on pages 292-339.

Work Sample & Commentary: *DNA Models*
High School Science

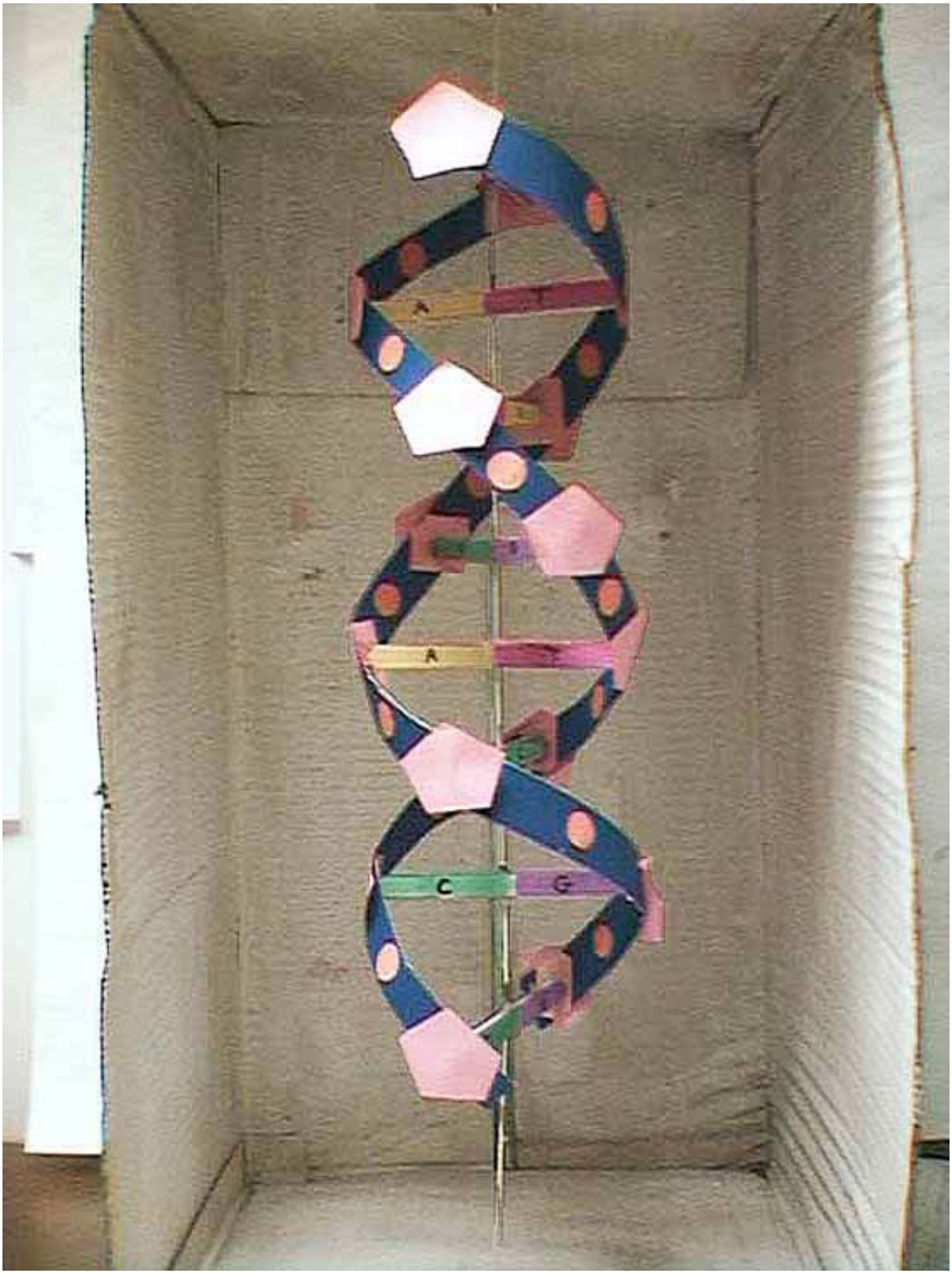
S8c Scientific Investigation: The student demonstrates scientific competence by completing [a] design.

(A) (B) (C) The students developed and executed designs that, while requiring revision, were creative and largely accurate.

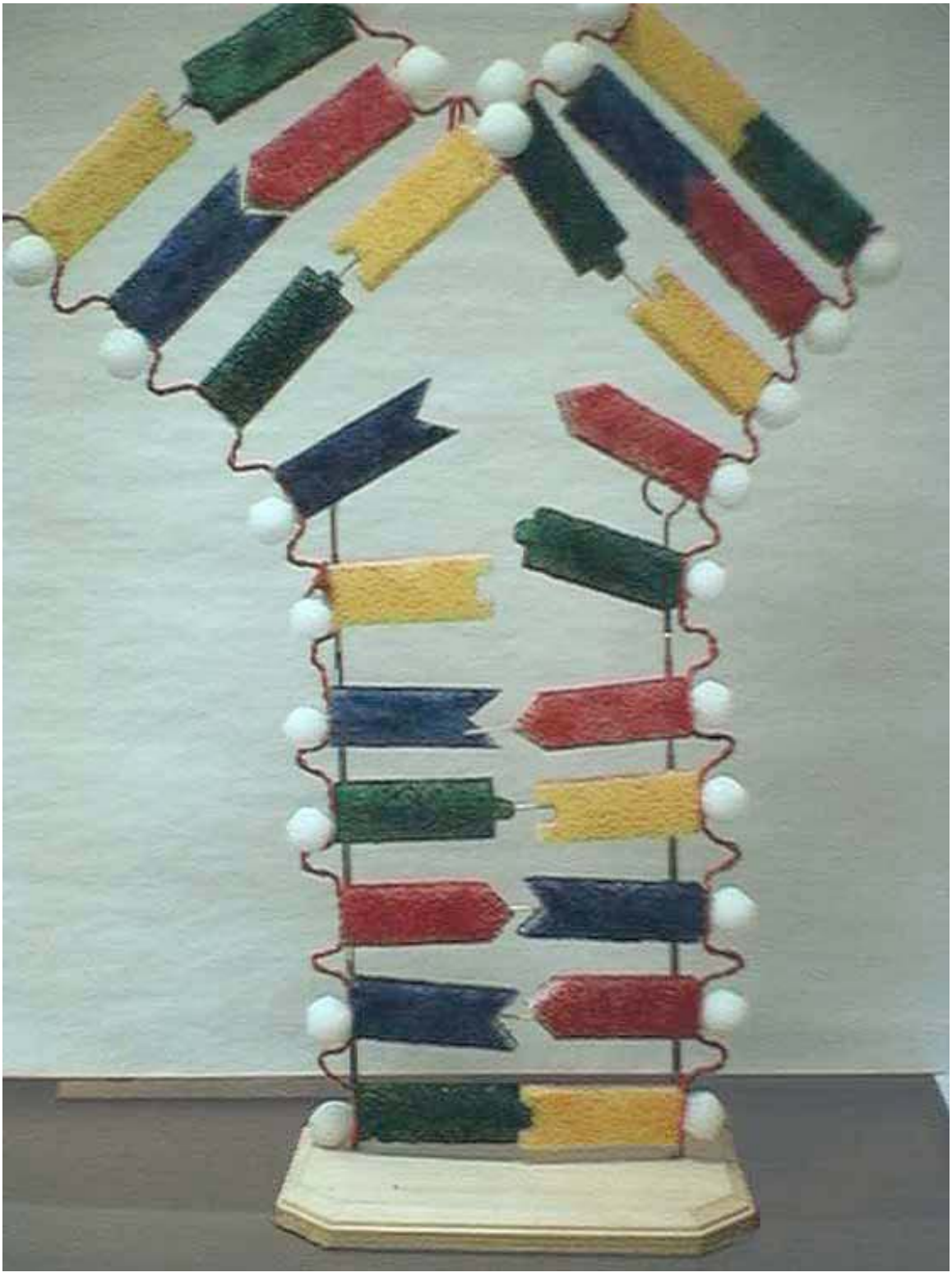
A



B



C



The task

One component of the task entitled "The Double Helix, Let's Unwind" was a bio-ethics position paper which was supported by documentation from the internet and other sources. This sample of student work was a piece of reflective writing excerpted from an internet research paper. The excerpt discusses the students' experience using the internet as a source of information. The work was part of a multi-task project, which was done by a team of students.

Circumstances of performance

This sample of student work was produced under the following conditions:

	alone	√	in a group
	in class	√	as homework
√	with teacher feedback	√	with peer feedback
	timed	√	opportunity for revision

This work sample illustrates a standard-setting performance for the following parts of the standards: [219]

S4d Scientific Connections and Applications: Impact of technology.

S6a Scientific Tools and Technologies: Use technology and tools.

S7c Scientific Communication: Critique published materials.

What the work shows

S4d Scientific Connections and Applications: The student produces evidence that demonstrates understanding of impact of technology, such as constraints and trade-offs…and problems and benefits.

(A) The student clearly states expectations.

(B) (C) (D) (E) The student lists problems encountered, such as minimal information, inoperative servers, the amount of time required to bring up information, and students' limited access to technology.

S6a Scientific Tools and Technologies: The student uses technology and tools (such as…computer aids) to observe and measure objects, organisms, and phenomena, directly, indirectly, and remotely, with appropriate consideration of accuracy and precision.

(F) The entire work shows that students used computers and the internet to collect data.

S7c Scientific Communication: The student critiques published materials, such as popular magazines and academic journals.

(B) (C) The student noted both the minimal nature of the internet references and the lack of accessibility.

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[219] The quotations from the Science performance descriptions in this commentary are excerpted. The complete performance descriptions are shown on pages 292-339.

F

The Perils of Surfing

For the BioResearch DNA Project, our class was instructed to conduct our research via the internet. This instruction did not strike us as unreasonable. Actually, we though the internet would make our research efforts much easier. We were
A inclined to believe that the internet abounded with information for our respective searches. However, all our inclinations were dashed in the face of reality.

According to a colleague involved with the project, "…I found that the internet wasn't all it was cracked up to be." One complaint borne against the internet is that information about genetic engineering is very minimal. One could put out a search for, let's say protein synthesis, but all one would find would be a fleeting mention of it in a DNA article. B

C Another problem presented by the internet was the very inconvenient service. When one puts in a request for a web site one expects an affirmative answer however many servers were down. Too many web servers were either down or no longer in service. The most exasperating aspect to this problem was that the computer would take two to three minutes to bring up this information. D

Although the internet is very useful, it still has many 'bugs' to be worked out. The fact remains that with the students busy schedule trying to use the internet is not very time efficient. Using the internet for science/medical searches takes valuable time that could be spent studying. When I went to the library to use the internet stayed there almost three hours and was rewarded with six web addresses, four of which had down servers.

While the internet may be good for online shopping and downloading games and music, the fact remains that most high
E school students do not have access to science and medical data online.

The task[220]

Students in a high school biology class were asked to create a concept map to show the relationship between DNA, its components and those of RNA. Students had to present their map and defend its structure to the class.

Circumstances of performance

This sample of student work was produced under the following conditions:

	alone	√	in a group
√	in class		as homework
√	with teacher feedback		with peer feedback
	timed	√	opportunity for revision

The work was done in teams of three students.

This work sample illustrates a standard-setting performance for the following parts of the standards: [221]

S2b Life Sciences Concepts: Molecular basis for heredity.

S4a Scientific Connections and Applications: Big ideas and unifying concepts.

S7e Scientific Communication: Communicate in a form suited to the purpose and the audience.

What the work shows

S2b Life Sciences Concepts: The student produces evidence that demonstrates understanding of molecular basis for heredity, such as DNA....

(A) (B) (C) The concept map shows the components of DNA, and the bonds that hold them together. The work shows the role of hydrogen bonds but does not distinguish them as weak, nor does it show location of the bonds. However, the overall organization of the concept map is logical and reasonably accurate.

(D) (E) (F) The concept map also includes key concepts such as formation of a complementary strand, transcription, and RNA.

(F) (G) The organizations of DNA and RNA are shown in terms of double versus single strand; note substitution of uracil for thymine.

S4a Scientific Connections and Applications: The student produces evidence that demonstrates understanding of big ideas and unifying concepts, such as order and organization [and] models....

(D) (E) (F) The relationship between DNA and RNA production is clearly shown.

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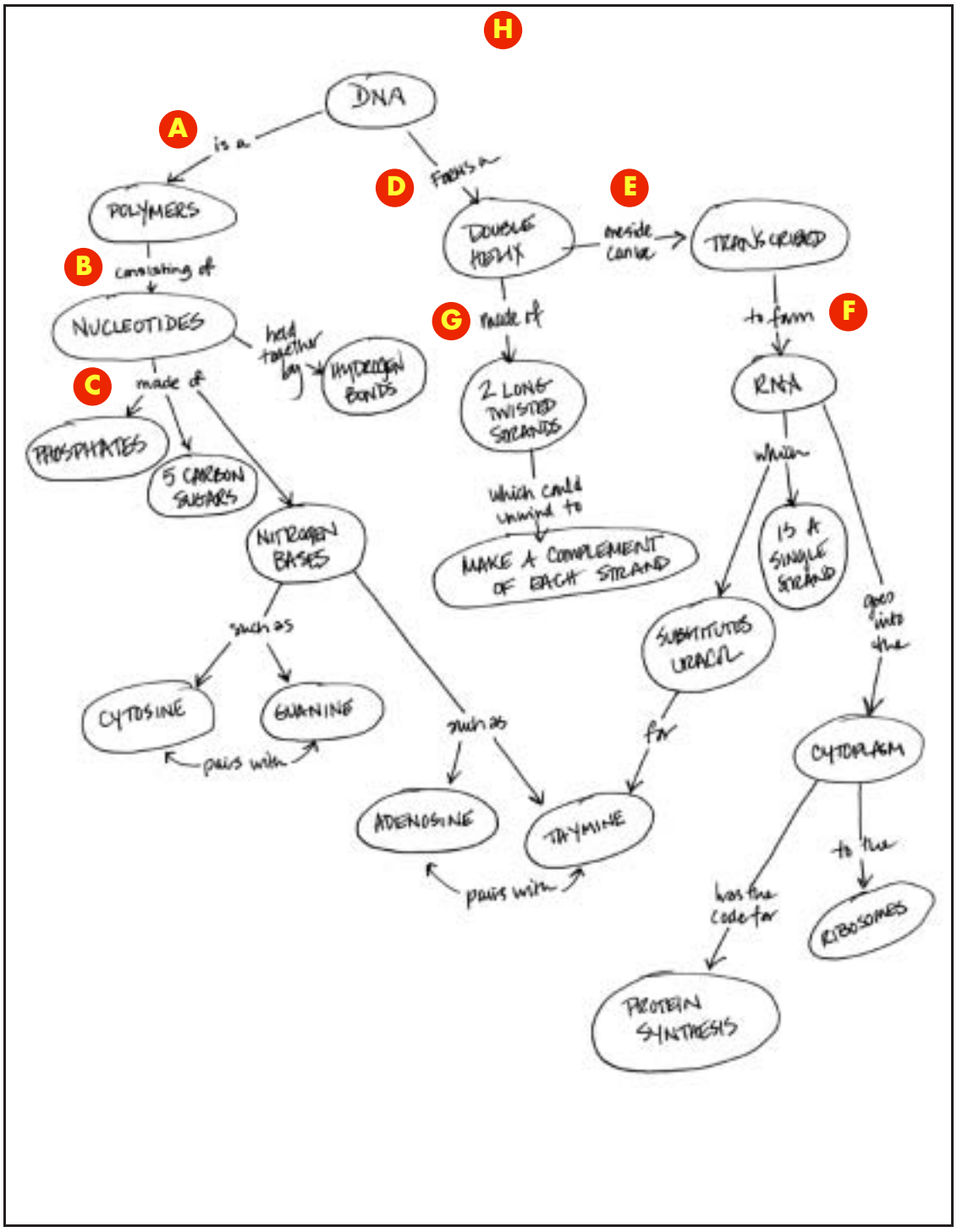
[220] For related work on Reproduction, see "Butterflies", page 89, and "It's All in the Genes", page 249.
[221] The quotations from the Science performance descriptions in this commentary are excerpted. The complete performance descriptions are shown on pages 292-339.

S7e Scientific Communication: The student communicates in a form suited to the purpose and the audience....

(H) The concept map is readable by students at differing levels of reading skill and is useful for a variety of learning styles.



The task[222]

Students were asked to build working models to show how the instructions for specifying an organism's characteristics are carried in DNA and its subunits. Students were required to give an oral presentation of their models.

Circumstances of performance

This sample of student work was produced under the following conditions:

alone		in a group
in class	√	as homework
with teacher feedback	√	with peer feedback
timed	√	opportunity for revision

This work sample illustrates a standard-setting performance for the following parts of the standards: [223]

S2a Life Sciences Concepts: The cell.

S4a Scientific Connections and Applications: Big ideas and unifying concepts.

S4b Scientific Connections and Applications: The designed world.

S7a Scientific Communication: Represent data and results in multiple ways.

S7d Scientific Communication: Explain a scientific concept or procedure to other students.

What the work shows

S2a Life Sciences Concepts: The student produces evidence that demonstrates understanding of the cell, such as cell structure and function relationships….

(A) (B) (C) The student clearly and succinctly demonstrates an understanding of the structural context of DNA within the cell.

(D) (E) The entire "Discussion" section clearly explains some basic biochemical structures and functions within the DNA molecule. The section concludes with an accurate application of these functions.

(F) The student's model is an accurate representation of the structure of the DNA molecule.

S4a Scientific Connections and Applications: The student produces evidence that demonstrates understanding of big ideas and unifying concepts, such as…models, form and function….

(G) The entire work is evidence that the student knows how to plan and build a model, and how to use a model to explain difficult concepts, such as the form and function of the DNA molecule and its subunits.

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[222] For related work on Reproduction, see "Butterflies", page 89, and "It's All in the Genes", page 249.
[223] The quotations from the Science performance descriptions in this commentary are excerpted. The complete performance descriptions are shown on pages 292-339.

S4b Scientific Connections and Applications: The student produces evidence that demonstrates understanding of the designed world, such as the…development of agricultural techniques….

(E) The student briefly describes how humans have applied knowledge of the structures and functions of the DNA molecule to agriculture.

S7a Scientific Communication: The student represents data and results in multiple ways, such as…diagrams, and…technical…writing; and selects the most effective way to convey the scientific information.

(G) The entire report is concisely and accurately written.

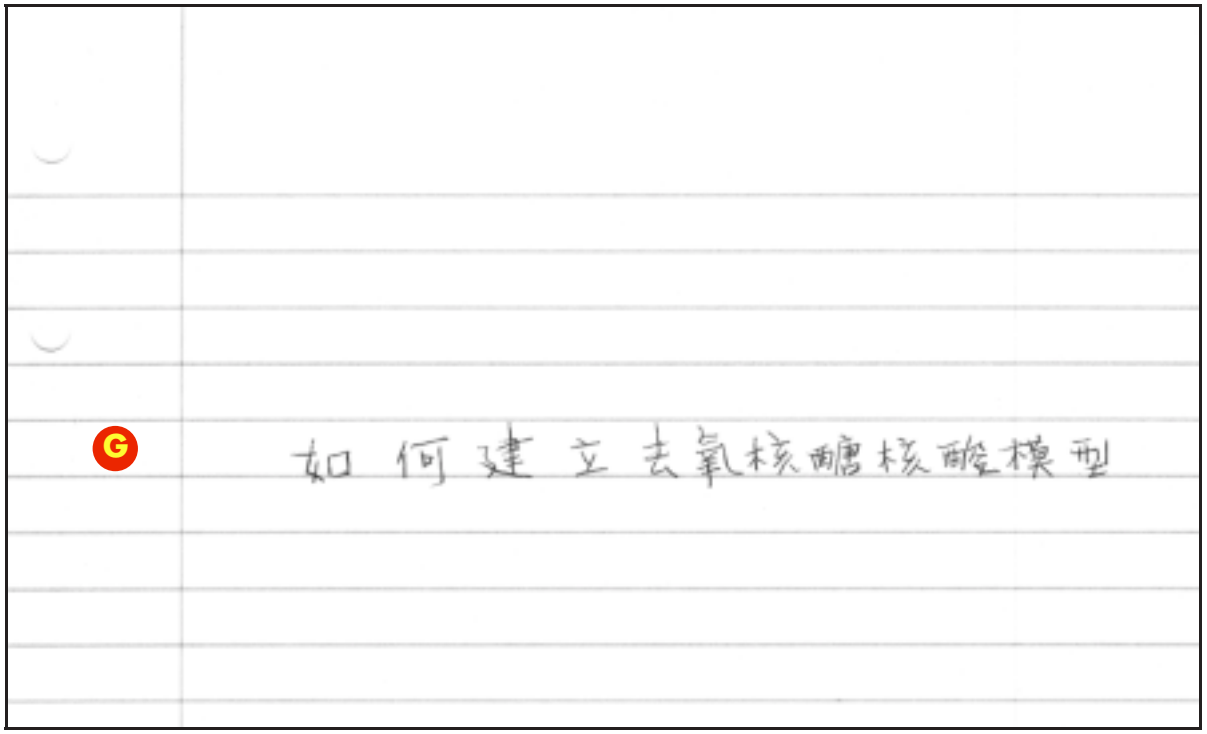
(H) (I) (J) The student illustrates the written report with carefully and accurately drawn diagrams.

S7d Scientific Communication: The student explains a scientific concept to other students.

(A) (B) The student interprets the model.

(D) The student reports clearly and succinctly about the structures and functions represented by the model.

(K) The student provides easily replicated instructions for building a similar model.



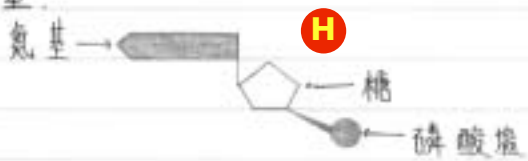
工作：建立一個去氧核醣核酸模型.
目的：更了解去氧核醣核酸形成的方式.
材料：硬紙板，木棍，金屬桿，彩色硬紙.
基礎知識：去氧核醣核酸負責攜帶並運送遺傳資料，且能控制細胞活動.

(A)去氧核醣核酸的構造.

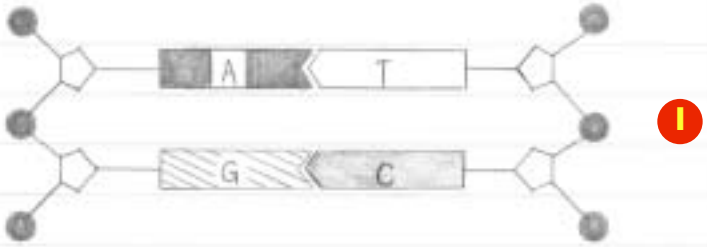
1. 每個細胞核內，有含長鏈去氧核醣核酸的染色体.

2. 去氧核醣核酸含有兩股，藉弱氫鍵結合，並扭曲成双螺旋的核苷酸.

3. 每個去氧核醣核苷酸含有一個糖，一個磷酸塩和一個氮基.



4. 一分子的去氧核醣核苷酸看起來像一個螺旋梯. 磷酸塩和糖組成梯柱. 一對氮基組成橫檔. 氮基配對只有兩種：腺嘌呤配(A)，胸腺嘧啶(T)，鳥嘌呤(G)，配胞嘧啶(C).



(B)去氧核醣核酸的複製.

1. 細胞分裂前，去氧核醣核酸先須複製.

2. 去氧核醣核酸梯子在橫檔的鹼基對間裂開，就像拉開拉鏈一樣.

3. 其他鹼基依照 A-T. C-G 的方式黏附在每個露出的另一半梯子上.

4. 每股和它互補的核苷酸，形成兩個一模一樣的新的去氧核醣核酸分子.

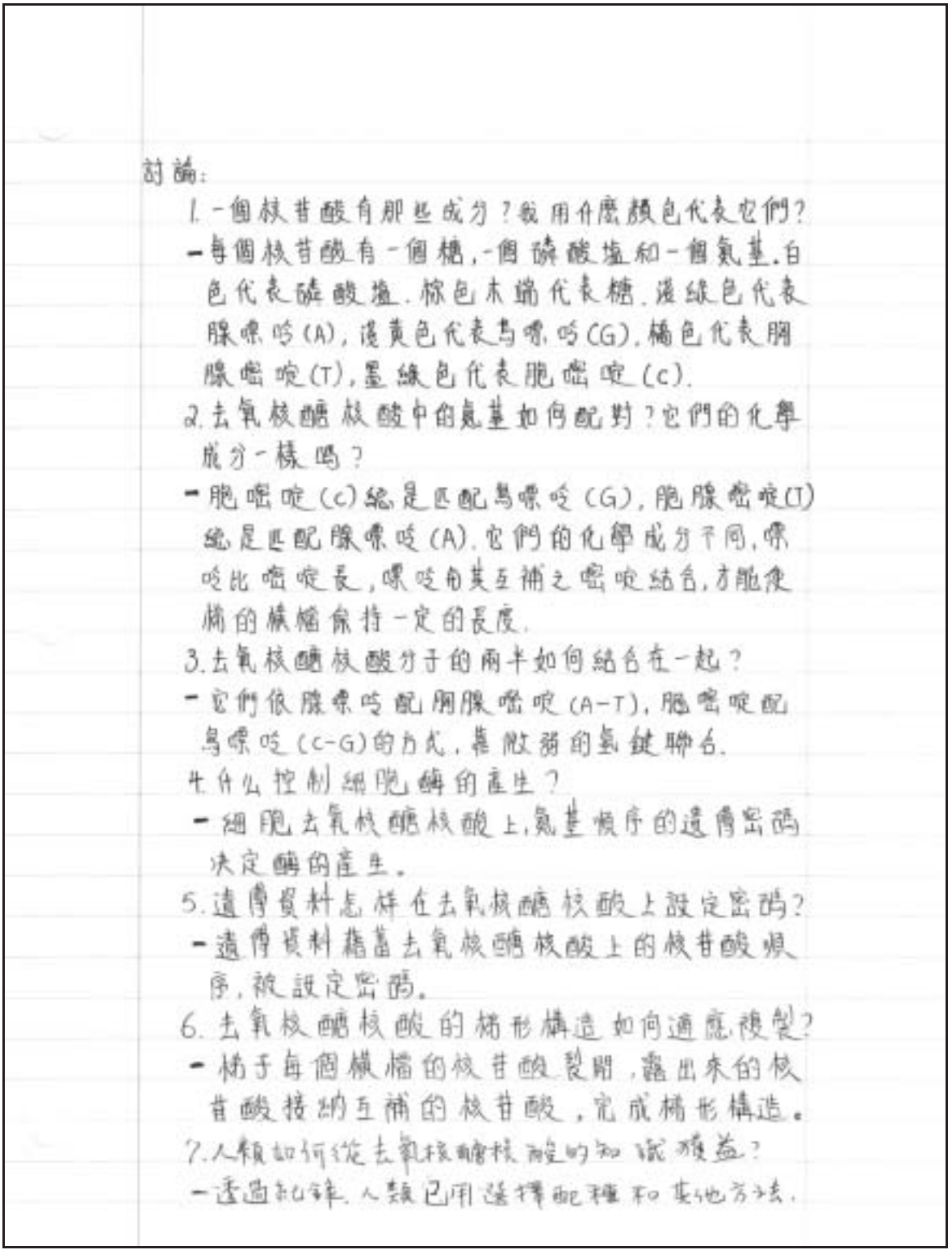
步驟: 1. 鋸成十個一樣大小的薄木條做橫檔.

2. 取部分木條，每個半用墨綠色紙，半用淡黃色紙包起來，代表 C-G 配對，但是兩頭不包.

3. 其餘的木條，每個半用淺綠色紙，半用橘色紙包起來，代表 A-T 配對，也是兩頭不包.

4. 在每個木條中央鑽個洞，好讓金屬桿可以把他們貫穿起來，並排列成螺旋形的梯子.

5. 在兩個硬紙板帶上，各切割十個跟木條寬度一樣大小的長方形洞，使木條的兩端剛好可以塞進洞裏.



討論:

1. 一個核苷酸有那些成分？我用什麼顏色代表它們？
- 每個核苷酸有一個糖，一個磷酸鹽和一個氮基。白色代表磷酸鹽，棕色木頭代表糖，淺綠色代表腺嘌呤(A)，淺黃色代表鳥嘌呤(G)，橘色代表胸腺嘧啶(T)，墨綠色代表胞嘧啶(C)。

2. 去氧核醣核酸中的氮基如何配對？它們的化學成分一樣嗎？
- 胞嘧啶(C)總是匹配鳥嘌呤(G)，胞腺嘧啶(T)總是匹配腺嘌呤(A)。它們的化學成分不同，嘌呤比嘧啶長，嘌呤和其互補之嘧啶結合，才能使梯的橫檔保持一定的長度。

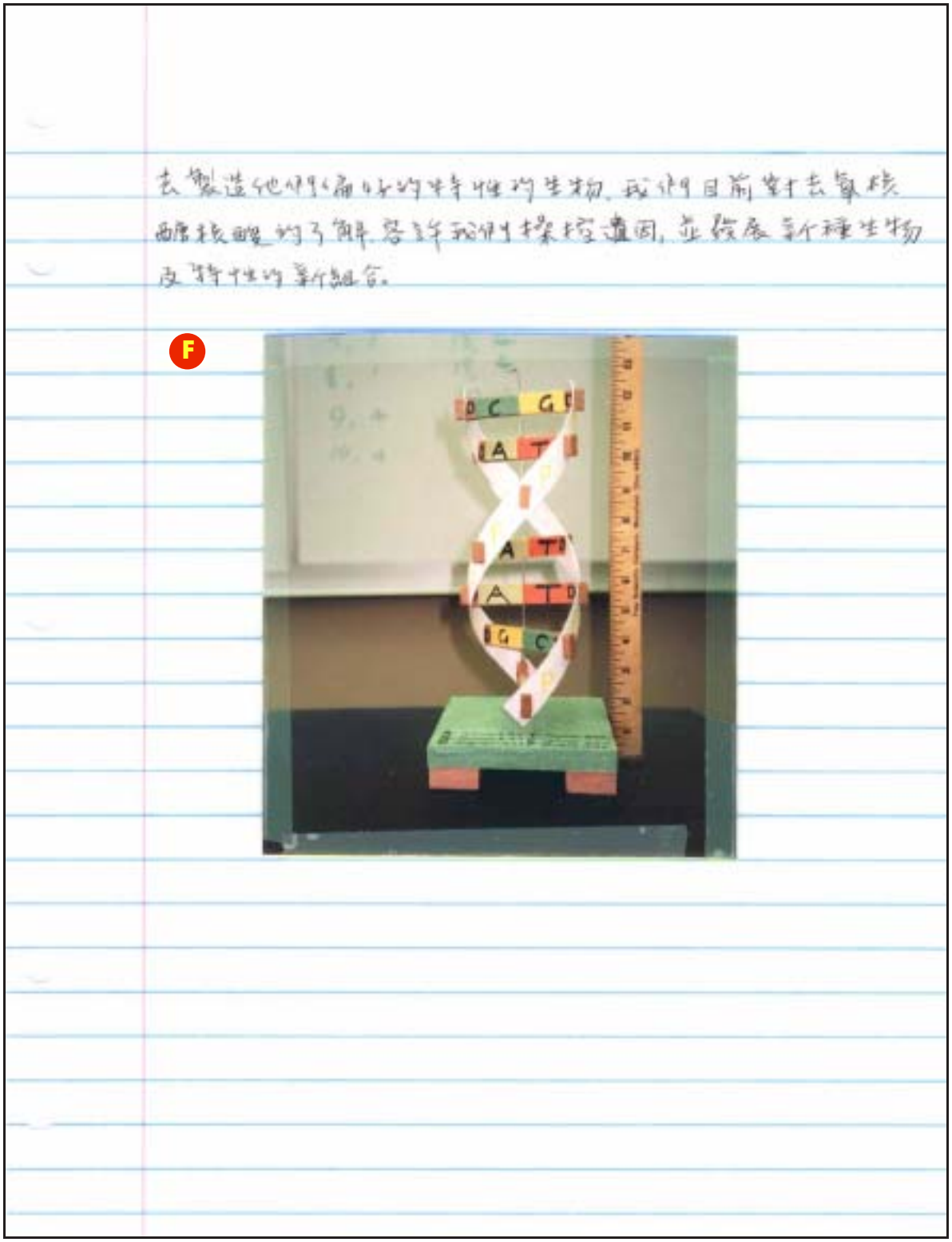
3. 去氧核醣核酸分子的兩半如何結合在一起？
- 它們依腺嘌呤配胸腺嘧啶(A-T)，胞嘧啶配鳥嘌呤(C-G)的方式，靠微弱的氫鍵聯合。

生什么控制細胞酶的產生？
- 細胞去氧核醣核酸上，氮基順序的遺傳密碼決定酶的產生。

5. 遺傳資料怎樣在去氧核醣核酸上設定密碼？
- 遺傳資料藉著去氧核醣核酸上的核苷酸順序，被設定密碼。

6. 去氧核醣核酸的梯形構造如何適應複製？
- 梯子每個橫檔的核苷酸裂開，露出來的核苷酸接納互補的核苷酸，完成梯形構造。

7. 人類如何從去氧核醣核酸的知識獲益？
- 透過紀錄，人類已用選擇配種和其他方法。


F
C G
A T
A T
A T
G C

G

TASK: to build a DNA model

PURPOSE: to better understand the way in which the DNA ladder is constructed

MATERIALS: cardboard, block, metal rod, color construction paper

INTRODUCTION: DNA is responsible for carrying and transmitting hereditary information as well as controlling the life activities of a cell.

A) the Structure of DNA:

A

1. Inside the nucleus of each living cell are chromosomes which contain long strands of DNA.
2. DNA consists of two strands of nucleotides, joined by weak hydrogen bonds and twisted into double helix.
3. Every DNA nucleotide contains a sugar, a phosphate group, and a nitrogenous base.
4. A molecule of DNA looks like a twisted ladder, the phosphates and sugar make up its uprights.
   The base pairs: A-T, and C-G make up of its rungs.

B) The Replication of DNA

B

1. DNA replication must occur before cell division.
2. The DNA ladder breaks between the nitrogen bases in the steps like unzipping a zipper.
3. The other nitrogen bases attach to each exposed half of the ladder.
4. Each strand and its complementary partner then form two new identical DNA molecules.

K

PROCEDURE:

1. to saw 10 thin wooden plates of equal size to make steps of the ladder
2. to wrap some plates half with dark green and half with light yellow paper to represent C-G base pairs, while leaving both ends unwrapped
3. to wrap the other plates half with light green and half with orange paper to represent A-T base pairs, also leaving both ends unwrapped
4. to drill a hole in the middle of each plate so that a metal rod can penetrate through them, while being arranged like a twisted ladder
5. On each of two cardboard strips, cut 10 slots of the same size as wooden plate width so that the ends of the wooden plates can be stuck into the slots

1

Translation

D DISCUSSION:

1. What are the basic components of a nucleotide?
   --a sugar, a phosphate and nitrogen base
   Which color did I use to represent these nucleotide components?
   --white color for phosphate, brown wooden end for sugar, dark green for cytosine, orange for thymine, light green for adenine, light yellow for guanine

2. How are the nitrogenous bases in DNA paired?
   -- Cytosine is always paired with guanine,. Adenine is always paired with thymine. Purines(Adenine and guanine) are longer than pyramidines(thymine and cytosine).

3. Explain how the two halves of the DNA molecule are held together
   --They are held by weak hydrogen bonds.

C 4. What controls the production of enzymes by the cells?
   --The genetic code in the sequence of bases in a cell's DNA controls the synthesis of its enzymes.

5. How is hereditary information encoded in DNA ?
   --Hereditary information is encoded by means of the sequence of nucleotides in DNA.

6. How is DNA's ladder structure adapted for replication?
   --An unzipping takes place between the nucleotides at each rung

E 7. How do humans benefit from the knowledge of DNA ?
   --Throughout recorded history, humans have used selective breeding and other methods to produce organisms with desirable traits. Our current understanding of DNA allows for the manipulation of genes and the development of new combination of traits and new varieties of organisms.

2

The task[224]

Students were given a data table showing a high school student's blood glucose levels as measured hourly over a 24-hour period. They were asked to graph the data; to draw conclusions about regulatory response from the data; and to use their conclusions to make inferences about the effects of injected insulin on diabetes.

Circumstances of performance

This sample of student work was produced under the following conditions:

√	alone		in a group
	in class	√	as homework
√	with teacher feedback		with peer feedback
√	timed		opportunity for revision

This work sample illustrates a standard-setting performance for the following parts of the standards:[225]

S2a Life Sciences Concepts: The cell.

S4a Scientific Connections and Applications: Big ideas and unifying concepts.

S4c Scientific Connections and Applications: Health.

S5b Scientific Thinking: Use concepts from Science Standards 1–4.

S6c Scientific Tools and Technologies: Analyze data.

S7b Scientific Communication: Argue from evidence.

What the work shows

S2a Life Sciences Concepts: The student produces evidence that demonstrates understanding of the cell, such as…regulation and biochemistry.

(A) The student understands that substances within the blood last for a finite time, and used this information to explain why regular injections of insulin are required to regulate diabetes.

(B) This answer accurately explains what happens to sugar in the blood after a meal. It also points out that insulin is involved in the entry of glucose into various cells.

S4a Scientific Connections and Applications: The student produces evidence that demonstrates understanding of big ideas and unifying concepts, such as…change and constancy; and cause and effect.

(C) (D) The answers demonstrate an understanding that eating as well as normal and strenuous metabolic demands cause changes in blood sugar levels, and that the effects of those changes are regulatory responses to maintain homeostasis.

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[224] For related work on Response to Environment, see "Bean Farmers", page 81, "Water Tolerance", page 98, "Toasted Bread", page 111, and "Snails", page 244.
[225] The quotations from the Science performance descriptions in this commentary are excerpted. The complete performance descriptions are shown on pages 292-339.

S4c Scientific Connections and Applications: The student produces evidence that demonstrates understanding of health, such as nutrition and exercise, [and] disease….

(A) (E) In the discussion of diabetes, the connection between the presence of insulin and the ability of the body to absorb glucose into cells is clearly stated.

(B) The student accurately correlates the regulatory effect of injected insulin with the production of glycogen.

S5b Scientific Thinking: The student uses concepts from Science Standards 1–4 to explain a variety of observations and phenomena.

(B) (E) Concepts related to S2a are accurately applied in making inferences about the regulatory effects of injected insulin.

(F) (G) (H) (I) (J) (K) Concepts related to S2a are accurately applied in making inferences about the data in the table.

S6c Scientific Tools and Technologies: The student analyzes data using concepts and techniques in Mathematics Standard 4, such as…appropriate data displays.

(L) The points on the graph are correctly plotted. The student chose appropriate scales and intervals for the graph, and the axes are correctly labeled. The use of a ruler or straight edge for drawing the axes and connecting lines would be recommended in a revision.

S7b Scientific Communication: The student argues from evidence, such as data produced…by others.

(A) (B) (E) The students correctly interpret the data presented in the table, and use their conclusions to make inferences about the effects of injected insulin.

Endocrine Feedback Exercise

Introduction:

The Endocrine System consists of a group of glands located all around the body that produce and secrete chemical messengers. These messengers, or **hormones**, travel through the blood stream causing effects in specific **target** tissues. The endocrine system serves as a fine tuner for maintaining homeostasis in the body. This system, combined with the nervous system, serves to control all body reactions and behaviors.

Hormone secretion by the various endocrine glands is controlled by delicate series of actions known as **feedback.** In this process the production and/or secretion of hormones is regulated by the presence or absence of a second blood chemical. For instance, the secretion of both glucagon and insulin, by the pancreas, is regulated by the presence or absence of glucose in the blood.

In this exercise you will examine the body's response to the normal change in blood glucose during a typical day.

Directions

Use the information on the chart below to construct a line graph of the % blood glucose over the course of a high school student's day. This student generally eats 3 meals a day, and is a member of the school's football team.

Time of Day	% Blood Glucose	Time of Day	% Blood Glucose
7AM	45	7PM	45
8AM	30	8PM	43
9AM	28	9PM	30
10AM	30	10PM	28
11AM	30	11PM	30
12 NOON	48	12 MIDNIGHT	29
1PM	43	1AM	29
2PM	30	2AM	28
3PM	30	3AM	30
4PM	24	4AM	28
5PM	28	5AM	30
6PM	30	6AM	30

Breakfast is at 6:30AM
Lunch is at 11:30AM
Dinner is at 6PM

Football Practice is from
3:30PM – 6:30PM

C **Analysis Questions**

1. In your own words, describe what is happening to the blood glucose levels throughout the day.
The glucose levels increase shortly after each meal is eaten. During practice, the level of glucose decreases.

2. What effect did eating have on the blood glucose level?
Eating increases the blood glucose levels

F 3. Why do you think there is a slight delay in the change of blood glucose levels after eating?
The delay is due to the fact that the food must be digested so that it can ~~to~~ break down into glucose.

G 4. What happens to the amount of glucose in the blood between:

lunch and football practice: The amount of glucose gradually decreases

during football practice: The amount slowly increases

H 5. Which hormone is responsible for the change in blood glucose levels between:

7:00AM and 11:00AM Insulin

3:00PM and 5:00PM Glucagon

A 6. Diabetes is a condition where the pancreas no longer produces any (or enough) insulin. If this student was a diabetic and did not know it, how would his blood sugar graph be different?

The glucose levels in the blood would be higher than that of a person without diabetes.

What problems should this create for the student?

The cells would not absorb enough glucose & would lack the energy to properly function. The person could pass out or even die

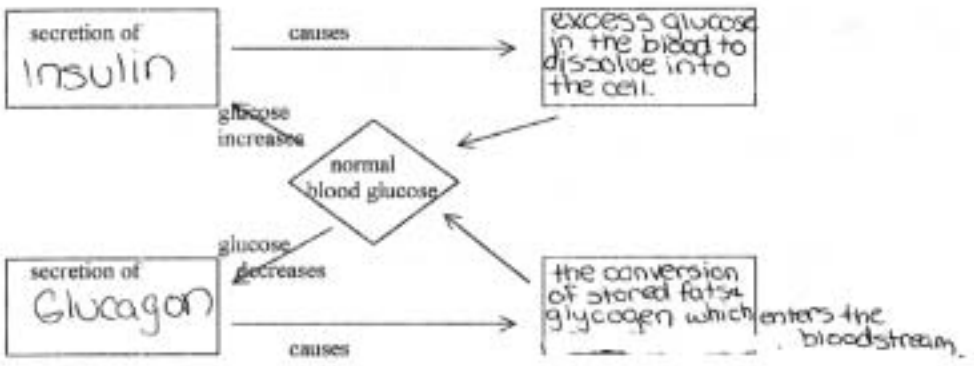
E 7. Hormones do not last in the blood stream indefinitely. For this reason your glands must constantly produce new hormones when needed. Using this information – why would a diabetic person require injections of insulin two or even three times a day?

Insulin injections would need to be given 2 or 3 times a day because when the insulin is injected into the bloodstream, it will only last for a period of time. Since the body cannot elevate the insulin levels sufficiently on its own, more insulin must be injected

Use the following information to complete the concept map below

Insulin works to decrease the blood glucose levels by:
- allowing glucose to diffuse into cells
- stimulating cell respiration to occur
- stimulating the formation of storage glycogen in the liver and fat cells around the body

Glucagon works to increase the blood glucose levels by:
- increasing the conversion of stored fats and glycogen into glucose which is placed into the blood



Endocrine Feedback Exercise

Introduction:

The Endocrine System consists of a group of glands located all around the body that produce and secrete chemical messengers. These messengers, or **hormones**, travel through the blood stream causing effects in specific **target** tissues. The endocrine system serves a s a fine tuner for maintaining homeostasis in the body. This system, combined with the nervous system, serves to control all body reactions and behaviors.

Hormone secretion by the various endocrine glands is controlled by delicate series of actions known as **feedback.** In this process the production and/or secretion of hormones is regulated by the presence or absence of a second blood chemical. For instance, the secretion of both glucagon and insulin, by the pancreas, is regulated by the presence or absence of glucose in the blood.

In this exercise you will examine the body's response to the normal change in blood glucose during a typical day.

Directions

Use the information on the chart below to construct a line graph of the % blood glucose over the course of a high school student's day. This student generally eats 3 meals a day, and is a member of the school's football team.

Time of Day	% Blood Glucose	Time of Day	% Blood Glucose
7AM	45	7PM	45
8AM	30	8PM	43
9AM	28	9PM	30
10AM	30	10PM	28
11AM	30	11PM	30
12 NOON	48	12 MIDNIGHT	29
1PM	43	1AM	29
2PM	30	2AM	28
3PM	30	3AM	30
4PM	24	4AM	28
5PM	28	5AM	30
6PM	30	6AM	30

Breakfast is at 6:30AM
Lunch is at 11:30AM
Dinner is at 6PM

Football Practice is from
3:30PM – 6:30PM

D

Analysis Questions

1. In your own words, describe what is happening to the blood glucose levels throughout the day.
Throughout the day, blood glucose levels fluctuate. During physical exercise, the glucose levels are at their lowest. And during lunch, glucose levels in the blood are at their highest
2. What effect did eating have on the blood glucose level?
It raised it significantly

I

3. Why do you think there is a slight delay in the change of blood glucose levels after eating?
There is a slight delay in the change of blood glucose levels after eating because the food needs to be digested and the sugar must be circulated throughout the bloodstream.

J 4. What happens to the amount of glucose in the blood between:

lunch and football practice: During lunch, glucose is at its highest and during football practice glucose levels drop to their lowest
during football practice: The glucose levels drop significantly

K 5. Which hormone is responsible for the change in blood glucose levels between:

7:00AM and 11:00AM Insulin

3:00PM and 5:00PM Glucagon

6. Diabetes is a condition where the pancreas no longer produces any (or enough) insulin. If this student was a diabetic and did not know it, how would his blood sugar graph be different?

His blood sugar would be high and off the charts.

What problems should this create for the student?

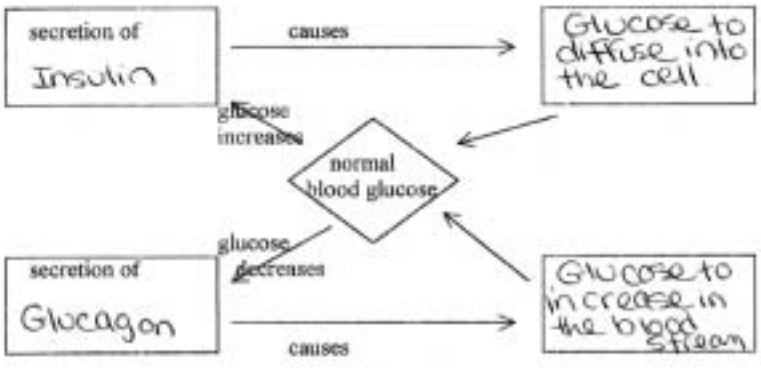
He would probably pass out, dehydrate or maybe there would be a possible death.

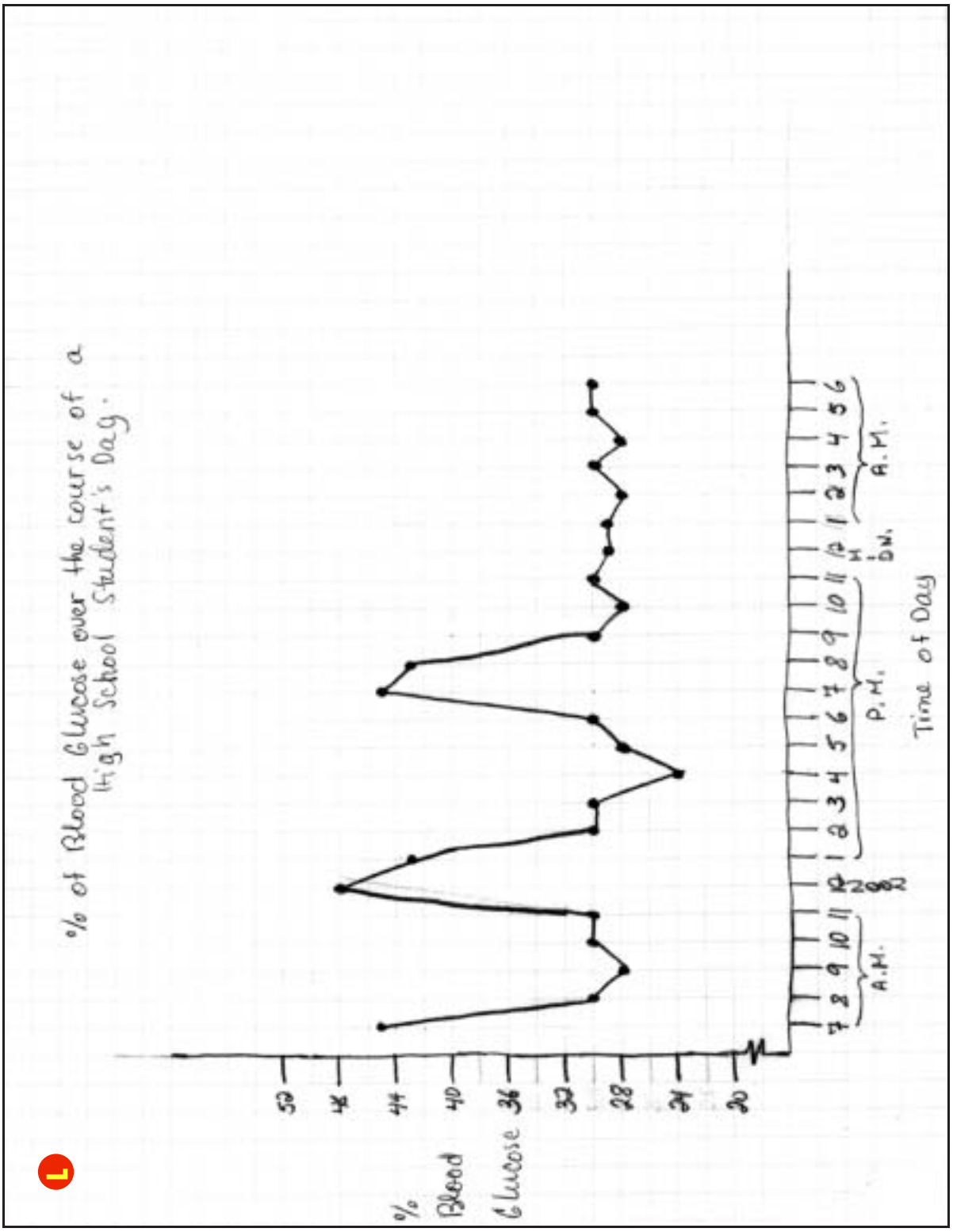
B 7. Hormones do not last in the blood stream indefinitely. For this reason your glands must constantly produce new hormones when needed. Using this information – why would a diabetic person require injections of insulin two or even three times a day? A diabetic person would require injections of insulin two or even three times a day because since insulin works to decrease the blood glucose levels by allowing glucose to diffuse into cells, stimulating cell respiration to occur and stimulating the formation of storage glycogen in the liver and fat cells around the body since a diabetic person does not produce enough insulin, they would need to receive two to three shots a day to prevent their glucose levels from rising to high.

Use the following information to complete the concept map below

Insulin works to decrease the blood glucose levels by:
- allowing glucose to diffuse into cells
- stimulating cell respiration to occur
- stimulating the formation of storage glycogen in the liver and fat cells around the body

Glucagon works to increase the blood glucose levels by:
- increasing the conversion of stored fats and glycogen into glucose which is placed into the blood




% of Blood Glucose over the course of a High School Student's Day.
% Blood Glucose
50
44
40
36
32
28
24
20
7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6
A.M.
P.M.
A.M.
Time of Day

Work Sample & Commentary: *Eagles*
High School Science

The task[226]

Small groups of students performed simulations that modeled the effects of predators and other environmental stresses, both natural and human-caused, on a prey population. Students were required to graph their data, and to draw a series of conclusions based on comparisons of their data.

Circumstances of performance

This sample of student work was produced under the following conditions:

	alone	√	in a group
√	in class		as homework
√	with teacher feedback		with peer feedback
	timed	√	opportunity for revision

This work sample illustrates a standard-setting performance for the following parts of the standards:[227]

S2d Life Sciences Concepts: Interdependence of organisms.

S2e Life Sciences Concepts: Matter, energy, and organization in living systems.

S4c Scientific Connections and Applications: Health.

What the work shows

S2d Life Sciences Concepts: The student produces evidence that demonstrates understanding of interdependence of organisms, such as…competition among organisms in ecosystems; and human effects on the environment.

(A) The student states that, by itself, natural competition among predator species doesn't significantly impact any one species. This conclusion was drawn directly from the data collected during the simulation.

(B) The student draws a correct conclusion about the indirect impact of pollution on a predator species.

S2e Life Sciences Concepts: The student produces evidence that demonstrates understanding of matter, energy, and organization in living systems, such as…environmental constraints.

(C) (D) The student demonstrates understanding of seasonal and climate constraints on a food chain.

(E) The student recognizes the effect on the carrying capacity of an increase in a predator population. It should be noted, however, that the student's statement directly conflicts the conclusion drawn in item (A). While both conclusions are logical and each one is correct within specific environmental conditions, the student should be challenged to describe in a revision the conditions that would support each statement.

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[226] For related work on Interdependence, see "Biomes", page 104, "Bio Box", page 225, "Owl Pellets", page 234, and "The Invincible Cockroach", page 460.

[227] The quotations from the Science performance descriptions in this commentary are excerpted. The complete performance descriptions are shown on pages 292-339.

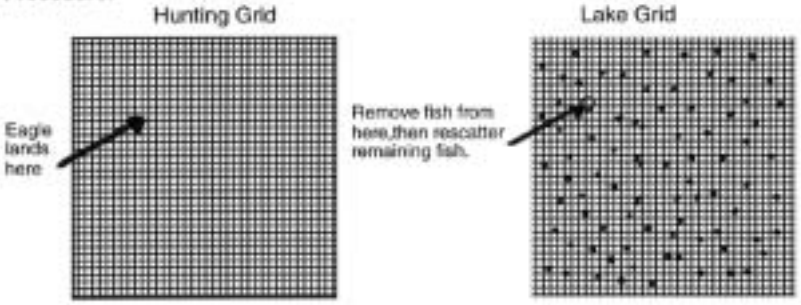
S4c Scientific Connections and Applications: The student produces evidence that demonstrates understanding of health, such as…resources, environmental stress, and population growth.

(B) (F) The student's conclusions are drawn directly from data collected during the simulation.

Ecology Unit- Predator-Prey Relationships

Background: Eagles mate for life. Each pair of eagles occupies, defends, and hunts a well defined territory. Each eagle hunts twice a day and will share the fish it catches with its mate, but it will feed itself first. If an eagle does not eat a total of nine fish in any three day period, it grows too weak to hunt and dies. Be sure to examine the data for each three-day period as you continue. If one eagle dies, continue hunting with the remaining eagle .

Procedure:



1. You have two 400 cm grids that represent 4 km lakes (10 cm = 1 km). This is where the eagles hunt for food. This will be their only source of food.
2. The 2 small heavy paper squares represent your eagles. The M paper represents the male eagle. The F paper represents the female eagle.
3. Lay the two grids near each other on the lab table. Scatter 250 grains of white rice over one of the grids. Each grain represents a large fish in the lake. Assume that eagles eat only large fish.
4. The other grid is the hunting grid. Hold the M square (male eagle) about 30 cm above the hunting grid and drop it onto the grid. Remove the rice grains below the eagle. These represent " prey " that has been captured and eaten.
5. Each adult eagle hunts twice a day. Re-scatter the remaining rice and repeat steps 4 and 5. Total the number of fish caught by the eagles on Day 1, and record the data for Day 1 on Table 1 of the Observation Chart.
6. Repeat steps 4 through 6 nine more times. Complete Table 1.
7. Ospreys and eagles compete for food. What would happen if 2 osprey also hunted in the lake, each averaging a take of 3 fish per day? Repeat the simulation, removing 6 fish per day for the ospreys' catch, and record your results in Table 2.
8. A drought occurs that causes the water level of the lake to fall. This causes one quarter of the fish to die. Repeat the simulation under this condition and record your results in Table 3.
9. Phosphate pollution causes the algae in the lake to grow out of control. The algae growth reduces the amount of dissolved oxygen in the lake water and causes three quarters of the fish to die. Repeat the simulation under this condition and record your results in Table 4.
10. Graph your data and answer the questions that follow.

Table 1. Control

Day	1	2	3	4	5	6	7	8	9	10
No. of fish	10	7	12	8	6	9	9	10	6	5

Table 2. Osprey

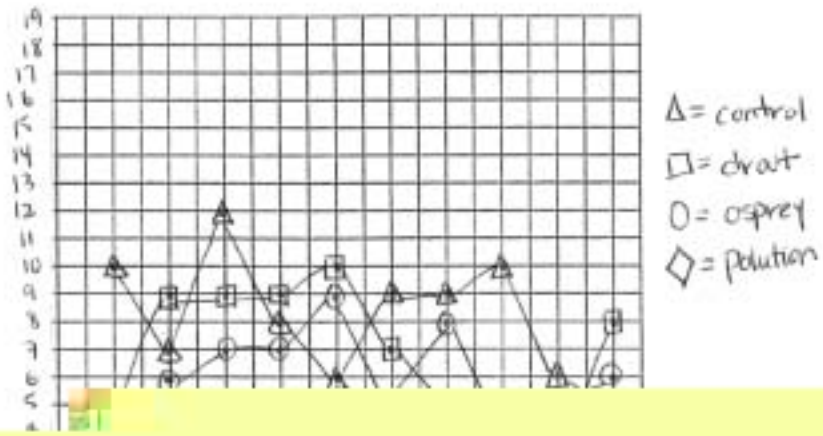
Day	1	2	3	4	5	6	7	8	9	10
No. of fish	3	6	7	7	9	5	8	4	5	6

Table 3. drout

Day	1	2	3	4	5	6	7	8	9	10
No. of fish	5	9	9	9	10	7	5	3	4	8

Table 4. polution

Day	1	2	3	4	5	6	7	8	9	10
No. of fish	0	3	0	0	1	1	2			



F

Analysis

1. How might eagle predation affect the fish population over time? I think that if the eagles get too many fish the fish population will not survive.

2. What effect, if any, might a small scale decrease in the fish population have on the eagle population?

none. only large changes can have an effect on the eagles.

A 3. Ospreys and eagles compete for food. What effect, if any, might the competition have on the eagle population? none. There was no change in the population.

C 4. Explain how a climate change might or might not indirectly affect the eagle population?

Because there are fewer fish available for the eagles their population will decrease

D 5. How can a seasonal change affect the eagle population?

Cold weather can freeze the lake and make it hard to catch fish so the eagles would go hungry.

B 6. Explain how pollution can indirectly affect the eagle population.

Pollution kills the fish and eagles need the fish to live, so it will decrease the eagle population.

Discussion Questions:

1. What is the carrying capacity of an ecosystem?

The carrying capacity of an ecosystem is how many organisms can survive successfully.

2. How would an increase in the eagle population affect the fish population? How is this similar to the competition from the ospreys?

E An increase in the eagle population is the same as competition from the ospreys because it reduces the number of fish and some eagles will go hungry and die.

Work Sample & Commentary: *The Invincible Cockroach*
High School Science

The task[228]

Students were instructed to choose a species that most people would say is gross, frightening, or a pest (such as a slug, snake, mosquito, or cockroach). The species could be from any environment, including the student's own. Students were asked to prepare a written and pictorial research project of the species that was selected. The student's report needed to respond to these questions:

- How does the species function in its ecosystem?
- Why is it considered a pest?
- How do humans deal with this pest in their environment?
- If this species suddenly disappeared how might humans be affected?

The student's research needed to include collection of a specimen (if possible); a field journal with observations /drawings of the behavior; location, occupation, and morphology of the specimen; visits to museums or nature centers; and use of the Internet or other technologies (magnifiers, microscopes, etc.)

Circumstances of performance

This sample of student work was produced under the following conditions:

√ alone	in a group
√ in class	as homework
√ with teacher feedback	with peer feedback
√ timed	√ opportunity for revision

The work was submitted as a national competition entry.

This work sample illustrates a standard-setting performance for the following parts of the standards:[229]

S2f Life Sciences Concepts: Behavior of organisms.

S4a Scientific Connections and Applications: Big ideas and unifying concepts.

S4c Scientific Connections and Applications: Health.

S6d Scientific Tools and Technologies: Acquire information from multiple sources.

S7a Scientific Communication: Represent data and results in multiple ways.

S7b Scientific Communication: Argue from evidence.

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[228] For related work on Interdependence, see "Biomes", page 104, "Bio Box", page 225, "Owl Pellets", page 234, and "Eagles", page 456.

[229] The quotations from the Science performance descriptions in this commentary are excerpted. The complete performance descriptions are shown on pages 292-339.

What the work shows

S2f Life Sciences Concepts: The student produces evidence that demonstrates understanding of behavior of organisms, such as the nervous system regulation [and] behavioral responses….

(A) (B) (C) The student describes behaviors such as nocturnal activity, thigmataxis, and reproductive specialization.

S4a Scientific Connections and Applications: The student produces evidence that demonstrates understanding of big ideas and unifying concepts, such as…form and function…and cause and effect.

(D) (E) (F) The student provides detailed information about structures and functions.

(G) (H) The student makes logical and sophisticated inferences that suggest a causal relationship between increased pesticide use and three diverse factors: the cockroach's resistance to pesticides, climate conditions, and product marketing.

S4c Scientific Connections and Applications: The student produces evidence that demonstrates understanding of health, such as disease and epidemiology, personal and environmental safety; and resources, environmental stress and population growth.

(G) (H) The student makes logical inferences about the relationship between increased pesticide use and the cockroach's resistance to pesticides, climate conditions, and product marketing.

(I) The student names several diseases that roaches carry, such as Salmonella, staph and strep. The student discusses the relationship between cockroach skin molts and the increased incidence of allergic reactions and asthmatic conditions among children who live in poor urban areas.

S6d Scientific Tools and Technologies: The student acquires information from multiple sources, such as print [and] the Internet….

(J) The bibliography shows that the student used print publications and downloaded information from the Internet.

S7a Scientific Communication: The student represents data and results in multiple ways, such as numbers, tables, graphs, and drawings….

(F) (H) (K) In addition to the well-reasoned and well-written narrative, the student includes diagrams and a graph.

S7b Scientific Communication: The student argues from evidence, such as data produced through his or her own experimentation or data produced by others.

(G) (H) The student makes connections between different evidence to hypothesize that chemicals used to kill roaches might do more harm to people and other organisms.

(K) The student indicates how this report has influenced a personal attitude toward the species.

THE INVINCIBLE COCKROACH

By _____

Staten Island, New York

A recent survey indicated that the cockroach was the most despised creature, beating out snakes, rats, bats, and spiders. I was able to observe this insect in its own environment when my father made an arrangement whereby I accompanied a health inspector on a tour of a roach-infested house.

The house I visited was old and not very clean. There was lots of clutter in the corners and the stove was very greasy. The inspector opened the food closet and I came face to face with the dreaded cockroach. In fact, I came face to face with several roaches. When the inspector moved a can, there seemed like hundreds. I was ready to run away.

The inspector explained to the people what they had to do in order to eliminate the problem. They needed to clean everything, remove the clutter, and throw out the old infested food. I never expected I would ever have to do research on the cockroach, but I became curious and wanted to find out what this bug was all about.

The cockroach that I saw is called the German cockroach or Blatella germanica. Humans consider it to be a pest because it invades where we live, eat and sleep. There are between 4,000 to 7,500 different species of roaches. Of this amount, only one percent are considered to be a pest. Some of the other more common species are:

1) Oriental Cockroach-*Blatta orientalis*

2) American Cockroach-*Periplaneta americana*

3) Brownbanded Cockroach-*Supella longipalpa*

They have pathogens or bacteria on their bodies, but none have been known to be transmitted to humans. Their mouths are used for chewing, not biting. Most roaches are nocturnal, that is, they prefer the night and are sensitive to all forms of light except for the red spectrum. They are most active right after dusk and right before dawn. They seem to appear according to a biological clock. This activity may be a response to a genetic defense because light may indicate the presence of humans, their most dangerous predator. They prefer to live in warm, moist places and

A

are more abundant in tropical areas. However, they can live in almost any environment and they have been found in the North and South Poles.

Cockroaches are thought to be about 350 million years old, making them one of the oldest surviving creatures. They have been able to survive because of their rapid reproductive cycles and adaptability to poisons, environments, and even nuclear bombs. One of the largest is the Madagascar hissing cockroach, which has become a popular pet. Another large roach is Megaloblatta blaberoides, a resident of Central and South America. It has been measured at about 100mm long. Some roaches can fly and one has been measured to have a wing span of about one foot.

D Their ability to withstand radiation is very interesting. They have a very hard outer shell or exoskeleton, which is less prone to absorb radiation. Their skin molts, which means shedding, and this removes the radiation. In addition, they have an unusual different chromosome structure, which is difficult for radiation to shatter. The butterfly is similar to the cockroach in this respect.

Although they live in proximity to each other in crevices or harbingers, they are not social insects such as the bee, termite, or the ant. This need B to keep in touch with their surroundings is called thigmotaxis. Their immunity extends to poisons, and they are known to survive decapitation. I later read that this is possible because they have two nerve centers-one in the head, the other in the tail. The only way it would eventually die would be from dehydration. They can do without food for over one month, but they need water at least once a week. They will feed on all foods, grease, paint, wallpaper paste, and even bookbinding.

C The female will have up to forty babies at one time. Some species will mate only once and they will remain pregnant for the rest of their lives. Adults will live for an average of eight to fifteen months. Cockroaches reproduce on an average of four times per year. Females have a broader abdomen and are more rounded than the male. This constant reproduction adds to their ability to become immune to environment changes or pesticides. The basic structure of the cockroach has, however, remained the same since the middle of the Silurian period almost 365 million

years ago. The life cycle of the cockroach is from egg-nymph-adult. This cycle is called simple metamorphosis. It means that the younger nymphs look very similar to the adult and will only differ in size.

E The basic anatomy of the cockroach is as follows:

F

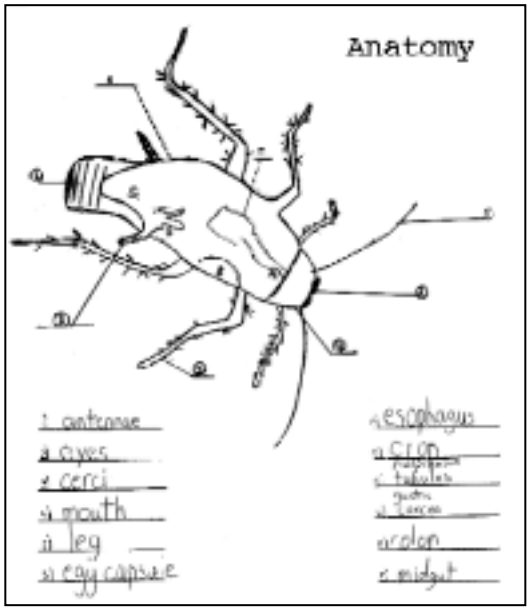
1) eye - compound eyes made of 2,000 individual lenses. They see poorly in red light and well in green light.

2) antannae - provides sense of smell while the hairs on the legs give them a sense of touch.

3) cerci - two little hairs on the rear end act as a motion detector. It alerts the roach to run in the opposite direction.

4) mouth - moves side to side

5) reproduction - female gives off scent to lure male for reproduction purposes



6) esophagus -(throat) food travels down to stomach.

7) crop - section of esophagus used to store food. There is a second set of teeth in the digestive tract.

8) gastric caeca - provides enzymes to help in digestion.

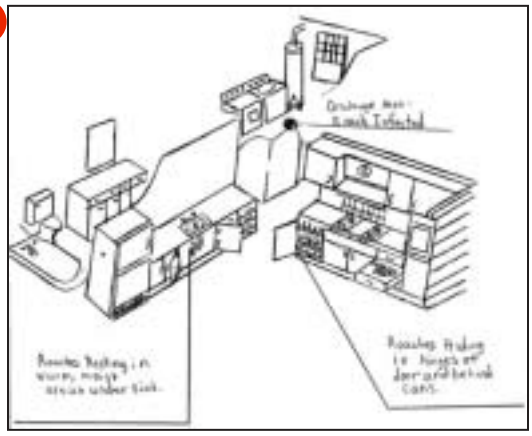
9) malpighian tubules - cleans out wastes.

10) colon - produces excrement.

11) respiratory - breathes through spiracles on side of the body, supplies oxygen to rest of the body.

The cockroach that I observed is more important as a pest problem than as an important link in the food chain. Other species do provide nourishment for certain insects. In particular, spiders are its natural enemy. However, they are too sluggish to really inflict harm. Frogs, toads, and salamanders are more effective predators. Lizards are also very successful in catching the roach. In some parts of the world the lizard is kept as a pet just to keep the house clean of roaches. Humans have also used the cockroach as a source of nourishment and for its medicinal value.

K



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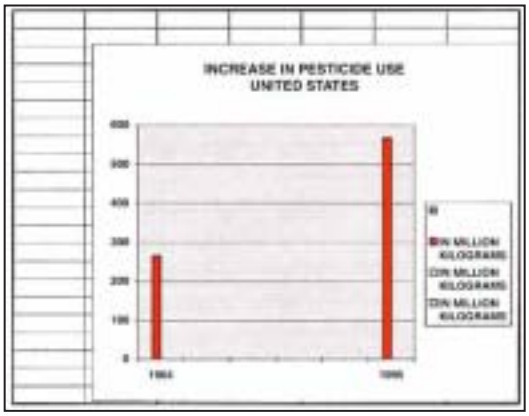
The roach, as a pest, is responsible for millions of dollars of spoiled food, pesticides, and damage to the environment from these pesticides. The non-deadly diseases they cause such as Salmonella, staph. and strep. have contributed to its being such a despised insect. Recent discoveries have suggested that the skin molts of the cockroach have caused allergic reactions and asthmatic conditions in some children who live in poor urban areas. If the roach were to disappear, humans would not have to spend millions of dollars trying to get rid of them. In addition, I feel that the chemicals that kill the roaches are doing more harm to people, animals, and plants than the roaches do themselves.

H

On one of the web sites, there was information from Rachel Carson's book, "Silent Spring," which was written over thirty years ago. It tells about the increasing and dangerous amounts of pesticides that are being used in America. It drew much attention and many laws were enacted to decrease the use of chemicals meant to control insects and keep them from contaminating food and invading our homes. I was very surprised to find out the following information:



Pesticide Use in the USA

1964 Chemical Usage	1995 Chemical Usage
245 million kilograms	567 million kilograms

G

The reasons for this increase may be the pest's increasing resistance to pesticides, adverse climate factors and advertising, leading to greater user acceptance of pesticides. I think that we must find alternative means of controlling these insects. We cannot allow them to destroy our food supply, but we are only harming ourselves by using so many

chemicals.

K After studying this insect, I have become less afraid of it than when I went on the inspection tour. The more you learn about something, the less you fear it. I have seen how the insect's body works in many ways like ours: It chews and digests its food. It can reproduce. It will produce excrement to rid itself of waste. It is part of the world's ecosystem. Only a small portion of the thousands of species are considered pests with little value in the food chain. In a tropical rain forest, cockroaches live on the forest floor or high in trees where they are part of the food web. They also frequently inhabit caves where they are a source of food for bats. They are not as destructive as other insects, such as the termite. They don't spread deadly germs like the mosquito has been found to do. They are not as dangerous as the black widow spider or the killer bee. If the roach would disappear, the species I observed would not affect the ecosystem in a negative way because there are many other species which can be a source of food without being such a problem for humans. If people would study it some more, then maybe the cockroach will not rank as the number one hated creature in the next survey.

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The task

During a laboratory lesson, students determined the circumference of a classroom globe using Eratosthenes's Method. After comparing their experimentally determined circumference with the accepted value for the circumference, students determined their percent error and identified possible sources of error. Finally, students were asked to apply this method to a novel situation—determining the size of the Unisphere in Flushing Meadows Park.

Circumstances of performance

This sample of student work was produced under the following conditions:

√ alone	√ in a group
√ in class	√ as homework
√ with teacher feedback	with peer feedback
timed	√ opportunity for revision

This work sample illustrates a standard-setting performance for the following parts of the standards: [230]

S5e Scientific Thinking: Identify problems; propose and implement solutions; and evaluate the accuracy, design, and outcomes of investigations.

S6a Scientific Tools and Technologies: Use technologies and tools.

S7a Scientific Communication: Represent data and results in multiple ways.

S7d Scientific Communication: Explain a scientific concept or procedure.

S7e Scientific Communication: Communicate in a form suited to the purpose and the audience.

What the work shows

S5e Scientific Thinking: The student identifies problems; proposes and implements solutions; and evaluates the accuracy, design, and outcomes of investigations.

(A) In the procedure, the student describes a proposed solution to the problem of determining the Unisphere's size.

(B) In the answer to question 3 in the conclusion, the student evaluates the investigation and identifies possible sources of error.

S6a Scientific Tools and Technologies: The student uses technologies and tools…to observe and measure objects…directly, indirectly and remotely, with appropriate consideration of accuracy and precision.

(A) (C) (D) In the diagrams, the student provides evidence of proper use of a ruler, a measuring tape, and a protractor.

(E) Data collected with the tools was subjected to appropriate consideration of accuracy by the calculation of the percent error for each experimental value.

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[230] The quotations from the Science performance descriptions in this commentary are excerpted. The complete performance descriptions are shown on pages 292-339.

S7a Scientific Communication: The student represents data and results in multiple ways, such as numbers, tables, and…diagrams; technical and creative writing; and selects the most effective way to convey the scientific information.

(A) (C) (D) The student presented the procedure in writing and the data in two diagrams. Choosing to use diagrams to support the written procedure demonstrates selection of the most effective way to convey scientific information.

(E) In the data table, the student shows consideration of accuracy by calculating the percent error for each of the experimental values.

S7d Scientific Communication: The student explains a scientific concept or procedure to other students.

(A) (C) (D) The procedure is explained and illustrated clearly.

(F) The answer to question 2 in the conclusion addresses variables that would affect the outcome of the investigation.

S7e Scientific Communication: The student communicates in a form suited to the purpose and the audience, such as by writing instructions that others can follow….

(A) The clear, concise, and logically sequenced procedure, especially as supported by labeled diagrams, demonstrates understanding of Eratosthenes's Method and could be easily replicated by others.

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Propose a method for determining the circumference of the Unisphere, and other ways to check the determination.

First, I would need two straight sticks and glue or clay. (After you find out where to position the sticks, the glue or clay will be used to fasten them into place.) In order for my method to work, this procedure must be done when the sun is at its highest place in the sky. Then I would place one stick directly on top of the Unisphere, and move it around until it casts no shadow, this will be stick A. I would then take the other stick and place it exactly two feet from the first stick on the globe, this will be stick B (make sure that both sticks are pointed directly toward the center of the Unisphere). Third, I would take a protractor and line it up with stick B so that the stick ends halfway into the protractor. After that I would take a ruler and place one end at the end of the shadow and the other end on the end of the stick like in the diagram.

The angle directly below the ruler is your shadow angle. Now, with the information we have, we can find the circumference of the Unisphere, using this formula:

$$\frac{\text{Distance between Sticks A and B}}{\text{Circumference}} = \frac{\text{Shadow Angle}}{360^\circ}$$

There are many ways to check the determination,

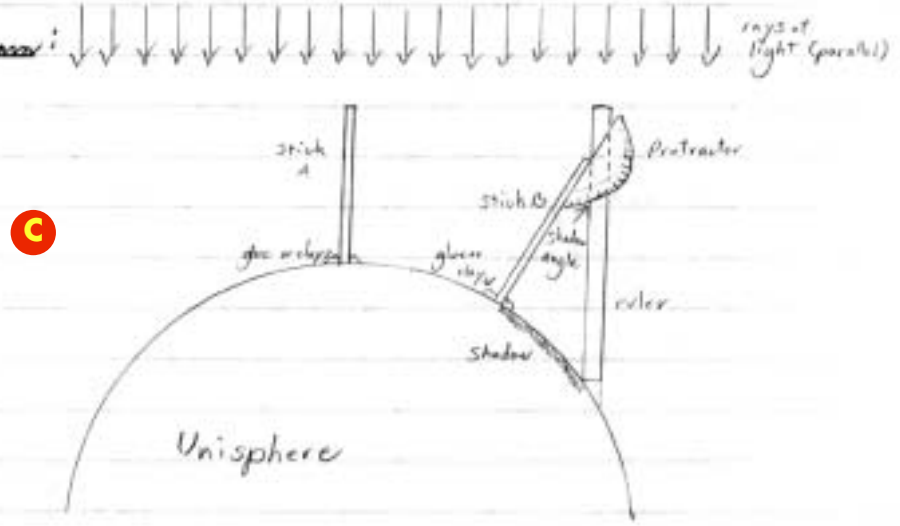
I will name three.

1.) You can make a model of the Unisphere, for example to a scale of 1/60, then you would repeat my procedure, (which only works with an over-head source of light) and whatever circumference you would come up with, you would multiply it by 60.

2.) You could do number 1.), except you would place stick B in a different place in the top hemisphere.

3.) You could simply measure the distance around the Unisphere with a tape measure.

Diagram:



C

Problem: How can you determine the circumference of the Unisphere?

Materials:

1.) 2 straight sticks
2.) Glue or clay (After you find out where to position the sticks, the glue or clay will be used to fasten them into place)
3.) protractor
4.) ruler

A

Procedure:

First, I would place one stick on top of the Unisphere and move it around until it casts no shadow, this will be stick A. I would next take the other stick and place it some measured distance from stick A, this will be stick B. Make sure that both sticks are pointed directly toward the center of the Unisphere. Then, I would take the protractor and line it up with stick B so that the stick ends halfway into the protractor. After that, I would take a ruler and place one end at the end of the shadow and the other end on the end of the stick like in the diagram.

The angle directly below the ruler is your shadow angle. Now, with the information we have, we

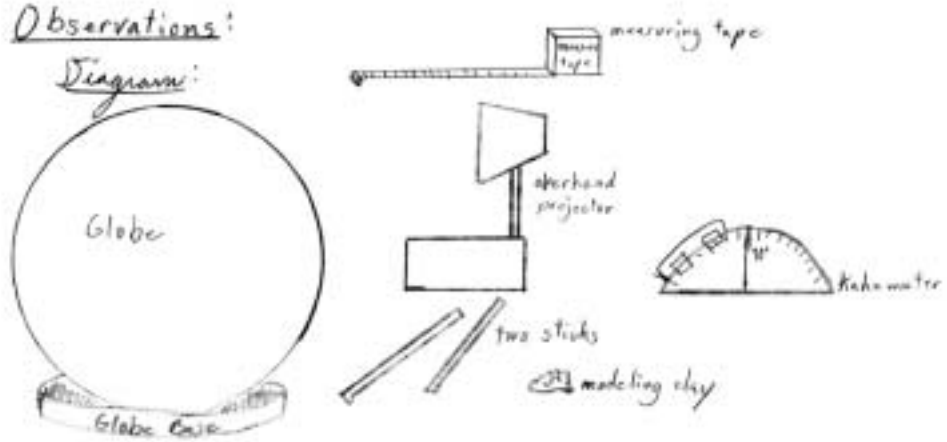
can find the circumference of the Unisphere, using this formula:

$$\frac{\text{Distance between Sticks A and B}}{\text{Circumference}} = \frac{\text{Shadow Angle}}{360^\circ}$$

Observations:

D

Diagram:



E

Data Table:

Distance	Shadow ∠	Circumference: Measured	Circumference: Accepted	% Error
7.6 cm.	58°	47.2 cm.	64.2 cm.	26.5%
9.2 cm.	49°	67.6 cm.	64.2 cm.	5.3%
7.0 cm.	30°	84.0 cm.	64.2 cm.	30.8%
11.7 cm.	60°	70.2 cm.	64.2 cm.	9.3%
6.0 cm.	20°	108.0 cm.	64.2 cm.	68.2%
12.5 cm.	50°	90.0 cm.	64.2 cm.	40.2%
9.3 cm.	37°	90.5 cm.	64.2 cm.	41.0%
Average Circumference		79.6 cm.	% Error for average circumference	23.9%

Conclusion:

You can determine the circumference of the Unisphere by using Eratosthenes' Principle and my procedure to solve the formula shown above.
How it applies to real life: Scientists involved with space travel need circumference. They need it because if they wanted to launch a satelite to Mars, and the moon was in the way, they would need the circumference of the moon in order to avoid it properly and without collision.

1) Produce an explanation of how observations are used to determine circumference. Observations such as shadow angle and distance between the sticks are the keys to providing the solution to the formula:

$$\frac{\text{distance between two sticks}}{\text{circumference}} = \frac{\text{shadow angle}}{360^\circ},$$

which determines circumference.

F 2) How must this experiment have to be changed, if we were to conduct it at various seasons of the year? At various seasons of the year the sun is at different altitudes in the sky because of the earth's tilt on its axis and its revolution around the sun. Therefore at different seasons throughout the year the sun's rays hit the earth at different angles, causing the length of shadows to change. If the length of shadows changes then the stick which previously cast no shadow will now cast one, so this experiment must be changed by moving stick A again so it casts no shadow in order for the setup to work properly.

B 3) What are some sources of error? Some possible sources of error are that we measured the shadow angle or the distance between two sticks wrong, also, the stick that wasn't supposed to cast a shadow may have cast a slight one.

4) What are some alternate methods of determining the circumference of a large spherical object? You can determine the circumference of a large spherical object by using this procedure except with stick B in a different place on the sphere, also, you can simply use measuring tape to find the circumference.

The task

Working in small groups, students constructed three-dimensional block diagrams of rock structures. They were then asked to discuss the rock structure and propose a possible sequence of geological events that could have produced that structure. After proposing a sequence of events, the students worked within their groups to model each event using modeling clay to represent rock. After the entire sequence of proposed events had been modeled in clay, the students were asked to compare and contrast their resulting clay structures with the original three-dimensional block diagrams. As a culminating activity, groups were asked to compare their proposed sequence of events and models with those of other groups.

Circumstances of performance

This sample of student work was produced under the following conditions:

	alone	√	in a group
√	in class		as homework
√	with teacher feedback		with peer feedback
	timed	√	opportunity for revision

The teacher facilitated the assignment and assisted the students with various aspects of the investigation. The student's work is a final revision.

This work sample illustrates a standard-setting performance for the following parts of the standards:[231]

S3c Earth and Space Sciences Concepts: Origin and evolution of the Earth system.

S4a Scientific Connections and Applications: Big ideas and unifying concepts.

S5e Scientific Thinking: Identify problems; propose and implement solutions; and evaluate the accuracy, design, and outcomes of investigations.

S5f Scientific Thinking: Work individually and in teams.

S7a Scientific Communication: Represent data and results in multiple ways.

S7e Scientific Communication: Communicate in a form suited to the purpose and the audience.

What the work shows

S3c Earth and Space Sciences Concepts: The student produces evidence that demonstrates understanding of origin and evolution of the Earth system....

(A) (B) (C) (D) (E) (F) (G) (H) In modeling and describing the sequence of events which could result in a particular landform, the student demonstrates understanding that existing landforms are the product of an evolutionary process which occurs over time.

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[231] The quotations from the Science performance descriptions in this commentary are excerpted. The complete performance descriptions are shown on pages 292-339.

S4a Scientific Connections and Applications: The student produces evidence that demonstrates understanding of big ideas and unifying concepts, such as…models, form and function….

(C) (D) (E) (F) (G) (H) The six tables dramatically show the student's interpretation of each model. A review of each table shows that the student transferred learning from model to model as the investigation proceeded.

S5e Scientific Thinking: The student identifies problems; proposes and implements solutions; and evaluates the accuracy, design, and outcomes of investigations.

(I) In step 5 of the procedural outline, the student evaluates the accuracy and design of the investigation and notes limitations of the models and the process by which the models were constructed.

(J) The student provides a troubleshooting list for subsequent investigators who might experience difficulty with the procedure.

S5f Scientific Thinking: The student works individually and in teams to collect and share information and ideas.

(K) (L) Use of the word "we" indicates the collaborative nature of the investigation.

S7e Scientific Communication: The student communicates in a form suited to the purpose and the audience, such as by writing instructions which demonstrates clarity of understanding so that other students can follow.

(C) (D) (E) (F) (G) (H) The student clearly communicates the way in which each geologic process was modeled. In correctly describing the geologic processes being modeled and the geologic principles involved, the student demonstrates clarity of understanding.

(J) The troubleshooting list provides for ease of replication of the investigation by other students.

S7a Scientific Communication: The student represents data and results in multiple ways, such as tables,…diagrams, and…technical…writing; and selects the most effective way to convey the scientific information.

(B) The student used a diagram format effectively.

(C) (D) (E) (F) (G) (H) The student describes the steps for building each model in the six tables. Incorporating narrative descriptions of the model-building procedures into the tables is innovative and very effective. In choosing to organize the report in this way, the student relates each step of each procedure to a geological event and principle.

Problem: How can we show the formation of geologic events using clay models?

Materials:
Plastic Knives
4 different colored clay (play-doh)
wax paper
rolling pin
tape
scissors

Vocabulary:
lithification
deposition
folding
erosion
faulting
emergence
submersion
Law of Superposition
Law of Cross-cutting relationships

Procedure:
1. First we take the 6 block diagrams, cut them out and assemble them with the tape.

2. The materials were given to us, and we did one of the diagrams together as a class. We followed the teacher's instructions on the construction of model #1.

K 3. The using the 4 colors of clay: red, white, yellow, and blue, we were assigned to construct 2 of the 6 block diagrams in our group of four. Red was sandstone. Blue was limestone, yellow was shale, and white was conglomerate. The unknown color used was green for our group (mixed blue and yellow). Depending on which block diagram you were assigned, you had to follow the pattern of which one came first.

L 4. We took some of the clay out and put it on the wax paper. One person rolled it flat with the rolling pin. (Be careful that the clay isn't rolled out too flat. Each layer should be around a quarter of an inch).

I 5. We constructed the model by putting one layer on top of another. At the end, we used the knife and cut it to make it more neat. If it was a certain geologic process involved (besides the deposition and lithification of a layer and erosion or submergence because you can't show submergence or erosion. Also, the deposition and lithification of a layer was just to put it on top of each other, we had to show it. For instance, if it was folded, we took the model and folded it. If some parts were eroded, we looked at the block diagram to see which part of it was eroded, and we peeled that layer off. If it showed faulting, we used the knife to cut it in half, and lifted one side up to show the foot wall.

6. After the first model was done, we used the next period to make the second model. It was basically the same procedure, only now we had to follow a different block diagram.

7. When we were finished with everything, we went over the steps and the geologic principles involved.

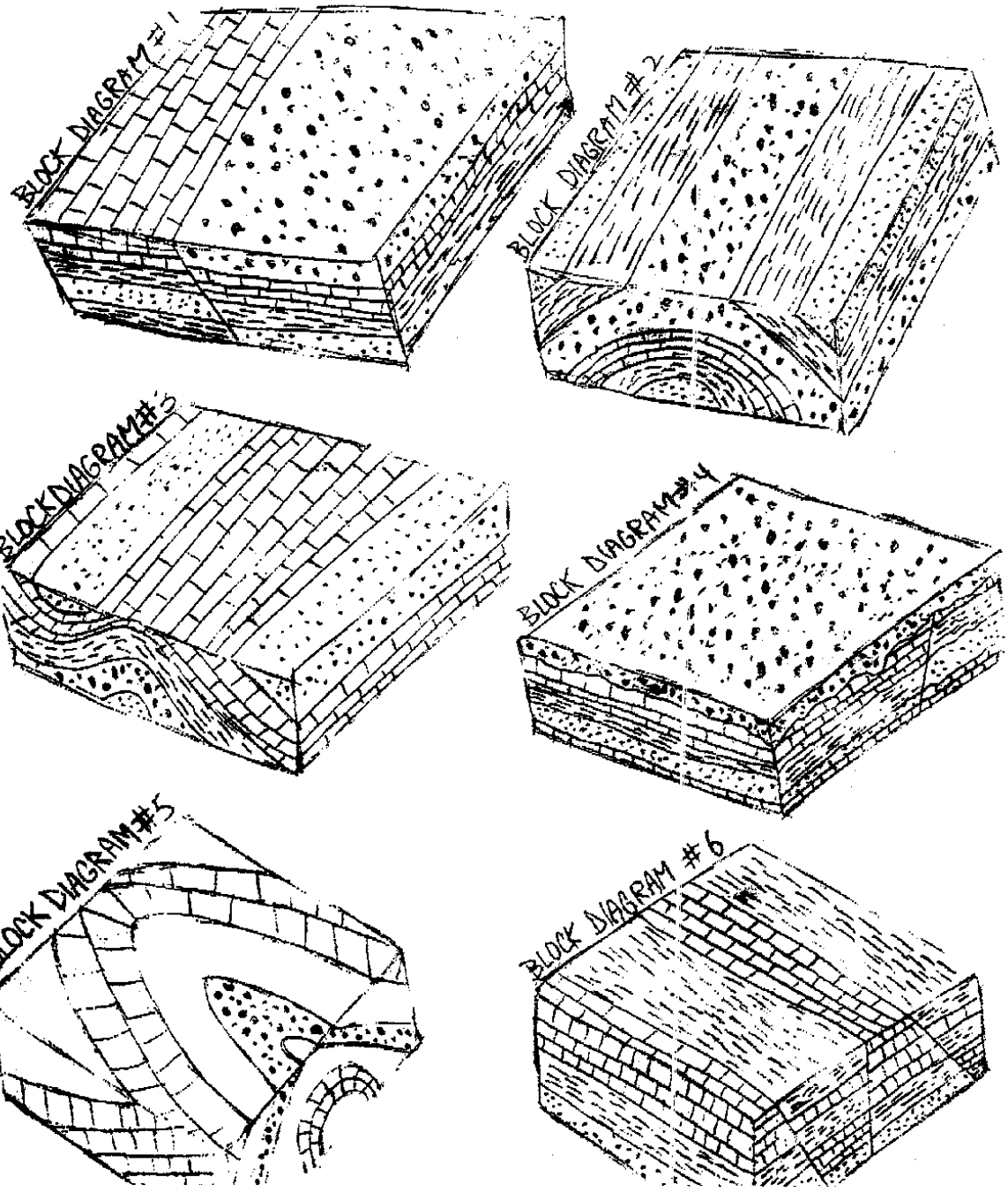
J

Things that might go wrong:
1. While constructing each layer, it might be too thin and fall apart once put together, so warn your students to make it a certain width.
2. Interpreting the block diagrams might be a little complicated. There are different sides to them, and it gets confusing for the students to try and figure out which one of the layers goes next. (I know that it was hard for me).
3. Students might get mixed up on the laws too. Most of them were the same, but some of them looked like it could be one thing, but it was really another, so it would be good to prepare them before starting.

Conclusion:
This project was actually fun, and we learned things too. We got to something hands on which made me visualize it better. We learned about the the geologic processes and principles. We learned about the formation of rocks, and what kinds of rocks there are, and what they've been through for all these years. I was proud that I understood that stuff, and made a geologic model. It was an interesting lab, and I hope that you're students learn as much as we did.

A

B


BLOCK DIAGRAM #1
BLOCK DIAGRAM #2
BLOCK DIAGRAM #3
BLOCK DIAGRAM #4
BLOCK DIAGRAM #5
BLOCK DIAGRAM #6

C

BLOCK DIAGRAM NUMBER ____1____

step number	procedure	geologic process modeled	geologic principles involved
1	put down a layer of yellow clay	deposition and lithification of shale	superposition - in any series of sedimentary beds, the oldest beds are on the bottom and the youngest beds are at the top.
2	put down a layer of red clay	deposition and lithification of sandstone	superposition
3	put down a layer of yellow clay	deposition and lithification of shale	superposition
4	put down a layer of blue clay	deposition and lithification of limestone	superposition
5	put down a layer of white clay	deposition and lithification of conglomerate	superposition
6	cut through all layers of clay. Push one side slightly upward. Attach the layers.	normal faulting	law of cross-cutting relationships - faults are younger than the rocks in which they are found.
7	_____	emergence	_____
8	cut off part of the top layers, exposing the blue layer on one side, and the white layer on the other side.	erosion	_____

D

BLOCK DIAGRAM NUMBER 2

step number	procedure	geologic process modeled	geologic principles involved
1	put down a layer of red clay	deposition and lithification of sandstone	superposition - in any series of sedimentary beds, the oldest beds are on the bottom and the youngest beds are at the top.
2	put down a layer of yellow clay	deposition and lithification of shale	superposition
3	put down a layer of blue clay	deposition and lithification of limestone	superposition
4	put down a layer of white clay	deposition and lithification of conglomerate	superposition
5	put down a layer of yellow clay	deposition and lithification of shale	superposition
6	put down a layer of red clay	deposition and lithification of sandstone	superposition
7	fold the clay by applying pressure from the sides.	folding	law of cross-cutting relationships - folds are younger than the rocks in which they are found.
8	_____	emergence	_____
9	cut off part of the top layers, exposing the blue layer on one side, and the white layer on the other side.	erosion	_____

E

BLOCK DIAGRAM NUMBER 3

step number	procedure	geologic process modeled	geologic principles involved
1	put down a layer of red clay	deposition and lithification of sandstone	superposition - in any series of sedimentary beds, the oldest beds are on the bottom and the youngest beds are at the top.
2	put down a layer of white	deposition and lithification of conglomerate	superposition
3	put down a layer of yellow	deposition and lithification of shale	superposition
4	put down a layer of blue clay	deposition and lithification of limestone	superposition
5	put down a layer of red clay	deposition and lithification of sandstone	superposition
6	fold the clay by applying pressure from the sides.	folding	law of cross-cutting relationships - folds are younger than the rocks in which they are found.
7	_____	emergence	_____
8	cut off part of the top layers, exposing the blue layer on one side, and the white layer on the other side.	erosion	_____

F

BLOCK DIAGRAM NUMBER ___4___

step number	procedure	geologic process modeled	geologic principles involved
1	put down a layer of blue clay	deposition and lithification of limestone	superposition - in any series of sedimentary beds, the oldest beds are on the bottom and the youngest beds are at the top.
2	put down a layer of red clay	deposition and lithification of sandstone	superposition
3	put down a layer of yellow clay	deposition and lithification of shale	superposition
4	put down a layer of blue clay	deposition and lithification of limestone	superposition
5	cut through all layers of clay. Push one side slightly upward. Attach the layers.	normal faulting	law of cross-cutting relationships - faults are younger than the rocks in which they are found.
6	_____	emergence	_____
7	cut across the top layer, in an irregular horizontal line, creating an unconformity	erosion	_____
8	_____	submergence	_____
9	put down a layer of white clay	deposition and lithification of conglomerate	superposition
10	_____	emergence	_____
11	_____	erosion	_____

BLOCK DIAGRAM NUMBER____5___

step number	procedure	geologic process modeled	geologic principles involved
1	put down a layer of green clay	deposition and lithification of an unknown layer	superposition - in any series of sedimentary beds, the oldest beds are on the bottom and the youngest beds are at the top.
2	put down a layer of blue clay	deposition and lithification of limestone	superposition
3	put down a layer of green clay	deposition and lithification of an unknown layer	superposition
4	put down a layer of white clay	deposition and lithification of conglomerate	superposition
5	put down a layer of green clay	deposition and lithification of an unknown layer	superposition
6	put down a layer of blue clay	deposition and lithification of limestone	superposition
7	_____	emergence	_____
8	fold the clay by applying pressure from the sides. Tilt the model.	folding, with a plunging fold axis (anticline)	law of cross-cutting relationships - folds are younger than the rocks in which they are found.
9	cut off part of the top layers, exposing the layers below to conform to the diagram.	erosion	_____

H

BLOCK DIAGRAM NUMBER ___6___

step number	procedure	geologic process modeled	geologic principles involved
1	put down a layer of red clay	deposition and lithification of sandstone	superposition - in any series of sedimentary beds, the oldest beds are on the bottom and the youngest beds are at the top.
2	put down a layer of yellow clay	deposition and lithification of shale	superposition
3	put down a layer of blue clay	deposition and lithification of limestone	superposition
4	put down a layer of yellow clay	deposition and lithification of shale	superposition
5	put down a layer of blue clay	deposition and lithification of limestone	superposition
6	put down a layer of yellow clay	deposition and lithification of shale	superposition
7	cut through all layers of clay in two places. Push up two sides slightly. Attach the layers.	normal faulting (horst and graben)	law of cross-cutting relationships - faults are younger than the rocks in which they are found.
8	_____	emergence	_____
9	cut off part of the top layers, exposing the layers below to match the diagram.	erosion	_____