LESSON 2

DNA Computers

- IN THIS LESSON YOU WILL REVIEW THE SKILL OF SCANNING, HOW TO MAKE COMPARISONS BETWEE TWO SUBJECTS, AND THE ADVANTAGES AND DISADVANTAGES OF SILICON AND DNA MICROPROCESSORS.

Before You Read

I *What do you know about DNA computers? Have you come across this topic before?*

1. If you know anything about this subject, please share your ideas with your classmates.
2. If you do not know anything about DNA computers, please try to guess what they are, and how DNA and computers could possibly be related.

Useful Phrases/Vocabulary

Starting sentences:

1. & 2. DNA computers are similar to traditional computers because…
We can place DNA computers into traditional computers to perform complicated tasks because…
We can insert DNA computers into human bodies and living organisms because they are very small...

2. DNA computers link DNA and computers together, and probably can perform tasks like _____ and _____.
DNA computers can deal with _____.
DNA computers can do things that traditional computers cannot do. For example, _____.
DNA computers can _____.

II *Reading Skills and Strategies—Scanning for Facts and Specific Information*

In this lesson, you are going to review scanning a text. This is especially useful for reading comprehension tests. To save time, look at the question first, and then scan the text to find the answer.

Scan for the following information in the article and write the answers in the blanks.

1. The name of a chip when DNA is integrated into it is _____. (paragraph 2)
2. How many times more data can DNA computers store compared to a typical personal computer? _____. (paragraph 3)
3. How many years have silicon microprocessors been the heart of the computing world? _____. (paragraph 4)
4. The number of electronic devices put on a microprocessor has doubled every _____. months. (paragraph 4)
5. Who predicted in 1965 that microprocessors would double in complexity every two years? _____. (paragraph 4)
6. How many DNA molecules can fit into an area no larger than 1 cubic centimeter? _____. (paragraph 6)
7. In what ways do conventional computers operate? _____. (paragraph 7)
8. Studying DNA computers may also lead people to better understand more complex computers called _____. (paragraph 8)

Reading

DNA Computers

by Kevin Bonsor

Even as you read this article, computer chip manufacturers are **furiously** racing to make the next **microprocessor** that will **topple** speed records. Sooner or later, though, this competition is bound to hit a wall. Microprocessors made of **silicon** will eventually reach their limits of speed and **miniaturization**. Chip makers need a new material to produce faster computing speeds.

You won't believe where scientists have found the new material they need to build the next generation of microprocessors. Millions of natural **supercomputers** exist inside living **organisms**, including your body. **DNA** (deoxyribonucleic acid) molecules, the material our genes are made of, have the **potential** to perform calculations many times faster than the world's most powerful human-built computers. DNA might one day be **integrated** into a computer chip to create a so-called **biochip** that will push computers even faster. DNA

molecules have already been harnessed to perform complex mathematical problems.

While still in their infancy, DNA computers will be capable of storing billions of times more data than your personal computer. In this article, you'll learn how scientists are using genetic material to create nano-computers that might take the place of silicon-based computers in the next decade.

Silicon vs. DNA Microprocessors

Silicon microprocessors have been the heart of the computing world for more than 40 years. In that time, manufacturers have crammed more and more electronic devices onto their microprocessors. In accordance with **Moore's Law**, the number of electronic devices put on a microprocessor has doubled every 18 months. Moore's Law is named after Intel founder Gordon Moore, who predicted in 1965 that microprocessors would double in complexity every two years. Many have predicted that Moore's Law will soon reach its end, because of the physical speed and miniaturization limitations of silicon microprocessors.

DNA computers have the potential to take computing to new levels, picking up where Moore's Law leaves off. There are several advantages to using DNA instead of silicon:

I. As long as there are cellular organisms, there will be a supply of DNA.

II. The large supply of DNA makes it a cheap resource.

III. Unlike the toxic materials used to make traditional microprocessors, DNA biochips can be made cleanly.

IV. DNA computers are many times smaller than today's computers.

DNA's key advantage is that it will make computers smaller than any computer that has come before, while at the same time holding more data. One pound of DNA has the capacity to store more information than all the electronic computers ever built; and the computing power of a teardrop-sized DNA computer, using the DNA logic gates, will be more powerful than the world's most powerful supercomputer. More than 10 trillion DNA molecules can fit into an area no larger than 1 cubic centimeter (0.06 cubic inches). With this small amount of DNA, a computer would be able to hold 10 **terabytes** of data, and perform 10 trillion calculations at a time. By adding more DNA, more calculations could be performed.

Unlike conventional computers, DNA computers perform calculations parallel to other calculations. Conventional computers operate linearly, taking on tasks one at a time. It is parallel computing that allows DNA to solve complex mathematical problems in hours, whereas it might take electronic computers hundreds of years to complete them.

The first DNA computers are unlikely to feature word processing, e-mailing and solitaire programs. Instead, their powerful computing power will be used by national governments for cracking secret codes, or by airlines wanting to map more efficient routes. Studying DNA computers may also lead us to a better understanding of an even more complex computer—the human brain.

"How DNA Computers Will Work." 17 November 2000. HowStuffWorks.com. <http://computer.howstuffworks.com/dna-computer.htm> 02 March 2009.

After You Read

Based on the article, decide if these statements are true or false

	T	F
1. Chip makers' aim is to make the next microprocessor faster.		
2. Millions of natural supercomputers exist inside living organisms.		
3. DNA molecules have already been used to perform complex mathematical problems.		
4. Scientists are using genetic material to create nano-computers that might take the place of conventional silicon-based computers.		
5. Silicon microprocessors have been the heart of the computing world for more than 70 years.		
6. In accordance with Moore's Law, the number of electronic devices put on a microprocessor has doubled every 9 months.		
7. Many people have predicted that Moore's Law will soon reach its end, because of the physical speed of DNA computers.		
8. The key advantage of DNA computers is that they are many times smaller than today's silicon computers.		
9. Conventional computers operate vertically, taking on tasks two at a time.		
10. The first DNA computers already have word processing, emailing, and solitaire programs.		

Vocabulary Comprehension

ESP Vocabulary

This vocabulary is commonly used in the field of information technology.

miniaturization	*n*	Miniaturization is the trend of producing ever smaller devices.
organism	*n*	a living thing such as a person, animal, or plant, especially an extremely small living thing
DNA (the abbreviation of deoxyribonucleic acid molecules)	*n*	deoxyribonucleic acid: a chemical substance that contains genetic information and is found in all living cells and some viruses
silicon	*n*	a chemical element that is often used to make small integrated electronic circuits
microprocessor	*n*	the integrated circuit that functions as a computer's central brain
Moore's Law		this phenomenon is named after Gordon Moore, the co-founder of Intel, who claimed in 1965 that the number of transistors that could be placed on a computer chip would double every two years, leading to exponential rises in processing power
biochip	*n*	a biochip is a small device that contains many small test sites, or microarrays, that enable it to perform thousands of biological reactions and tests in a very short period of time
supercomputer	*n*	a supercomputer is a relatively high performance computer that can process a great deal of information quickly. Because of Moore's Law, today's supercomputers may become tomorrow's personal computers
terabyte	*n*	a million bytes

General Vocabulary

This vocabulary is used for general purposes.

potential	*n*	the possibility to develop or achieve something in the future
integrated	*adj*	combining things, people or ideas of different types in one effective unit, group or system
capacity	*n*	the amount of something that can be put in a container; an ability

furiously	*adv* *adj*	very actively; very angrily furious
topple	*v*	to fall over, or to make someone or something do this
harness	*v*	to get control of something in order to use it for a particular purpose
teardrop	*n*	a single tear
cubic	*adj*	cubic units are used for measuring volume, i.e., the amount of 3D space that an object takes up
linearly	*adv* *adj*	related to a straight line; related to chronological order linear
solitaire	*n*	card game for one person that is a popular—but very basic—Windows game

Exercise

Please unscramble the words to make some of the terms from this lesson.

1	ilnaer	consisting of lines or of one straight line
2	nhrases	to get control of something in order to use it for a particular purpose
3	irufuso	extremely angry
4	ytapicca	the amount of information that can be stored on a computer or on a CD or floppy disk
5	ilatreios	card game for one person that is a popular—but very basic—Windows game
6	opialtent	the possibility to develop or achieve something in the future
7	tegartined	combining things, people, or ideas of different types in one effective unit, group, or system

Language Focus

Collocation

*As discussed in the reading, computer chip manufacturers are furiously updating **microprocessors**, which are capable of producing faster **computing speeds**, holding more **data**, and performing more **calculations** at a time. The table below shows that the five reoccurring nouns in the reading—**computing speeds, calculations, code, data, and microprocessor**—share the same collocation pattern: **Verb + Noun**.*

Pay careful attention to the verbs which frequently precede these specific nouns.

Verb + Noun

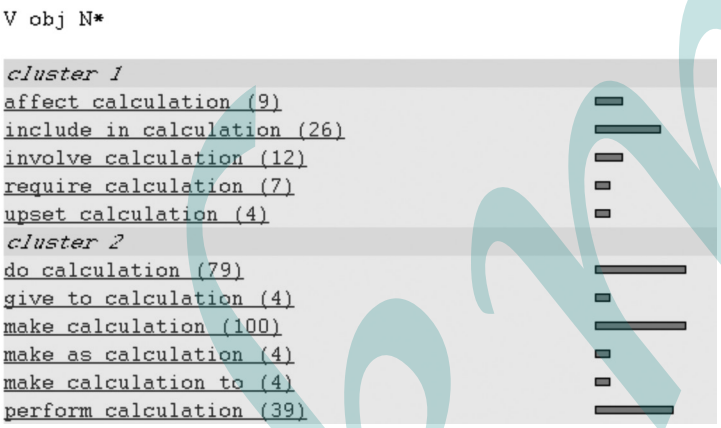
Verb	Noun	Example
produce	computing speeds	Chip makers need a new material to **produce** faster **computing speeds**. (Line 4)
perform	calculations	Unlike conventional computers, DNA computers **perform calculations** parallel to other calculations. (Line 39) With this small amount of DNA, a computer would be able to hold 10 terabytes of data, and **perform** 10 trillion **calculations** at a time. By adding more DNA, more **calculations** could be **performed**. (Line 36)
crack	code	Instead, their powerful computing power will be used by national governments for **cracking** secret **codes**, or by airlines wanting to map more efficient routes. (Line 44)
hold store	data	DNA's key advantage is that it will make computers smaller than any computer that has come before, while at the same time **holding** more **data**. (Line 31) While still in their infancy, **DNA computers** will be capable of **storing** billions of times more **data** than your personal computer. (Line 12)
build	microprocessors	You won't believe where scientists have found the new material they need to **build** the next generation of **microprocessors**. (Line 5)

Exercise

After reading the above collocation table, Katie, a curious learner in your class, decided to double check with ***JTW*** *and see if those collocations were the most commonly used. She keyed in* ***calculation****, selected* ***V obj N****, and found the two result images. She is wondering how she can best interpret these results. Help her by using the hints provided in the brackets.*

Katie: (pointing at Image 1) Look! ***Perform calculation*** *only occurs 39 times and* ***make calculation*** *occurs 100 times! Do you think that means* ***perform calculation*** *isn't good?*

Image 1



You: _____ [Hint: frequency]

Katie: (pointing at Image 2) Now look at these lines containing **make/made/making calculation(s)**. Why are there words in between?

Image 2

Buyers on their part will make similar calculations, and if at any time the price should rise consider
to do so - I would have to make the same calculation as I made this year
An alternative to making yield calculations based on average life is to make them based on equi
Jonathan Hallivell and I have made an approximate calculation of what the no-boundary condition would
Once we recognize that the group is making certain calculations as to the likely response to their views
Built its model, the company then made rough calculations of costs and an approximate indication of their
Finally, he made a calculation, the nature of which eluded Dougal, and scribbled
missing bits of the film while he made rapid calculations as to whether he might conceivably be able to
Wickham made a swift calculation
He made a rapid calculation.

You: _____ [Hint: to decorate/ polish]

Katie: Yeah, you're right. Hey look, I made this table. These are words occurring before **calculations(s)** according to Image 2. Do you think these adjectives share certain attributes or types?

Adjective		Noun
similar	rough	calculations
the same	rapid	
approximate	swift	
certain		

You : That's an interesting question. Let me see. _____

_____

Katie: Excellent. Thank you!

You : No problem.

Language Spot—Comparison

Comparison is comparing and contrasting two things, showing how they are similar and different. This section will teach you how to compare two things, and introduces some words and phrases that will help you.

1. To show similar characteristics between two things: **be similar to, both, also, too, as well.**

Earthquakes hit Japan very frequently.
Earthquakes hit Taiwan very often

In order to demonstrate this similarity between Japan and Taiwan—

The earthquake situation in Taiwan is very similar to that in Japan.

Both Japan and Taiwan suffer from earthquakes.

Earthquakes hit Japan. They also occur frequently in Taiwan.

Earthquakes hit Japan frequently, and they hit Taiwan very often too.

2. To show the differences between two things: **on the other hand, however, but, in contrast.**

The new school year usually begins in September in Taiwan.
The new school year usually begins in April in Japan.

The new school year usually begins in September in Taiwan. On the other hand, it usually begins in April.

In Taiwan the new school year usually begins in September. However, in Japan it usually begins in April.

In Taiwan the new school year usually begins in September. but in Japan it usually begins in April.

In Taiwan the new school year usually begins in September. In contrast, it usually begins in April in Japan.

Exercise

Look at paragraph five in this article. Paraphrase the sentences/points it contains, using the comparison words above.

1. DNA computers have the potential to take computing to new levels, picking up where Moore's Law leaves off.
   ANS: _____
2. The large supply of DNA makes it a cheap resource.
   ANS: _____
3. DNA computers are many times smaller than today's computers.
   ANS: _____

Tasks

I *Imagine yourself as a scientist who does a lot of research on DNA computers. A group of high-school students are now on a field trip, visiting your laboratory in order to learn more about DNA computers. Try to explain the benefits of using DNA rather than silicon for computing. You can use the information that appeared in paragraph 5 and 6 as a basis for you answer.*

II *The reading talks about the differences between traditional and DNA computers. Work in groups of four. Find more information on DNA computers. For example, the person* ***who*** *proposed the notion of DNA computers,* ***when*** *they were first proposed,* ***how*** *they were first developed and used, and so on. Use the comparison words introduced above and other new words introduced in this lesson in your presentation. Present what you find to the class.*

Useful Phrases/Vocabulary

Starting sentences:

I. There are several benefits to using DNA instead of silicon.
   First, _____. Second, _____.
   Third, _____. Fourth, _____.

II. There are several advantages to using DNA instead of silicon.
   Firstly, _____. Next, _____.
   In addition, _____. Lastly, _____.

The key advantage with DNA is that it will allow computers to become smaller than before, while at the same time to have more capacity.

while

academic word