

# UNIT 6

## AFRAID OF THE NANOWORLD?

*“In thinking about nanotechnology today, what's most important is understanding where it leads, what nanotechnology will look like after we reach the assembler breakthrough.”*

K. Eric Drexler

### Learning Objectives

*In this unit you will:*

- ✓ learn the vocabulary connected with nanotechnology
- ✓ revisit the Infinitive Construction
- ✓ use key words for efficient reading
- ✓ use various speech patterns to make predictions
- ✓ express opinions in arguments and discussions
- ✓ learn how to write an academic essay

## LEAD IN

### 1. Read and comment on the quotation:

*“Quite simply, the world is about to be rebuilt (and improved) from the atom up. Clothing...food...cars...housing...medicine...the devices we use to communicate and recreate...the quality of the air we breathe...and the water we drink, are all about to undergo profound and fundamental change. And as a result, so will the socio and economic structure of the world. Nanotechnology will shake up just about every business on the planet.”*

Josh Wolfe, Editor of Forbes Magazine

### 2. Many incredible claims have been made about the future of nanotechnology. We speak about nanoparticles, nanosensors, nanobots, nanotubes and nanomaterials. Work in pairs and discuss these questions:

- What exactly does “nano” mean?
- Why has nanotechnology attracted so much attention in recent years?
- Do you think that nanotechnology will radically change our life in future? In which way?

### 3. Report your ideas to the rest of the class.

## READING

### 1. Read the text “How small is small?” and answer the questions.

- a) What is nanotechnology?
- b) What is the size of nanomaterials?
- c) When did the idea of nanotechnology first appear?
- d) How are the names of Richard Feynman and Eric Drexler connected with the development of nanotechnology?
- e) What possibilities does the nanoscale provide?
- f) What are the application areas for nanotechnology?

### 2. The text has eight paragraphs (A-H). Identify the key idea in each paragraph and write a paragraph heading.

*Example:* (A) – Science on a miniature scale

### 3. Compare your headings as a class.

## How Small Is Small?

### (A) *Science on a miniature scale*

Nanotechnology is science and engineering at the scale of atoms and molecules. It is the manipulation and use of materials and devices so tiny that nothing can be built any smaller.

(B) \_\_\_\_\_

Nanomaterials are typically between 0.1 and 100 nanometers (nm) in size - with 1nm being equivalent to one billionth of a meter. If one nanometer was roughly the width of a pinhead, then one meter on this scale would stretch the entire distance from Washington, DC to Atlanta - around 1000 kilometers. But a pinhead is actually one million nanometers wide. Most atoms are 0.1 to 0.2 nm wide, strands of DNA around 2nm wide, red blood cells are around 7000 nm in diameter, while human hairs are typically 80,000 nm across.

(C) \_\_\_\_\_



People have made use of some unusual properties of materials at the nanoscale for centuries. Tiny particles of gold for example, can appear red or green, a property that has been used to colour stained glass windows for over 1000 years. However, the idea of nanotechnology was born only in 1959 when Nobel Prize winning physicist Richard Feynman gave a lecture exploring the idea of building things at the atomic and molecular scale. He imagined the entire Encyclopedia Britannica written on the head of a pin.

(D) \_\_\_\_\_

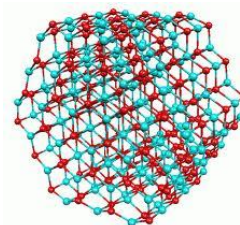
When K. Eric Drexler popularized the word 'nanotechnology' in the 1980's, he was talking about building machines on the scale of molecules, a few nanometers wide; motors, robot arms, and even whole computers, far smaller than a cell. Drexler spent many years describing and analyzing these incredible devices, and responding to accusations of science fiction. In fact, experimental nanotechnology appeared in 1981, when IBM scientists in Zurich, Switzerland, built the first scanning tunneling microscope (STM).



It made it possible to see single atoms by scanning a tiny probe over the surface of a silicon crystal.

(E) \_\_\_\_\_

The nanometer length scale is unique because it makes it possible to change the fundamental properties of materials without altering their chemical composition. Nanoparticles have very high surface areas and their behaviour and mobility can be changed. Nanotechnology allows scientists to specifically analyze, organize and control matter on many length scales simultaneously. This creates unlimited possibilities for products and applications. Advanced nanotechnology, or that which works with artificial intelligence, nanorobots and self-assembly is expected to increase significantly.



(F) \_\_\_\_\_

Nanoparticles are currently used in the electronic, magnetic, optoelectronic, biomedical, pharmaceutical, cosmetic, energy, catalytic and materials industries. In the medical field they are used to aid in drug delivery and medical imaging, and in future nanotechnology is predicted to contribute to new cancer therapies, new treatments for infections and brain diseases and new drugs with fewer side effects.

(G) \_\_\_\_\_

Nanotechnology is also expected to play a major role in environmental protection. Nanoparticles may be used in contaminant neutralization, magnetic techniques, special filtering and cleaning methods, environmental decontamination and energy conservation and in the production of energy efficient devices.

(H) \_\_\_\_\_

Nanotechnology involves manipulations of matter at extremely small levels and its applications appear to be almost limitless. Cancer cures, shirts that change colour, self-heating/cooling clothes, super processors the size of sugar cubes, alloys both lighter and stronger than steel are just a handful of the potential applications of this technology that may bring about more change in 25 years than the entire 20<sup>th</sup> century.

## Focus on language

1. Read the text again. Find international words and write them down. There are about forty of them. Make sure you can pronounce them correctly in English.

*Example:* nanotechnology – нанотехнология/и; molecular - молекулярный

2. Match the verbs from A with the most suitable word(s) from B. In case of difficulties look back in the text. Then translate the word combinations into Russian.

A	B
1) to manipulate	a) medical imaging
2) to make use of	b) cancer therapies
3) to give	c) matter
4) to explore	d) chemical composition
5) to popularize	e) accusations
6) to build	f) unlimited possibilities
7) to describe	g) the word “nanotechnology”
8) to respond to	h) machines
9) to alter	i) a lecture
10) to control	j) a scanning tunneling microscope
11) to create	k) the idea
12) to aid in	l) unusual properties
13) to contribute to	m) materials

3. Here is the sentence from the text. How do you translate it into Russian?

*Nanotechnology is also expected to play a major role in environmental protection.*

### The Infinitive Construction (Complex Subject)

Study the model and the sentences given below. Remember the way the sentences are translated into Russian:

smb/smith + verb + to-infinitive

Note the typical verbs that are used to form this Infinitive Construction:

#### A) Passive

to be thought  
to be believed  
to be assumed  
to be expected

to be predicted  
to be considered  
to be reported  
to be said

#### B) Active\*

to appear  
to seem  
to prove  
to happen

#### C) be+adj

to be likely  
to be unlikely  
to be sure  
to be certain

\*These verbs are active in form but passive in their meaning.

*Examples:*

- *Nanotechnology is predicted to contribute to new cancer therapies.*

Делаются предположения, что нанотехнологии будут способствовать появлению новой терапии онкологических заболеваний.

- *Nanotechnology applications appear to be limitless.*

Оказывается, что применения нанотехнологий являются безграничными.

- *Nanotechnology is likely to change every sphere of our life in the near future.*

Вероятно, нанотехнологии изменят каждую сферу нашей жизни в ближайшем будущем.

**4. Rewrite the sentences (a-g) following the Complex Subject model in the box. Make use of the verbs in brackets. Translate the sentences into Russian.**

Example:

Nanotechnology will impact a broad range of fields, from basic science to consumer goods. (*assume*)  
**Nanotechnology is assumed to impact a broad range of fields, from basic science to consumer goods.**

- Nanoscale science will be as important as steam engine, the transistor and the Internet. (*believe*)
- Nanotechnology will revolutionize essentially all manufactured products, from computers to medical instruments to solar cells to planes and rockets. (*expect*)
- A technology that lets each individual design and build whatever they want will not be compatible with centralized control. (*appear*)
- Many areas of biomedicine will benefit from nanotechnology. (*consider*)
- Molecular scale positional devices will resemble very small versions of their everyday macroscopic counterparts. (*be likely*)
- Self-cleaning or 'easy-to-clean' surfaces on ceramics and glasses will be the most prominent application of nanotechnology in the household appliances. (*prove*)
- Nanotechnology will make medical services much more inexpensive as well as much more effective. (*think*)

## LISTENING

**1. Listen to an interview with Ian Pearson, a specialist in nanotechnology, and fill in the chart.**

Field of application for nanotechnology	Possible benefits
✓ .....	✓ .....
✓ .....	✓ .....
✓ .....	✓ .....

**2. Listen again and fill in the gaps in the extracts (a-c).**

- "... in the future nanotechnology could go far, far further. One day scientists could (1) \_\_\_\_\_ molecules to create tiny computers or (2) \_\_\_\_\_ that will fuse with our bodies."
- "Nanorobots will be programmed to (3) \_\_\_\_\_ and reconstruct the molecular structure of cancer cells and viruses to make them harmless. There is even a speculation that nanorobots could (4) \_\_\_\_\_ or reverse the aging process, and life expectancy could (5) \_\_\_\_\_ significantly."
- "Besides nanotechnology has also the potential to have a (6) \_\_\_\_\_ effect on the environment. For instance, airborne nanorobots could be programmed to rebuild the thinning (7) \_\_\_\_\_ layer. Manufacturing materials using the bottom up method of nanotechnology also creates less (8) \_\_\_\_\_ than traditional manufacturing process. Cutting down trees, mining coal or drilling for oil may no longer be necessary. Resources could simply be (9) \_\_\_\_\_ by nanomachines."

## SPEAKING

Work in small groups and discuss:

- Which ideas discussed in the interview in the **Listening** task do you find most surprising? Why?
- What dangers or risks connected with nanotechnology can you predict?

Make use of the expressions in the boxes.

### Functional language Making predictions

I'm certain that..., I doubt that...,  
I would imagine that...,  
There is no doubt that...,  
It's highly unlikely that...,  
There's a chance that...,  
The chances are that...,

### Future time expressions

by the middle of this century  
in five years' time  
in the near future  
in the next few years  
within a decade or so  
in the distant future  
(not) in my lifetime

## READING

1. The headline of the text you are going to read is "The Hype and Hope of Nanotechnology".  
What do you think it is about? Work in groups of three. Write down some predictions.  
Discuss them as a class.
2. Read the text and check your predictions.

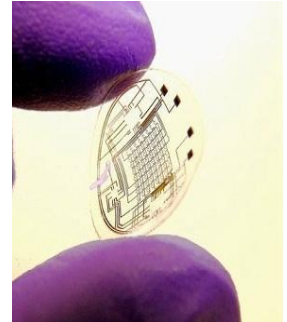
### THE HYPE AND HOPE OF NANOTECHNOLOGY



Will nanotechnology change human life in ways never thought possible? Is nanotechnology the key that will unlock the door to the next Industrial Revolution? The current debate around this field of science is frequently polarized into two **opposing camps**. On the one hand there are scientists, engineers and investors who are keen to promote the field as a source of new products and processes. They promise that these will lead to changes as revolutionary as those caused by the explosion of information and communications technologies in recent decades. On the other hand there are environmentalist critics and others who warn that the **potential hazards** of nanotechnology remain unknown, some even demanding a **moratorium** on new developments in the area.

So, what are some of the **bright-side manifestations** of nanotechnology?

- Cancer cells could be destroyed by silicon combs; “nanobots” could clear blocked blood vessels; bio-compatible, high-performance materials could be created for use in **artificial implants**.
- The use of nanofibers would make clothes water and stain repellent or wrinkle-free and would guarantee full-surface protection from electrostatic charges for the wearer; **military application** could be in camouflage where nanocameras mixed with nanodisplays could create an “invisibility coat”, acting like the skin of a chameleon.
- Mass storage devices would be built that can store more than a hundred billion billion bytes in a volume the size of a sugar cube; and parallel computers of the same size that can deliver a billion billion instructions per second.
- Microscopic solar cells in building facades and on road surfaces would produce cheap energy; nanotechnology would cut costs both of the solar cells and the equipment needed to deploy them, making solar power economical and **moving it into the mainstream**.
- Nanotechnology would dramatically reduce the costs and increase the capabilities of space ships and space flight; travel in space would no longer be reserved for an elite few. And many more...



But at scales of a millionth of a millimeter, materials can develop unusual and unpredictable properties, leading to concerns about risks to health and the environment. So, what are the **possible downsides** of this new technology?

- Rapid and inexpensive manufacture **of advanced weapons** could also be developed quickly; an arms race based on this technology could destabilize existing power structures in unpredictable ways.
- Criminal technologies, from weapons to spy systems to communication to smuggling, would **get a boost** from the ability to fabricate advanced products as needed; criminals and terrorists with stronger, more powerful, and much more compact devices could do serious damage to society.
- Molecular manufacturing would allow the creation of very small, inexpensive supercomputers that could run a programme of constant surveillance on everyone. There might be attempts of introducing **round-the-clock surveillance** of every citizen.
- **Self-replicating nanomachines** could run out of control and **reproduce so exponentially** that they could consume everything available and turn terrestrial life into mush or ‘grey goo’.

These ideas barely scratch the surface of what is possible. In any case, there is no sense in elaborating on frightening scenarios that are as misleading as naïve promises that ‘the whole thing is harmless’. It would be more effective for the development of this new technology to be accompanied by education and critical examination.

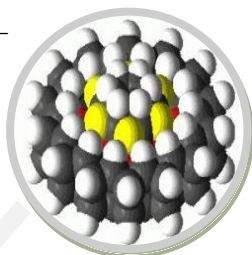
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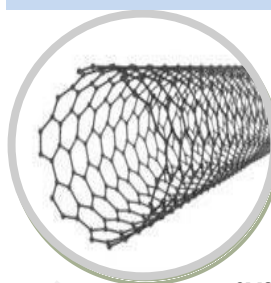
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**Нано** (от греч. nanos – «карлик») – миллиардная доля чего-либо. Область прикладной науки и техники, занимающаяся изучением свойств объектов размером в  $10^{-9}$  метра. Нанотехнологии манипулируют отдельными атомами и молекулами, а также разрабатывают устройства подобных размеров.



Что дают сейчас?



### Материалы

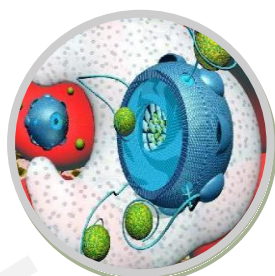
#### Порошки, суспензии.

Улучшают работу двигателей, предотвращают ржавчину, помогают материалу самоочищаться или не смачиваться водой.

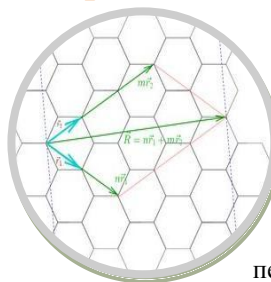
**Упаковки.** Увеличивают срок годности продукции. Сверхпрочные материалы из углеродных нанотрубок.

### Медицина

Разработка новых лекарств (в том числе от рака) и диагностического оборудования. Первые нанороботы, способные путешествовать по организму животных.



### Энергетика, электроника



Покрытие для солнечных панелей. Увеличивает КПД.

Безопасное хранение водорода с помощью нанотрубок.

Увеличение объемов компьютерной памяти и скорости передачи данных.

Новые полупроводниковые приборы и микросхемы.

### Материалы

Конструирование любых молекул. Создание абсолютно прочных материалов. Появление наноеды – несуществующей в природе пищи для человека и животных.

### Медицина

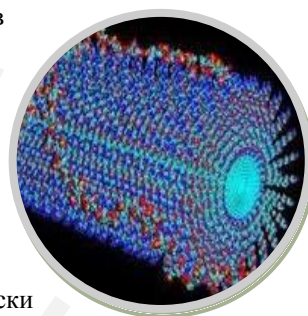


Лекарства направленного действия, проникающие на пораженную ткань или опухоль. Индивидуальные препараты.

Микрохирургия нового уровня, повсеместное

использование нанороботов для диагностики и лечения почти всех болезней.

Выращивание тканей и органов. Оживление замороженных ранее людей с целью их лечения, продления жизни. Фактически достижение бессмертия.



### Энергетика, электроника

Принципиально новые типы двигателей и топливных элементов.



Сверхминиатюрные электронные устройства. Новые способы записи и хранения информации. Гибкие дисплеи, появление электронной бумаги.

## Get real

Search the Internet and/or popular science books and magazines for more information on the potential benefits and possible risks of nanotechnology. Prepare to report your findings to the class.

### SPEAKING

1. Work in teams. Discuss your arguments *'for'* and *'against'* nanotechnology.

#### Team A

You support the idea that nanotechnology will only change our life for better. You think that people, who speak about risks and dangers connected with nanotechnology, exaggerate the problem.

#### Team B

You admit that nanotechnology might bring lots of benefits. Still you are afraid that such benefits would be outweighed by different hazards brought about by nanotechnology.

2. Present your ideas to your opponents. Make sure you include the introduction, the arguments *'for'* or *'against'* nanotechnology and the conclusion. Try to be as convincing as possible.

<i>Functional language</i>	<i>Agreeing and disagreeing</i>
Opinions	I think (that).../In my opinion.../As for me...
Agreeing	Absolutely/Right/That's right. I agree/You're right.
Disagreeing	I know, but... /I see your point, but.../I'm not sure.../That's not true...

### WRITING

Read these statements. Choose one of them and write an essay to express your opinion. Follow the guidelines in the *Study help* box.

- Nanotechnology will develop regardless of what we do or don't do.
- Nanotechnology represents not only wonderful benefits for humanity, but also grave risks.
- The anticipated threats and benefits of nanotechnology are exaggerated as they are based on theoretical rather than practical experience.

### Possible introduction:

Nanotechnology is the use of very small particles-measured in the billionths of a metre. At these sizes, even the simplest, best-known materials can take on surprising new properties....

### Study help

An academic essay in English follows the following structure:

**Introduction:** re-statement of the topic and indication of writer's position

#### Body of the essay:

Paragraph 1: main ideas  
supporting ideas

Paragraph 2: main ideas  
supporting ideas

**Conclusion:** summary of views and re-statement of position

## In the Realm of Science

### 1. Learn to say the following:

- $10^9$  ten to the power nine
- $10^{-9}$  ten to the power minus nine

### 2. Read the prefixes that show various sizes.

Number	Prefix	Symbol	Number	Prefix	Symbol
$10^1$	deka-	da	$10^{-1}$	deci-	d
$10^2$	hecto-	h	$10^{-2}$	centi-	c
$10^3$	kilo-	k	$10^{-3}$	milli-	m
$10^6$	mega-	M	$10^{-6}$	micro-	u (greek mu)
$10^9$	giga-	G	$10^{-9}$	nano-	n
$10^{12}$	tera-	T	$10^{-12}$	pico-	p
$10^{15}$	peta-	P	$10^{-15}$	femto-	f
$10^{18}$	exa-	E	$10^{-18}$	atto-	a
$10^{21}$	zeta-	Z	$10^{-21}$	zepto-	z
$10^{24}$	yotta-	Y	$10^{-24}$	yocto-	y

## Progress Monitoring

In this unit you have worked on the vocabulary on the topic: "Nanotechnology"

Tick (V) the points you are confident about and cross (X) the ones you need to revise.

- |  |   |
|--|---|
| 1. nanoparticles/nanobots/nanotubes  | 11. mass storage devices                        |
| 2. at the scale of atoms/molecules   | 12. to move sth into the mainstream             |
| 3. fundamental/unusual properties of materials                             | 13. bio-compatible/high-performance materials   |
| 4. scanning tunnelling microscope  | 14. advanced weapons                            |
| 5. potential/unlimited possibilities for applications                      | 15. to increase the capabilities of space ships |
| 6. to bring about sth  | 16. self-replicating nanomachines               |
| 7. self-assembly/artificial implants                                       | 17. to sound amazing/unbelievable               |
| 8. self-heating/cooling/water-and stain repellent/<br>wrinkle-free clothes | 18. to monitor sb's body/detect/fix problems    |
| 9. potential hazards of sth  | 19. to rush quickly into the future             |
| 10. to use a bottom up method  | 20. to represent wonderful benefits/grave risks |

**1. Cross out the odd word. Explain your choices.**

- a) device, machine, technique, computer
- b) chemical, optoelectronic, biomedical, unlimited
- c) atom, crystal, molecule, particle
- d) potential, microscopic, atomic, molecular
- e) scientists, engineers, environmentalists, nanobots
- f) risk, threat, conservation, hazard

**2. Give English equivalents to these Russian word combinations.**

- a) происходить от греческого «карлик»
- b) производство энергосберегающих устройств
- c) разделяться на два противостоящих лагеря
- d) потенциальные риски/опасности
- e) новые типы двигателей и топливных элементов
- f) достигать подъема от чего-либо
- g) выходить из под контроля

**3. Write the word and the Russian equivalent next to each transcription.**

e.g. ['molɪkjʊ:l] – molecule – молекула

- a) [daɪ'æmɪtə]
- b) [kən'trəʊl]
- c) [mə'leɪkjʊlə]
- d) ['prəʊsesə]
- e) [tek'nɒlədʒɪ]
- f) [mə'fɪ:n]
- g) ['maɪkræskəʊp]

**4. Identify and underline Infinitive constructions (Complex Subject) in the sentences below. Translate the sentences into Russian.**

- a) In future nanotechnology is claimed to be able to manipulate molecules and create tiny computers or nanobots that will fuse with our bodies.
- b) Potential applications of nanotechnology are likely to bring about more change in 25 years than the entire 20<sup>th</sup> century.
- c) Advanced nanotechnology, or that which works with artificial intelligence, nanorobots and self-assembly, is supposed to increase significantly.
- d) Self-replicating machines are certain to run out of control and consume everything available.
- e) Bio-compatible, high-performance materials are promised to be created for use in artificial implants.
- f) Water-and-stain repellent and wrinkle-free clothes are reported to be produced with the use of nanofibers.