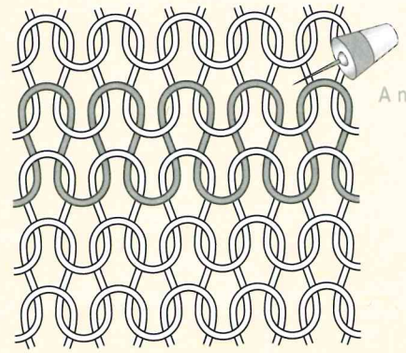
UNIT 21

Micromachines

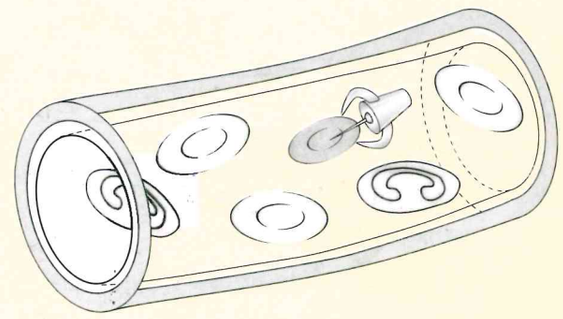
CD 2-45

Section 1 *Vocabulary*

A. Read the text and look at the pictures.



A nanobot changing a textile



A nanobot delivering medicine to a cell

We saw in Unit 8 that, in nature, atoms combine to make molecules and molecules combine to make elements and compounds which appear naturally, as metal, wood, oil, etc. Technology works with these substances to make products. However, there is a new technology, which works with the atoms and molecules themselves to make products. This is called **nanotechnology**.

Nanotechnology is the new science of building products from atoms and molecules. Scientists are now trying to join atoms and molecules together to make products thousands of times smaller than the present instruments and machines.

The prefix **nano-** means the dimension of one billionth. A **billion** is 1 and 9 zeros. Therefore one **nanometer** is one billionth of a meter or 10^{-9} meters or 1 **nm**. One nanometer is the size of a few or a few tens of atoms, and the thickness of a strand of DNA is 2 nanometers. The ratio of one nanometer to one meter is the same as that of a child's marble to the Earth.

There are an enormous number of **applications** of nanotechnology. In theory, scientists can use it to make **devices** which can measure single atoms, **textiles** that can change properties according to needs, ceramics which do not get dirty when we use them, and **vehicles** which are stronger but lighter and therefore use far less energy.

There are great expectations for nanotechnology in the field of **medicine** in particular. Progress is already being made in such areas as **microscopic** medical devices that can pinpoint and deliver medication to cancer cells. It will be possible to make **nanobots** (tiny robots) which can enter your body to kill disease or mend broken bones.

B. **Write the meaning of the bold part of each set of words. Use the words or phrases in the box.**

before / earth / heat / not / pressure / skill / small / very small

1. **nano**technology, **nano**bots, **nano**tubes very small
2. **tech**nology, **tech**nical skill
3. **pre**fix, **pre**position, **pre**paration before
4. **therm**ometer, **therm**al heat
5. **dis**ease, **dis**like, **dis**agree not
6. **micro**scope, **micro**processor small
7. **geo**logy, **geo**metry, **geo**graphy, **geo**thermal earth
8. **bar**ometer, milli**bar** pressure

C. **Write the correct prefix in each space in the table. Use the prefixes in the box.**

centi- / deci- / giga- / kilo- / mega- / micro- / milli- / nano-

Prefix	Symbol	Number / Fraction	Factor
giga	G	one billion	10^9
mega	M	one million	10^6
kilo	k	one thousand	10^3
deci	d	one tenth	10^{-1}
centi	c	one hundredth	10^{-2}
milli	m	one thousandth	10^{-3}
micro	μ	one millionth	10^{-6}
nano	n	one billionth	10^{-9}

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Section 2 Reading

The World's Smallest Thermometer

Dr. Yoshio Bando of the National Institute of Materials Science, Japan, has announced the production of a thermometer which is less than one tenth of the thickness of a human hair. The thermometer is one of the first practical applications of nanotechnology, the science of atomic machines.

The word "nano" comes from an ancient Greek word meaning "dwarf". Three to five atoms side by side have a diameter of one nanometer.

Dr. Bando's thermometer, which is about a thousandth of a millimeter long and 85 nanometers in diameter, is a nanotube, filled with gallium. Nanotubes are large macromolecules which were discovered in 1991 by Sumio Iijima, a professor at Meijo University in Nagoya.

The tubes are cylinders of graphite, which is a naturally-occurring form of carbon. The gallium inside Dr. Bando's nanotubes acts in the same way as mercury in a normal thermometer. In other words, as the temperature rises, it expands in proportion. Temperatures up to 1,000 degrees can be measured by the device, which will also be used to detect faults in electronic circuits.

Scientists say there are many other possible applications for nanotubes. In the future, they may be inserted into the human body for medical monitoring. They could be used in situations which are dangerous for humans, in order to detect toxic gases, for example.

Nanotubes are so adaptable because of their remarkable physical properties which change according to diameter, length and the amount of twist on the tube.

A. **Choose the best answer in each case.**

1. Dr. Bando's thermometer contains:
   a. graphite
   b. gallium
   c. mercury
   d. carbon
2. The word *tube* means:
   a. graphite
   b. cylinder
   c. cylinder inside a cylinder
   d. gallium

3. Nanotubes can be found with different:
   a. widths
   b. lengths
   c. amounts of twist
   d. widths, lengths and amounts of twist

4. Dr. Bando's thermometer measures:
   a. rises in temperature
   b. temperatures above 1,000 degrees
   c. temperatures below 1,000 degrees
   d. faults in electronic circuits

5. An atom has a diameter of between:
   a. one quarter and one half of a nanometer
   b. one half and two-thirds of a nanometer
   c. one third and one fifth of a nanometer
   d. one half and three-quarters of a nanometer

B Study the following example sentences.

Using modals in the passive

Temperatures up to 1,000 degrees **can be measured** by the device.
The device **will** also **be used** to detect faults in electronic circuits.
In the future, they **may be inserted** into the human body for medical monitoring.

C Put each sentence into the passive.

1. We could locate them in situations which are dangerous for humans.

They could be located in situations which are dangerous for humans

2. We can even find some nanotubes with several walls.

some nanotubes can even be found with several walls

3. Scientists will use nanotubes on silicon chips.

Graphite tubes can even be found with several walls

4. We can find graphite in nature.

Graphite can be found in nature

5. We can only see nanotubes with a very strong electron microscope.

Nanotubes can only be seen with a strong electron microscope

CD 2-47

Section 3 Listening

A Listen and complete the summary of the reading text in Section 2. Write one word in each space.

Dr. Yoshio Bando has produced a _____ by nanotechnology. The device, which is a _____ 85 nanometers in diameter, is filled with _____. This element expands in proportion to _____, like mercury. Scientists say there will be many more _____ of the new science including sensors for medical monitoring.

CD 2-48

B Listen to the lecture. Choose the best answer in each case.

1. How many objectives are there in the e-Japan strategy?
   a. two
   b. three
   c. four
   d. five

2. How long after Phase I did Phase II start?
   a. 2 years
   b. 3 years
   c. 4 years
   d. 5 years

3. Phase II of the strategy includes the objective of broadband access for:
   a. every family in Japan
   b. 20 million people in Japan
   c. 30 million families in Japan
   d. digital signing

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C Listen again and complete the summary using the words in the box. Write one word in each space.

access / applications / documents / e-business / network

The e-Japan strategy aims:

- to form the world's most advanced telecommunications _____
- to facilitate _____ through the digital signing of _____
- to speed up _____ to the Internet through broadband
- to use nanotechnology for a large number of _____