МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ ТЕХНІЧНИЙ УНІВЕРСИТЕТ
“ХАРКІВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ”

Методичні вказівки
до практичних занять з розвитку навичок читання та усного мовлення англійською мовою
за спеціальністю «Нано- та мікротехнології»

для студентів та магістрів ФТ факультету

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Методичні вказівки до практичних занять з розвитку навичок читання та усного мовлення англійською мовою за спеціальністю «Нано- та мікротехнології» для студентів та магістрів ФТ факультету / Сост.: О.Я.Лазарєва. – Харків: НТУ «ХПІ», 2010. – 35 с.

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ВСТУП

Нанотехнологія – одна з найновіших та найперспективніших галузей теоретичної та прикладної науки, яка вже знайшла широке застосування в різних сферах виробництва та наукових досліджень. Створення об’єктів розмірами в декілька нанометрів та можливість управління ними та їхніми властивостями стали привабливими, корисними, а часто й незамінними в медицині, електроніці, космічних технологіях тощо. Різним аспектам використання нанотехнологій у різних сферах і присвячена ця збірка текстів.

Методичні вказівки складно з 9 автентичних тематичних текстів, споряджених міні-словником та низкою вправ, що дозволяють студентам розширити свій словарний запас, відпрацювати різні розмовні моделі, активізувати комунікативні навички.

Окремий розділ «Supplementary Reading» містить 5 додаткових текстів, які студенти можуть використовувати для самостійного опрацювання, підготування доповідей тощо.

Text 1. The Big Future of Nanotechnology

Active Vocabulary:

to deal	мати справу	argue	стверджувати
invisible	невидимий	novel	новина; новітній
by most accounts	у всіх відношеннях	delivery	постачання
level	рівень	to punch	протикати
stain-proof	такий, що не линяє	to disrupt	розривати; порушувати
scratch-resistant	стійкий до подряпин	benefit	користь
fuel cells	паливні елементи	determine	визначати

Nanotechnology deals in the realm of the nearly invisible. The word comes from the Greek *nanos*, meaning «dwarf». But by most accounts, the technology's potential is anything but small.

Scientists and engineers can now physically work with materials at the atomic level to create stain-proof fabrics, scratch-resistant paints and longer-lasting tennis balls. And researchers say new medical diagnostic tools and smaller, more efficient fuel cells and batteries based on nanoscience are on the way.

From computer chips invisible to the naked eye to microscopic machines that seek out and destroy cancers inside the human body, many scientists argue that the potential of nanotechnology could be endless, but not without controversy.

"If we can get a nanoparticle into a cell, that might prove to be a novel and useful drug delivery device," says Ms. Kulinowski, Executive Director of the Center for Biological and Environmental Nanotechnology at Rice University. "On the other hand, it might prove to be a toxin to the cell either by punching a hole in the cell membrane or otherwise disrupting the cell's function."

Still there's nearly universal agreement among scientists and policy makers that much more research is needed on the health and environmental effects of this new technology.

Whether the benefits of nanotechnology outweigh the risks will determine the future of what many researchers and investors hope will be the world's next industrial revolution.

Exercise 1. Give negative of the following words:
efficient, useful, hopeful, possible, order, necessary, connect, definite, polite, correct, comfortable, organic.

Exercise 2. Answer the questions:
1. Where does the word "nano" come from and what does it mean? 2. What can scientists and engineers create using nanotechnology? 3. What are the possible medical applications of the nanotechnology? 4. Why can nanoparticles be harmful to human health? 5. What aspects of nanotechnology should be studied?

Exercise 3. Try to find the origins of the following words and explain them using the pattern: *The word ___ comes from ___:*
bicycle, television, portfolio, microscope.

Text 2. How can nanotechnology improve fuel cells?

Active Vocabulary:

nanoparticles	наночастинки	digital	цифровий
to reduce	зменшувати	conventional	традиційний
to replace	замінювати	to plug	підключати
entirely	повністю	electric outlet	електрична розетка
device	прилад	tank	бак, цистерна

Catalysts are used with fuels such as hydrogen or methanol to produce hydrogen ions. Platinum, which is very expensive, is the catalyst typically used in this process. Companies are using nanoparticles of platinum to reduce the amount of platinum needed, or using nanoparticles of other materials to replace platinum entirely and thereby lower costs.

Fuel cells contain membranes that allow hydrogen ions to pass through the cell but do not allow other atoms or ions, such as oxygen, to pass through. Companies are using nanotechnology to create more efficient membranes; this will allow them to build lighter weight and longer lasting fuel cells.

Small fuel cells are being developed that can be used to replace batteries in handheld devices such as PDAs (Personal Digital Assistant) or laptop computers. Most companies working on this type of fuel cell are using methanol as a fuel and are calling them DMFC's, which stands for direct methanol fuel cell. DMFC's

are designed to last longer than conventional batteries. In addition, rather than plugging your device into an electrical outlet and waiting for the battery to recharge, with a DMFC you simply insert a new cartridge of methanol into the device and you're ready to go.

Fuel cells that can replace batteries in electric cars are also under development. Hydrogen is the fuel most researchers propose for use in fuel cell powered cars. In addition to the improvements to catalysts and membranes discussed above, it is necessary to develop a lightweight and safe hydrogen fuel tank to hold the fuel and build a network of refueling stations. To build these tanks, researchers are trying to develop lightweight nanomaterials that will absorb the hydrogen and only release it when needed. The Department of Energy is estimating that widespread usage of hydrogen powered cars will not occur until approximately 2020.

Exercise 1. Decipher the abbreviations using the phrases *stands for, means, is deciphered as:*

PC, NATO, UNESCO, AIDS, GPS, AMD, MIT, CERN ;)

Exercise 2. Say whether these statements are TRUE or FALSE:

1. Platinum is used as a catalyst in chemical reactions with some fuels such as petrol and gas. 2. Companies are trying to increase the consumption of platinum. 3. Nanotechnology is used to create membranes which can trap the ions of hydrogen. 4. Laptop computers can operate only connected to the electric grid. 5. Small fuel cells are being designed to replace rechargeable batteries for notebooks and laptops. 6. Most researchers propose to use spirit in fuel cell powered cars. 7. Lightweight nanomaterials are being developed to make the body of cars. 8. Hydrogen powered cars will be widely used only in the next century.

Exercise 3. Compose 3 sentences using the pattern *Rather than V-ing ...* which means *Замість того, щоб ..., e.g.: You may use a calculator rather than making calculations yourself.*

Text 3. Nano-scale fuel cells may be closer than we think, thanks to an inexpensive new manufacturing method

Active Vocabulary:

cell	клітина; комірка; чарунка	capacity	місткість; ємність
essential	важливий	to strip	знімати; позбавляти
to expand	розширювати	to harvest	збирати врожай
response	відповідати	fuzzy	неясний; нечіткий
entertainment	розваги	frontier	кордон
unavoidable	невідворотний	to etch	гравірувати; травити
to provide	забезпечувати; постачати	to borrow	позичати

We live in a world of hand-held devices: iPods, cell phones, PDAs, pagers... the list of essential personal technology keeps expanding, and the natural response is consolidation. It's rare these days to see a new cell phone that isn't also a digital camera, and MP3 players can be integrated into just about anything. We're just a short step away from universal, hand-held devices that combine communication, media, and entertainment into one slim package. What's stopping us? In a word, power.

Cell phones last a few days on a single battery; laptop computers, two to three hours. If you could have a pocket-sized personal computer with a cell-phone sized battery, how long do you think it would last? Just long enough to check your e-mail, or play a game of solitaire? It's a sad but unavoidable fact that the more complicated an electronic device gets, the less efficient it is.

Enter fuel cells, with an energy capacity at least ten times greater than that of conventional batteries. Where a lithium-ion battery can provide 300 Watt-hours per liter, the methanol in a fuel cell has a theoretical capacity of up to 4800 Watt-hours per liter! Imagine your laptop running for a full day without needing to recharge, and you can see why industry leaders such as Toshiba, IBM, and NEC have been pouring funds into fuel cell research.

A polymer-electrolyte membrane (PEM) fuel cell generates current by stripping hydrogen atoms from a chemical source, breaking them apart on a catalyst (such as platinum), and harvesting the electrons. The hydrogen ions (protons) left over from this process are separated from the fuel by an electrolyte, and when brought into contact with the atmosphere they bind to oxygen molecules and produce water. The more fuel you can bring into contact with the

catalyst, the more current can be drawn from the cell. A high catalytic surface area is the key to efficiency.

To compress more power into smaller volumes, researchers have begun to build fuel cells on the fuzzy frontier of nanotechnology. Silicon etching, evaporation, and other processes borrowed from chip manufacturers have been used to create tightly packed channel arrays to guide the flow of fuel through the cell. The point is to pack a large catalytic surface area into a wafer-thin volume. This approach is not only expensive, but inherently limited by its two-dimensional nature.

Exercise 1. Compose 2 sentences using the pattern: *The more ..., the more.*
E.g.: The higher the temperature, the higher the pressure.

Exercise 2. Answer the questions:
1. What is one of the main problems of modern hand-held devices? 2. How long may a pocket-sized computer on a usual battery last? 3. How can new fuel cells improve the situation? 4. What is the key to the efficiency of the fuel cells? 5. What technological processes are used to produce miniature fuel cells?

Exercise 3. Read the text below. How is it connected to the text above? How can you explain the title of the text?

Fiat Lux!

Researchers Kenneth Lux and Karien Rodriguez, at the University of Wisconsin, came up with an exciting new approach to the problem. Their method not only improves the performance of nano-scale fuel cells, but completely sidesteps the need for industrial-strength technology. “Even the best electrocatalysts, on a flat surface, give only hundreds of microamps per square centimeter. What you really want is … to increase the surface area by orders of magnitude.” Lux explains to PhysOrg.com, “To do this you need a three-dimensional structure.”

Lux and Rodriguez found their fuel channels ready-made in a commonly available, porous alumina filter costing only about $1. The filter is riddled with neat, cylindrical holes only 200 nanometers in diameter, and was already being used at their lab as a template for the growth of nanowires. Lux hit on the idea of creating nanowires in a platinum-copper alloy, then dissolving the copper by

soaking the filter in nitric acid. In place of a solid nanowire, each hole was left with a porous platinum electrode. The partially dissolved wires are structurally complex, as befits their random nature, and have an enormous surface area for their size.

To build a fuel cell, they fill the pores with acid. A sheet of electrolyte-loaded filter paper (or polymer-electrolyte) is placed between two of the nano-electrode arrays to carry off the hydrogen ions. Electrodes can then be placed anywhere on the outer surface of the sandwich, allowing the electrical connections to be easily configured. Stacks of these fuel cell arrays can be connected in series or parallel, to provide higher voltage or current respectively.

Of course, the result is hardly perfect. Lux estimates that only a third of the electrodes are active, and admits that there is a lot of room for improvement. Even this proof-of-concept prototype, however, has an energy capacity an order of magnitude higher than its two-dimensional lithographic counterparts! The price can't be beat, either, with a total materials cost of only $200. "It's a really simple method." says Lux, "My power source for making the nanowires was an AA battery."

If fuel-cell technology can be perfected, we might be looking at a future of cheap, disposable battery packs for our favorite electronic gadgets. When your universal media manager runs out of energy, you'll just run to the store and buy it a methanol sandwich!

Text 4. Targeted Drug Delivery That Hits the Mark

Active Vocabulary:

to hit the mark	досягти успіху	to involve	включати
challenge	виклик; проблема	rod	прут; стрижень; вудка
treatment	лікування; обробка	vessel	посуд; посудина; судина
debilitating	послаблюючий	tumor	пухлина
to deliver	доставляти	to bind	зв'язувати
target	ціль	to attach	прикріпляти; приєднувати
approach	підхід	to insert	вставляти; вміщати

One of the challenges with current cancer treatments is how to deliver drugs to tumors without causing debilitating side effects. By delivering drugs in a more targeted way, some of those side effects can be reduced. There are several

companies and universities developing targeted drug delivery using nanoparticles. One method being developed by researchers at MIT and University of California at San Diego and Santa Barbara looks interesting. They have divided the task between two nanoparticles in order to increase the targeting effectiveness.

The approach involves several steps. First, they inject gold nanorods into the blood stream. The gold nanorods stay in the healthy blood vessels but exit the leaky blood vessels found at the site of tumors. The gold nanorods then accumulate in the tumor and an infrared laser is used to heat the gold nanorods, thereby heating the tumor.

The heating of a tumor increases the level of a stress related protein (called p32) on the surface of the tumor. Because an amino acid (called LyP-1) binds to the p32 protein, they developed a process to attach LyP-1 to spherical nanoparticles called liposomes. They then insert molecules of a chemotherapy drug inside the liposome.

When the drug packed liposome is injected into the bloodstream, the amino acids on the nanoparticles attach to the proteins, the heat has pushed to the surface of the tumor and more of the drug is delivered to the tumor.

Why Nanorods Work Better Than Nanospheres

Several methods in use today use spherical gold nanoparticles for drug delivery, so why did this group choose nanorods instead? It turns out that nanorods of different lengths absorb different frequencies of infrared radiation. The company making the nanorods, NanopartzTM, has shown that gold nanorods absorb infrared much more efficiently than spherical gold nanoparticles. Therefore gold nanorods do a better job of absorbing infrared light and heating up the tumor than spherical nanoparticles do.

It’s interesting to see this concept of using a combination of different nanoparticles doing different parts of the task to develop a system to deliver chemotherapy drugs to cancer tumors. It will be very interesting to see which of the several methods of targeted drug delivery under development is put into widespread use.

Exercise 1. Say whether these statements are TRUE or FALSE:

1. Scientists try to eliminate unwanted side effects of delivering drugs to tumors by using nanotechnology. 2. The new drug delivery method may be done by one

step. 3. The nanorods injected into the blood stream are made of silver. 4. The researchers use laser to heat the tumor. 5. The heat provides better absorption of the drug. 6. In the current methods of drug delivery they use spherical, cubical and ellipsoid nanoparticles. 7. Researchers use nanorods instead of nanoshpheres because nanorods absorb drugs much better.

Exercise 2. Say about the destination of the below-given objects and processes using the phrases: *is used to; is designed for; is aimed at; the purpose of ... is:*
injection, blood vessels, drug, laser, nanoparticles; computer, cell-phone, MP3-player, umbrella.

Exercise 3. Give synonyms to the following words:
a challenge, to deliver, a target, to reduce, to involve, to accumulate, a job.

Text 5. Small Windmills Improved With Nanotubes

Active Vocabulary:

supplement	додатковий	route	шлях
windmill	вітряк	to rely on	покладатись
to assume	вважати	to revert	вертатись
to withstand	витримувати	to grind	молоти
epoxy	епоксидна смола	blade	лезо; лопать
to improve	покращувати	conventional	традиційний

Solar panels are a widely accepted way to generate electricity if your house is off the grid or if you want to supplement power from the grid, however in some regions windmills may be much more effective.

Considering that adding nanotubes to composites produces stronger, lighter components I had assumed that nanotubes would be used to produce larger windmills that can withstand higher winds. I was therefore interested to find Eagle Windpower taking a different approach in one of their product lines by using an epoxy containing carbon nanotubes to improve small windmills, small enough to be used to power a single house.

Why go the windmill route for power generation on your house? Remember that not every place in the world gets enough hours of sunlight to make solar

power practical. For example in December Fairbanks, Alaska, gets about 4 hours of sunlight a day. If you lived in Miami, Florida, which gets over 10 hours of daylight in December, solar is great, but your average Fairbanks resident would be left out in the cold with only solar to rely on. Also, for people who actually live off the grid windmills are a logical choice, reverting back to the days when windmills were used to pump water and grind grain.

To service this windmill market, Eagle Windpower uses the nanotube based epoxy, and techniques taken from ski manufacturing to automate their blade manufacturing process, to produce lightweight, cost competitive, windmill blades. Eagle Windpower says the lightweight blades result in small windmills that produce 30 percent more electric power than windmills with conventional blades.

Exercise 1. Answer the questions:

1. What power sources could be used if your house is off the grid? 2. What approach to power supply does Eagle Windpower suggest? 3. Why in your opinion the company Eagle Windpower has such a name? 4. Why solar panels are not effective in Fairbanks? 5. How did our predecessors use windmills? 6. What parts of windmills are produced using nanotechnology?

Exercise 2. Compose the story beginning: *If I were rich* ... using the pattern: *if* <subject> <Past Indefinite> ..., <subject> *would* <Infinitive>...

Exercise 3. Put as many questions as you can to the following sentences:

1. Eagle Windpower produces windmills with unconventional blades. 2. Alaska towns get about 4 hours of sunlight in December. 3. Eagle Windpower uses epoxy containing carbon nanotubes to improve small windmills.

Text 6. Dressing Up: Thermoelectric Nanowires vs. Nano Solar Cells

Active Vocabulary:

advantage	перевага	to dope	вводити добавку
waste	залишковий	to scorch	обпалювати
embedded	вбудований	awning	навіс; тент
to reduce	зменшувати	handy	зручний

to maintain	підтримувати	lead time	час на підготовку проекту
requirement	вимога	in the meantime	тим часом
roughness	грубість; нерівність	silicon	кремній

Thermoelectric devices can convert heat into electricity. Many temperature sensing devices take advantage of this effect by using electricity to measure temperature in devices called thermocouples. Various researchers are working to produce inexpensive and efficient thermoelectric materials that can change waste heat into electricity.

Recently there was an announcement that researchers at Berkeley had made silicon nanowires that convert heat into electricity using a thermoelectric effect. One possible use of these is to charge portable devices. The wires could be embedded in fabric, so that your jacket could become a charging station, using your body heat to generate the electricity.

Other researchers have made thermoelectric nanowires. The difference with Berkeley's work is that they have reduced the diameter of the wires and modified the surface texture to reduce the thermal conductivity while maintaining the electrical conductivity, a key requirement of thermoelectric materials. It is, in fact, the combination of the wire diameter, the roughness of the surface texture, and doping the silicon with boron that reduce the thermal conductivity without having serious impact on the electrical conductivity.

This concept can be applied in other ways as well. One possibility for this research is that cars could be set up to use their own waste heat to run the radio and other electrical devices in the car. Siphoning off and making use of heat from power plants would be another logical use. All that heat your laptop computer generates that now scorches your thighs could be used to power the laptop up.

This got me thinking about the folks who are working on a parallel track to embed solar cells in fabric. Konarka Technologies, for example, is currently selling solar cell material to Sky Shades, a maker of awnings. By embedding nanoparticles in plastic film they produce a lightweight, flexible photovoltaic material called Power Plastic®. The process involves printing or coating nanoparticles (such as quantum dots or nanocrystals) onto other material using a process similar to printing ink on newspaper.

That’s when I started wondering, why would you need both of these technologies? Then a light went off in my brain—solar doesn’t work in the dark, or in regions of the country where it’s cloudy many days of the year. That’s why the combination of these two solutions could work to ensure that you’re inexpensively charged up, 24/7.

The jacket of the future might have thermo electric nanowires in strategic places (under your arms is a logical hot spot) with solar cells embedded on the shoulders. Imagine how handy a military jacket with both thermo-electric nanowires and solar cells would be. Lighter weight batteries that can be constantly recharged could be carried onto the battlefield to power communications or other equipment.

When will you find such a juiced up jacket in your local department store? You’re probably looking about ten years lead time till you make that shopping trip. In the meantime keep that cell phone charger handy and check my Nanotechnology and Energy Web page for updates.

Exercise 1. Give synonyms to the following words from the text:

to convert, to use, device, inexpensive, waste, heat, fabric, to reduce, to modify, requirement, in fact, impact, to apply, possibility, power, folks, for example, currently, produce, similar to, regions, handy, constantly, equipment, probably.

Exercise 2. Say whether these statements are TRUE or FALSE:

1. Thermoelectric devices can covert water into vapour. 2. Researches from Berkley made their nanowires from gold. 3. Thermoelectric jacket may use the energy of sun to power your hand-held devices. 4. One of the possible applications of the thermoelectric effect in the car is to use the waste heat to power radio and other electrical devices. 5. Konarka Technologies is now producing photovoltaic materials using nanotechnology. 6. Thermoelectric technology and solar cells may be also used in military uniform. 7. We can buy thermoelectric jackets in any shop today.

Exercise 3. Find in the text the English words which have similar equivalents in your native language. Note that sometimes they have different meanings, e.g. *silicon* means *кремній* but not *силікон*. Consult the dictionary to find the difference or similarity.

Text 7. Santa Goes Nano

Active Vocabulary:

annual	щорічний	to make up for	компенсувати
to retire	виходити на пенсію	one-too-many	зайвий
capacitor	конденсатор	invasive surgery	агресивна хірургія
given	за умови, що	to perfect	вдосконалювати
heft	вага	spill	пролиття
insulator	ізолятор	to punch	проколювати

With the holidays coming up I got to wondering how nanotechnology might help Jolly Old St. Nick with his annual gift-giving. I came up with several ideas to make Santa's life easier.

Rudolph the Red Nosed Reindeer has to retire sometime, so Santa will need some kind of light to guide him on his rounds. To keep a sleigh headlight going he can use an ultra-capacitor, a battery replacement being developed by MIT. Using carbon nanotubes, the capacitor can store ten times as much energy as current hybrid car batteries -- perhaps enough to light Santa's way around the world. Such an ultra-capacitor would also be light weight, so it won't overtax his reindeer (who, let's face it, given Santa's heft are carrying a pretty big load to begin with).

The last thing Santa needs is to get sick in December, so it's important that he keep warm on those sub-zero North Pole nights. Aspen Aerogels makes nanoporous materials (Pyrogel) that are excellent insulators. Fabric made of these materials contains billions of nano-sized air pockets that stop heat from escaping. With boots made of Pyrogel, Santa could avoid getting cold feet just as Christmas approaches.

And let's face it, hundreds of years of sliding down chimneys must also have taken its toll on Santa's knees. To make up for one-too-many hard landings, Santa's doctor might try using nano-robots to regenerate the meniscus (the pads between bones in his knees). These nano-robots would be so tiny that they could make repairs without invasive surgery. It may take a few decades to perfect this technique, but Santa's lasted this long, and since he's not about to retire, he'll just have to wait a little longer.

It's no secret that on his rounds Santa finds lots of milk and cookies waiting for him, and naturally spills do occur. What Santa needs is something like Nano-

Tex's nano-whiskers. These can be used in fabrics to cause liquids to bead up. These tiny pointed carbon whiskers can be used to make milk roll off the old fellow's suit. Tiny tots trying to catch a glimpse of him will find his suit neat and clean, thanks to nanotechnology.

But what about Santa's elves who have to slave away making toys all year long? For them a Star Trek-like replicator based on molecular manufacturing techniques would be a great gift. All they have to do is throw some raw materials into the replicator, punch a button and voila: a toy! Building a toy atom by atom, a replicator may actually make toys strong enough to last beyond Christmas morning.

Exercise 1. Say whether these statements are TRUE or FALSE:

1. Instead of the reindeer Santa may use a nano-motor. 2. A special battery replacement is being developed in MIT. 3. The new capacitor will use nano-wires. 4. The boots which are made using nano-technology can prevent Santa from getting cold. 5. Nano-technology may also be used to cure Santa's stomach. 6. Thanks to nano-technology Santa's clothes will always be clean. 7. Molecular manufacturing technique can be applied to produce sweets for children.

Exercise 2. Give plural of the following words. Remember that the words having Roman or Greek origin often have a special form of Plural:

meniscus, nucleus, radius, focus, cactus, curriculum, millennium, forum, spectrum, memorandum, momentum, optimum, formula, alumna, antenna, crisis, analysis, axis.

Exercise 3. Pay attention to the italicized pattern in the fragment "the capacitor can store *ten times as much energy as* current hybrid car batteries" which means *ten times more energy than* .... Say the same using the pattern *as ... as*:

1. His watch is twice more expensive than mine. 2. There are tree times more pages in this textbook on physics than in that one. 3. With this TV antenna we can watch ten times more programs than earlier. 4. Next time I will put twice more sugar in the cake than this time. 5. The new computer makes such calculations ten times quicker than the old one. 6. Your suitcase is twice heavier than mine.

Text 8. Bright Ideas: Nanotechnology and Electronics

Active Vocabulary:

to emit	випромінювати	high definition	висока чіткість
to enable	давати змогу	reliable	надійний
to detach	відокремлювати	solid state	твердий стан
to attach	прикріпляти	available	наявний
shape	форма	feature	риса; властивість
sturdy	міцний; твердий	fine	дрібний; тонкий
to tally up	підраховувати	probe	зонд; щуп
flexible	гнучкий	scale	масштаб
resolution	рішення; роздільність	to enhance	вдосконалювати

I recently read about researchers at the University of Michigan who have demonstrated that nanowires can be used as electrodes in organic light emitting diode (OLED) displays, thereby enabling manufacture of larger flexible OLED displays. This started me thinking about how nanotechnology might affect the appearance and function of electronic devices.

For example, could a laptop computer display unroll like a portable movie screen or could you detach it from the laptop and attach it to the back of an airline seat with Velcro®? Or might the laptop of tomorrow be roughly the same shape as the ones we use today, but be thinner, lighter, sturdier, and able to perform more functions? I began to tally up the ways that nanotechnology might change laptops.

One option to the nanowire-enabled flexible OLED displays could be a very thin, low-power, high resolution screen that uses nanotubes. Motorola is working on such a display which it calls a nano-emissive display because the nanotubes emit electrons at each spot on the display that has to be illuminated to form a picture. This display actually works much like an old fashioned TV, but can provide laptops with very lightweight screens and fine enough resolution for high definition TV.

Motorized hard drives may also become a thing of the past, replaced by lighter, faster, and more reliable solid state hard drives. One such drive is the 64 Gb solid state hard drive that Samsung is making available later this year. These drives are created using a process that prints nano-scale features called transistor

gates on the memory chip. The width of these gates can vary. The Samsung module uses flash memory chips with 60 nanometer-wide transistors gates. It will be interesting to see how quickly manufacturers convert from conventional hard drives to flash based-hard drives as they become available with 64 Gb and greater capacity.

Less conventional technologies are also being explored, such as the atomic force microscopy-based memory being developed in IBM's Millipede project. This type of memory uses many fine silicon probes with tips 1 nanometer in diameter. Researchers are projecting that this chip should be able to store 1 terabyte (abbreviated Tb, and equaling 1,000 gigabytes) on a 1 square inch silicon chip.

Microprocessor manufacturers are also making processors with nano-scale transistors that use less power and fit more transistors on each silicon chip, therefore providing higher performance. The current generation of microprocessors is being built with 65 nanometer gate width transistors and processors that use 45 nanometer gate width transistors should be available in the next few months as the race to increase the computing capabilities of your laptop continues.

Nanotechnology is also providing options for powering your laptop. Lithium ion batteries are commonly used in laptops and many lithium ion battery manufacturers use nano-enhanced electrodes to improve battery performance and safety. A company called ZPower is developing batteries composed of silver and zinc that use nanoparticle-enhanced electrodes. The claim is that these batteries will have twice the energy density of lithium ion batteries and allow your laptop to operate longer on a single charge.

Several companies are working on fuel cells powered by methanol. These cells use a nano-enhanced catalyst and could run your laptop for as long as a full day. When the fuel cell runs out you just replace the methanol cartridge, rather than having to plug your laptop into a wall outlet.

Nanotechnology will certainly transform laptops and other electronic devices over the next few years, and with the many types of changes who knows what the laptop of tomorrow will be. It could weigh just ounces and run for weeks on a single charge. We can only hope that while reinventing the laptop some manufacturers take the opportunity to also design a chassis that offers a break from today's standard flat, black or grey box. Imagine impressing your

friends with a laptop with a display that unfurls like a sail and a case that comes in every color of the rainbow.

Exercise 1. Say whether these statements are TRUE or FALSE:

1. Researchers at Michigan University has developed a technique for producing flexible computer monitors. 2. Motorola is working on the creation of a display containing nano-shperes. 3. a Nano-emissive display works much like an old TV-set. 4. Samsung is already selling its solid state hard drives. 5. New nano-technology hard drives are placed on the flash-memory chip. 6. IBM is developing a 1 square inch memory chip which can store 5,000 Tb. 7. Microprocessors using 45 nanometer gate width transistors are already available. 8. Nano-scale transistors used for production of processors can increase power consumption. 9. Manufacturers of lithium ion batteries use nano-technology to produce battery cases. 10. ZPower is developing batteries composed of silver and copper. 11. New batteries can 10 times increase the energy density. 12. When your laptop is powered by methanol fuel cell you have to recharge it plugging it into a wall outlet.

Exercise 2. Replace the underlined words with one of the options:

1. My grandfather says that weather changes <u>affect</u> his health.
a) improves b) troubles c) influences
2. This flower has an unusual <u>shape</u>.
a) colour b) form c) smell
3. <u>Actually</u>, my brother knows English much better than me.
a) unfortunately b) evidently c) in fact
4. We need to <u>replace</u> this light bulb.
a) change b) throw away c) break
5. Now it is possible to <u>convert</u> solar energy into electricity.
a) transfer b) transform c) translate
6. This exercises will help you <u>improve</u> your English.
a) forget b) stabilize c) make better

Exercise 3. Find in the text the words that mean:

1. an institution of higher education having authority to award bachelors' and higher degrees, usually having research facilities; 2. a device capable of

representing information visually; 3. an informal word for film; 4. a stable elementary particle present in all atoms, orbiting the nucleus in numbers equal to the atomic number of the element in the neutral atom; 5. a tiny wafer of semiconductor material, such as silicon, processed to form a type of integrated circuit or component such as a transistor; 6. a very brief space of time; 7. a bow-shaped display in the sky of the colours of the spectrum, caused by the refraction and reflection of the sun's rays through rain or mist.

Text 9. Nanotechnology on the Road

Active Vocabulary:

to inspire	надихати	to gain a foothold	закріпитися
performance	продуктивність	ramp up	збільшення
appealing	привабливий	obstacle	перепона; завада
density	щільність; питома вага	powder	порошок
issue	питання	sufficiently	достатньо
proprietary	патентований	fleet	парк (напр. машин)
to incorporate	об’єднувати; включати	plentiful	багатий на щось
surface	поверхня	to intend	збиратися
vehicle	транспортний засіб	utility	комунальне підприємство
to meet the requirement	задовольнити потребу	psi = pound per square inch	фунт на квадратний дюйм
to evaluate	оцінювати	hurdle	перешкода

The astronomical price of gas this summer inspired me to look at how nanotechnology might help reduce the cost of driving. I identified two rays of hope: better batteries for cars powered by electricity and hydrogen fuel cells.

Electric or Hybrid Cars

Electric and hybrid cars are becoming more popular given the cost of a tank of gas. Work by nanotech companies such as Altair Nanotechnologies and A123Systems to improve the performance of lithium ion batteries may make

electric cars even more appealing. Lithium ion batteries have a higher power density than the nickel metal hydride batteries currently used in electric and hybrid cars. Using lithium ion batteries you can store the same amount of power in a lighter weight, smaller package. Also lithium ion manufacturers project that their batteries will last about ten years, about four years longer than nickel metal hydride batteries.

However previous generations of lithium ion batteries were slower to charge and had safety issues much publicized when batteries in laptop computers caught fire. Nanotechnology companies have changed the material used in the lithium ion battery electrodes. Each has used its own proprietary material composition both to reduce the risk of the battery catching fire and to incorporate the ability of a nanostructured surface to provide faster charge transfer between the chemicals in the battery and the electrodes.

It appears that the efforts of these companies will result in improved hybrid and electric cars, with some becoming available in 2008. Batteries from Altair are being used in electric vehicles made by Phoenix Motorcars. Currently these are only being sold for use in corporate fleets but should be available to consumers in 2008. Batteries from A123Systems, as well as other lithium ion battery manufacturers, are being evaluated by GM for use in Saturn hybrids.

Once these nano-enhanced lithium ion batteries pass evaluations by GM and other car manufacturers, electric or hybrid cars can be produced that will have higher performance than cars using nickel metal hydride batteries or the same performance while using smaller/lighter batteries.

Of course for hybrid or electric cars that use nano-enhanced lithium ion batteries to gain a foothold the batteries will also have to come down in price and be manufactured in large numbers. It will be interesting to see how battery manufacturers manage the manufacturing ramp up if the demand for these batteries increases both for electronic devices, such as laptop computers, and cars.

Those Elusive Hydrogen Fuel Cells

You may have heard talk about hydrogen fuel cells powered cars replacing gasoline powered cars, but don’t hold your breath. The major obstacles to widespread use of hydrogen fuel cell powered cars in the next few years are the lack of a network of hydrogen fuel stations and the need for lightweight, safe hydrogen fuel tanks.

Researchers are developing hydrogen fuel tanks based upon absorption of hydrogen in solid materials (such as the metal hydride powder that a company named EDC Ovonics is using), carbon or other materials, that are sufficiently safe, lightweight, fast to refuel, and inexpensive to meet the requirements of mass market cars.

Widespread usage of cars powered by hydrogen fuel cells won't happen until refueling stations become as plentiful as your neighborhood gas station. Currently there are only a few hundred hydrogen fueling stations around the world, many intended to be used by a few demonstration vehicles within eco-minded transit bus systems or part of a commercial or utility fleet. Even California only has 24 hydrogen refueling stations at this time.

One of the basic challenges in establishing these stations is deciding how to refill the hydrogen tank in a car. A 6000 psi hydrogen supply is used to fill the high pressure gas cylinders used on many demonstration vehicles. On the other hand, a 1500 psi hydrogen supply is used to fill the cylinders made by EDC Ovonics; that store hydrogen in a solid.

The California Fuel Cell Partnership, a coalition between industry and government is planning to establish a standard fuel delivery method over the next 5 years before they can begin to build a network of hydrogen fuel stations.

These hurdles mean that hydrogen fuel cell powered cars won't be your way soon leaving high gas prices next summer. In fact, the Department of Energy's Hydrogen Program is estimating the start of mass market usage of hydrogen fuel cell cars around 2020.

Exercise 1. Give synonyms to the following words from the text:

price, to reduce, to improve, to store, manufacturer, issue, to change, ability, to enhance, demand, increase, fast, plentiful, around the world, method, in fact.

Exercise 2. Say whether these statements are TRUE or FALSE using the words: *sure, of course, certainly, quite right, absolutely true* if you agree; and *certainly not, nothing of the kind, by no means, not exactly* if you don't.

Example: a) Electrons are negatively charged. – Quite right. b) The Earth has a form of a cube. – Nothing of the kind. It has a form of a sphere.

1. Lithium ion batteries are used in hydrogen powered cars. 2. Lithium ion batteries can last more than 5 years. 3. Lithium ion batteries caused fire in laptop

computers. 4. Nanotechnology companies have changed the material of which the case of the lithium ion battery was made. 5. General Motors approved the use of the lithium ion batteries in their cars. 6. Nickel metal hydride batteries are more effective than lithium ion batteries. 7. Hydrogen fuel cells powered cars are not used widely today mainly because they are very expensive. 8. To produce hydrogen fuel tanks researchers use solid materials and carbon. 9. Today there are more than 5 thousand hydrogen fueling stations around the world.

Exercise 3. Try to explain in English the meaning of the following words:
electricity, a tank, a computer, a consumer, to talk, hydrogen, fuel, a market, a year, a price.

SUPPLEMENTARY READING

Text 1. Nanotechnology in Space

Nanotechnology may hold the key to making spaceflight more practical. Advancements in materials to make lightweight solar sails and the cable for the space elevator could significantly cut the cost of reaching orbit and traveling in space, as well as dramatically reducing the amount of rocket fuel used. Also new materials, along with nanosensors and nanorobots could improve the performance of spaceships, spacesuits and equipment used to explore planets and moons, making a big difference on the 'final frontier.'

Nanotechnology Fueling Rockets

The space elevator is a device that will dramatically reduce the cost of sending cargo into orbit. Like any elevator the space elevator will have a cable, however it will need to be stronger than any existing cable. Roughly 90,000 kilometers long, the space elevator cable will probably be made from carbon nanotubes. It will be anchored at the top to an asteroid (called the counterweight) in orbit around the earth, and at the bottom by an anchor station, perhaps floating in the ocean similar to a drilling rig.

This device would eliminate the need to use rocket fuel, and dramatically reduce the cost of sending cargo into orbit (about 95% of the weight of the space shuttle at blast off is rocket fuel). Instead, solar cells on space elevator cars would convert light from a laser beam mounted on the anchor station into electricity to drive the car up or down the cable like a vertical monorail.

While there are some engineering challenges, to me the most intriguing of which is actually stringing this 90,000 kilometer cable between the anchor station in the ocean and the counterweight asteroid in orbit, steps are underway to address these challenges. A report by NASA's Institute for Advanced Concepts gives a very good introduction to the techniques necessary to construct the space elevator. Yearly competitions conducted by the Elevator 2010 group are providing a focus for energetic minds to demonstrate prototypes with some substantial cash prizes, totaling one million dollars in 2007.

Setting Sail in Space

Once you have people and cargo in orbit nanotechnology can be used to reduce the rocket fuel needed to travel to the moon or planets. Just as sailboats

are propelled by wind while on the seas, spaceships can be propelled by light from the sun reflected off of solar sails while travelling through space. That means that the only fuel required would be during liftoff, docking, or landing.

However solar sails will have to be very large, spreading for kilometers, and very thin to keep their weight low. That's where nanotechnology enters the picture. Researchers at the University of Texas have used carbon nanotubes to make thin, lightweight sheets that may replace the polymer sheets that have been experimented with to date. While there are details still to be worked out (such as how to unfurl a thin, fragile sail in orbit, along with the continual struggle to reduce weight) this method has great potential for reducing the amount of fuel needed to travel between planets.

Building Better Engines

For those times when spacecraft need engines there's a type of engine called ion thrusters that uses less fuel than chemical rockets. Unlike chemical rockets, which push a spaceship by burning fuel and expelling the resulting hot gasses ion thrusters use electricity gathered from solar cells to generate electric fields that push ions away from the spaceship.

Researchers at the University of Michigan have developed ion thrusters that use MEMS devices to accelerate charged nanoparticles. This Nanoparticle Field Extraction Thruster or NanoFET is designed to allow it to last longer than other types of ion thrusters and allow multiple NanoFETs to be clustered together. This could simplify the job of spacecraft engineers by allowing the same thruster design to be used on spacecraft over many different missions just by changing the number of NanoFETs mounted on the spacecraft.

How Nanotechnology Can Improve Spaceships

Regardless of how fuel efficient propulsion systems are, it's still important to make spacecraft lightweight. Researchers are investigating nanotube composites from which they can manufacture strong and lightweight skin and structural members for spacecraft. However this is just the start of how nanotechnology could change the way that spaceships are made. NASA has included a concept called self healing spaceships in their 2030 nanotechnology roadmap. Just as your skin heals a small puncture wound NASA is looking to nanotechnology to provide a way for the skin and structural components of a spaceship to seal up damage from meteors that strike the spaceship.

NASA is also planning to use nanosensors to improve the monitoring of spaceship systems such as life support. The ability of nanosensors to quickly report changed levels of trace chemicals in air could be very useful to keeping life support systems working correctly in a spaceship's closed system. A longer term proposal is to place nanosensors throughout the skin of a spacecraft to act like nerve endings in your skin. When a particular region of the spacecraft skin becomes stressed or damaged, the main computer is alerted to take action and alter the spaceship's course, just as you would jerk your hand away from a hot stove.

What the Well Dressed Astronaut Will Wear

Occasionally astronauts have to leave their spaceships, so researchers at Northeastern University and Rutgers University propose that we protect the astronauts by including layers of bio-nano robots in their spacesuits. The outer layer of bio-nano robots would respond to damages to the spacesuit, for example to seal up punctures. An inner layer of bio-nano robots could respond if the astronaut was in trouble, for example by providing drugs in a medical emergency.

The term "bio-nano robots" comes from the use of biological molecules to provide portions of the robots mechanism. For example, proteins have mechanisms to travel within a body that enable it them to work as a motor for a nano robot. These proteins could be connected to carbon nanotubes that link parts of the nano robot together. When you think about it, this idea is just like harnessing a horse to a cart as the nano robots hitch a ride on the proteins. There's a lot of development work to be done, but it will be interesting to see how these self-healing suits turn out.

Text 2. Nanotechnology in the Food Industry

Nanotechnology is having an impact on several aspects of the food industry, from how food is grown to how it is packaged. Companies are developing nanomaterials that will make a difference not only in the taste of food, but also in food safety, and the health benefits food delivers.

Nanomaterials in Food Packaging

Use of nanomaterials in food packaging is already a reality. One example is bottles made with nanocomposites that minimize the leakage of carbon dioxide out of the bottle; this increases the shelf life of carbonated beverages without

having to use heavier glass bottles or more expensive cans. Another example is food storage bins with silver nanoparticles embedded in the plastic. The silver nanoparticles kill bacteria from any food previously stored in the bins, minimizing harmful bacteria.

There are other food packaging products currently under development. For example nanosensors in plastic packaging can detect gases given off by food when it spoils and the packaging itself changes color to alert you to food gone bad. Plastic films are being developed that will allow the food to stay fresher longer. These films are packed with silicate nanoparticles to reduce the flow of oxygen into the package and the leaking of moisture out of the package,

Nanosensors are being developed that can detect bacteria and other contaminates such as salmonella on the surface of food at a packaging plant. This will allow for frequent testing at a much lower cost than is incurred by sending samples to a lab for analysis. This point-of-packaging testing, if conducted properly, has the potential to dramatically reduce the chance of contaminated food reaching grocery store shelves.

There are also nanosensors being developed to detect pesticides on fruit and vegetables. While this would be useful at a packing plant I'm anxiously waiting for the handheld version so I can check out the apples and grapes in my local grocery store!

Nanomaterials Changing Food Characteristics

Nanoparticles are being used to deliver vitamins or other nutrients in food and beverages without affecting the taste or appearance. These nanoparticles actually encapsulate the nutrients and carry them through the stomach into the bloodstream. For many vitamins this delivery method also allows a higher percentage of the nutrients to be used by the body because, when not encapsulated by the nanoparticles, some nutrients would be lost in the stomach.

Research is also being conducted to develop nanocapsules containing nutrients that would be released when nanosensors detect a deficiency in your body. Basically this research could result in a super vitamin storage system in your body that gives you just what you need, when you need it.

Nanomaterials are being developed to improve the taste, color, and texture of foods. For example "interactive" foods are being developed that would allow you to choose which flavor and color a piece of food has. The idea is that nanocapsules that contain flavor or color enhancers sit in the food waiting until a

hungry consumer triggers them. The method hasn't been published, so it will be interesting to see how this particular trick is accomplished.

Finally, nanoparticle emulsions are being used in ice cream and various spreads to improve the texture and uniformity.

Nanotechnology in Agriculture

Researchers are working on pesticides encapsulated in nanoparticles; these only release pesticide in an insect's stomach, which minimizes the contamination of plants themselves.

Another development being looked at is a network of nanosensors and dispensers throughout a food crop. The sensors recognize when a plant needs nutrients or water, before you could see any sign that the plant is deficient. The dispensers then release fertilizer, nutrients, or water as needed, optimizing the growth of each plant in the field one by one.

Regulation of Nanotechnology in the Food Industry

While there are lots of opportunities for using nanotechnology to improve food production, packaging, and quality, there is also some concern about how this will play out. For example the organizers of the Joint Symposium on Food Safety and Nutrition, organized by the Central Science Laboratory in the UK and the Joint Institute for Food Safety and Applied Nutrition at the University of Maryland, have chosen to focus their 2007 symposium on Nanotechnology in Foods and Cosmetics. They feel that nanotech materials both have "the potential for use in a vast variety of products and may pose new and unique safety issues."

In its February, 2007 meeting the European Food Safety Authority Regulatory agency announced that it was forming a scientific panel to conduct a risk assessment of nanoparticles in food and food packaging. This panel should be able to draw input and expertise from across Europe. For example, Denmark's National Food Institute is working on a project to gather toxicology information on nanoparticles and the UK Food Safety Authority has put together a report that provides "an outline of potential areas for future regulation relating to the use of nanotechnology and nanomaterials in foods".

In August 2006, the U.S. Food and Drug Administration (FDA) formed a Nanotechnology Task Force with goals that include:

Evaluate the effectiveness of the agency's regulatory approaches and authorities to meet any unique challenge that may be presented by the use of nanotechnology materials in FDA-regulated products.

Explore opportunities to foster innovation using nanotechnology materials to develop safe and effective drugs, biologics, and devices, and to develop safe foods, feeds, and cosmetics.

While the regulatory agencies may be making these efforts a little late, because some products are already available and development has been started on many more, we can hope that current discussions will help consumers to benefit from improved and safe food products with a minimum of controversy.

Text 3. Chemotherapy: Nano Medical Cures Coming Closer?

In updating my Nanotechnology in Medicine page recently, I noticed that several efforts to use nanotechnology in medicine have moved from the realm of research papers to the pre-clinical or clinical testing stage. For example, CytImmune has published the preliminary results of a phase 1 clinical trial of a targeted chemotherapy treatment method. They use gold nanoparticles attached to a molecule of a tumor-killing agent called tumor necrosis factor alpha (TNF) as well as a molecule of Thiol-derivatized polyethylene glycol (PEG-THIOL), which hides the TNF bearing nanoparticle from the immune system. The PEG-THIOL allows the nanoparticle to flow through the blood stream without being attacked. The combination of a gold nanoparticle, TNF and PEG-THIOL is named Aurmine.

The nanoparticle carrying the TNF tends to accumulate in cancer tumors but does not appear to accumulate in other regions of the body, which limits the toxic effects of TNF on healthy cells. CytImmune uses a combination of two techniques to target the TNF-carrying nanoparticle to cancer tumors. First, the nanoparticle is designed to be too big to exit most healthy blood vessels, however some blood vessels located at the site of tumors are leaky, allowing the nanoparticle to exit the blood vessel at the tumor site. The second technique involves the TNF molecules binding to the tumor.

The fact that they had to get all these details right, determine the right size, a way to hide the nanoparticle from the immune system as well as choosing a targeting molecule to bind to the cancer turmor, gives you some idea as to why it has taken a while to go from research concept to clinical testing.

TNF has been shown to be most effective when administered with other chemotherapy drugs.Therefore, now that the phase 1 trial involving 16 patients is

over, CytImmune is planning a phase 2 trial with Aurmine combined with other chemotherapy drugs. They are also performing pre-clinical testing of another combination in which TNF, PEG-THIOL and a chemotherapy drug called paclitaxel is bound to the surface of the nanoparticle. Three other treatments are under development using nanoparticles combined with TNF and other chemotherapy drugs. It will take a while to bring these treatments through all the phases required for qualification with the FDA, however it is exciting that they have progressed from the realm of research papers to trials that will lead to targeted treatment for patients.

Text 4. Nanotechnology Aids Delivery of Drugs in Patients

If your drug use consists of an occasional aspirin, you may not see the need for serious work on drug delivery. But if you were diabetic, having to inject insulin several times a day, or a cancer patient experiencing debilitating side effects from your treatment, the benefits of improved drug delivery could change your life.

Perhaps the most publicized use of nanotechnology in drug delivery under development is the use of nanoparticles to deliver drugs to cancer cells. However, that's just the tip of the drug delivery iceberg: there are a number of other ways that nanotechnology can make the delivery of drugs more efficient and potentially less unpleasant for the patient.

Destroying Cancer without Side Effects

Several companies and universities are working on developing nanoparticles that seek out cancer cells and destroy them while causing minimal harm to healthy cells. NanoBioDrug from Nanobiotix are nanoparticles with molecules on the surface that are attracted to certain types of diseased cells. Researchers at Harvard Medical School have shown that nanoparticles with a particular RNA strand on their surface are attracted by prostate cancer cells, for example. Once the nanoparticles are concentrated in the diseased cells, the material in the core of the nanoparticle is activated by a signal which could be delivered by an MRI, ultrasound, or laser light.

The mechanism of killing the diseased cell varies. For example, if the magnetic signal from an MRI is used with a nanoparticle whose core is iron oxide, the magnetic signal moves each nanoparticle and physically stirs up the

insides of the cell, thereby destroying it. If an ultrasound signal is used, the core of the nanoparticle could contain chemicals that are released by the signal. At this point in time, studies of the effectiveness of NanoBioDrugs on cancer in large animals are currently underway.

Getting Rid of Those Needles

Many drugs are injected, rather than being taken in pill form, because they can be destroyed by acids in the stomach. BioDelivery Sciences International has developed a method whereby drug molecules are contained in particles called nanocochleate. These particles protect the drug from stomach acid. When the nanocochleate particles reach the blood stream, they fuse with cells, releasing the drug into one cell and then heading off to do the same with other cells.

BioDelivery is conducting pre-clinical studies of the first drug to use this method, a fungal infection-fighting drug that is currently delivered by injection. In similar work a university in Taiwan, the National Tsing Hua University, has been successful in delivering insulin in studies with laboratory rats. The insulin molecule is encapsulated in nanospheres made from a polymer called chitosan, and delivered orally. If all goes well, this pill form of insulin will be a godsend to millions of diabetics worldwide.

Stopping the Common Cold in its Tracks

But what about the holy grail of medical breakthroughs, preventing the common cold? NanoBio Corporation may just have found a way to use nano-sized antimicrobial droplets, called nanoemulsions, to head your next cold off at the pass. The key to helping you avoid catching a cold or the flu is the longevity of the nanoemulsions; they can stay in your respiratory tract for several hours and continue to kill viruses while having no discernable side-effects. If you, like me, dislike hanging out in groups during cold or flu season, keep a watch on this research and hope it gets into clinical trials and through the approval process soon.

NanoBio and the University of Michigan are also developing a variety of vaccines that use nanoemulsions. These vaccines would be applied with a nasal swab rather than by injection, and would not require refrigeration.

Going Skin Deep

Novavax, Inc. encapsulates drugs in emulsion nanoparticles (called micellar nano particles) that transport a drug through the skin. You spread the emulsion on your skin like a lotion. This method avoids passing the drug through your

stomach with associated side effects. The emulsion provides a reservoir of the drug just under the surface of your skin from which the drug can continue to spread into your bloodstream, maintaining stable levels of the drug over time.

An estrogen replacement therapy lotion using micellar nano particles is already on the market and a testosterone therapy lotion is under development. Novavax now seems to be focused on vaccines and is licensing the micellar nano particles technology. The technique may eventually be used across a range of products such as hormones, pain killers, and allergy relief.

Making the Daily Dose Obsolete

pSivida Limited has a drug delivery product called BioSilicon. This is a silicon particle riddled with nano-sized pores. The drug to be delivered is loaded into the pores and as the silicon particle dissolves, the drug is released. pSivida can customize the size and porosity of silicon particles to control the time it takes them to dissolve. BioSilicon may be used in implants under the skin that could release a drug over days, weeks or months.

Text 5. Tunnelling to the beginning of time
The Large Hadron Collider

The LHC (Large Hadron Collider) is an international project, in which the UK has a leading role. The LHC is asking some Big Questions about the universe we live in.

How did our universe come to be the way it is?

The Universe started with a Big Bang – but we don't fully understand how or why it developed the way it did. The LHC will let us see how matter behaved a tiny fraction of a second after the Big Bang. Researchers have some ideas of what to expect – but also expect the unexpected!

What kind of Universe do we live in?

Many physicists think the Universe has more dimensions than the four (space and time) we are aware of. Will the LHC bring us evidence of new dimensions?

Gravity does not fit comfortably into the current descriptions of forces used by physicists. It is also very much weaker than the other forces. One explanation for this may be that our Universe is part of a larger multi dimensional reality and that gravity can leak into other dimensions, making it appear weaker. The LHC may allow us to see evidence of these extra dimensions - for example, the production of mini-black holes which blink into and out of existence in a tiny fraction of a second.

What happened in the Big Bang?

What was the Universe made of before the matter we see around us formed? The LHC will recreate, on a microscale, conditions that existed during the first billionth of a second of the Big Bang.

At the earliest moments of the Big Bang, the Universe consisted of a searingly hot soup of fundamental particles - quarks, leptons and the force carriers. As the Universe cooled to 1000 billion degrees, the quarks and gluons (carriers of the strong force) combined into composite particles like protons and neutrons. The LHC will collide lead nuclei so that they release their constituent quarks in a fleeting 'Little Bang'. This will take us back to the time before these particles formed, re-creating the conditions early in the evolution of the universe, when quarks and gluons were free to mix without combining. The debris detected will provide important information about this very early state of matter.

Where is the antimatter? The Big Bang created equal amounts of matter and antimatter, but we only see matter now. What happened to the antimatter?

Every fundamental matter particle has an antimatter partner with equal but opposite properties such as electric charge (for example, the negative electron has a positive antimatter partner called the positron). Equal amounts of matter and antimatter were created in the Big Bang, but antimatter then disappeared. So what happened to it? Experiments have already shown that some matter particles decay at different rates from their anti-particles, which could explain this. One of the LHC experiments will study these subtle differences between matter and antimatter particles.

Why do particles have mass?

Why do some particles have mass while others don't? What makes this difference? If the LHC reveal particles predicted by theory it will help us understand this.

Particles of light (known as photons) have no mass. Matter particles (such as electrons and quarks) do – and we're not sure why. British physicist, Peter Higgs, proposed the existence of a field (the Higg's Field), which pervades the entire Universe and interacts with some particles and this gives them mass. If the theory is right then the field should reveal itself as a particle (the Higg's particle). The Higg's particle is too heavy to be made in existing accelerators, but the high energies of the LHC should enable us to produce and detect it.

What is our Universe made of?

Ninety-six percent of our Universe is missing! Much of the missing matter is stuff researchers have called 'dark matter'. Can the LHC find out what it is made of?

The theory of 'supersymmetry' suggests that all known particles have, as yet undetected, 'superpartners'. If they exist, the LHC should find them. These 'supersymmetric' particles may help explain one mystery of the Universe – missing matter. Astronomers detect the gravitational effects of large amounts of matter that can't be seen and so is called 'Dark Matter'. One possible explanation of dark matter is that it consists of supersymmetric particles.

Навчальне видання

Методичні вказівки
до практичних занять з розвитку навичок читання та усного мовлення англійською мовою
за спеціальністю «Нано- та мікротехнології»

для студентів та магістрів ФТ факультету

Укладач: **ЛАЗАРЄВА** Ольга Ярославна

Англійською мовою

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