UNIT 7

NANOMEDICINE

Pre-reading discussion:

1) How can nanotechnology help treat patients?
2) Will nanotech medicine replace traditional medicine in the future? Prove your opinion.

Task 1. *Look at the headline and say what issues are discussed in text 1.*

Task 2. *Skim the text. State the topic and the main idea. Speak on the style and genre of the text, the writer, possible readers, and the function of the text. Is the author British or American? What makes you think so?*

Task 3. *Does the heading reflect the topic accurately? Are paragraphs placed in the logical order? Find general information, supporting facts and secondary ideas.*

Text 1

Biomedicine and health care

Drug delivery

Nanotechnology promises to impact medical treatment in multiple ways. First, advances in nanoscale particle design and fabrication provide new options for drug delivery and drug therapies. More than half of the new drugs developed each year are not water-soluble, which makes their delivery difficult. In the form of nanosized particles, however, these drugs are more readily transported to their destination, and they can be delivered in the conventional form of pills.

More important, nanotechnology may enable drugs to be delivered to precisely the right location in the body and to release drug doses on a predetermined schedule for optimal treatment. The general approach is to attach the drug to a nanosized carrier that will release the medicine in the body over an extended period of time or when specifically triggered to do so. In addition, the surfaces of these nanoscale carriers may be treated to seek out and become localized at a disease site—for example, attaching to cancerous tumours. One type of molecule of special interest for these applications is an organic dendrimer. A dendrimer is a special class of polymeric molecule that weaves in and out from a hollow central region. These spherical "fuzz balls" are about the size of a typical protein but cannot unfold like proteins. Interest in dendrimers derives from the ability to tailor their cavity sizes and chemical properties to hold different therapeutic agents. Researchers hope to design different dendrimers that can swell and release their drug on exposure to specifically recognized molecules that indicate a disease target. This same general approach to nanoparticle-directed drug delivery is being explored for other types of nanoparticles as well.

Another approach involves gold-coated nanoshells whose size can be adjusted to absorb light energy at different wavelengths. In particular, infrared light will pass through

several centimetres of body tissue, allowing a delicate and precise heating of such capsules in order to release the therapeutic substance within. Furthermore, antibodies may be attached to the outer gold surface of the shells to cause them to bind specifically to certain tumour cells, thereby reducing the damage to surrounding healthy cells.

Bioassays

A second area of intense study in nanomedicine is that of developing new diagnostic tools. Motivation for this work ranges from fundamental biomedical research at the level of single genes or cells to point-of-care applications for health delivery services. With advances in molecular biology, much diagnostic work now focuses on detecting specific biological "signatures." These analyses are referred to as bioassays. Examples include studies to determine which genes are active in response to a particular disease or drug therapy. A general approach involves attaching fluorescing dye molecules to the target biomolecules in order to reveal their concentration.

Another approach to bioassays uses semiconductor nanoparticles, such as cadmium selenide, which emit light of a specific wavelength depending on their size. Different-size particles can be tagged to different receptors so that a wider variety of distinct colour tags are available than can be distinguished for dye molecules. The degradation in fluorescence with repeated excitation for dyes is avoided. Furthermore, various-size particles can be encapsulated in latex beads and their resulting wavelengths read like a bar code. This approach, while still in the exploratory stage, would allow for an enormous number of distinct labels for bioassays.

Another nanotechnology variation on bioassays is to attach one half of the single-stranded complementary DNA segment for the genetic sequence to be detected to one set of gold particles and the other half to a second set of gold particles. When the material of interest is present in a solution, the two attachments cause the gold balls to agglomerate, providing a large change in optical properties that can be seen in the colour of the solution. If both halves of the sequence do not match, no agglomeration will occur and no change will be observed.

Approaches that do not involve optical detection techniques are also being explored with nanoparticles. For example, magnetic nanoparticles can be attached to antibodies that in turn recognize and attach to specific biomolecules. The magnetic particles then act as tags and "handlebars" through which magnetic fields can be used for mixing, extracting, or identifying the attached biomolecules within microlitre- or nanolitre-sized samples. For example, magnetic nanoparticles stay magnetized as a single domain for a significant period, which enables them to be aligned and detected in a magnetic field. In particular, attached antibody–magnetic-nanoparticle combinations rotate slowly and give a distinctive magnetic signal. In contrast, magnetically tagged antibodies that are not attached to the biological material being detected rotate more rapidly and so do not give the same distinctive signal.

Microfluidic systems, or "labs-on-chips," have been developed for biochemical assays of minuscule samples. Typically cramming numerous electronic and mechanical components into a portable unit no larger than a credit card, they are especially useful for conducting

rapid analysis in the field. While these microfluidic systems primarily operate at the microscale (that is, millionths of a metre), nanotechnology has contributed new concepts and will likely play an increasing role in the future. For example, separation of DNA is sensitive to entropic effects, such as the entropy required to unfold DNA of a given length. A new approach to separating DNA could take advantage of its passage through a nanoscale array of posts or channels such that DNA molecules of different lengths would uncoil at different rates.

Other researchers have focused on detecting signal changes as nanometre-wide DNA strands are threaded through a nanoscale pore. Early studies used pores punched in membranes by viruses; artificially fabricated nanopores are also being tested. By applying an electric potential across the membrane in a liquid cell to pull the DNA through, changes in ion current can be measured as different repeating base units of the molecule pass through the pores. Nanotechnology-enabled advances in the entire area of bioassays will clearly impact health care in many ways, from early detection, rapid clinical analysis, and home monitoring to new understanding of molecular biology and genetic-based treatments for fighting disease.

(Based on https://www.britannica.com/technology/nanotechnology/Nanotubes-and-nanowires)

Task 4. *Phonetic drill.*

Pronounce these words correctly: soluble ['sɔljub(ə)l], schedule [UK: /'ʃedʒu:l/, US: /ˈskedʒ.u:l/], carrier ['kærɪə], tumour [ˈtju:mə], dendrimer [‘dendrʌmɜ:], fuzz [fʌz], therapeutic ['θerə'pju:tɪk], capsule ['kæpsju:l], bind [baɪnd], thereby [ðeə'baɪ], bioassay ['baɪəu'æseɪ], fluorescence [flu(ə)'res(ə)ns], agglomerate [ə'glɔm(ə)rɪt], minuscule [ˈmɪ.nəˌskju:l], entropy ['entrəpi], pore [pɔ:], membrane ['membreɪn].

Task 5. *Answer the following questions:*

1. What new options for drug delivery and drug therapy appear with advances in nanotechnology?
2. What is an organic dendrimer?
3. Why are researchers interested in dendrimers?
4. What is being done in the development of diagnostic tools?
5. What can be referred to as bioassays?
6. What approaches to bioassays exist nowadays? Speak on them.

Task 6. *How much do you agree with the following statements*?

- Nanotechnology will have a positive impact on medical practice.
- Researchers have chosen dendrimers due to the ability to hold different therapeutic agents.
- Advances in molecular biology facilitated the development of diagnostic tools.
- Success of nanotechnology in medicine may also have an adverse effect on economy.

Task 7. *Give definitions of the following terms:* an organic dendrimer, bioassays, microfluidic systems, entropy.

Task 8. *Provide synonyms for the following words used in text 1:*
To impact treatment, predetermined schedule, when triggered to do so, another approach involves, an area of intense study, these analyses are referred to as, in the exploratory stage

Task 9. *Choose the key words to be used in the resume of text 1.*

Task 10. *Make up a resume of the text by developing each of the italicized sentences into a paragraph*:
Nanotechnology holds a great promise in medicine.
Developing diagnostic tools is an important area of research.
There are several approaches to bioassays.

Task 11. *Translate the underlined sentences of text 1 in writing.*

Task 12. *Read the text below and do the tasks that follow.*

Assistive devices and tissue engineering

Another ……(biomedicine) application of nanotechnology involves ….(to assist) devices for people who have lost or lack certain natural ……(capable). For example, researchers hope to design retinal implants for vision-impaired ……(individual). The concept is to implant chips with photodetector arrays to transmit signals from the retina to the brain via the optic nerve. ……(Meaning) spatial information, even if only at a rudimentary level, would be of great ……(to assist) to the blind. Such research illustrates the tremendous challenge of designing hybrid systems that work at the interface between inorganic devices and ……(biology) systems.

Closely related research involves …..(to implant) nanoscale neural probes in brain tissue to activate and control motor functions. This requires ……(effect) and stable "wiring" of many electrodes to neurons. It is exciting because of the ……(possible) of recovery of control for motor-impaired individuals. Studies …….(to employ) neural stimulation of damaged spinal cords by …..(electricity) signals have demonstrated the return of some locomotion. Researchers are also seeking ways to assist in the regeneration and …..(to heal) of bone, skin, and cartilage—for example, developing synthetic ……(biocompatibility) or biodegradable structures with nanosized voids that would serve as templates for regenerating specific tissue while ……(to deliver) chemicals to assist in the repair process. At a more sophisticated level, researchers hope to someday build nanoscale or microscale machines that can repair, assist, or replace more-complex organs.

(Based on https://www.britannica.com/technology/nanotechnology/Nanotubes-and-nanowires)

a) *provide the appropriate form of the words in brackets*

b) compare text 1 and the text in task 12. Speak on similarities and differences.

Task 13. *Work in pairs:*

A is an optimist. He/she is sure that nanomedicine will change our life for the better.

B is a pessimist. He/she is quite convinced that it will change our life for the worse.

Task 14. *Translate from Russian into English:*

а) производство, доставка лекарственного средства, медикаментозное лечение, водорастворимый, носитель, опухоль, дендример, происходить от, терапевтическое средство, нанооболочка, длина волны, тем самым, ген, биопроба, селенид кадмия, ослабление, латексные гранулы, экспериментальная стадия, одноцепочный, энтропия, мембрана;

в) Технологии развиваются стремительными темпами и позволяют создавать устройства и приложения, которые открывают безграничные возможности в самых различных областях медицины. В результате, человек все больше и больше приближается к пониманию того, что происходит в его организме не только на клеточном, молекулярном, но и атомном уровне - на наноуровне:

Лечение рака. На сегодняшний день уже сделаны первые успешные шаги в работе по использованию нанотехнологий в лечении рака. Данный процесс осуществляется благодаря тому, что небольшие специализированные функции некоторых наноустройств можно более точно направить на раковые клетки. При этом происходит уничтожение раковых клеток и не наносится ущерб окружающим их здоровым клеткам.

Доставка лекарств. Системы для автоматизации доставки лекарств способствуют повышению согласованности между системами организма. При этом обеспечивается лекарствами та система, которая в них нуждается. Для обеспечения высвобождения определенных лекарственных веществ в нужное время и без человеческих ошибок с помощью нанотехнологий можно программировать системы доставки.

(Based on https://imedplanet.com/stati/zhurnal-mediczina-22-veka/25-sposobov-ispolzovaniya-nanotexnologij-v-mediczine)

Task 15. *Watch the film 'What is nanomedicine?' (6.47 min) on youtube.com https://www.youtube.com/watch?v=_jGRRNuMmZQ and summarize the information in no more than 10 sentences.*