КАЗАНСКИЙ ФЕДЕРАЛЬНЫЙ УНИВЕРСИТЕТ

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PROFESSIONAL ENGLISH: BIOTECHNOLOGY

Учебное пособие

Казань – 2025

УДК 811.11
ББК 80/84
П26

Рекомендовано к изданию Учебно-методической комиссией Института международных отношений, истории и востоковедения Казанского федерального университета (протокол №7 от 30 апреля 2025 г.)

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П26 Professional English: Biotechnology: учебное пособие / С.М. Переточкина, Ф.Б. Ситдикова, И.А. Тухватуллина. – Казань: Изд-во Казан. ун-та, 2025. – 151 с.

Учебное издание предназначено для обучающихся 2 и 3 курсов по направлениям подготовки «Биотехнические системы и технологии (Медицинское оборудование: физические принципы и приборостроение)» и «Биотехнические системы и технологии (Медицинская томография: физические принципы и приборостроение)», изучающих дисциплину «Иностранный язык в профессиональной сфере». Учебное пособие состоит из 12 самостоятельных блоков для изучения научно-популярных текстов по специально отобранным темам, каждый из которых включает в себя упражнения на закрепление лексики и развитие навыков говорения и письма. В конце представлен глоссарий по специальности. Пособие составлено на английском языке согласно требованиям профиля подготовки и имеет практическую профессиональную направленность. В пособии использованы материалы энциклопедий, словарей, справочников, научных статей.

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ОТ АВТОРОВ

Учебное пособие предназначено для студентов естественно-научных факультетов, а именно – для студентов – биотехнологов Института физики Казанского (Приволжского) федерального университета уровня Intermediate / Upper-Intermediate. Данное пособие содержит аутентичные и авторские материалы, а также ряд практических заданий по английскому языку для специальных целей (ESP).

Целью пособия является овладение студентами компетенциями устного и письменного профессионально-ориентированного общения на английском языке. В задачи пособия входит развитие навыков и умений самостоятельно работать с аутентичными текстами на английском языке.

Пособие состоит из 12 модулей, каждый из которых содержит материалы для изучающего чтения и перевода научной и научно-популярной литературы инженерной и биологической направленности, реферирования текстов, ведения дискуссий, изложения презентаций и написания эссе по заданным темам.

Приложение содержит методические указания и клише для составления аннотаций текстов и статей, а также по составлению презентаций и написанию эссе.

Пособие может быть рекомендовано к использованию для аудиторной и самостоятельной работы студентов. Материалы пособия прошли апробацию в студенческих группах.

Contents

UNIT 1

THE SUBJECT OF BIOTECHNOLOGY

PRE-READING

Before reading the text try to discuss the following questions:

- Give the definition of biotechnology in your own words.
- What are the main goals of biotechnology nowadays?

1. Practice reading the following words with the help of given transcriptions.

biotechnology	[ˌbʌɪə(ʊ)tɛkˈnɒlədʒ]	vaccines	[ˈvæksiːnz]
harnesses	[ˈhɑːnəsɪz]	herbicide	[ˈhəːbɪsʌɪd]
cellular	[ˈsɛljʊlə]	environment	[ɪnˈvʌɪrənm(ə)nt]
breakthrough	[ˈbreɪkθruː]	decreasing	[dɪˈkriːsɪŋ]
cardiovascular	[ˌkɑːdɪəʊˈvaskjʊlə]		

2. Read the following words and try to remember them:

VOCABULARY

combat	[ˈkɒmbat]	бороться
harness	[ˈhɑːnəs]	использовать
heal	[hiːl]	исцелить
confronting	[kənˈfrʌntɪŋ]	противостоящий
greenhouse	[ˈgriːnhaʊs]	парниковый
toolbox	[ˈtuːlbɒks]	инструментарий
affecting	[əˈfɛktɪŋ]	затрагивающий
precise	[prɪˈsʌɪs]	точный
debilitating	[dɪˈbɪlɪteɪtɪŋ]	изнурительный
facilitate	[fəˈsɪlɪteɪt]	содействовать
application	[ˌæplɪˈkeɪʃənz]	использование
cardiovascular	[ˌkɑːdɪəʊˈvaskjʊlə]	сердечно-сосудистый
nutrition	[njʊˈtrɪʃ(ə)n]	питание

READING

3. Read the text and answer the questions.

The subject of Biotechnology

At its simplest, biotechnology is technology based on biology – biotechnology harnesses cellular and biomolecular processes to develop technologies and products that help improve our lives and the health of our planet. We have used the biological processes of microorganisms for more than 6,000 years to make useful food products, such as bread and cheese, and to preserve dairy products.

Modern biotechnology provides breakthrough products and technologies to combat debilitating and rare diseases, reduce our environmental footprint, feed the hungry, use less and cleaner energy, and have safer, cleaner and more efficient industrial manufacturing processes.

Currently, there are more than 250 biotechnology health care products and vaccines available to patients, many for previously untreatable diseases. More than 13.3 million farmers around the world use agricultural biotechnology to increase yields, prevent damage from insects and pests and reduce farming's impact on the environment. And more than 50 biorefineries are being built across North America to test and refine technologies to produce biofuels and chemicals from renewable biomass, which can help reduce greenhouse gas emissions.

Recent advances in biotechnology are helping us prepare for and meet society’s most pressing challenges. Here's how to:

Heal the World

Biotech is helping to heal the world by harnessing nature's own toolbox and using our own genetic makeup to heal and guide lines of research by:

- Reducing rates of infectious disease;
- Saving millions of children's lives;
- Changing the odds of serious, life-threatening conditions affecting millions around the world;
- Tailoring treatments to minimize health risks and side effects;

- Creating more precise tools for disease detection; and
- Combating serious illnesses and everyday threats confronting the developing world.

Fuel the World

Biotech uses biological processes such as fermentation and harnesses biocatalysts such as enzymes, yeast, and other microbes to become microscopic manufacturing plants. Biotech is helping to fuel the world by:

- Streamlining the steps in chemical manufacturing processes by 80%;
- Lowering the temperature for cleaning clothes and potentially saving $4.1 billion annually;
- Improving manufacturing process efficiency to save 50% or more on operating costs;
- Reducing use of and reliance on petrochemicals;
- Using biofuels to cut greenhouse gas emissions by 52% or more;
- Decreasing water usage and waste generation; and
- Tapping into the full potential of traditional biomass waste products.

Feed the World

Biotech improves crop insect resistance, enhances crop herbicide tolerance and facilitates the use of more environmentally sustainable farming practices. Biotech is helping to feed the world by:

- Generating higher crop yields with fewer inputs;
- Lowering volumes of agricultural chemicals required by crops-limiting the run-off of these products into the environment;
- Using biotech crops that need fewer applications of pesticides and that allow farmers to reduce tilling farmland;
- Developing crops with enhanced nutrition profiles that solve vitamin and nutrient deficiencies;
- Producing foods free of allergens and toxins such as mycotoxin; and
- Improving food and crop oil content to help improve cardiovascular health.

(Adopted from https://www.bio.org/what-biotechnology)

QUESTIONS

1. What is biotechnology based on?
2. When did people start using biotechnology?
3. What issues does modern biotechnology deal with?
4. What is the contribution of these technologies to medicine?
5. What is biofuel and is there an economic benefit of its using?
6. How does biotechnology help people in feeding?

AFTER TEXT TASKS

4. Match the words similar in meaning.

1. untreatable	a) revolving
2. yield	b) decrease
3. minimize	c) influence
4. impact	d) harvest
5. renewable	e) diminish
6. create	f) get better
7. improve	g) incurable
8. decrease	h) make

5. Match the words opposite in meaning.

1. develop	a) consistency
2. improve	b) stop
3. disease	c) destroy
4. create	d) degrade
5. confronting	e) medication

6. ***Translate the following word combinations into Russian.***

1. Technology based on
2. To reduce our environmental footprint
3. To reduce farming's impact on the environment
4. Are being built across North America
5. Recent advances in biotechnology

6. Changing the odds of serious, life-threatening conditions
7. Creating more precise tools for disease detection
8. Decreasing water usage and waste generation

7. Find the English equivalents to the word combinations in the text.

1. Сокращение использования и зависимости от нефтехимии
2. Парниковые газы
3. Неизлечимые болезни
4. Сохранение жизней миллионов детей
5. Создание более точных инструментов для выявления болезни
6. Индивидуальное лечение отдельных лиц для минимизации рисков здоровья и побочных эффектов
7.Использование полного потенциала традиционных отходов биомассы
8. Создание более высоких урожаев с меньшими затратами
9. Производство продуктов, свободных от аллергенов и токсинов

8. Complete the sentences using the text.

1. Biotechnology harnesses cellular and…processes to develop … and products that help improve our lives and the health of our planet.
2. Currently, there are more than 250 biotechnology health care … and … available to patients, many for previously … diseases.
3. And more than 50 biorefineries are being built across … to test and refine technologies to … biofuels and chemicals from … biomass, which can help reduce greenhouse gas emissions.
4. More than 13.3 million … around the world use agricultural biotechnology to increase…, prevent damage from insects and pests and … farming's impact on the environment.
5. Biotech uses biological processes such as … and harnesses biocatalysts such as enzymes, yeast, and other microbes to become … manufacturing plants.
6. Using biofuels to cut … gas emissions by 52% or more.

7. Using biotech crops that need fewer … of pesticides and that allow farmers to reduce tilling … .
8. Improving food and crop oil content to help … cardiovascular … .
9. Retell the text **The subject of Biotechnology.**

COMPREHENSION

10. Read the text about the history of biotechnology and make up questions to it.

Nowadays, pioneers of biotechnology are discovering original solutions for better feed, food and consumer goods. They build on the information gained through the scientific innovation of previous pioneers. Observe how precedent discoveries have improved quality of life.

Increasing on their sympathetic of methodical processes, ancient Egyptians innovated with their use of advanced fermentation and breeding practices. Did you know?

The antique Egyptians made wine using fermentation techniques based on a sympathetic of the microbiological processes that happen in the absence of oxygen. Egyptians also used fermentation technologies to create dough rise throughout bread making.

Opening with his first visit to the Americas in 1492, Christopher Columbus and other explorers introduced corn, native to the Americas, to the rest of the world, and European growers modified the plant to their unique growing conditions. Spanish navigators also returned with potatoes, which are native to the Andes in South America. Two centuries after their European introduction, potatoes were a staple in European countries.

In 1864, French chemist Louis Pasteur developed the process named after him and known today as pasteurization, which uses heat to destroy damaging microorganisms in products. The products are then sealed airtight for safety. Pasteur's scientific breakthrough enhanced quality of life, allowing products such as milk to be transported without spoiling.

People didn't be familiar with where genes lived until DNA (deoxyribonucleic acid) was "discovered" or unspoken in the early 1950s.

British scientist Rosalind Franklin's DNA research shaped the foundation for James Watson and Francis Crick's 1953 detection of the structure of DNA, the ladder-like double helix. Watson and Crick perfected the DNA structural replica that Franklin explores earlier.

In 1973, researchers Stanley Cohen and Herbert Boyer were the first in the direction of apply this technique. Working to help people living with diabetes, they lifted hereditary materials from one organism's DNA and copy them into another's. It's the story of insulin.

Modern biotechnology deals more with the treatment of ailments and alteration of organisms to better human life. Most breakthroughs in biotechnology have all been relatively current, with the earliest advancement being about 170 years ago with the discovery of microbes. Proteins were only discovered in 1830, with the isolation of the first enzyme following closely three years later. In 1859, Darwin published his revolutionary book, On the Origin of Species. Six years later, Gregor Mendel, considered the father of modern genetics, discovers the laws of heredity and laid the groundwork for genetic research. Near the turn of the century, Louis Pasteur and Robert Koch provided the basis for research in microbiology. These numerous advancements allowed modern biotechnology to rise.

With the advent of X-ray diffraction, Watson and Crick discovered the structure of deoxyribonucleic acid (DNA)- a double helix. This is considered one of the most important discoveries in biotechnology it has led to the possibility to directly alter genetic traits. Key advances in biotechnology that followed include Nirenberg and Khorana deciphering the codons of 20 amino acids and Borlaug successfully increasing the yield of wheat by 70%.

(Adopted from http://www.biotechonweb.com/History-of-biotech.html)

11. Take turns to ask and answer questions to the text about the history of biotechnology.

12. Translate the following text into English.

Впервые термин «биотехнология» применил венгерский инженер Карл Эреки в 1917 году. Использование в промышленном производстве микроорганизмов или их ферментов, обеспечивающих технологический процесс известны издревле. В начале XX века активно развивалась бродильная и микробиологическая промышленность. В эти же годы были предприняты первые попытки наладить производство антибиотиков, пищевых концентратов, полученных из дрожжей, осуществить контроль ферментации продуктов растительного и животного происхождения. Первый антибиотик – пенициллин – удалось выделить и очистить до приемлемого уровня в 1940 году. Это дало новые задачи: поиск и производство лекарственных веществ, продуцируемых микроорганизмами повышением уровня биобезопасности новых лекарственных препаратов.

(Adopted from https://ru.wikipedia.org/wiki/Биотехнология)

WRITING

13. Write a 200–250 words essay on the following topic:

- How would I help humanity as a scientist in the field of biotechnology.

UNIT 2

BRANCHES OF BIOTECHNOLOGY

PRE-READING

- How many branches of biotechnology do you know?
- What field of biotechnology are you going to study?

1. Practice reading the following words with the help of given transcriptions.

gene	[ʤi:n]	environmental	[ɪn˛vaɪ(ə)rən´mentl]
genome	[ˈʤi:nəʊm]	pesticide	[´pestɪsaɪd]
antibiotic	[˛æntɪbaɪ´ɒtɪk]	mitochondrion	[mʌɪtə(ʊ)ˈkɒndrɪən]
organism	[´ɔ:gənɪz(ə)m]	medication	[˛medɪ´keɪʃ(ə)n]
industrial	[ɪn´dʌstrɪəl]	marine	[mə´ri:n]

2. Read the following words and try to remember them.

VOCABULARY

cure	[ˈkjʊə]	метод лечения
crop	[krɒp]	урожай, культура
fungus	[ˈfʌŋgəs]	грибок
biofilm	[bɪəˈfɪlm]	биопленка
bioremediation	[baɪɒrɪˈmi:dɪeɪʃn]	биовосстановление
enzyme	[ˈenzaɪm]	фермент
drug	[drʌg]	медикамент, лекарство
fertility	[fɜ:ˈtɪlɪtɪ]	плодородие
micropropagation	[maɪkrəʊprɒpəˈgeɪʃn]	микроразмножение
stock	[stɒk]	запас, склад
substitute	[ˈsʌbstɪtju:t]	замена
vehicle	[ˈvi:ɪkl]	транспортное средство
manipulation	[mənɪpjʊˈleɪʃn]	воздействие

READING

3. Read the text and answer the questions.

Branches of Biotechnology

Biotechnology has more than a few different branches which are referred to by dissimilar terms mainly noticeable with dissimilar colors to clarify the biotechnological field that it is used in. The majority extensively used ones for medical processes, like finding genetic cures by going through genomic manipulations and creating organisms to produce antibiotics.

Green biotechnology is used in orientation to agricultural process that use biotechnology. Some examples of that would be the development of transgenic plants that are calculated to survive under precise environmental circumstances. A large goal of the green biotechnology is to expand more environment friendly solutions, for example to find a way take out the need for pesticides.

Green biotechnology which is more usually known as Plant Biotechnology is a rapidly increasing field within Modern biotechnology. It essentially involves the opening of foreign genes into inexpensively important plant species, resulting in crop improvement and the production of novel products in plants.

The term used for manufacturing biotechnology is white biotechnology. This type of biotechnology is used to decrease the costs for producing industrial supplies that occur when traditional processes are used. For example, white biotechnology can expand an organism that is capable to produce a certain useful chemical by natural processes quite than by industrial ways that it was done earlier.

The industrial biotechnology society usually accepts an informal divide between manufacturing and pharmaceutical biotechnology. An example would be that of company rising fungus to produce antibiotics, e.g. penicillin from the penicillium fungi.

Some additional examples of branches of biotechnology are blue biotechnologies that deal with marine and a marine usage of biotechnology, but that is not very extensively used. When discussing about not the straight research part of biotechnology then bioeconomy is used to talk about the savings and the economical benefits that biotechnology brings.

Biotechnology with marine organisms, feed into aquaculture, marine animal and fish health, marine natural goods (including medicines), biofilms, bioremediation, marine ecology and bio-oceanography and other marine products (e.g. Enzymes).

There are several branches of Biotechnology. They are classified as:

Blue Biotechnology:

This branch of biotechnology helps to control the marine organisms and water borne organisms. It is a process which has to do with marine or underwater environment.

Bioinformatics:

Bioinformatics is the combination of computer and biotechnology. It helps in finding the analysis of data related to Biotechnology. It is used for various purposes like drugs, for the development of medicines; it is also used to improve the fertility of crops and plants and also for pest, drought and it is resistance to diseases.

Green Biotechnology:

Green Biotechnology is the term used for the agricultural sector. With the help of the process called the Micropropagation (a practice of producing larger number of plants through the existing stock of plants) which helps in selecting the right quality of plants and crops.

Red Biotechnology:

Red biotechnology is referred to as Medical Biotechnology. It is used for the production of drugs and antibiotic medicines. It also helps to create or design organisms. Through the process of genetic manipulation it helps

to cure genetic issues in organisms. It also helps in analysing diseases in organisms. It also helps in developing new ways of diagnosis by performing tests.

White Biotechnology:

White Biotechnology is also called and known by the name Industry Biotechnology. This kind of biotechnology is used and applied in industries and its processes. The various uses of this Biotechnology include: biopolymers (Plastics) Substitutes, new invention of vehicle parts and fuels for the vehicles, invention of fibers for the clothing industry, it is also involved in developing new chemicals and the production process.

(Adopted from http://www.biotechonweb.com/branches-of-biotech.html)

QUESTIONS:

1. What is the title of biotechnology that controls marine organisms?
2. What are the objectives of Bioinformatics?
3. What is the other name of Green Biotechnology?
4. What branch of biotechnology deals with medicine?
5. What branch of biotechnology is referred to industry?

AFTER TEXT TASKS

4. Match the words opposite in meaning.

1. different	a) artificial
2. majority	b) connect
3. increasing	c) similar
4. divide	d) decline
5. improvement	e) minority
6. natural	f) decreasing

5. Translate the following word combinations into Russian.

1. The industrial biotechnology
2. Plant Biotechnology
3. Biotechnology with marine organisms
4. Biopolymers (Plastics) Substitutes
5. Marine natural goods (including medicines)

6. Environment friendly solutions
7. Process called the Micropropagation
8. By the name Industry Biotechnology

6. Find the English equivalents to the word combinations in the text.

1. Медицинская Биотехнология
2. Трансгенные растения
3. Улучшение урожая
4. Устойчивость к болезням
5. Подводный мир
6. Переносимые водой
7. Биотехнология с морскими организмами
8. Топливо для транспорта

7. Match the following terms with definitions.

1. Bioinformatics	a) is referred to as Medical Biotechnology.
2. Green Biotechnology	b) is the combination of computer and biotechnology.
3. Red biotechnology	c) is a branch of biomedical sciences that uses novel technologies for production, formulation, and synthesis of biological substances from the living organisms, which act as drug molecules for the treatment
4. White Biotechnology	d) are Transgenic plants.
5.Plants whose DNA is modified	e) is the term used for the agricultural sector.
6.Pharmaceutical biotechnology	f) is also called and known by the name Industry Biotechnology.

8. Complete the sentences using the text.

1. Green biotechnology is … in orientation to agricultural … that use biotechnology.
2. It essentially … the opening of foreign genes into inexpensively important plant species.
3. Some additional examples of branches of … are blue biotechnologies that deal with marine and a … usage of biotechnology.
4. Biotechnology with marine organisms, feed into aquaculture, marine … and fish health, marine natural … (including medicines).
5. Red biotechnology is referred to as … Biotechnology.
6. Green Biotechnology is the term … for the … sector.

9. Find out the key words of the text Branches of Biotechnology.

10. Use the key words to write out the main idea of the text Branches of Biotechnology.

11. Give the summary of the text Branches of Biotechnology.

COMPREHENSION

12. Read the text about other colors of biotechnology and make up questions to it.

Other colors of biotechnology

Although the aforementioned categories are considered to be the most established, other areas have also been assigned colors. Yellow biotechnology refers to biotechnology used to improve nutrition. Closely linked to green biotechnology, yellow biotechnology aims to utilize enzymatic and microbial processes, as well as genetic modification, to improve the nutritional content of foods.

Grey biotechnology heavily focuses on environmental preservation and contaminant removal, whist brown biotechnology involves the use and management of desert land. Smaller branches include gold biotechnology, primarily bioinformatics, violet biotechnology, relating to patents and law, and dark biotechnology, associated with biological weapons and bioterrorism.

As biotechnology as a whole is such a broad and varied field, the color code offers a simple classification system that allows similar areas of biotechnology to be grouped together. This makes searching for articles or news about a particular area easier, as it reduces the need for multiple specific keywords.

For example, when searching for articles or papers on advances in health-related biotechnology, a search for 'red biotechnology' may return more relevant results in one go than multiple searches using specific keywords such as health, medicine, vaccines, and pharmaceuticals.

Although widely used, the color code is not definitive and different authors and institutions may use slight variations. Although there are definite benefits to such system, there is definitely room for improvement. To be most effective, it would be beneficial to support an official color code, with properly defined categories, to minimize confusion caused by different adaptations of the code.

There is also some degree of debate as to whether certain colors are truly representative of their relative sectors, however, the colors themselves are mostly arbitrary and serve only as a simple and easily recognizable label. If this could be more widely agreed on and made uniform across different organizations, the color-coding system could become an increasingly valuable tool.

(Adopted from https://www.azolifesciences.com/article/The-Colors-of-Biotechnology3b-What-do-they-mean.aspx)

13. Take turns to ask and answer questions to the text "Other colors of biotechnology".

14. Translate the following text into Russian.

Key differentiators between Biotechnology and Bioengineering

Biotechnology and Bioengineering have their important roles in today's society. The key differentiators between these two branches are given below:

- Whilst Biotechnology can be defined as the use of biological systems in the development of drugs or pertinent products, bioengineering is the use

of the principles of engineering as well as its techniques to problems that arise in biology and medicine. We can take the design and manufacture of artificial limbs as well as organs as an example.

- Also, Biotechnology is the application of aspects of living organisms in the arenas of medicine, agriculture, technology and business, Biological engineering is the use of the methods as well as concepts of science and mathematics to resolve problems that arise in life sciences.

One other major difference between the two is that, while biotechnology is mainly concerned with the genetic mutation as well as genetic machination of gene cells, Bioengineering encompasses two chief ideas - (1) the use of engineering sciences to examine and study how animals as well as plants' function; (2) the use of engineering technologies as to create and design new devices.

(Adopted from http://entrance-exam.net/difference-between-biotechnology-and-bioengineering/#ixzz4XMKW3UN9)

SPEAKING

15. Make up the presentation on one of the different aspects of biotechnology.

- Biotechnology is a new field of science.
- The evolution of biotechnology.
- Branches of biotechnology.
- The most important discoveries in the field of biotechnology.

UNIT 3

WHAT IS DNA TECHNOLOGY?

PRE-READING

- What does the abbreviation DNA stand for?
- What DNA technologies do you know?

1. Practice reading the following words with the help of given transcriptions.

gene	[ʤi:n]	eukaryote	[ju:ˈkarıəʊt]
genome	[ˈʤi:nəʊm]	organelle	[ˌɔ:gəˈnɛl]
polymerase	[ˈpɒlıməreız]	chloroplast	[ˈklɔ:rə(ʊ)plast]
electrophoresis	[ɪˌlɛktrə(ʊ)fəˈri:sıs]	mitochondrion	[ˌmʌıtə(ʊ)ˈkɒndrıən]
diabetic	[dʌıəˈbɛtık]		

2. Read the following words and try to remember them.

VOCABULARY

cell	[sel]	клетка
gene	[ʤi:n]	ген
disorder	[dısˈɔ:də]	расстройство
cutting edge	[ˈkʌtıŋ ɛʤ]	передовой
paste	[peıst]	вставлять, ставить
sequence	[ˈsi:kwəns]	последовательность
polymerase chain reaction (PCR)	[ˈpɒlıməreız ʧeın] [ri:ˈækʃən]	полимеразная цепная реакция (ПЦР)
plasmid	[ˈplazmıd]	плазмида
replicate	[ˈrɛplıkeıt]	копировать
target (DNA)	[ˈtɑ:gıt]	(ДНК-)мишень
electrophoresis	[ɪˌlɛktrə(ʊ)fəˈri:sıs]	электрофорез
stain	[steın]	окрашивать
dye	[daı]	краситель

genome	[ˈʤiːnəʊm]	геном
eukaryote	[juːˈkarɪəʊt]	эукариот
organelle	[ˌɔːgəˈnɛl]	органелла
chloroplast	[ˈklɔːrə(ʊ)plast]	хлоропласт
mitochondrion	[ˌmʌɪtə(ʊ)ˈkɒndrɪən]	митохондрия

READING

3. Read the text and answer the questions.

What is DNA technology?

What is biotechnology?

Biotechnology is the use of an organism, or a component of an organism or other biological system, to make a product or process for a specific use.

This is a very broad definition, and it can include both cutting-edge laboratory techniques and traditional agricultural and culinary techniques that have been practiced for hundreds of years. For example, **gene therapy.** Gene therapy is an emerging technique used to treat genetic disorders that are caused by a nonfunctional gene. It works by delivering the “missing” gene’s DNA to the cells of the body.

What is DNA technology?

Many examples of modern biotechnology depend on the ability to analyze, manipulate, and cut and paste pieces of DNA.

DNA technology is important to both basic and applied (practical) biology. For instance, a technique used to make many copies of a DNA sequence, called polymerase chain reaction (PCR), is used in many medical diagnostic tests and forensics applications as well as in basic laboratory research.

Examples of DNA technologies

Let's look at some examples of DNA analysis and manipulation techniques that are commonly used in modern molecular biology.

• **DNA cloning.** In DNA cloning, researchers "clone" – make many copies of – a DNA fragment of interest, such as a gene. In many cases, DNA cloning involves inserting a target gene into a circular DNA molecule called a plasmid. The plasmid can be replicated in bacteria, making many copies of the gene of interest. In some cases, the gene is also expressed in the bacteria, making a protein (such as the insulin used by diabetics).

• **Polymerase chain reaction (PCR).** Polymerase chain reaction is another widely used DNA manipulation technique, one with applications in almost every area of modern biology. PCR reactions produce many copies of a target DNA sequence starting from a piece of template DNA. This technique can be used to make many copies of DNA that is present in trace amounts (e.g., in a droplet of blood at a crime scene).

• **Gel electrophoresis.** Gel electrophoresis is a technique used to visualize (directly see) DNA fragments. For instance, researchers can analyze the results of a PCR reaction by examining the DNA fragments it produces on a gel. Gel electrophoresis separates DNA fragments based on their size, and the fragments are stained with a dye so the researcher can see them.

• **DNA sequencing.** DNA sequencing involves determining the sequence of nucleotide bases (As, Ts, Cs, and Gs) in a DNA molecule. In some cases, just one piece of DNA is sequenced at a time, while in other cases, a large collection of DNA fragments (such as those from an entire genome) may be sequenced as a group.

What is a genome?

A **genome** refers to all of an organism's DNA.

In eukaryotes, which have a nucleus in their cells to hold their DNA, the word *genome* is usually used for the nuclear genome (DNA found in the nucleus), excluding the DNA found in organelles such as chloroplasts or mitochondria.

(Adopted from https://www.khanacademy.org/science/biology/biotech-dna-technology/intro-to-biotech-tutorial/a/intro-to-biotechnology)

QUESTIONS:

1. What is gene therapy?
2. Give the examples of DNA technology.
3. What does polymerase chain reaction produce?
4. In which areas is the PCR used?
5. How can researchers analyze the results of polymerase chain reactions?
6. What does DNA sequencing involve?

AFTER TEXT TASKS

4. Match the words similar in meaning.

1. delivering	a) usually
2. stained	b) malady
3. entire	c) modern
4. commonly	d) supplying
5. applied	e) whole
6. disorder	f) practical
7. insert	g) colored
8. replicate	h) piece
9. fragment	i) copy
10. cutting-edge	j) paste

5. Match the words opposite in meaning.

1. theoretical	a) unite
2. cut	b) hide
3. including	c) practical
4. separate	d) common
5. visualize	e) paste
6. specific	f) excluding

6. Translate the following word combinations into Russian.

1. Cutting-edge laboratory techniques
2. DNA manipulation technique
3. Determining the sequence of nucleotide bases

4. Delivering the “missing” gene’s DNA to the cells of the body
5. Forensics applications
6. To produce many copies of a target DNA sequence
7. To separate DNA fragments based on their size
8. Circular DNA molecule

7. Find the English equivalents to the word combinations in the text.

1. Сельскохозяйственные и кулинарные методы
2. Генетические расстройства
3. ДНК-клонирование
4. Почти во всех областях современной биологии
5. Исходя из кусочка матрицы ДНК
6. Путем изучения фрагментов ДНК
7. Окрашены красящим веществом
8. Вызваны нефункциональным геном

8. Match the following terms with definitions.

1. Polymerase chain reaction	a) a molecule that carries the genetic instructions used in the growth, development, functioning and reproduction of all known living organisms
2. DNA	b) the genetic material of an organism
3. Gene	c) a membrane-enclosed organelle found in eukaryotic cells
4. Plasmid	d) the basic physical and functional unit of heredity
5. Genome	e) a technique used in molecular biology to make the copies of a particular section of DNA
6. Nucleus	f) a small, circular, double-stranded DNA molecule

9. Complete the sentences using the text.

1. Biotechnology is the use of an organism, or a component of an … or other …, to make a product or process for a specific use.
2. Gene therapy is an emerging technique used to … genetic disorders that are caused by a … gene.
3. It works by … the "missing" gene's DNA to the cells of the body.
4. DNA technology is important to both … and … (practical) biology.
5. In DNA … , researchers "clone" – make many copies of – a … fragment of interest, such as a gene.
6. The plasmid can be replicated in … , making many copies of the gene of interest.
7. Gel electrophoresis is a technique used to … DNA fragments.
8. In eukaryotes, which have a … in their cells to hold their DNA, the word *genome* is usually used for the nuclear genome (DNA found in the nucleus), excluding the DNA found in organelles such as … or ... .

10. Mark the following sentences True or False.

1. Biotechnology can include only techniques that have been practiced for hundreds of years.
2. PCR reactions produce many copies of a target DNA sequence starting from a piece of template DNA.
3. DNA sequencing involves determining the sequence of nucleotide bases (As, Ts, Cs, and Gs) in a DNA molecule.
4. Gel electrophoresis is a technique used to make the copies of DNA fragments.
5. In eukaryotes, which have a nucleus in their cells to hold their DNA, the word *genome* is usually used for the nuclear genome (DNA found in the nucleus), including the DNA found in organelles such as chloroplasts or mitochondria.

11. Find out the key words to make up the outline of the text.

12. Give the summary of the text 'What is DNA technology?'

COMPREHENSION

13. Read, translate and give the title to the following text.

DNA technology has revolutionized modern science. Deoxyribonucleic acid (DNA), or an organism's genetic material inherited from one generation to the next holds many clues that have unlocked some of the mysteries behind human behavior, disease, evolution, and aging.

Recent advances in DNA technology including cloning, PCR, recombinant DNA technology, DNA fingerprinting, gene therapy, DNA microarray technology, and DNA profiling have already begun to shape medicine, forensic sciences, environmental sciences, and national security. In 1956, the structure and composition of DNA was elucidated and confirmed previous studies more than a decade earlier demonstrating DNA is the genetic material that is passed down from one generation to the next. A novel tool called PCR (polymerase chain reaction) was developed not long after DNA was discovered. PCR represents one of the most significant discoveries or inventions in DNA technology and it lead to a 1993 Nobel Prize award for American born Kary Mullis (1949-2019).

PCR is the amplification of a specific sequence of DNA so that it can be analyzed by scientists. Amplification is important, particularly when it is necessary to analyze a small sequence of DNA in quantities that are large enough to perform other molecular analyses such as DNA sequencing. Not long after PCR technology was developed, genetic engineering of DNA through recombinant DNA technology quickly became possible. Recombinant DNA is DNA that has been altered using bacterial derived enzymes called restriction endonucleases that act like scissors to cut DNA. The pattern that is cut can be matched to a pattern cut by the same enzymes from a different DNA sequence. The sticky ends that are created bind to each other and a DNA sequence can therefore be inserted into another DNA sequence.

DNA technology, especially when applied to foods and reproductive medicine, continues to generate controversy. It will likely continue to be a

large part of public debate and have an impact on every aspect of medical diagnostics, therapeutics, forensics, and genetic profiling.

(Adopted from https://www.encyclopedia.com/science/encyclopedias-almanacs-transcripts-and-maps/dna-technology)

14. Read and translate the text. Try to convey the content close to the text.

Что такое ДНК человека

ДНК – что это такое простыми словами и как она устроена? Физически это макромолекула, которая не только хранит в себе наследственную информацию, но и является подробной инструкцией по развитию всего организма условно из одной универсальной клетки. Если сравнить человека с компьютером, а все многообразие биологической жизни – с различными формами роботизированных компьютеров, ДНК в этом сравнении будет биологическим языком программирования. С той лишь разницей, что биологические виды устроены намного сложнее и совершеннее самых передовых компьютеров.

К примеру, все биологические виды обладают уникальной способностью деления и преобразования клетки. Фактически в ходе самовоспроизводства клетки биомасса не только материализуется сама из себя, но и физически преобразовывается под решение множества узкоспециализированных задач. А все многообразие живых видов, их форм, уникальных способностей исходит из деления одной универсальной клетки. Одно это уже уходит далеко за грань всех современных генетических достижений.

История открытия

Фактически открытие дезоксирибонуклеиновой кислоты произошло дважды. Первым открытие молекулы совершил Иоганн Фридрих Мишер в 1869 году. Будучи швейцарским биологом и физиологом, он из клеток, содержащихся в гное, смог выделить большую молекулу с высоким содержанием азота и фосфора. Свое

открытие он назвал нуклеин, а позже – нуклеиновой кислотой, когда были открыты ее кислотные свойства.

Первоначально ученые считали, что основная функция нуклеиновой кислоты состоит в хранении фосфора. А предположения, что она может содержать в себе наследственную информацию, вызывали насмешки, поскольку структура молекулы казалась им слишком простой и однообразной для таких функций. Также считалось, что наличие дезоксирибонуклеиновой кислоты свойственно только животным клеткам, а в растениях содержится только РНК. Но в 1934–1935 годах советские ученые-биологи А. Н. Белозерский и А. Р. Кизель это наглядно опровергли и опубликовали результаты своих работ в советских и мировых научных журналах.

Повторное открытие ДНК уже в качестве носителя наследственной информации и не только было совершено в 1944 году. Группа исследователей, состоящая из Освальда Эвери, Колина Маклауда и Маклина Маккарти, проводила эксперименты с трансформацией бактерий и доказала, что основную роль в этом процессе играет дезоксирибонуклеиновая кислота.

(Adopted from https://mygenetics.ru/blog/genetika/chto-takoe-dnk-cheloveka/)

SPEAKING

15. Find more information on the Internet about the latest advances in DNA technology. Make a presentation about one of them.

UNIT 4
DNA CLONING

PRE-READING

Do you agree or disagree with the following statements?

- People will someday be cloned for spare parts.
- Cloning is a dangerous technology that should be illegal.

1. Practice reading the following words with the help of given transcriptions.

identical	[aɪˈdentɪkəl]	biopharmaceuticals	[baɪəfɑːməˈsjuːtɪkl]
procedure	[prəˈsiːʤə]	hormone	[ˈhɔːməʊn]
circular	[ˈsɜːkjʊlə]	flourescent	[flʊ(ə)ˈres(ə)nt]
insulin	[ˈɪnsjʊlɪn]	cystic	[ˈsɪstɪk]
antibiotic	[æntɪbaɪˈɒtɪk]	neuron	[njʊəˈrɒn]

2. Read the following words and try to remember them.

VOCABULARY

multiple	[ˈmʌltɪpl]	множественный
insert	[ˈɪnsət]	вставлять
enzyme	[ˈenzaɪm]	фермент
offspring	[ˈɒfsprɪŋ]	потомок
restriction	[rɪsˈtrɪkʃn]	ограничение
recombinant	[rɪˈkɒmbənənt]	рекомбинантный
biopharmaceuticals	[baɪəfɑːməˈsjuːtɪkl]	биофармацевтические препараты
digestion	[d(a)ɪˈʤestʃ(ə)n]	пищеварение
fibrosis	[faɪˈbrəʊsɪs]	фиброз
glow	[gləʊ]]	светиться
purify	[ˈpjʊərɪfaɪ]	очищать
clot	[klət]	сгусток

READING

4. Read the text and answer the questions.

DNA cloning

The word “cloning” means to clone something is to make a genetically exact copy of it. In a molecular biology lab, what’s most often cloned is a gene or other small piece of DNA.

Overview of DNA cloning

DNA cloning is the process of making multiple, identical copies of a particular piece of DNA. In a typical DNA cloning procedure, the gene or other DNA fragment of interest (perhaps a gene for a medically important human protein) is first inserted into a circular piece of DNA called a *plasmid.* The insertion is done using enzymes that “cut and paste” DNA, and it produces a molecule of recombinant DNA, or DNA assembled out of fragments from multiple sources.

Next, the recombinant plasmid is introduced into bacteria. Bacteria carrying the plasmid are selected and grown up. As they reproduce, they replicate the plasmid and pass it on to their offspring, making copies of the DNA it contains.

What is the point of making many copies of a DNA sequence in a plasmid?

In some cases, we need lots of DNA copies to conduct experiments or build new plasmids. In other cases, the piece of DNA encodes a useful protein, and the bacteria are used as “factories” to make the protein. For instance, the human insulin gene is expressed in E. coli bacteria to make insulin used by diabetics.

Steps of DNA cloning

DNA cloning is used for many purposes. As an example, let's see how DNA cloning can be used to synthesize a protein (such as human insulin) in bacteria. The basic steps are:

1. Cutting and pasting DNA

Cut open the plasmid and "paste" in the gene. This process relies on restriction enzymes (which cut DNA) and DNA ligase (which joins

DNA). Our goal in cloning is to insert a target gene (e.g., for human insulin) into a plasmid. We combine the fragments with DNA ligase, which links them to make a recombinant plasmid containing the gene.

2. Bacterial transformation and selection

Transform the plasmid into bacteria. Use antibiotic selection to identify the bacteria that took up the plasmid. A plasmid typically contains an antibiotic resistance gene, which allows bacteria to survive in the presence of a specific antibiotic. Thus, bacteria that took up the plasmid can be selected on nutrient plates containing the antibiotic. Methods like restriction enzyme digestion and PCR are commonly used to check the plasmids.

3. Protein production

Grow up lots of plasmid-carrying bacteria and use them as "factories" to make the protein. Harvest the protein from the bacteria and purify it. Only then is the insulin biologically active, that is, able to act as a hormone in a patient's body. Production of insulin that can be used by diabetics requires that these additional steps be incorporated into the protein purification procedure, so that the insulin protein takes on its correct three-dimensional form.

Uses of DNA cloning

DNA molecules built through cloning techniques are used for many purposes in molecular biology. A short list of examples includes:

Biopharmaceuticals. DNA cloning can be used to make human proteins with biomedical applications, such as the insulin mentioned above. Other examples of recombinant proteins include human growth hormone, which is given to patients who are unable to synthesize the hormone, and tissue plasminogen activator (tPA), which is used to treat strokes and prevent blood clots. Recombinant proteins like these are often made in bacteria.

Gene therapy. In some genetic disorders, patients lack the functional form of a particular gene. Gene therapy attempts to provide a normal copy of the gene to the cells of a patient’s body. For example,

DNA cloning was used to build plasmids containing a normal version of the gene that's nonfunctional in cystic fibrosis.

Gene analysis. In basic research labs, biologists often use DNA cloning to build artificial, recombinant versions of genes that help them understand how normal genes in an organism function. For instance, researchers studying neurons in fruit flies might use DNA cloning to assemble a reporter construct for a neural gene. In this construct, the regulatory region (promoter) of the gene might be pasted in front of a gene encoding a fluorescent protein. When transferred into a fly, the "reporter gene" would be expressed in the same neurons as the neural gene itself, causing those neurons to glow (fluoresce) under UV light. These are just a few examples of how DNA cloning is used in biology today. DNA cloning is a very common technique that is used in a huge variety of molecular biology applications.

(Adopted from https://www.khanacademy.org/science/biology/biotech-dna-technology/dna-cloning-tutorial/a/overview-dna-cloning)

QUESTIONS:

1. What does DNA cloning mean?
2. What is a plasmid?
3. How is a molecule of recombinant DNA produced?
4. What are the basic steps of DNA cloning?
5. What do people use for making a protein?
6. What does antibiotic resistance mean?
7. What methods are commonly used to check the plasmids?
8. Where is DNA cloning used?

AFTER TEXT TASKS

4. Match the words similar in meaning.

1. purpose	a. to avoid
2. protein	b. goal
3. to prevent	c. fiber

4. offspring d. clump
5. clot e. descendent

5. Match the words opposite in meaning.

1. within a. passive
2. basic b. take away
3. active c. without
4. encode d. secondary
5. provide e. decipher

6. Translate the following word combinations into Russian.

1. DNA sequence
2.To combine the fragments with DNA ligase
3. Nutrient plates
4. Survive in the presence
5. Prevent blood clots
6. Tissue plasminogen activator
7. The target protein

7. Find the English equivalents to the word combinations in the text.

1. Создание множества одинаковых копий
2. Собранный из фрагментов
3. Расщепление ферментами
4. Синтезировать гормон
5. Процедура очистки белка
6. Плодовые мушки
7. Препятствовать образованию тромбов

8. Insert the missing words:

protein	transformation
plasmid	gene

1) DNA cloning is a molecular biology technique that makes many identical copies of a piece of DNA, such as a (1)… .

2) In a typical cloning experiment, a target gene is inserted into a circular piece of DNA called a (2)… .
3) The plasmid is introduced into bacteria via process called (3)… , and bacteria carrying the plasmid are selected using antibiotics.
4) Bacteria with the correct plasmid are used to make more plasmid DNA or, in some cases, induced to express the gene and make (4)... .

9. Find out the key words to make up the outline of the text DNA cloning.

10. Give the summary of the text DNA cloning.

COMPREHENSION

11. Read the text and translate it. Write down the main idea of the text.

Human cloning

Human cloning is the creation of a genetically identical copy of an existing or previously existing human. There are two commonly discussed types of human cloning: therapeutic cloning and reproductive cloning. Therapeutic cloning involves cloning cells from an adult for use in medicine and is an active area of research. Reproductive cloning would involve making cloned human beings. Such reproductive cloning has not been performed and is illegal in many countries. A third type of cloning called replacement cloning. It is theoretical possibility, and would be a combination of therapeutic and reproductive cloning. Replacement cloning would entail the replacement of an extensively damaged, failed, or failing body through cloning followed by whole or partial brain transplant. Some people and groups oppose therapeutic cloning, but most scientific, governmental and religious organizations oppose reproductive cloning. Many scientific organizations have made public statements suggesting that human reproductive cloning be banned until safety issues are resolved. Serious ethical concerns have been raised by the idea that it might be possible in the future to harvest organs from clones.

Some people have considered the idea of growing organs separately from a human organism - in doing this, a new organ supply could be established without the moral implications of harvesting them from humans.

The first human hybrid human clone was created in November 1998, by American Cell Technologies. It was created from a man's leg cell, and a cow's egg whose DNA was removed. It was destroyed after 12 days.

On January, 2008, Wood and Andrew French, Stemagen's chief scientific officer in California, announced that they successfully created the first 5 mature human embryos using DNA from adult skin cells, aiming to provide a source of viable embryonic stem cells. It is not clear if the embryos produced would have been capable of further development, but Dr. Wood stated that if that were possible, using the technology for reproductive cloning would be both unethical and illegal. Thus, the 5 cloned embryos were destroyed.

(Adopted from https://taylorandfrancis.com/knowledge/Engineering_and_technology/Biomedical_engineering/Clone/)

12. Translate an abstract. What are the main pros and cons of cloning? What can you add?

Анализ проблемы клонирования показывает, что само по себе клонирование имеет минусы и плюсы. Так, к недостаткам можно отнести:

1) идея иметь двойника сама по себе противоестественна, она противоречит уникальности. С точки зрения морали возникает вопрос, как мы будем относиться к созданным клонам;

2) в результате клонирования появятся генетически идентичные организмы, и нет уверенности в том, что это не приведет к проблемам биологического и физиологического характера, не повлияет на индивидуальность;

3) в связи с многократностью повторяющихся одних и тех же комбинаций генов при очень широком распространении клонирование

может привести, как опасаются многие ученые, к уменьшению резистентности к различным инфекциям и эпидемиям;

4) могут возникнуть различные нарушения в структуре ДНК, что приведет к неконтролируемым метаморфозам человеческого организма;

5) использование клонирования в злостных целях, таких как создание целой армии безропотных и безжалостных воинов, воспитанных на принципах, лишенных гуманизма;

6) возможность неудачных экспериментов с клонированием, которые приведут к летальным исходам;

7) отрицание клонирования мировыми религиями, которые считают это явление противоестественным;

8) моральные и нравственные устои не позволяют смириться с явлением клонирования.

И это лишь малая часть недостатков клонирования. В чем же видят преимущества клонирования? К ним можно отнести:

1) использование клонирования в медицине, благодаря чему появятся новые возможности при лечении многих заболеваний;

2) решить вопрос с бесплодием, так как репродуктивное клонирование создает клон донора;

3) клонирование жизненно важных органов для использования их в медицине (в мире существует нехватка донорских органов).

На наш взгляд (и в этом вопросе такую же точку зрения имеют многие ученые), клонирование человека пока только идея. Человечество не должно воплощать эту идею в жизнь, ведь ее последствия непредсказуемы. Любые научные достижения должны тщательно изучаться, пройти долгий экспериментальный путь. Человечеству не стоит торопиться, но развивать научные направления в этой области возможно. Работы по клонированию, как предсказывают, помогут современной медицине выйти на новый уровень.

(Adopted from https://epomen.ru/issues/2017/08/04.pdf)

SPEAKING

13. Role Play Game.

You are on the debates "Should we legalize cloning?" Select a role for yourself from the list below and prepare to speak on their behalf.

- A person who has a clone
- His clone
- A person who wants to have a clone
- A doctor
- A lawyer
- A psychologist
- A priest
- A businessman

UNIT 5

HUMAN GENOME PROJECT

PRE-READING

- What is Human Genome?
- Do human genes influence our diseases?

1. Practice reading the words with the help of given transcriptions.

genome	[ˈʤiːnəʊm]	alienated	[ˈeɪljəneɪtɪd]
government-sponsored	[ˈgʌvnmənt-ˈspɒnsəd]	protein	[ˈprəʊtiːn]
approximately	[əˈprɒksɪmɪtli]	formative	[ˈfɔːmətɪv]
identical	[aɪˈdɛntɪkəl]	chemical	[ˈkɛmɪkəl]

2. Read the following words and try to remember them.

VOCABULARY

nucleotides	[ˈnjuːklɪətaɪdz]	нуклеотиды
strand	[strænd]	прядь
labors	[ˈleɪbəz]	труды
sequencing	[ˈsiːkwənsɪŋ]	последовательность действий
approximately	[əˈprɒksɪmɪtli]	примерно
mapping	[ˈmæpɪŋ]	картирование
hereditary	[hɪˈrɛdɪtəri]	наследственный
prearranged	[ˌpriːəˈreɪnʤd]	заранее подготовленный
identical	[aɪˈdɛntɪkəl]	одинаковый
ultimately	[ˈʌltɪmɪtli]	в конечном итоге
alienated	[ˈeɪljəneɪtɪd]	отчужденный
distinguish	[dɪsˈtɪŋgwɪʃ]	выделить

READING

3. Read the text and answer the questions.

Human Genome Project

The Human Genome Project (HGP) is a global methodical research project with a main goal of formative the sequence of chemical base pairs which make up DNA, and of identifying and map the about 20,000-25,000 genes of the human genome from both a physical and functional standpoint.

Human Genome Research Institute labors.

Most of the government-sponsored sequencing was performed in universities and research centers from the United States, the United Kingdom, Japan, France, Germany, China and Pakistan. The mapping of human genes is an important step in the growth of medicine and other aspects of physical condition care.

Project goals were to:

– Identify all the approximately 20,000-25,000 genes in human DNA,

– Determine the sequences of the 3 billion chemical base pairs that make up human DNA,

– Store this information in databases,

– Improve tools for data analysis,

– Transfer related technologies to the private sector, and

– Address the ethical, legal, and social issues The project began in 1989 and was at first head by Ari Patrinos, head of the Office of Biological and Environmental investigate in the U.S. Department of Energy's Office of Science. Francis Collins directed the National Institutes of Health National (ELSI) that may arise from the project.

To help achieve these goals, researchers also deliberate the hereditary makeup of quite a few nonhuman organisms.

HGP remains one of the largest single investigative projects in modern science.

Human Genome Project Process

After the judgment that DNA's information of nucleotides (A, C, T, and G), it was supposed that one could find this series through a technique

of analyze a large number of identical strand of DNA and identify each nucleotide in order of its appearance in the DNA sequence. This technique was ultimately discovered in 1977 by Fredrick Sanger. His method, known as Sanger Sequencing, relied on two main principles.

DNA can be alienated by size. This was temporarily discussed in the section on Laboratory Techniques with regard to gel electrophoresis. Keep in mind that DNA is negatively charged, it will migrate towards the positive electrode when an electric current is applied. When placed in a gel composed of polyacrylamide beads, larger strand of DNA will migrate through the gel slower. It allows one to actually distinguish a strand of DNA 400 base pairs long from a strand of DNA 401 base pairs long.

In adding, the chemical structure of DNA allows geneticists to influence its normal function and use it to recognize the series of a strand of DNA. As was discuss in the section about DNA duplication, cells have a protein called DNA Polymerase II that adds nucleotides complementary to the original strand, allowing it to form two identical strands of DNA from a template strand. To do this, it adds one nucleotide complementary to the template strand at a time.

(Adopted from https://www.biotechonweb.com/Humene-Genome-Project.php)

QUESTIONS:

1. What is the Human Genome Project?
2. When did HGP start?
3. Where were the most researches conducted?
4. What are the main objectives of the project?
5. What is the method of Fredrick Sanger?
6. What is the advantage of gels composed of polyacrylamide beads?

AFTER TEXT TASKS

4. Match the words opposite in meaning.

1. allow	a) end
2. most	b) prohibit
3. begin	c) minority

4. important	d) positive
5. nonhuman	e) different
6. negative	f) faster
7. identical	g) trivial
8. slower	h) human

5. Match the words similar in meaning.

1. store	a) purpose
2. goal	b) match
3. address	c) keep
4. identify	d) thread
5. strand	e) move
6. migrate	f) solve

6. Translate the following word combinations into Russian.

1. The human genome project
2. Formative the sequence of chemical base pairs
3. The mapping of human genes
4. Address the ethical, legal, and social issues
5. Nonhuman organisms
6. Improve tools for data analysis
7. Identical strand of DNA
8. Relied on two main principles
9. A gel composed of polyacrylamide beads
10. Migrate through the gel
11. The template strand

7. Find the English equivalents to the word combinations in the text.

1. Спонсируемые государством
2. Развитие медицины
3. Уход за физическим состоянием
4. Улучшить инструменты для анализа данных
5. Наследственность

6. Порядок его появления в последовательности ДНК
7. Могут быть отчуждены по размеру
8. Распознать серию нити ДНК

8. Match the following terms with definitions.

1. Genome	a) the monomer comprising DNA or RNA biopolymer molecules. (Each nucleotide consists of a nitrogenous heterocyclic base (or nucleobase); a five-carbon pentose sugar (deoxyribose in DNA or ribose in RNA); and a phosphate group.)
1. DNA	b) any of numerous large, complex naturally-produced molecules composed of one or more long chains of amino acids, in which the amino acid groups are held together by peptide bonds.
2. Genes	c) global methodical research project with a main goal of formative the sequence of chemical base pairs which make up DNA
3. Human genome project	d) a unit of heredity; a segment of DNA or RNA that is transmitted from one generation to the next, and that carries genetic information such as the sequence of amino acids for a protein
4. Nucleotide	e) the complete genetic information (either DNA or, in some viruses, RNA) of an organism, typically expressed in number of base pairs.
5. Protein	f) a biopolymer of deoxyribonucleic acids (a type of nucleic acid) that has four different chemical groups, called bases: adenine, guanine, cytosine, and thymine.

9. Reorder the words to make a sentence.

1) remains, HGP, modern, largest, science. single, projects, one of, the in, investigative.

2) This, Fredrick Sanger. ultimately, was, 1977, by, discovered, in, technique.
3) National Institutes, directed, Health National Human Genome Research Institute, the, labors. of, Francis Collins.
4) can, by, be, alienated. DNA, size.
5) allows, to, It, actually, DNA. a, of, one, distinguish, strand.

9. Insert the necessary word in the gap.

1) Keep in mind that DNA is _____ charged, it will migrate towards the _____ electrode when an electric current is applied.
2) The Human Genome Project (HGP) is an global methodical research project with a main goal of formative the sequence of chemical _____ which make up ___, and of identifying and map the about 20,000-25,000 _____ of the human genome from both a physical and functional standpoint.
3) The _____ of human genes is an important step in the growth of _____ and other aspects of physical condition care.
4) To help achieve these goals, researchers also deliberate the hereditary makeup of quite a few _____ organisms.
5) After the judgment that DNA's information of _____ (A, C, T, and G), it was supposed that one could find this series through a technique of analyze a large number of identical _____of DNA and identify each nucleotide in order of its appearance in the ____ sequence.

10. Find out the key words to make up the outline of the text.

11. Retell the text Human Genome Project using the key words.

COMPREHENSION

12 Read the text and get ready to answer the questions.

1) What is the main goal of The Human Genome Project?
2) How many genes are there in the human genome?
3) What is the name of the Project Director at the National Center for Human Genome Research?
4) How many chromosomes does a human cell contain?

5) What kind of a molecule is a protein?
6) What is the shape of DNA?
7) How many based pairs does a complete human genome contain?
8) How is an error gene called?
9) What similar molecule does a cell convert DNA to?
10) What do many diseases come from?

The Human Genome Project

Eyes of brown? or blue?… Curly hair? or straight? Dimples?… Freckles? It's in our genes. Heredity. There are also many things in our genes that we would rather avoid, such as heart disease, diabetes, cancer, arthritis, muscular dystrophy, and other illnesses.

Many diseases come from alterations in our genes. To decipher our genetic code, a scientific journey has begun called The Human Genome Project. The genetic code is the complete instructions of all the genes that tell our body how to develop.

Over the years, some genes have been discovered for certain diseases. People who have a family history of these diseases can be tested for the specific gene. But there are many more diseases with genetic components that have not yet been uncovered. Scientists are still unclear what or which genes affect the diseases. Francis Collins MD, PHD, is the Project Director at the National Center for Human Genome Research. He said that "by uncovering all 30,000 to 40,000 genes in the human genome, we uncover the heredity basis of most diseases and that would put us in a position to diagnose them better, treat them and practice preventative medicine."

What are Genes? They are found in the part of the cell called the nucleus. Human cells contain 23 pairs of chromosomes, 46 in all. One member of each pair comes from the mother and one from the father. Genes occur in pairs, like the chromosomes. A chromosome is a very long chemical molecule called DNA. Genes are segments of DNA molecules. DNA is shaped like a twisted ladder. Rungs of the ladder are chemicals called "base pairs". Chemical "A" is always paired up with "T" and "G" is always with "C". The complete human genome (all our DNA) contains three

billion “base pairs”. The Human Genome Project will find the sequence of all of them. This knowledge will revolutionize our understanding of the way genes influence disease, because the genes’ “base pair” sequence is the code that determines what it does.

What do genes do? They give cells the instructions they need to make complex molecules called proteins. Each gene code is for a different protein. A cell first converts DNA to a similar molecule called RNA.

Occasionally, the gene that codes for a protein has an error in its based pair sequence. The cell then makes a protein that is not able to do what it should. This is called a mutated gene. Mutated genes play a major role in human diseases. Since genes are incredibly small, it is difficult for scientists to isolate them. Making it easier for scientists to find disease-causing genes is the main goal of the Human Genome Project.

(Adopted from Воеводина О.С., Нестерова О.Ю., Садыкова А.Р. English for biotechnologists and biologists: Английский язык для биотехнологов и биологов: Учеб. пособие. Ижевск: Изд-во «Удмуртский университет», 2012. – 375с.)

14. ***Read and translate the text.***

How did the Human Genome Project affect biological research in general?

The Human Genome Project demonstrated that production-oriented, discovery-driven scientific inquiry which did not involve the investigation of a specific hypothesis or the direct answering of preformed questions could be remarkably valuable and beneficial to the broader scientific community.

The project was also a successful example of “big science” in biomedical research. The magnitude of the technological challenges prompted the Human Genome Project to assemble interdisciplinary groups from across the world, involving experts in engineering, biology, and computer science, among other areas. It also required the work to be concentrated in a modest number of major centers to maximize economies of scale.

Before the Human Genome Project, the biomedical research community viewed projects of such scale with deep skepticism. These kinds of massive scientific undertakings have become more commonplace and well-accepted based in part on the success of the Human Genome Project.

(Adopted from https://www.genome.gov/about-genomics/educational-resources/fact-sheets/human-genome-project)

WRITING

15. ***Write an essay proving the statement:*** *Human Genome Project is considered to be the most important biomedical research undertaking of the 20th Century.*

UNIT 6
DENISOVAN GENOME

PRE-READING

Have you ever heard about Denisovan DNA as a type of ancient human DNA that has been found in the genomes of some present-day humans?

1. Practice reading the following words with the help of given transcriptions.

identify	[aɪˈdentɪfaɪ]	archaic	[ɑːˈkeɪɪk]
ancestor	[ˈænsestər]	New Guinea	[njuː ˈgɪnɪ]
exquisite	[ɪkˈskwɪzɪt]	Siberia	[saɪˈbɪərɪə]
fossilized	[ˈfɒsɪlaɪzd]	segment	[ˈsegmənt]
comparison	[kəmˈpærɪsn]	thrive	[θraɪv]

2. Read the following words and try to remember them.

VOCABULARY

hominid	**[**ˈhɒmɪnɪd**]**	человекообразный
Neanderthal	**[**niːˈændətɑːl**]**	неандерталец
fossilized	[ˈfɒsɪlaɪzd]	окаменевший
interbreed	[ɪntəˈbriːd]	скреститься
pinkie	**[**ˈpɪŋki**]**	мизинец
bone	**[**bəʊn**]**	останки
genetic overlap	**[**dʒəˈnetɪkˌəʊvəˈlæp**]**	генетическое совпадение
genetic mixing	**[**dʒəˈnetɪk mɪksɪŋ**]**	генетическое смешивание
genetic diversity	**[**dʒəˈnet.ɪk daɪˈvɜːsɪti**]**	генетическое разнообразие
Melanesian	**[**meləˈnɪzɪən**]**	меланизийцы
homo sapiens	[ˈhəʊməʊ ˈsæpɪenz]	человек разумный
thrive	[θraɪv]	процветать
exquisite	[ɪkˈskwɪzɪt]	превосходный, изысканный

READING

3. Read the text and answer the questions.

Denisovan genome

When our ancestors first migrated out of Africa around 60,000 years ago, they were not alone. At least two of our hominid cousins had made the same journey, Neanderthals and Denisovans. Neanderthals, the better known of the two species, left Africa about 300,000 years ago and settled in Europe and parts of western Asia. The Denisovans are a much more recent addition to the human family tree. In 2008, paleoanthropologists digging in a cave in southern Siberia unearthed a 40,000-year-old adult tooth and an exquisitely preserved fossilized pinkie bone that had belonged to a young girl who was between five and seven years old when she died.

Recently, scientists successfully extracted nuclear DNA from the pinkie bone and conducted comparison studies with the genomes of modern humans and Neanderthals. Studies show the girl was closely related to Neanderthals, yet distinct enough to merit classification as a new species of archaic humans, which scientists named “Denisovan” after the cave where the pinkie bone was found. The Denisovan genome also suggests the young girl had brown hair, eyes, and skin.

Surprisingly, the scientists found genetic overlap between the Denisovan genome and that of some present-day east Asians, and, in particular, a group of Pacific Islanders living in Papua New Guinea, known as the Melanesians. It appears the Denisovans contributed between 3 to 5 percent of their genetic material to the genomes of Melanesians. Scientists think that the most likely explanation is that Denisovans living in eastern Eurasia interbred with the modern human ancestors of Melanesians. When those humans crossed the ocean to reach Papua New Guinea around 45,000 years ago, they brought their Denisovan DNA over with them.

If this genetic mixing did occur, the fact that Denisovans were discovered in Siberia but contributed to the genomes of modern humans living in Southeast Asia suggests the species ranged widely across Asia, although their low genetic diversity also indicates their numbers were never so high.

According to one theory, Neanderthals, Denisovans, and modern humans are all descended from the ancient human *Homo heidelbergensis*. Between 300,000 to 400,000 years ago, an ancestral group of *H. heidelbergensis* left Africa and then split shortly after. One branch ventured northwestward into West Asia and Europe and became the Neanderthals. The other branch moved east, becoming Denisovans. By 130,000 years ago, *H. heidelbergensis* in Africa had become *Homo sapiens*, our ancestors, who did not begin their own exodus from Africa about 60,000 years ago.

By comparing the genomes of apes, Denisovans, Neanderthals, and modern humans, scientists hope to identify DNA segments unique to the different groups. Early results already suggest modern humans underwent genetic changes involved with brain function and nervous system development, including ones involved in language development, after splitting from Neanderthals and Denisovans. Identifying and understanding these genetic tweaks could help explain why our species survived and thrived while our close relatives died out.

Adopted from http://lingualeo.com/ru/jungle/biotechnology-248405#/page/1

QUESTIONS:

1. When did our ancestors move from Africa?
2. What did the paleoanthropologists discover in the cave in the southern part of Siberia?
3. How many percent of their genetic material did the Denisovans bring to the genomes of the Melanesians?
4. Who are mutual ancestors of Neanderthals, Denisovans and modern people?
5. Why do scientists compare the genomes of monkeys, Denisovans, Neanderthals and modern humans?

AFTER TEXT TASKS

4. Translate the following word combinations into Russian.

1. The better known of the two species
2. A much more recent addition to the human family tree
3. An exquisitely preserved
4. Low genetic diversity
5. According to one theory
6. Genetic tweak
7. Survived and thrived

5. Find the English equivalents to the word combinations in the text.

1. 40 000-летний взрослый зуб
2. Сравнительные исследования
3. Новый вид архаичных людей
4. Скрещиваться с современными человеческими предками
5. Уникальные для разных групп
6. Подверглись генетическим изменениям

6. Insert prepositions and translate the sentences into Russian.

1. __ 2008, paleoanthropologists digging __ a cave __ southern Siberia unearthed a 40,000-year-old adult tooth and an exquisitely preserved fossilized pinkie bone that had belonged __ a young girl who was between five and seven years old when she died.
2. Recently, scientists successfully extracted nuclear DNA __ the pinkie bone and conducted comparison studies __ the genomes of modern humans and Neanderthals.
3. Scientists think that the most likely explanation is that Denisovans living __ eastern Eurasia interbred __ the modern human ancestors of Melanesians.
4. __ 130,000 years ago, H. heidelbergensis __ Africa had become Homo sapiens—our ancestors—who did not begin their own exodus __ Africa until about 60,000 years ago.

5. Early results already suggest modern humans underwent genetic changes involved __ brain function and nervous system development, including ones involved __ language development, __ splitting from Neanderthals and Denisovans.

7. Match the words similar in meaning

1. ancestors	a. contemporary
2. species	b. man
3. modern	c. evolution
4. cave	d. sort
5. human	e. den
6. ape	f. antecedent
7. development	g. monkey
8. bone	h. skeleton

8. Use your dictionary to find the derivatives of the words. Translate the words into Russian.

gene – genetic …
science –
success –
explain –
contribute –

9. Complete the sentences using the text.

1. When our ancestors first migrated out of Africa around __, they were not alone.
2. Recently, scientists successfully extracted __ from the pinkie bone and conducted comparison studies with the genomes of modern humans and Neanderthals.
3. The __ are a much more recent addition to the human family tree.
4. When those humans crossed the ocean to reach Papua New Guinea around 45,000 years ago, they brought their __ over with them.
5. It appears the Denisovans contributed between 3 to 5 percent of their genetic material to the genomes of __.

10. Find out the key words to make up the outline of the text 'Denisovan genome'.

11. Retell the text 'Denisovan genome' using the key words.

COMPREHENSION TASK

12. Read the text and answer the questions.

1) What is the Hippocratic principle?
2) Is there a controversy in this area?
3) Who is a 'replacement person'?
4) What do people think about the creation of a 'replacement person'?
5) What will involve the participation of at least three parties: the experts, the community of possible beneficiaries and the general public?

Human genetics ethics

The use of biotechnology in relation to human beings is governed by the Hippocratic principle that interventions must be for the benefit of the individual person concerned. Controversy in this area is not generated by dissent from this principle but by disagreement about what constitutes a human person, with all the moral rights appertaining to that status.

Some believe that this status is established at the moment of conception. If that is the case then no manipulation of the early embryo, other than for its own direct benefit, could be ethically justified. Others, however, take a more developmental view of the way in which a human fetus grows into a person, with the dawning of sentience and eventually of mentality. Currently, that research is also limited to projects investigating aspects of human fertility.

Although the repair of damaged tissues in the ill or injured is seen as being highly desirable, the creation of a 'replacement person' is not so acceptable. Respect for the human person forbids this - not because there is an intrinsic human right to possess a unique genome but because a human being is to be valued for their self and not used as a surrogate for another. The same moral intuition leads to an abhorrence of the idea of using genetic manipulation to produce 'designer babies' with qualities according to

parental specification. Persons are never to be commodified: ethically, they are never means but always ends.

Science, by gaining knowledge, confers power; if that power is to be used to choose the good and refuse the bad then wisdom must be added to knowledge. This quest for judicious decisions will involve the participation of at least three parties: the experts, the community of possible beneficiaries and the general public.

If this prospect of a rational debate about biotechnology is to be realized, a considerable educational program will be required. It is clear that many people still lack the rudimentary degree of scientific understanding that is indispensable as the basis for reaching informed, ethical conclusions on these issues.

(Adopted from https://cyberpedia.su/9xbd19.html)

13. Translate an abstract. Write down questions to each paragraph.

Biotechnology: Social, Legal, and Ethical Issues

Biotechnology is a field of science that involves the use of living organisms, biological systems, and processes to develop new products and technologies.

It has transformed the way we produce food, medicines, and industrial materials, and has opened up new opportunities for research and innovation.

Biotechnology has the potential to transform the way we live, but it also raises a range of social, legal, and ethical issues that need to be addressed.

Access to its benefits, impact on traditional industries and livelihoods, and potential for economic and political inequality are some of the social issues that need to be addressed. Legal issues such as intellectual property rights, bioethics, and regulatory oversight also need to be tackled to ensure that the benefits of biotechnology are accessible to all while maintaining safety standards.

Ethical issues such as the use of genetic information, unintended consequences, and impact on biodiversity also require careful consideration to ensure that biotechnology is used in a responsible manner.

To address these issues, there needs to be a collaborative effort between biotechnology companies, regulatory bodies, governments, and the public.

Biotechnology companies need to prioritize social responsibility and ethical practices while developing new products and technologies. Regulatory bodies need to ensure that biotechnology is subject to strict oversight while also facilitating innovation.

Governments need to create policies and frameworks that promote social equity, economic growth, and environmental sustainability. The public needs to be informed and engaged in the biotechnology discourse to ensure that their voices are heard and their concerns addressed.

In conclusion, biotechnology is a field of science that has the potential to revolutionize our world, but it also raises a range of social, legal, and ethical issues that need to be addressed.

(Adopted from https://www.tutorialspoint.com/biotechnology-social-legal-and-ethical-issues)

WRITING

14. Create a code of ethics regulations for biotechnologists. Write what they should do and what they must not do.

UNIT 7
GEL ELECTROPHORESIS

PRE-READING

- What do you know about gel electrophoresis?
- How is this technology used in modern molecular biology?

1. Practice reading the following words with the help of given transcriptions.

electrophoresis	[ɪˌlɛktrəʊfəˈriːsɪs]	electrode	[ɪˈlɛktrəʊd]
technique	[tɛkˈniːk]	commercial	[kəˈməːʃəl]
fragment	[ˈfrægmənt]	coverage	[ˈkʌvərɪdʒ]
molecule	[ˈmɔlɪkjuːl]	phosphate	[ˈfɒsfeɪt]
polysaccharide	[ˌpɒlɪˈsækəˌraɪd]	fluorescent	[flʊəˈresnt]

2. Read the following words and try to remember them.

VOCABULARY

representing	/rɛprɪˈzɛnt/	представление
yardstick	/ˈjɑːdˌstɪk/	критерии
involve	/ɪnˈvɔlv/	включать
backbone	/ˈbækˌbəʊn/	основа
sequencing	/ˈsiːkwəns/	упорядочивание
band	/bænd/	группа
squishy	/ˈskwɪʃɪ/	мягкий
hydrogen	/ˈhaɪdrɪdʒən/	водород
indentation	/ɪndɛnˈteɪʃən/	углубление
slab	/slæb/	пластина
agarose	/ˈeɪgɑːrəʊz/	агароза
well	/wɛl/	Колодец\скважина
gel box	/dʒɛl bɔks/	коробка геля

READING

3. Read the text and answer the questions.

Gel electrophoresis

Gel electrophoresis is a technique used to separate DNA fragments (or other macromolecules, such as RNA and proteins) based on their size and charge. Electrophoresis involves running a current through a gel containing the molecules of interest. Based on their size and charge, the molecules will travel through the gel in different directions or at different speeds, allowing them to be separated from one another.

All DNA molecules have the same amount of charge per mass. Because of this, gel electrophoresis of DNA fragments separates them based on size only. Using electrophoresis, we can see how many different DNA fragments are present in a sample and how large they are relative to one another. We can also determine the absolute size of a piece of DNA by examining it next to a standard "yardstick" made up of DNA fragments of known sizes.

What is a gel?

Gel electrophoresis involves a gel: a slab of Jello-like material. Gels for DNA separation are often made out of a polysaccharide called **agarose**, which comes as dry, powdered flakes. When the agarose is heated in a buffer (water with some salts in it) and allowed to cool, it will form a solid, slightly squishy gel. At the molecular level, the gel is a matrix of agarose molecules that are held together by hydrogen bonds and form tiny pores. At one end, the gel has pocket-like indentations called **wells**, which are where the DNA samples will be placed:

Before the DNA samples are added, the gel must be placed in a **gel box**. One end of the box is hooked to a positive electrode, while the other end is hooked to a negative electrode. The main body of the box, where the gel is placed, is filled with a salt-containing buffer solution that can conduct current. The end of the gel with the wells is positioned towards the negative electrode. The end without wells (towards which the DNA fragments will migrate) is positioned towards the positive electrode.

How do DNA fragments move through the gel?

Once the gel is in the box, each of the DNA samples we want to examine is carefully transferred into one of the wells. One well is reserved for a **DNA ladder**, a standard reference that contains DNA fragments of known lengths. Commercial DNA ladders come in different size ranges, so we would want to pick one with good "coverage" of the size range of our expected fragments.

Next, the power to the gel box is turned on, and current begins to flow through the gel. The DNA molecules have a negative charge because of the phosphate groups in their sugar-phosphate backbone, so they start moving through the matrix of the gel towards the positive pole. When the power is turned on and current is passing through the gel, the gel is said to be **running**.

What is sequencing?

DNA sequencing is the process of determining the sequence of nucleotide bases (As, Ts, Cs, and Gs) in a piece of DNA. Today, with the right equipment and materials, sequencing a short piece of DNA is relatively straightforward.

Sequencing an entire genome remains a complex task. It requires breaking the DNA of the genome into many smaller pieces, sequencing the pieces, and assembling the sequences into a single long "consensus." However, thanks to new methods that have been developed over the past two decades, genome sequencing is now much faster and less expensive than it was during the Human Genome.

(Adopted from https://pediaa.com/how-does-gel-electrophoresis-separate-dna-fragments/)

QUESTIONS:

1) What is "gel electrophoresis"?
2) How are DNA fragments loaded?
3) When can DNA fragments be seen as bands?
4) How does "gel electrophoresis" separate DNA fragments?

5) What do we see when we use gel electrophoresis?
6) What gel is used in electrophoresis?
7) What is the buffer?
8) What is the charge of DNA molecules?

AFTER TEXT TASKS

4. Translate the following word combinations into Russian.

1) DNA sequencing
2) Gel electrophoresis
3) DNA-binding dye
4) Slightly squishy gel
5) DNA fragments
6) Negative charge

5. Find the English equivalents to the word combinations in the text.

1) Отделить фрагменты
2) Образцы ДНК
3) Стандартный критерий
4) Порошкообразные хлопья
5) Геном человека
6) Проводить ток

6. Insert the necessary word in the gap.

1) DNA fragments are _____ charged, so they move towards the positive electrode.
2) Gel _____ is a technique used to separate DNA fragments according to their size.
3) At the _____ level, the gel is a matrix of agarose molecules that are held together by hydrogen bonds and form tiny pores.
4) Gels for DNA separation are often made out of a polysaccharide called _____, which comes as dry, powdered flakes.

5) DNA sequencing is the process of _____ the sequence of nucleotide bases (As, Ts, Cs, and Gs) in a piece of DNA.

7. ***Mark the following sentences True or False.***

1) DNA fragments are positively charged.
2) All DNA molecules have the same amount of charge per mass.
3) We can't determine the absolute size of a piece of DNA by examining it next to a standard "yardstick" made up of DNA fragments of known sizes.
4) Gel electrophoresis involves a gel: Proteins, fats and carbohydrates.
5) At the molecular level, the gel is a matrix of agarose molecules that are held together by hydrogen bonds and form tiny pores.

8. ***Reorder the words to make a sentence.***

1) All / mass / molecules / amount / DNA / have the / of charge / per / same.
2) involves / containing / Electrophoresis / the molecules / a gel / running / a current / of interest / through.
3) The end / towards/ with the wells/ the negative / of the gel / is positioned / electrode.
4) DNA / of determining / sequencing / the sequence / (As, Ts, Cs, and Gs) in a piece of / nucleotides / of DNA / is the process.
5) An entire / genome / a complex / Sequencing / remains / task.

9. ***Find the English variants of the following sentences in the text.***

1) Используя электрофорез, мы можем увидеть, сколько различных фрагментов ДНК присутствует в образце и как они относятся друг к другу.
2) В одном конце у геля есть подобные карману углубления, называемые скважинами, в которые помещаются образцы ДНК.
3) К одному концу коробки подведен положительный электрод, в то время как к другому подведен отрицательный электрод.

4) Основная часть коробки, в которой находится гель, заполнена содержащим соль буферным раствором, который может проводить ток.
5) Молекулы ДНК имеют отрицательный заряд из-за фосфатных групп в их сахарофосфатном остове, поэтому они начинают двигаться через матрицу геля по направлению к положительному полюсу.

10. Read and translate the key points of the text Gel electrophoresis.

Key points:

• Gel electrophoresis is a technique used to separate DNA fragments according to their size.
• DNA samples are loaded into wells (indentations) at one end of a gel, and an electric current is applied to pull them through the gel.
• DNA fragments are negatively charged, so they move towards the positive electrode. Because all DNA fragments have the same amount of charge per mass, small fragments move through the gel faster than large ones.
• When a gel is stained with a DNA-binding dye, the DNA fragments can be seen as bands, each representing a group of same-sized DNA fragments.
• DNA sequencing is the process of determining the sequence of nucleotides (As, Ts, Cs, and Gs) in a piece of DNA.

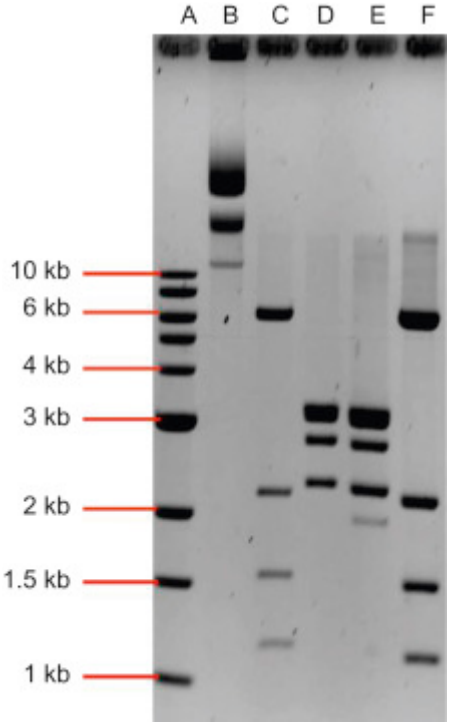
11. Give the summary of the text Gel electrophoresis.

COMPREHENSION TASK

12. Read the text and make up questions to it. Ask your partner. Make up a dialogue with a partner.

Gel electrophoresis is a method used to visualize and separate nucleic acids of different sizes. DNA separation is achieved by the application of an electric field. DNA, being negatively charged, will move from the cathode (−) to the anode (+) when voltage is applied. Separation occurs within different types of gels. These gels contain pores allowing DNA molecules to pass through depending on the size of the fragment. Larger fragments will encounter greater obstruction from the gel matrix and therefore tend to move

the least distance along the gel. Smaller fragments are able to maneuver through gel pores more easily and therefore tend to move the furthest. Once electrophoresis is complete, the gel is stained with an intercalating dye such as ethidium bromide. Ethidium bromide binds to the bases of DNA and fluorescence under UV light to allow for viewing (Fig.). The relative size of the fragments produced on the gel is determined by comparing their position to that of a molecular weight marker.



(Adopted from https://www.sciencedirect.com/topics/neuroscience/gel-electrophoresis)

13. Read and translate the text.

История открытия электрофореза

Электрофорез ведет свое начало от исследований профессора Московского университета Федора Федоровича Рейсса. В 1807 году он провел следующий опыт. В кусок влажной глины были помещены два отрезка стеклянной трубки, в которые насыпали хорошо промытый песок и затем налили в них до одинакового уровня воды. После того как в трубках с совершенно прозрачной над песком водой были опущены электроды от вольтова столба (источник электрической энергии, сконструированный Алессандро Вольта) и включен ток, Ф.Ф.

Рейсс наблюдал, что в трубке с положительно заряженным электродом вода стала мутнеть, сквозь слой песка начинали проникать частички глины, образуя суспензию в воде. Одновременно уровень в трубке с анодом понижался, а в трубке с катодом повышался. Происходило перемещение воды навстречу частицам глины. Этот опыт показал, что частицы глины в воде несут отрицательный заряд.

Движение заряженных дисперсных частиц в дисперсионной среде под действием внешнего электрического поля называется электрофорезом, а движение жидкости через пористое твердое тело – электроосмосом.

(Adopted from https://www.volgmed.ru/uploads/files/2019-7/115283-otchet_up_pupg_goremykina_kazmina.pdf)

SPEAKING

14. Find more information on the Internet and make the report about new Electrophoretic techniques.

UNIT 8

BREAKTHROUGH TECHNOLOGIES

PRE-READING

- ***What Breakthrough technologies are used in modern medical equipment?***

1. Practice reading the following words with the help of given transcriptions.

generate	[ˈdʒenəreɪt]	implant	[ɪmˈplɑːnt]
influence	[ˈɪnflʊəns]	process	[ˈprəʊsəs]
cell	[sel]	breakthrough	[ˈbreɪkθruː]
stimulator	[ˈstɪmjʊleɪtə]	diagnosis	[daɪəgˈnəʊsɪs]
battery	[ˈbætərɪ]	ultrasound	[ʌltrəˈsaʊnd]

2. ***Read the following words and try to remember them****.*

VOCABULARY

pacemaker	[ˈpeɪsmeɪkə]	электрокардиостимулятор
investigate	[ɪnˈvɛstɪgeɪ]	исследовать
feasibility	[fiːzɪˈbɪlɪti]	возможность
facility	[fəˈsɪlɪtɪ]	установка
specimen	[ˈspesɪmən]	образец
super-resolution	[ˈsjuːpə rezəˈluːʃn]	сверхразрешение
no-threshold	[nəʊ ˈθreʃhəʊld]	отсутствие порога
flawed	[flɔːd]	некорректный
trial	[ˈtraɪəl]	эксперимент
routinely	[ruːˈtiːnlɪ]	обычно
fetus	[ˈfiːtəs]	зародыш
rigorously	[ˈrɪgərəslɪ]	строго
utero	[ˈjuːtrə]	внутриутробный

READING

3. Read the text and answer the questions.

Breakthrough technologies

A. The notion of solar cells. Using the power cells under skin, can help people, that have pacemakers and deep brain stimulators. Swiss researchers found, that to provide devices during winter and summer they need 3.6 square sm solar cells. Most of electronic implants depend from large batteries and process of changing them is stressful and holds risk of medical complications. In our days more groups of researchers put forward their variants of solar cells. Various research groups have recently put forward prototypes of small electronic solar cells that can be carried under the skin and can be used to recharge medical devices. The solar cells convert the light from the sun that penetrates the skin surface into energy.

To investigate the facilities of this type of generators, Swiss researchers in the head Bereutor (the lead author Lukas Bereuter of Bern University Hospital and the University of Bern in Switzerland) generate special cells that can count output energy, and placed them under skin to 32 Swiss volunteers to one week on different season. The experiment showed that no matter what season tiny cells generate much more that necessary to work a typical cardiac pacemaker. Bereutor believes that technologies can be scaled up and applied in any other mobiles, solar powered application on humans. Aspects such as the catchment area of a solar cell, its efficiency and the thickness of a patient's skin must be considered.

B. Researchers at University of Nottingham have developed a breakthrough technology, that use sound rather than light with potential application in stem-cell transplants and cancer diagnosis. The new nanoscale ultrasound technique uses shorter-than-optical wavelengths of sound and could even rival the optical super-resolution techniques which won the 2014 Nobel Prize for Chemistry.

This new kind of sub-optical phonon (sound) imaging provides invaluable information about the structure, mechanical properties and behaviour of individual living cells at a scale not achieved before.

This kind of sub-optical phonon(sound) give invaluable information about structure, mechanical properties and etc. In optical microscopy, that use lights(photons), the smallest object is limited by wavelength. For biological specimens, the wavelength cannot be smaller than blue light, because the energy carried in ultraviolet can damage cells. Optical super-resolution imaging have limitations in biological studies. This is because fluorescent dyes are toxic and requires huge amounts of light and spend a lot of time to see imagination of damaged cells. Unlike the light sound have less problems. That enable to Nottingham researcher use smaller wavelength and see smaller things and get higher results.

C. In an article published in the January 2017 issue of "The Journal of Nuclear Medicine", said that small medical radiation does not increase risk of cancer. The long-held belief based on inaccurate, 70-years-old hypothesis. "We have shown that Hermann Muller`s theory is made during the 1946 Nobel Lecture that all radiation is harmful, regardless of how low is dose" - known as the linear no-threshold hypothesis (LNTH), states Jeffry A. Siegel, PhD, president and CEO of Nuclear Physics Enterprises, Marlton, New Jersey. Siegel says, that policies based on "no matter that kind and how small is dose of radiation, it is any way harm", and as known as ALARA (as low as reasonably achievable) just increase fear of radiation(radiophobia). Citing numerous studies, the authors assert that the LNTH and ALARA are fatally flawed, as they focus only on molecular damage while ignoring protective, biological responses. Low doses of radiation stimulate protective responses. There will now be further analysis of the trial`s results, including a health economics analysis, to confirm if the extra scan should be used routinely.

An additional MRI scan during pregnancy could help to more accurately detect fetal abnormalities and give more certainty for parents whose 20-week ultrasound scan showed a potential problem, according to new research by scientists at the University of Sheffield. Within the study, two fetuses (of 570, less than one per cent) were diagnosed correctly by the ultrasound and incorrectly by the MRI. Only cases identified by the

ultrasound scan were given the extra MRI, so any cases where an ultrasound did not identify an abnormality would not have been included in this study. This extra information helped doctors give a more accurate diagnosis and advice to parents.

Professor Rod Scott of the University of Vermont in the USA, commented on the importance of the research: "Accurate diagnosis of significant brain abnormalities has important therapeutic implications. Consequently, it is essential that tools used for prenatal diagnosis are rigorously evaluated. This trial strongly supports the view that in utero Magnetic Resonance (iuMR) imaging is an excellent technique, and it should be incorporated into clinical practice as soon as possible"

(Adopted from https://atomicinsights.com/journal-nuclear-medicine-article-fear-medical-radiation-based-bad-science/)

QUESTIONS:

1. What is the function of tiny solar cells that are carried under the skin of the people?
2. What did Bereutor's team of researchers create?
3. What is the sensitivity of a new nanoscale ultrasound technique?
3. What is the smallest size of biological specimens in optical microscopy?
4. Why are low dose of radiation not dangerous for patients?
5. How can an additional MRI scan help during pregnancy?

AFTER TEXT TASKS

4.Match the words to make the word combinations.

1. solar	a) energy
2. electronic	b) cells
3. battery	c) implants
4. MRI	d) power
5. brain	e) scan
6. high-	f) abnormality

5.Match the words opposite in meaning.

1. separate	a) back
2. light	b) unite

3. find c) dark
4. cut d) hide
5. forward e) paste

6. Translate the following word combinations into Russian.

1. The notion of using solar cells
2. To put forward prototypes
3. The results of this study can be scaled up
4. Must be properly re-educated
5. The MRI confirmed the ultrasound diagnosis

7. Find the English equivalents to the word combinations in the text.

1. Медицинские осложнения.
2. Для исследования возможности
3. Зона охвата солнечной батареи
4. Толщина кожи пациента
5. Оптические методы сверхвысокого разрешения
6. Бесценная информация
7. Давнее убеждение
8. Защитные реакции
9. Существенные отклонения в мозге
10. Терапевтические последствия

8.Match the following terms with definitions.

1.Solar cells	a) is a medical imaging technique used in radiology to form pictures of the anatomy and the physiological processes of the body in both health and disease
2.Nanoscale ultrasound technique	b) is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon

3.DNA	c) technique that uses shorter-than-optical wavelengths of sound and could even rival the optical super-resolution techniques.
4.X-ray	d) the genetic material of an organism
5.MRI - scan	e) a form of electromagnetic radiation

9. Insert the necessary word in the gap.

Words to insert*: medical, scans, increase, super-resolution, powered, volume.*

1.The notion of using solar cells placed under the skin to continuously recharge implanted electronic (1)... devices is a viable one.

2.Most electronic implants are currently battery (2)..., and their size is governed by the battery (3)... required for an extended lifespan.

3.Optical (4)... imaging also has distinct limitations in biological studies.

4.Evidence presented demonstrates a reduced, not (5)..., cancer risk at radiological imaging doses.

5.In the study, doctors analysing the MRI and ultrasound (6)… were asked to rate how confident they were of their diagnosis.

10 Mark the following sentences True or False.

1.Process of changing electronic implants is not stressful and risky.

2.The solar cells convert the light from the sun that penetrates the skin surface into energy.

3.No matter what season, the tiny cells were always found to generate much more of power that a typical cardiac pacemaker uses.

4. Sound have more problems than light.

5. Citing numerous studies, the authors assert that the LNTH and ALARA are correct.

11. Give the subtitles to each of the parts of the text Breakthrough technologies.

12. Give the summary of the text 'Breakthrough technologies'.

COMPREHENSION

13. Render the following text.

LINEAR NO-THRESHOLD

Linear no-threshold (LNT) is a hypothesized model of cancer induction in response to ionizing radiation. The model says that additional cancer risk is linear with respect to the absorbed dose, and becomes zero only at zero dose. This model is used as the basis of most nuclear-related legislation around the world, and in some chemical risk assessment.

LNT estimates that the risk of premature death from radiation-induced cancer is around 5 % per sievert or 0.5 % per 100 mSv of exposure. For reference, the average annual human dose from background radiation is about 3.1 mSv.

The effects of low dose radiation in humans are very difficult to establish, because the required sample sizes are very large and background cancer incidence is very high. However, the effect of high doses delivered in a short time is well known, mainly from the studies on Japanese atomic bomb survivors. The high dose data clearly indicates an increased risk of cancer for acute doses larger than 100 mSv, and is linear with respect to the dose. It was later augmented by data from studies of people occupationally exposed to radiation and from animal research.

The LNT model extrapolates the risk from high doses linearly to low doses, assuming that cancer risk is zero at zero dose. The justification for this is as follows:

- *In vivo*, there is a linear relationship between the radiation dose and double-strand breaks in the DNA, for doses from 1 mGy to 100 Gy.
- Each double-strand break is hypothesized to have the same probability of making the containing cell cancerous.
- Each cancerous cell is hypothesized to have the same probability of developing into a disease.

The main conclusion of this model is that no level of radiation is completely safe, and consequently radiation exposure must be reduced until it is as low as reasonably achievable (ALARA). A useful feature of the model is that the effect of radiation on a population can be estimated by summing together the individual doses into a collective dose. This leads to measuring total occupational exposure of a group of people to radiation in units such as man-sieverts. LNT states that a collective dose of 20 man-sieverts will cause one radiation-related cancer death, regardless of the size of the exposed group and the distribution of dose amongst its members. For example, it predicts that the 1×10^{11} bananas eaten each year, each of which gives a banana-equivalent dose of 1×10^{-7} Sv, must be causing about 500 cancer deaths annually.

Since the LNT hypothesis was formulated, lots of new research has been conducted that doesn't conform to LNT's postulated dose response. One example is a study of lung cancer mortality in the United States by Bernard Cohen, which demonstrates that the human response to low level radon exposure is definitely not linear. The recent research finding indicates that low level radiation damage is repaired more efficiently, which would reduce the effectiveness of low dose radiation relative to LNT. Some organizations, such as the Health Physics Society and the French Academy of Sciences reject using the linear no-threshold model to predict the health effects of low level radiation exposure. Health Physics Society rejects the LNT-based concept of collective dose and says that it is wrong to say "if 2000 people get a CT scan (10 mSv), then one of them will die from cancer", while the French Academy of Sciences endorses the existence of radiation hormesis.

(*Adopted from https://rationalwiki.org/wiki/Linear_no-threshold#)*

WRITING

15. Write an essay concerning the topic: **Application of radiation in medicine.** In your essay answer the question: ***Is it justified to use radiation in treating patients?***

UNIT 9

RAPID AND CHEAP ON-THE-SPOT DIAGNOSES

PRE-READING

- ***The first step in treating or curing any disease or infection is diagnosis. In recent years the biotechnology industry has been developing new diagnostic tools. What latest advances in diagnostics and the diagnostic applications of biotechnology do you know?***

1. Practice reading the following words with the help of given transcriptions.

microscopic	[maɪkrəsˈkɒpɪk]
diagnostic	[daɪəgˈnɒstɪk]
microfluidic	[maɪkrəʊfluːˈɪdɪk]
tuberculosis	[tjuːbɜːkjʊˈləʊsɪs]
analyse	[ˈænəlaɪz]
software	[ˈsɒftweər]
blood	[blʌd]
integration	[ɪntɪˈgreɪʃn]
microlitre	[maɪkrəˈliːtə]
reliable	[rɪˈlaɪəbl]

2. Read the following words and try to remember them.

VOCABULARY

valve	[vælv]	клапан
chamber	[ˈʧeɪmbə]	камера
constraint	[kənˈstreɪnt]	ограничение
swapping	[ˈswɒpɪŋ]	обмен

complexity	[kəmˈpleksɪtɪ]	сложность
susceptible	[səˈseptəbl]	восприимчивый
fit	[ˈfɪt]	установливать
race	[reɪs]	гонка
consistent	[kənˈsɪstənt]	последовательный
boost	[buːst]	повышать
yield	[jiːld]	продуктивность
adhesive	[ədˈhiːsɪv]	клеящий материал

READING

3. Read the text and answer the questions.

Rapid and cheap on-the-spot diagnoses

Rapid and cheap on-the-spot diagnoses for diseases such as tuberculosis and cancer are a step closer thanks to a new modular valve for microfluidic chips.

Swapping delicate microscopic flow valves for a universal modular valve system has enabled Singapore's Agency for Science, Technology and Research (A*STAR) researchers to dramatically decrease the cost and complexity of microfluidic diagnostic chips - business card-sized devices that can analyse blood on the spot for a range of disease biomarkers.

"Microfluidic chips are advancing point-of-care diagnosis for many diseases," says Alicia Toh from A*STAR's Singapore Institute of Manufacturing Technology (SIMTech). "Inside these chips, tiny microvalves precisely direct microlitres of fluid through a series of microchannels for automated analysis. However, integrating microvalves into the microchannels is complex and highly susceptible to fabrication defects, which translates into a higher cost per device. In the medical diagnostic sector the race is on to lower the cost per diagnosis by producing cheaper microfluidic diagnostic chips."

Toh and her colleagues Zhiping Wang and Zhenfeng Wang addressed the problem by moving the microvalves off the main microfluidic chip, and created a modular valve that is fitted to the surface of the chip after fabrication. The valves consist of a microfluidic channel that connects to surface ports on the chip, and an air chamber that allows the channel to be pinched by increasing the air pressure. The team demonstrated that their modular valves could precisely manipulate chemical concentrations through fluidic routing, which is critical in many advance diagnostic applications.

By mass producing these microvalve modules separate from the microfluidic chip and testing valve function prior to chip integration, we can achieve much lower defect rates, which boosts yields and results in a much lower cost per device. This technology will reduce waste and help contribute to sustainable manufacturing practices for microfluidic chips.

Getting the valve design right, however, was complicated. The team used state-of-the-art software to predict the microscopic interactions between the flexible elastomeric silicone membrane and the fluid in the microchannel. Using materials that are compatible with the latest microfluidics technologies was also a big constraint.

"The industry is rapidly moving toward more costeffective thermoplastic materials," says Toh. "By using compatible materials, we can achieve reliable integration without additional surface modification or adhesives." Greater adoption of microfluidic technology will mean that we could see our modular microvalves being used in a wide spectrum of applications.

Toh and her team are exploring the production of microvalve modules using a variety of novel materials. "Greater adoption of microfluidic technology will mean that we could see our modular microvalves being used in a wide spectrum of applications," she says.

(Adopted from https://www.sciencedaily.com/releases/2017/01/170120193755.htm)

QUESTIONS:

1. How quickly is it possible to determine the diagnosis on the spot?
2. What does the abbreviation of A*STAR mean?
3. How do microfluidic microcircuits work?
4. How did Alicia Toh and her team manage to lower the cost of diagnostic devices?
5. What software did the team use?
6. What was the requirement for the materials the scientists used?

AFTER TEXT TASKS

4. Match the words similar in meaning.

1)	rapid	a) shipment
2)	range	b) methodology
3)	fluid	c) nucleus
4)	valve	d) dice
5)	effective	e) budget
6)	cheap	f) good
7)	bone	g) gate
8)	cell	h) fluent
9)	technique	i) distance
10)	delivery	j) quick

5. Match the words opposite in meaning.

1)	inside	a) secondary
2)	disease	b) outside
3)	advance	c) health
4)	implants	d) retreat
5)	leading	e) natural part of the body

6. Translate the following word combinations into Russian.

1) Point-of- care
2) State-of- the-art
3) Dramatically decrease
4) Fabrication defects

5) Increasing the air pressure
6) Sustainable manufacturing practices
7) Advance diagnostic applications

7. Find the English equivalents to the word combinations in the text.

1) Диагностические чипы
2) Модульный клапан
3) Стоимость и сложность
4) Устройства размером с визитную карточку
5) Высокая восприимчивость
6) Решить проблему
7) Широкий спектр применения

8. Complete the sentences using the text.

1) Inside these ….., tiny microvalves precisely direct microlitres of ….. through a series of microchannels for automated analysis.

2) In the ……. diagnostic …… the race is on to lower the cost per diagnosis by producing cheaper microfluidic diagnostic chips.

3) The …… consist of a microfluidic channel that connects to surface ports on the …. , and an air chamber that allows the channel to be pinched by increasing the air ……

4) The team demonstrated that their …. could precisely manipulate chemical concentrations through …, which is critical in many advance diagnostic applications.

5) This technology will reduce … and help contribute to sustainable … practices for microfluidic chips.

9. Match the following terms with definitions.

1) Chamber	a) a health condition that has a specific set of symptoms and traits
2) Disease	b) the use of science in industry, engineering, etc.

3) Technology	c) a natural or artificial enclosed space
4) Cost effective	d)an electronic circuit on one plate of semiconductor material
5) Chip	e) providing good value for the money spent

10. Find out the key words to make up the outline of the text Rapid and cheap on-the-spot diagnoses.

11. Give the summary of the text Rapid and cheap on-the-spot diagnoses.

COMPREHENSION

12. Read and translate the abstract.

Potential applications of engineered nanoparticles in medicine and biology: an update

Nanotechnology advancements have led to the development of its allied fields, such as nanoparticle synthesis and their applications in the field of biomedicine. Nanotechnology driven innovations have given a hope to the patients as well as physicians in solving the complex medical problems. Nanoparticles with a size ranging from 0.2 to 100 nm are associated with an increased surface to volume ratio. Moreover, the physico-chemical and biological properties of nanoparticles can be modified depending on the applications. Different nanoparticles have been documented with a wide range of applications in various fields of medicine and biology including cancer therapy, drug delivery, tissue engineering, regenerative medicine, biomolecules detection, and also as antimicrobial agents. However, the development of stable and effective nanoparticles requires a profound knowledge on both physico-chemical features of nanomaterials and their intended applications. Further, the health risks associated with the use of engineered nanoparticles needs a serious attention.

(Adopted from https://pubmed.ncbi.nlm.nih.gov/30097748/)

13. Read the text and write down the main advances in biotechnology-based diagnostics.

Diagnostic Applications of biotechnology

Advances in biotechnology-based diagnostics will afford improved and earlier detection of infectious and genetic diseases. Currently, some diseases are extraordinarily difficult to diagnose properly. What will these new advances mean for the patient? Early diagnosis of diseases can have a significant impact in three areas:

HIGHER SURVIVAL RATE. The theory is the same for biotechnology-based diagnostics. In fact, some of these diagnostics will be able to identify illnesses (cancer, alcoholism and others) before the appearance of any symptoms. Although early detection is not a guarantee of survival against all diseases, many patients will live longer if appropriate therapy begins as soon as possible.

IMPROVED QUALITY OF LIFE FOR THE PATIENT. By identifying a disease at its earliest stages, doctors can often prescribe treatments with the fewest side effects. For heart disease, it may mean a change in diet and increased exercise instead of surgery. For cancer, early diagnosis may mean surgical alternatives to chemotherapy are more feasible.

REDUCED HEALTH CARE COSTS. Again, by diagnosing a disease at its earliest stages, patients can often avoid surgery and hospitalization by undergoing less expensive treatments. Not only does this benefit the patient afflicted with the disease, but it can have an impact on health care and insurance costs throughout society.

(Adopted from https://www.unexplainable.net/meditation/diagnostic-applications-of-biotechnology.php)

SPEAKING

14. Find more information about new diagnostic methods in biotechnology. Choose one of them an make the presentation.

UNIT 10
CONFOCAL LASER SCANNING MICROSCOPY

PRE-READING

1. Practice reading the following words with the help of given transcriptions.

microscopy	[maɪˈkrɒskəpi]
diagnosing	[ˈdaɪəgnəʊzɪŋ]
spectrograph	[ˈspɛktrəˌgræf]
pattern	[ˈpætən]
resolution	[rɛzəˈluːʃən]
infrared	[ˈɪnfrəˈrɛd]
substance	[ˈsʌbstəns]
laser	[ˈleɪzə]

2. Read the following words and try to remember them.

VOCABULARY

blur-free	[ˈblɜːfriː]	неразмытый
diagnosing	[ˈdaɪəgnəʊzɪŋ]	диагностирование
visualizing	[ˈvɪʒwəˌlaɪzɪŋ]	визуальное
eyepiece	[ˈaɪpiːs]	окуляр
wavelength	[ˈweɪvlɛŋθ]	длина волны
pattern	[ˈpætən]	шаблон
fingerprint	[ˈfɪŋgəprɪnt]	отпечаток пальца
snapshot	[ˈsnæpʃɒt]	снимок
sample	[ˈsɑːmpl]	образец
illuminate	[ɪˈljuːmɪneɪt]	освещать
subtle	[sʌtl]	тонкий
spike	[spaɪk]	всплеск
resolution	[rɛzəˈluːʃən]	разрешение

READING

3.Read the text and answer the questions.

Confocal laser scanning microscopy

Confocal laser scanning microscopy (CLSM or LSCM) is a valuable tool for obtaining high resolution images and 3-D reconstructions. The key feature of confocal microscopy is its ability to produce blur-free images of thick specimens at various depths. Images are taken point-by-point and reconstructed with a computer, rather than projected through an eyepiece.

The principle for this special kind of microscopy was developed by Marvin Minsky in 1953. A new type of laser scanning confocal microscope (LSCM) holds the promise of diagnosing skin cancer in a single snapshot.

Typical LSCMs take 3-D images of thick tissue samples by visualizing thin slices within that tissue one layer at a time. Sometimes scientists supplement these microscopes with spectrographs, which are devices that measure the pattern of wavelengths, or "colors," in the light reflected off of a piece of tissue. This pattern of wavelengths acts like a fingerprint, which scientists can use to identify a particular substance within the sample. But the range of wavelengths used so far with these devices has been narrow, limiting their uses.

Not so with the new microscope developed by physicists from the Consiglio Nazionale delle Ricerche (CNR) in Rome. Unlike other combination "confocal microscope plus spectrograph" devices, the new machine is able to gather the spectrographic information from every point in a sample, at a wide range of wavelengths, and in a single scan.

To achieve this, the authors illuminate the sample with multiple colors of laser light at once – a sort of "laser rainbow" – that includes visible light as well as infrared. This allows scientists to gather a full range of information about the wavelengths of light reflected off of every point within the sample. Using this method, the researchers took high-resolution pictures of the edge of a silicon wafer and of metallic letters painted onto a piece of silicon less than half a millimeter wide.

They also demonstrated that it is possible to apply this technique to a tissue sample (in this case, chicken skin) without destroying it. With further testing, the researchers say the microscope could be used to detect early signs of melanoma; until then, it may be useful for non-medical applications, such as inspecting the surface of semiconductors.

A new form of scanning microscopy that simultaneously reveals physical and electronic profiles of metal nanostructures has been demonstrated at JILA, a joint institute of the National Institute of Standards and Technology (NIST) and University of Colorado at Boulder. The new instrument is expected to be particularly useful for analyzing the make-up and properties of nanoscale electronics and nanoparticles.

Scanning photoionization microscopy (SPIM), described in a new paper, combines the high spatial resolution of optical microscopy with the high sensitivity to subtle electrical activity made possible by detecting the low-energy electrons emitted by a material as it is illuminated with laser pulses. The technique potentially could be used to make pictures of both electronic and physical patterns in devices such as nanostructured transistors or electrode sensors, or to identify chemicals or even elements in such structures. The JILA-built apparatus includes a moving optical microscopy stage in a vacuum, an ultrafast near-ultraviolet laser beam that provides 7 to inject two photons (particles of light) into a metal at virtually the same time, and equipment for measuring the numbers and energy of electrons ejected from the material. By comparing SPIM images of nanostructured gold films to scans using atomic force microscopy, which profiles surface topology, the researchers confirmed the correlations and physical mapping accuracy of the new technique. They also determined that lines in SPIM images correspond to spikes in electron energy, or current, and that contrast depends on the depth of electrons escaping from the metal as well as variations in material thickness. Work is continuing to further develop the method, which may be able to make chemically specific images, for example, if the lasers are tuned to different colors to affect only one type of molecule at a time.

(Adopted from https://microbenotes.com/confocal-microscope/)

QUESTIONS:

1) What is a confocal laser scanning microscopy?
2) Who developed special kind of microscopy?
3) What is the main idea of the microscopy?
4) What allow scientists to gather a full range of information about the wavelengths of light?
5) What are the main applications of CLSM?
6) What are the main advantages of scanning photoionization microscopy?

AFTER TEXT TASKS

4.Translate the following word combinations into Russian.

1. High resolution images
2. Laser scanning
3. Wavelength
4. A wide range of wavelengths
5. Piece of tissue
6. Multiple colors of laser light
7. High sensitivity
8. Mapping accuracy
9. Scanning photoionization microscopy

5. Find the English equivalents to the word combinations in the text

1. Рак кожи
2. Образец ткани
3. Спектрографическая информация
4. Лазерная радуга
5. Инфракрасный свет
6. Высокое пространственное разрешение
7. Достаточная пиковая мощность
8. Всплески энергии электронов

6. Insert the necessary word in the gap.

1. The key feature of confocal microscopy is its ability to produce blur-free _____ of thick specimens at various depths.
2. The principle for this special kind of microscopy was developed by _____in 1953.
3. His pattern of wavelengths acts like a ____, which scientists can use to identify a particular substance within the sample.
4. With further testing, the researchers say the microscope could be used to detect early signs of _____.
5. A new form of scanning microscopy that _____ reveals physical and electronic profiles of metal nanostructures has been demonstrated at JILA, a joint institute of the National Institute of Standards and Technology (NIST) and University of Colorado at Boulder.

7. Mark the following sentences True or False.

1. Confocal Laser Scanning Microscopy (CLSM or LSCM) is a valuable tool for obtaining low resolution images and 3D reconstructions.
2. The key feature of confocal microscopy is its ability to produce blur-free images of thick specimens at various depths.
3. Images are received point-to-point and are projected through the eyepiece, rather than reconstructed using a computer.
4. The principle for this special kind of microscopy was developed by Marvin Minsky in 1963.
5. A new type of laser scanning confocal microscope (LSCM) holds the promise of diagnosing skin cancer in a single snapshot.

8. Find the full name of these abbreviations in the text.

1. CLSM –
2. NIST –
3. SPIM –
4. CNR –

9. Find out the key words to make up the outline of the text.

10. Give the summary of the text 'Confocal laser scanning microscopy'.

COMPREHENSION

11. Read the text and write down the advantages and disadvantages of confocal microscopy.

When deciding which type of microscopy to use, one may ask, "Why confocal microscopy?" Transmission electron microscopy offers superb resolution; however, it is damaging to living specimens and suffers from fixation and sectioning artifacts. Conventional light microscopy allows examination of living and fixed cells with a variety of imaging modes including fluorescence. However, ultrastructural details cannot be obtained because of the relatively low resolution of the light microscope (0.2μm). Another difficulty with conventional light microscopy is that it suffers from out-of-focus information which often blurs the image.

Confocal microscopy offers several advantages over conventional light and electron microscopy. First, the confocal microscope optically sections the specimen. This eliminates any physical sectioning artifacts observed with conventional light and electron microscopic techniques. Since optical sectioning is relatively noninvasive, living as well as fixed samples can be observed with greater clarity. Another advantage of confocal microscopy is that optical sections can be taken in different planes. Another advantage of confocal microscopy is that the optical sections are obtained in a digital format. This greatly facilitates image processing and makes it very easy for the user to obtain a digital print of the image, eliminating the need for darkroom chemicals and lengthy waiting periods to obtain photographs. An additional advantage of using the confocal microscope is that all the fluorochromes of multiple-labeled specimens are in register, unlike in conventional fluorescence microscopy.

Although confocal microscopes have many advantages, they do have some disadvantages. Confocal laser scanning microscopes (CLSMs) are limited by the available wavelengths of light produced by lasers (*laser lines*). This is unlike the conventional fluorescence light microscope which uses a mercury or xenon arc lamp as the illumination source and therefore offers a full range of excitation wavelengths including UV. The intensity of the laser beam can be harmful to living cells, if the laser light has not been

suitably attenuated. However, the new multiphoton microscope systems have effectively solved this problem. An unfortunate disadvantage of confocal microscopes is their price. Depending on the setup, a confocal microscope can be over 10 times the price of a typical conventional fluorescence light microscope. The cost of owning and operating a confocal microscope can be minimized if several researchers share the microscope in a centralized "core" facility. Another disadvantage of some confocal microscope systems is that they often take up more space than a conventional fluorescence light microscope since they also require space for a laser, scan head, and computer hardware. Recent confocal microscope systems are more compact than earlier versions. Although most confocal systems come with easy-to-use software, users require training and an understanding of the confocal principle to obtain the best confocal images. Personal confocal systems are usually easier to use than the more sophisticated multiuser confocal systems because fewer features are available on the personal systems.

(Adopted from https://www.sciencedirect.com/science/article/abs/pii/S0091679X02700022)

12. Read and translate the text.

Лазерный сканирующий конфокальный биологический микроскоп

Лазерный сканирующий конфокальный биологический микроскоп предназначен для получения максимально возможного, для световых микроскопов, разрешения благодаря применению лазера в качестве источника освещения и способу получения изображения. Своё название этот класс оборудования получил из-за особенности формирования изображения в фокальной плоскости. Кратко, механизм получения изображения описывается, как послойное формирование изображения образца на одном уровне глубины резкости, за счёт ограничения глубины фокуса и использования точечных когерентных источников света. Последняя особенность позволяет называть эти

приборы «лазерный сканирующий микроскоп с точечной диафрагмой».

Конфокальная микроскопия предлагает несколько преимуществ по сравнению с обычной широкопольной оптической микроскопией, включая возможность контроля глубины резкости, устранения или уменьшения фоновой информации за пределами фокальной плоскости (фон приводит к ухудшению качества изображения), а также возможность сбора последовательных оптических срезов из толстых образцов. Основным ключом к конфокальному подходу является использование методов пространственной фильтрации для устранения расфокусированного света или бликов в образцах, толщина которых превышает непосредственную плоскость фокусировки. В последние годы возросла популярность конфокальной микроскопии, отчасти из-за относительной легкости получения чрезвычайно высококачественных изображений из образцов, подготовленных для обычной флуоресцентной микроскопии, и растущего числа применений в клеточной биологии. Это применимо для визуализации как фиксированных, так и живых клеток, тканей. Фактически, конфокальная технология оказывается одним из самых важных достижений, когда-либо достигнутых в оптической микроскопии.

(Adopted from https://www.microsystemy.ru/info/articles/lazernyy-skaniruyushchiy-konfokalnyy-biologicheskiy-mikroskop/?ysclid=m6e2osrjvr945502025)

SPEAKING

13. Nowadays confocal microscopy is used in different devices which are applied in manufacture, biology and medicine. Choose one of them and make the presentation about its characteristics and the field of application.

UNIT 11
POSITRON EMISSION TOMOGRAPHY

PRE-READING

- What does the abbreviation CT stand for?
- What other medical imaging technologies do you know?

1. Practice reading the following words with the help of given transcriptions.

tomography	[təˈmɒgrəfɪ]	chemically	[ˈkemɪklɪ]
roentgenography	[rɒntəˈnɒgrəfɪ]	isotope	[ˈaɪsəʊtəʊp]
electroencephalography	ɪlektrɒnkefəˈlɒgrəfɪ	metabolically	[metəˈbɒlɪklɪ]
oncology	[ɔnˈkɔlədʒɪ]	phantom	[ˈfæntəm]
neuropsychology	njʊəˈrəʊsaɪkɒlədʒɪ	axial	[ˈæksɪəl]

2. Read the following words and try to remember them.

VOCABULARY

three-dimensional	[θriː- dɪˈmenʃənl]	трехмерная
rotation	[rəʊˈteɪʃn]	вращения
decay	[dɪˈkeɪ]	распад
mental	[mentl]	психическое
cognitive	[ˈkɔgnɪtɪv]	познавательные
irregularity	[ɪregjʊˈlærɪtɪ]	неровность
geting	[ˈgeɪtɪŋ]	стробирование, пропускание
unevenly	[ʌnˈiːvnlɪ]	неравномерно
tumour	[ˈtjuːmə]	опухоль
human brain	[ˈhjuːmən breɪn]	человеческий мозг
respiratory	[rɪsˈpaɪərətərɪ]	дыхательный
blurring	[blɜːɪnŋ]	размытие

READING

3. Read the text and answer the questions.

Positron emission tomography

CAT scan

Computed tomography (CT), originally known as computed axial tomography (CAT) and body section roentgenography, is a medical imaging method employing tomography where digital geometry processing is used to generate a three-dimensional image of the internals of an object from a large series of two-dimensional X-ray images taken around a single axis of rotation.

Positron emission tomography

Positron emission tomography (PET) is a nuclear medicine medical imaging technique which produces a three-dimensional image or map of functional processes in the body. It is used heavily in clinical oncology (medical imaging of tumors and the search for metastases), for clinical diagnosis of brain diseases such as dementias. PET is also an important research tool to map human brain and heart function.

To conduct the scan, a short-lived radioactive tracer isotope which decays by emitting a positron, and which has been chemically incorporated into a metabolically active molecule, is injected into the living subject (usually into blood circulation). Then the research subject or patient is placed in the imaging scanner.

Functional neuroimaging is the use of neuroimaging technology to measure an aspect of brain function, often with a view to understanding the relationship between activity in certain brain areas and specific mental functions. It is primarily used as a research tool in cognitive neuroscience and neuropsychology.

Common methods include positron emission tomography (PET), functional magnetic resonance imaging (fMRI), multichannel electroencephalography (EEG) or magnetoencephalography (MEG), and near infrared spectroscopic imaging (NIRSI).

A study presented at SNM's 58th Annual Meeting focuses on the effect that breathing irregularities have on the accuracy of 4D positron emission tomography (PET) scans and outlines a PET imaging method that reduces "motion artifacts" or image blurring arising from respiratory motion.

Respiratory gating technologies have dramatically improved the diagnostic quality of PET imaging, which provides functional images of physiological processes occurring in the body. The problem is that patients with respiratory disease, heart conditions or other serious disease are likely to be breathing unevenly. Respiratory gating systems are designed to work with normal breathing patterns, but not with irregular respiratory cycles.

Researchers conducted phantom studies to compare respiratory-gated PET imaging with non-gated PET imaging. Phantom studies were performed with inanimate objects and specialized motion devices that move in a controlled manner in order to simulate tumors in respiratory motion. The 4D PET and CT studies were conducted in succession with a hybrid PET/CT system.

Results of the study show that non-gated PET with 4D CT imaging can be an alternative to respiratory-gated PET imaging for determining tumor activity in patients with highly irregular breathing.

NIRSIT, a functional near-infrared spectroscopy neuroimaging device, is set to change the landscape of neuroscience research and the medical sector by offering high spatial resolution as well as high temporal resolution in a portable and wireless manner. NIRSIT is a device based on the near-infrared spectroscopy principle, which:
a) utilizes light to detect hemodynamic changes in the cerebral blood flow;
b) visualizes brain activation regions in the prefrontal area of the brain in real time. Furthermore, NIRSIT is probably the one and only portable and wireless NIRS device designed to be used for brain research and clinical research purposes.

One of the promising areas of NIRSIT application is cognitive research. NIRSIT allows the researchers to monitor the subject's brain activation changes and analyze the results in an intuitive way, using both the

3D brain mapping images as well as the oxy-deoxy graphs covering the prefrontal area of the brain.

Following the introduction of fMRI in humans, the review identifies a range of key breakthroughs in functional brain imaging that have been critical in enhancing our understanding of the brain, including the development of statistical and computational modelling that are helping to revolutionize our understanding of brain function.

The review identified a number of current challenges and opportunities for the functional brain imaging research community. These include:

- the need to identify a number of specific goals and targets for human functional brain imaging research
- a continued need for support for multidisciplinary and multi-sector research hubs
- a requirement to increase sample sizes in functional brain imaging studies to enhance our understanding of the normal brain and the prevalence of specific conditions
- the importance of encouraging and facilitating the involvement of clinicians in the development of clinical applications -- to help bring functional brain imaging to the clinic
- the potential for greater working with industry to bring about developments in molecular imaging and to drive innovation in drug development
- a need to continue to develop human functional brain imaging techniques and do basic, exploratory research
- the importance of ensuring we understand the social and ethical implications of brain-imaging research.

(Adopted from https://medicalxpress.com/news/2011-06-irregular-affect-accuracy-d-petct.html)

QUESTIONS:

1. How was the computer tomography originally known?
2. What is a computed tomography?

3. What is a Positron emission tomography?
4. What is a Functional neuroimaging?
5. What are the common methods of medical imaging?
6. What are the results of phantom research?
7. What is a NIRSIT? What are the principles of its work?

AFTER TEXT TASKS

4. Translate the following word combinations into Russian.

1. Positron emission tomography
2. Computed axial tomography
3. Body section roentgenography
4. Nuclear medicine medical imaging
5. Tool to map human brain
6 A short-lived radioactive tracer isotope
7. Functional neuroimaging
8. High spatial resolution
9. Clinical research purposes
10. 3D brain mapping images

5. Find the English equivalents to the word combinations in the text.

1. Трехмерное изображение
2. Ось вращения
3. Кровообращение
4. Нарушения дыхания
5. Размытие изображения
6. Технологии респираторного стробирования
7. Респираторно-защищенный
8. Неодушевленные предметы
9. Высокое временное разрешение
10. Беспроводной способ

6. Insert the necessary word in the gap.

1. …(1) tomography (CT), originally known as computed axial tomography (CAT) and body section roentgenography, is a medical imaging method

employing tomography where digital geometry processing is used to generate a …(2) image of the internals of an object from a large series of two-dimensional X-ray images taken around a single axis of rotation.
2. Respiratory gating technologies have dramatically improved the diagnostic quality of PET imaging, which provides …(3) images of physiological processes occurring in the body.
3, Respiratory gating systems are designed to work with normal breathing patterns, but not with…(4) respiratory cycles.
4. …(5) is a device based on the near-infrared spectroscopy principle.
5. NIRSIT is probably the one and only portable and wireless NIRS device designed to be used for brain research and …(6) research purposes.

7. What do the abbreviations stand for? Write the full name.

1. PET –
2. CT –
3. CAT –
4. fMRI –
5. MEG –
6. NIRSI –

8. Complete the sentences using the text.

1. The Nanoscale Advanced Integrated Systems (NAIS) Lab Team at Korea Advanced Institute of Science and Technology (KAIST)…
2. The 4D PET and CT studies were conducted in succession with…
3. The problem is that patients with respiratory disease,…
4. Functional neuroimaging is the use of neuroimaging technology to measure an aspect of brain function,…
5. It is primarily used as a research tool in…

9. Mark the following sentences True or False.

1. Positron emission tomography (PET) used heavily in clinical oncology (medical imaging of tumors and the search for metastases), for clinical diagnosis of brain diseases such as dementias.

2. PET is also an important research tool to map human liver and heart function.
3. Functional neuroimaging is the use of neuroimaging technology to measure an aspect of heart function.
4. Respiratory gating technologies have greatly improved the diagnostic quality of PET imaging.
5. One of the promising areas of NIRSIT application is cognitive research.

10. ***Reorder the words to make a sentence.***

1. spectroscopy, NIRSIT, is, device, the, a, near-infrared, on, principle, based.
2. imaging, conducted, studies, researchers, phantom, respiratory-gated, imaging, with, compare, non-gated, PET, PET, to.
3. technology, of, neuroimaging, an, function, the, neuroimaging, to, measure, aspect, use, of, brain, functional, is.
4. clinical, is, heavily, in, it, oncology, used.
5. designed, gating, normal, are, to, respiratory, work, systems, with, breathing, to, patterns.

11. Insert prepositions and translate the sentences.

1. Positron emission tomography (PET) is a nuclear medicine medical imaging technique which produces a three dimensional image or map __ functional processes __ the body.
2. PET is also an important research tool … map human brain and heart function.
3. Then the research subject or patient is placed __ the imaging scanner
4. Researchers conducted phantom studies __ compare respiratory-gated PET imaging __ non-gated PET imaging.
5. A single scan could diagnose the cause __ foot pain better and __ less radiation exposure to the patient than other methods.

12.Complete the sentence translating the words in brackets

1.Medical imaging technique which produces a three dimensional image or (карту) of functional (процессов) in the body.
2. To conduct the (сканирования), a short-lived radioactive tracer isotope which decays by emitting a positron, and which has been (химически) incorporated into a metabolically active molecule, is injected into the living subject.
3. It is primarily used as a research tool in cognitive (нейронауке) and neuropsychology.
4. A single scan could diagnose the cause of foot pain better and with less radiation exposure to the patient than other (методы).
5. They need to identify a number of (конкретные) goals and targets for human (функциональных) brain imaging research.

13. Find out the key words to make up the outline of the text.

14. Give the summary of the text Positron emission tomography.

COMPREHENSION

15. Read and translate the text.

Появление компьютерных томографов

Первые математические алгоритмы для КТ были разработаны в 1917 году австрийским математиком И. Радоном. Физической основой метода является экспоненциальный закон ослабления излучения, который справедлив для чисто поглощающих сред. В рентгеновском диапазоне излучения экспоненциальный закон выполняется с высокой степенью точности, поэтому разработанные математические алгоритмы были впервые применены именно для рентгеновской компьютерной томографии.

В 1963 году американский физик А. Кормак повторно (но отличным от Радона способом) решил задачу томографического

восстановления, а в 1969 году английский инженер-физик Г. Хаунсфилд из фирмы EMI сконструировал «ЭМИ-сканер» – первый компьютерный рентгеновский томограф, клинические испытания которого прошли в 1971 году, – разработанный только для сканирования головы. Средства на разработку КТ были выделены фирмой EMI, в частности, благодаря высоким доходам, полученным от контракта с группой The Beatles.

В 1979 году «за разработку компьютерной томографии» Кормак и Хаунсфилд были удостоены Нобелевской премии по физиологии или медицине.

(Adopted from https://ru.wikipedia.org)

16. Read the text and make up questions to it. Make up a dialogue asking questions to your partner.

Magnetic Resonance Imaging (MRI) is a noninvasive medical imaging technique that uses the body's natural magnetic properties to produce detailed images. It is an essential tool for diagnosing various medical conditions and guiding treatment decisions.

MRI works by utilizing the hydrogen protons found abundantly in water and fat within the body. When a patient is placed in a strong magnetic field, these protons align, creating a magnetic vector. By introducing radio waves, the magnetic vector is deflected and emits a signal, which is used to create the MRI images. Multiple pulse sequences are employed to emphasize different tissues or abnormalities, allowing for a comprehensive analysis of the body.

One of the significant advantages of MRI is its ability to detect diseases and abnormalities without the use of radiation, making it a safe procedure for patients.

Key Takeaways:

- MRI uses the body's natural magnetic properties to produce detailed images.
- Hydrogen protons in water and fat are used for the imaging process.

- Multiple pulse sequences are employed to emphasize different tissues or abnormalities.
- MRI can detect diseases and abnormalities by analyzing the different relaxation times of protons in various tissues.
- MRI is a safe procedure that does not use radiation.

The Technology Behind MRI Scanning

MRI scanning is made possible by advanced technology that utilizes strong magnetic fields, radio waves, and gradient electric coils. These components work together to create detailed images of the body's internal structures. The MRI machine functions by generating a magnetic field that aligns the hydrogen protons in the body. This alignment creates a magnetic vector that emits a signal when deflected by radio waves.

The gradient electric coils are essential in producing different resonance frequencies, allowing the machine to capture images of specific slices of the body. These coils alter the magnetic field in a controlled manner, enabling the creation of detailed cross-sectional images. Receiver

coils act as antennae, receiving and enhancing the weak signals emitted by the hydrogen protons. This improves the quality of the images produced.

"MRI machines use strong magnetic fields, usually between 0.5 and 1.5 tesla, to align the hydrogen protons in the body."

Multiple pulse sequences are employed during an MRI scan to emphasize different tissues or abnormalities. This is achieved by taking advantage of the different relaxation times of protons in various tissues. By analyzing these relaxation times, radiologists can identify and differentiate between different types of tissues and any potential abnormalities present.

The technology behind MRI scanning continues to advance, resulting in clearer and more detailed images that aid medical professionals in accurate diagnosis and treatment planning.

(Adopted from https://tagvault.org/blog/how-does-a-mri-work-medical-imaging/)

SPEAKING

17. ***Find some more information about different* medical imaging technologies and tomography. Work in groups. Prepare a presentation about one of the technologies***.

UNIT 12

BETTER MATERIAL FOR BONE TISSUE REGENERATION

PRE-READING

- What do you know about bone tissue regeneration?
- Have you ever heard about biodegradable implants?

1. Practice reading the following words with the help of given transcriptions.

tissue	[ˈtɪʃuː]	crystallize	[ˈkrɪstəlaɪz]
furthermore	[ˈfɜːðəˈmɔː]	calcite	[ˈkælsæɪt]
vaterite	[ˈvætəraɪt]	snails	[sneɪlz]
process	[ˈprəʊsəs]	colleagues	[ˈkɒliːgz]
nanofiber	[ˈnænəˈfaɪbər]	submicron	[sʌbˈmaɪkrɒn]

2. Read the following words and try to remember them.

VOCABULARY

bone tissue	[ˈbəʊn ˈtɪʃuː]	костная ткань
biodegradable	[ˌbaɪədɪˈgreɪdəbl]	биоразлагаемый
vaterite-based	[ˈvætəraɪt ˈbeɪst]	на основе ватерита
scaffold	[ˈskæfəld]	каркас
porous	[ˈpɔːrəs]	пористый
electrospun fiber	[ɪˈlektrəˈspʌn faɪbər]	электропряденые волокна
cytocompatibility	[ˈsaɪtəkəmˌpætɪˈbɪlɪtɪ]	цитосовместимость
non-woven fabric	[ˈnɔb ˈwəʊvn]	нетканое полотно
electrospinning	[ɪˈlektrəʊˈspɪnɪŋ]	электропрядение
tissue engineering	[ˈtɪʃuː endʒɪˈnɪərɪŋ]	тканевая инженерия
polycaprolactone	[ˈpɒlɪˈkæprələktəʊn]	поликапролактон
furthermore	[fɜːðəˈmɔː]	кроме того, более того
promising	[ˈprɒmɪsɪŋ]	перспективный

aragonite	[aˈrəg(ə)naɪt]	арагонит
counterpart	[ˈkaʊntəpɑːt]	двойник, копия
gastropods	[ˈgæstrəpɒdz]	брюхоногие моллюски
permeability	[pɜːmɪəˈbɪlɪtɪ]	проницаемость
substitute	[ˈsʌbstɪtjuːt]	замещать, заменять
to arrange randomly	[əˈreɪndʒ ˈrændəmlɪ]	расположить хаотично
in vivo	[ɪn ˈvɪvəʊ]	в естественных условиях
regeneration	[rɪdʒenəˈreɪʃn]	восстановление

READING

3. Read the text and answer the questions.

Better material for bone tissue regeneration

A new study has revealed a technology how to cover biodegradable implants with a human skeleton similar mineral.

Bone tissue regeneration, one of the issues of tissue engineering, is a research area for Dmitry Gorin and his international colleagues, a leading research fellow at the RASA Center in Tomsk Polytechnic University. The scientists have developed a new vaterite-based coating for nanofiber material used as scaffold to grow bone tissue cells in a shorter time.

The process of porous calcium carbonate (CaCO3) covering on electrospun poly(ε-caprolactone) (PCL) fibers was described in this study. The cytocompatibility test shown the suitability of PCL/CaCO3 scaffolds for cell culturing.

The scientists have non-woven PCL (poly e-caprolactone) fiber by an electrospinning technique. This technology was first developed in the USSR in the 30s last century, but it has long been classified. Then it was discovered again in the US. In regenerative medicine, nonwoven materials fabricated by an electrospinning technique can be successfully used as scaffolds for tissue engineering materials because of their unique physical chemical properties due to their nanostructured nature.

"We published the work opening new possibilities for creating scaffolds for bone growth, and in this respect it is really new and original. The work's feature is that we had a well-known of polycaprolactone matrix, and have grown on the surface of its nanofiber a coating out of one of the polymorphic calcium carbonate modifications (CaCO3) -- vaterite -- a very interesting material in terms of drug delivery (since it has a porous structure). Furthermore, in the body under certain conditions vaterite may recrystallize in bone components. Therefore vaterite / PCL composite is a promising material for bone implants," says the study's co-author, Dr. Dmitry Gorin, a leading researcher of the Novel Dosage Laboratory of RASA Center at TPU, and a professor of Saratov State University.

In nature vaterite is a very rare mineral due to the fact that its structure is unstable under the conditions of Earth's surface. Vaterite has two much more common counterparts with the same chemical formula (CaCO3): aragonite and the most commonly occurring calcite.

Vaterite is a biomineral found in nature as a component part of the skeleton of some gastropods (e.g. snails).

In order cells begin to grow, they need a basis. The basis can be different: you have to pick up the one which properties ensure the rapid growth of cells, and therefore faster regeneration of tissues. This material must meet certain requirements as the permeability of medium for various substances and water vapor permeability. After transplantation scaffolds trigger cell growth process, and then degrade. According to Dmitry Gorin, when it deals building a future bone tissue, in this case, the composite basis degradation will go slowly enough, about a month or more, which is enough to substitute the implant with the newly-formed bone tissue.

PCL fibers are obtained as mentioned above, by electrospinning. The method is that under pressure polymer solution is fed through the needle and due to the potential difference applied between the second electrode and the needle, the thread is formed with a submicron diameter. The thread falls freely onto the substrate, which is the second electrode, and forms a non-woven fabric.

The obtained threads can be directed, but for the tasks described in the article they were to be arranged randomly. Modern membrane materials used in cloth manufacturing are permeable to steam but do not to water, and made by the same technology.

Later the researchers are planning to study the behavior of the new implant material in vivo in order to investigate the possibility of using this material for bone tissue regeneration.

(Adopted from https://www.sciencedaily.com/releases/2016/12/161220093946.htm)

QUESTIONS:

1. What is the field of research of Dmitry Gorin and his international colleagues?
2. For what purpose did scientists develop a new coating based on vaterite?
3. How did scientists obtain non-woven PCL fiber?
4. When and where was this technology first developed?
5. What does Dr. Dmitry Gorin tell about their new scientific project? What new possibilities does it open?
6. What information does the article give about the biomineral called vaterite?
7. What are the requirements for the basis for future bone tissue?
8. What is the electrospinning method? Find the corresponding sentence in the text.
9. Are modern membrane materials permeable to steam?
10. What are the researchers planning to study next?

AFTER TEXT TASKS

4. Translate the following word combinations into Russian.

1) Biodegradable implants
2) Regenerative medicine
3) Coating out
4) Under pressure
5) Bone tissue
6) Electrospun fibers

7) Non-woven fabric
8) Tissue engineering
9) Permeability
10) To arrange randomly

5. ***Find the English equivalents to the word combinations in the text.***

1) Один из вопросов
2) Уровень развития
3) Скелет человека
4) Новые возможности
5) Полиморфизм
6) Современные мембранные материалы
7) Перспективный материал
8) Расположить хаотично
9) Тканевая инженерия
10) Цитосовместимость

6. Complete the sentences using the text.

1) A new study has revealed a … how to cover biodegradable implants with a human skeleton similar … .
2) This technology was first … in the … in the 30s last century, but it has long been classified.
3) The scientists have developed a new vaterite-based … for nanofiber material used as … to grow bone tissue cells in a shorter time.
4) … is a biomineral found in nature as a … of the skeleton of some … .
5) Vaterite has two much more common … with the same chemical formula.
6) When it deals building a future bone tissue, about a month or more is enough to … the implant with the newly-formed bone tissue.
7) The thread falls freely onto the substrate, which is the second electrode, and forms a … fabric.
8) The scientists have non-woven PCL fiber by an … technique.
9) “We published the work opening new possibilities for creating … for

bone growth".

10) Later the researchers are planning to study the … of the new implant material in … .

7. Match the following terms with definitions.

1)CaCO3	a) a mineral, of which the human skeleton consists.
2) Polymorphism	b) a biomineral found in nature as a component part of the skeleton of some gastropods
3) Ca5(PO4)3(OH)	c) calcium carbonate
4) Vaterite	d) a carbonate mineral and one of the three most common naturally occurring crystal forms of calcium carbonate (CaCO3), the others being calcite and vaterite.
5) Aragonite	e) the existence of substances with the chemical formula but different crystal structure types

8. Match the beginnings and the endings of the given sentences.

№	Beginnings		Endings
1	Bone tissue regeneration is a research area	**a**	vaterite may recrystallize in bone components.
2	A new study has revealed a technology how to	**b**	of drug delivery since it has a porous structure.
3	This technology was developed in the USSR in the	**c**	for Dmitry Gorin and his international colleagues.
4	In the body under certain conditions	**d**	electrode, and forms a non-woven fabric.

5	Nonwoven materials fabricated by an electrospinning technique can be used	**e**	cover biodegradable implants with a human skeleton similar mineral.
6	Vaterite is a very interesting material in terms	**f**	30s last century, but it has long been classified.
7	In order cells begin to grow,	**g**	as scaffolds for tissue engineering materials.
8	The thread falls freely onto the substrate, which is the second	**h**	they need a basis.

9. ***Mark true (T) or false (F) sentences below. Express your opinion using the suggested phrases in the box.***

Agreeing	Disagreeing
That's quite right. That's true. Yes, I agree with the statement. I agree with you 100 percent. I absolutely agree with it. I'm of exactly the same opinion. I couldn't agree with you more. No doubt about it.	I don't agree with it. Not really. I disagree, I'm afraid I don't think that's right I'm afraid I can't agree with it. Surely not! On the contrary, … It is absolutely wrong.

1. Scientists have proposed a new technology that allows bone tissue cells to regenerate much faster.
2. Cytocompatibility testing showed that PCL/CaCO3 scaffolds were unsuitable for cell culture.
3. Very few people know that the new technology of using PSL fiber for growing bone tissue cells was first developed in the USA in the 30s last century.
4. Vaterite occurs in nature as a component of the skeleton of some gastropods.

5. The obtained threads can be arranged randomly, but for the tasks described in the article they had to be arranged directly.
6. In nature, vaterite is a fairly common mineral.
7. Nonwoven materials produced by electrospinning can be successfully used in regenerative medicine as scaffolds for tissue engineering materials.
8. According to Dmitry Gorin, the composite basis degradation will go for about a month or more, which is not enough to substitute the implant with the newly-formed bone tissue.
9. The researchers are studying the behavior of the new material in vitro to investigate the possibility of using this material for bone tissue regeneration.

10. Find out the key words to make up the outline of the text.

11. Give the summary of the text 'Better material for bone tissue regeneration'.

COMPREHENSION

12. Read the text and make up 10 questions to it.

Biodegradable and bioactive polymer/ceramic composite scaffolds

Bone tissue regeneration is one of the areas within tissue engineering that has gained considerable attention by the research community. Critical size bone defects due to trauma or disease are very difficult to repair via the natural growth of host tissue. Therefore, there exists a need to fill these defects with a bridging (usually porous) material (termed scaffold), which should also, in combination with relevant cells and signaling molecules, promote the regeneration of new bone tissue.

The biomaterials of choice for the development of bone tissue engineering scaffolds are those exhibiting bioactive properties. Bioactive materials react with physiological fluids and form tenacious bonds to bone through the biological interaction of collagen fibers with the material surface and thus they can transfer loads to and from living bone.

Prominent bioactive materials are inorganic compounds, such as bioceramics, including selected compositions of silicate glasses and glass-ceramics, as well as Hydroxyapatite (HA) and related amorphous or crystalline calcium phosphates.

Like most ceramic materials, the major disadvantage of bioactive ceramics is their low fracture toughness. They are thus often used combined with biopolymers, both stable polymers, for example, Poly(Methyl Methacrylate) (PMMA), Polyethylene (PE) and, specially for tissue engineering applications, biodegradable polymers, for example, aliphatic polyesters.

(Adopted from https://www.sciencedirect.com/topics/engineering/bone-tissue-regeneration)

13. Take turns to ask and answer questions to the text Biodegradable and bioactive polymer/ceramic composite scaffolds.

14. Translate the following text into English.

Регенерация костной ткани в прошлом и настоящем

Реконструкция или регенерация дефектов кости интересует человечество на протяжении многих тысячелетий. С давних времен ученые и хирурги продолжали совершенствовать науку о костной пластике, чтобы обеспечить наиболее правильное хирургическое вмешательство с наилучшими клиническими результатами.

В настоящее время стандартное лечение переломов заключается в извлечении трансплантатов из других частей тела с их трансплантацией в места переломов. Аутотрансплантаты обрели повсеместное признание, поскольку собственная кость пациента демонстрирует все ключевые биологические характеристики: остеогенность, остеоиндуктивность и остеоиндуктивность.

Альтернативной стратегией являются синтетические заменители костной ткани, разработанные для преодоления естественных ограничений ауто и аллотрансплантата. Эти заменители или каркасы

изготавливают из различных материалов, включая природные и синтетические полимеры, керамику и композиты.

(Adapted from https://bioimplantat.ru/articles/articles/regeneratsiya-kostnoy-tkani-etapy-materialy-i-signalnye-molekuly/)

WRITING

15. Write a 200 - 250 word essay on one of the following topics:

- Achievements of modern biotechnology
- The future of biotechnology

SUPPLEMENTARY READING

• Read and translate the texts to find the additional information. Write down the key words and make up the summaries of the texts.

Text 1. Applications of Biotech on Medicine and Agriculture

Biotechnology is a very huge field and its applications are used in a variety of fields of science such as agriculture and medicine. The pasture of biotechnology, genetic engineering, has introduced techniques like gene therapy, recombinant ***DNA technology and polymerase chain retort*** which employ genes and DNA molecules to make a diagnosis diseases and put in new and strong genes in the body which put back the injured cells. There are some applications of biotechnology which are live their part in the turf of medicine and giving good results:

Biopharmaceutical

By means of the technique of biotechnology, the drugs biopharmaceuticals were urbanized. There are no chemicals concerned in the combination of these drugs, but microorganisms have completed it likely to expand them. Large molecules of proteins are typically the source of biopharmaceuticals. They when under attack in the body attack the hidden mechanisms of the disease and wipe out them. Now scientists are annoying to expand such biopharmaceutical drugs which can be treated against the diseases like hepatitis, cancer and heart diseases.

Gene therapy

Gene therapy is one more technique of biotechnologies which is used to delicacy and diagnoses diseases like cancer and Parkinson's disease. The apparatus of this technique is that the fit genes are under attack in the body which either obliterate the injured cells or replace them. In some cases, the fit genes make corrections in the genetic information and that is how the genes start performance in the favor of the body.

Pharmacogenomics

Pharmacogenomics is an additional genetically modified method which is used to learn the genetic information of a personality. It analyzes the

body's reply to sure drugs. It is the mixture of pharmaceuticals and genomics. The aspire of this field is to expand such drugs which are inserted in the person according to the genetic information there in the individual.

Genetic testing

Genetic testing is a technique of heredity which is used to conclude the genetic diseases in parents, sex and carrier screening. The technique of genetic testing is to use DNA probes which have the sequence alike to the mutated sequences. This technique is also used to recognize the criminals and to test the parenthood of the child.

It is completed that no field of science can be winning until it uses the techniques of biotechnology. Scientists are operational in the research area to expand new drugs and vaccines and are also judgment cures for the diseases which were not easy to treat in the past decade. Biotechnology is a field of miracle.

Applications Of Biotech In Agriculture

Biotechnology is frequently deliberated the similar with the biomedical investigate, but there are a group of other industries which take advantage of biotech method for studying, cloning and varying genes. We have turn out to be familiar to the thought of enzymes in our everyday lives and a lot of people are recognizable with the argument adjacent the use of GMOs in our foods. The agricultural industry is at the middle of that debate, but since the days of George Washington Carver, agricultural biotech has been producing innumerable new products that have the possible to alter our lives for the improved.

Vaccines

Oral vaccines have been in the works for much existence as a likely solution to the increase of disease in immature countries, where costs are excessive to extensive vaccination. Hereditarily engineered crops, frequently fruits or vegetables, planned to carry antigenic proteins from transferable pathogens that will activate an immune reply when injected. An example of this is a patient-specific vaccine for treating cancer. An anti-

lymphoma vaccine has been made using tobacco plants carrying RNA from cloned malignant B-cells. The resultant protein is then used to vaccinate the patient and boost their immune system beside the cancer. Tailor-made vaccines for cancer treatment have shown substantial promise in preliminary studies.

Antibiotics

Plants are used to create antibiotics for both human and animal use. An expressing antibiotic protein in stock feed, fed straight to animals, is less expensive than traditional antibiotic production, but this practice raise many bioethics issues, because the result is widespread, possibly needless use of antibiotics which may encourage expansion of antibiotic-resistant bacterial strain. Quite a few rewards to using plants to create antibiotics for humans are condensed costs due to the larger quantity of product that can be produced from plants versus a fermentation unit, ease of purification, and condensed risk of contamination compared to that of using mammalian cells and culture media.

Flowers

There is extra to agricultural biotechnology than just hostility disease or civilizing food quality. There is some simply aesthetic application and an example of this is the use of gene recognition and transfer techniques to improve the color, smell, size and other features of flowers.

Similarly, biotech has been used to make improvement to other common ornamental plants, in particular, shrubs and trees. Some of these changes are similar to those made to crops, such as enhancing cold confrontation of a breed of tropical plant, so it can be grown in northern gardens.

Biofuels

The agricultural industry plays a big role in the biofuels industry, as long as the feedstock's for fermentation and cleansing of bio-oil, bio-diesel and bio-ethanol. Genetic engineering and enzyme optimization technique are being used to develop improved quality feedstocks for more efficient

change and higher BTU outputs of the resulting fuel products. High-yielding, energy-dense crops can minimize relative costs associated with harvesting and transportation (per unit of energy derived), resulting in higher value fuel products.

Plant and Animal Reproduction

Enhancing plant and animal behavior by traditional methods like cross-pollination, grafting, and cross-breeding is time-consuming. Biotech advance let for changes to be made rapidly, on a molecular level through over-expression or removal of genes, or the introduction of foreign genes.

The last is possible using gene expression control mechanism such as specific gene promoters and transcription factors. Methods like marker-assisted selection improve the efficiency of "directed" animal breeding, without the controversy normally associated with GMOs. Gene cloning methods must also address species differences in the genetic code, the presence or absence of introns and post-translational modifications such as methylation.

Pesticide-Resistant Crops

Not to be mystified with pest-resistance, these plants are broadminded of pesticides, allow farmers to selectively kill nearby weeds with no harming their crop. The most well-known example of this is the Roundup-Ready technology, urbanized by Monsanto.

First introduced in 1998 as GM soybeans, Roundup-Ready plants are unaffected by the herbicide glyph sate, which can be applied in copious quantity to get rid of any other plants in the field. The profit to this is savings in time and costs associated with conservative tillage to reduce weeds, or multiple applications of different types of herbicides to selectively eliminate exact species of weeds. The probable drawbacks include all the controversial arguments against GMOs.

Nutrient Supplementation

In an attempt to get better human health, mainly in immature countries, scientists are creating hereditarily distorted foods that hold nutrients known

to help fight disease or starvation. An example of this is Golden Rice, which contain beta-carotene, the forerunner for Vitamin A manufacture in our bodies. People who eat the rice create more Vitamin A, and necessary nutrient lacking in the diets of the poor in Asian countries.

Three genes, two from daffodils and one from a bacterium, proficient of catalyzing four biochemical reactions, were cloned into rice to make it "golden". The name comes from the color of the transgenic grain due to over expression of beta-carotene, which gives carrots their orange color.

A biotic strain confrontation

A lesser quantity of than 20% of the earth is arable land but some crops have been hereditarily altered to make them more liberal of conditions like salinity, cold and drought. The detection of genes in plants in charge for sodium uptake has lead to growth of knock-out plants able to grow in high salt environments. Up- or down-regulation of record is usually the method used to alter drought-tolerance in plants. Corn and rapeseed plants, capable to thrive, are in their fourth year of field trials in California and Colorado, and it is predictable that they'll reach the marketplace in 4-5 years.

Manufacturing power Fibers

Spider silk is the strongest fiber known to man, stronger than kevlar (used to make bullet-proof vests), with an advanced tensile power than steel. In August 2000, Canadian company Nexia announces growth of transgenic goats that formed spider silk proteins in their milk. While this solved the trouble of mass-producing the proteins, the agenda was shelve when scientists couldn't figure out how to spin them into fibers like spiders do.

By 2005, the goats be up for sale to anyone who would take them. While it seems the spider silk design has been put on the shelf for the time-being, it is a technology that is sure to appear again in the future, once more information is gather on how the silks are woven.

Applications Of Biotech On Food processing

Application of biotechnology to food processing in rising countries is a subject of debate and deliberations for a long time. Biotechnological study

as practical to bioprocessing in the size of rising countries, targets growth and development of customary fermentation processes. However, there are a few issues which need to be discussed in rising countries while using the technology for various applications.

Socio-economic in addition to cultural factors

Traditional fermentation processes engaged in most developing countries are short input, suitable food processing technologies with negligible investment necessities. These process are, however, often unrestrained, unhygienic and inefficient and usually result in products of variable quality and small shelf lives. Fermented foods, nevertheless, find wide consumer getting in developing countries and add considerably to food security and nutrition.

Infrastructural and logistical factors

Corporal infrastructural necessities for the produce, allotment and storage (e.g. by refrigeration) of microbial cultures or enzymes on an incessant basis is generally obtainable in urban areas of many developing countries. However, this is not the case in most rural areas of developing countries.

Should research be oriented to ensure that individuals at all levels can benefit from request of biotechnology in foodstuff fermentation processes? What is necessary for the level of fermentation technologies and procedure controls to be upgrade in order to increase competence, yields and the quality and safety of fermented foods in increasing countries?

Nourishment and foodstuff security

Fermentation process improves the dietary value of foods from side to side the biosynthesis of vitamins, necessary amino acids and proteins, through improving protein and fiber digestibility; enhancing micronutrient bioavailability and humiliating anti-nutritional factors.

Intellectual property rights (IPRs)

The processes used in the higher areas of agricultural biotechnology tend to be enclosed by IPRs this apply also to biotechnology process used

in food processing. On the other hand, many of the traditional fermentation processes applied in mounting countries are base on traditional knowledge

(Downloaded from http://www.biotechonweb.com/branches-of-biotech.html)

Text 2. Examples of Biotechnology in Agriculture

Biotechnology is widely used in agriculture to improve plant growth and yields, increase resistance to pests and diseases, and enhance nutritional content. In fact, it's estimated that up to 80% of all processed foods today contain ingredients derived from biotechnology. From genetically engineered crops to the Sterile Insect Technique (SIT) for insect control on fruit trees and grapevines, examples of biotechnology in agriculture are widespread.

In this post, we'll discuss some of the most common examples of how biotechnology is being used in the agricultural sector as well as the advantages of biotechnology.

Genetically Modified Crops

Genetically modified crops are created by inserting genes from different organisms into the DNA sequence of specific crop varieties. This produces traits that would not occur naturally, such as resistance to pests or environmental conditions like drought. The GMO industry has evolved over the years, with progress being made in developing crops that are tolerant to herbicides, resistant to disease, and insect-resistant.

Many people oppose GMOs because they are not sure about their long-term effects on human health and the environment. However, many scientific studies have suggested that GMOs, as an example of successful biotechnology application in agriculture, are safe for both humans and the environment. More research still needs to be done to ensure that GMOs are safe and beneficial in the long term.

Advantages of GMO biotechnology:

- Increased efficiency and reduced costs
- Higher crop yields

- Ability to generate new food products
- Improved quality of life for farmers

Developing of Biofuels

Another greatexample of biotechnology in agriculture is the development of biofuels. Biofuels are types of fuel that can be produced using natural inputs like algae, corn stover, and sugarcane bagasse instead of petroleum products. This helps to reduce greenhouse gas emissions because they do not emit any carbon when burned. It also does not take away from the food supply because some inputs, like algae, can be grown on wastewater or using arable land that isn't fit to grow crops.

This also gives more options for where the fuel source comes from and may increase competition, which could lower prices. Using advanced biotech methods to develop biofuels has the potential to help reduce greenhouse gas emissions and provide a more reliable fuel source.

Advantages of biofuels:

- Reduced greenhouse gas emissions
- Increased competition may lead to lower prices
- More options for where fuel source comes from

Improving Plant Growth

Improving plant growth is another example of biotechnology in agriculture. Since the beginning of agriculture, farmers have been breeding plants to get more desirable traits such as larger fruits size, more robust plant growth, or improved flavor. This is an example of traditional cross-breeding methods where a farmer selects what she thinks are the best examples from each generation for further breeding. In short, this method requires generations of experiments to obtain the desired result.

However, with the advent of biotechnology, sustainable plant growth can be achieved quickly and efficiently. These plants are altered in a laboratory to possess a specific trait, such as resistance to pests, abiotic stress, and several other factors. Once the variety is created, it only takes a few generations for farmers to obtain examples that have all desired traits

and grow much more efficiently because they no longer need to worry about previous growth challenges.

Advantages of biotechnology for plant growth:

- Increased tolerance to stress factors, such as drought or salinity
- Faster growth rates and shorter generation times
- Costs less than traditional breeding methods

Improving Plant Seed Quality

We can't mention examples of biotechnology in agriculture without noting the increased quality of seeds available to farmers. Biotechnology has allowed for more effective and efficient ways of improving the crops that feed our population, as well as ensuring high-quality seeds at harvest time. Seed quality has always been the basis for a good crop, and biotechnology has allowed seeds to be improved in several ways.

For example, scientists have been able to improve the ability of seeds to withstand different conditions such as drought or flooding by using DNA technology that targets specific genes responsible for water uptake during these stressful times. In addition, biotechnologists have introduced new genetic material into plants that can lead to higher nutritional value in many foods we eat every day, like fruits, vegetables, grains, and oilseeds.

Advantages of biotech in improving seed quality:

- Improved crops
- More food for the world's population.
- Better crop yields in the face of changing conditions around the globe
- Increased nutritional value

Improve Animal Health and Breeding

Another great example of biotechnology in agriculture is improving animal health and breeding. Biotechnology is now being used in livestock production, which allows the animals to grow faster with less food for better meat quality. It can even be used for cloning. Animals that are resistant to diseases can also be bred using biotechnology. By using biotechnology solutions, farmers can increase their production and improve the quality of animal products.

The animal biotech industry has a long way to go, but the potential is huge. This technology has great advantages over conventional methods and may be a key to feeding our growing population in the future. When combined with plant-based biotechnology, the potential for increased food production is even greater. We can only hope that this technology will be used to help us sustainably feed the world.

Advantages of biotechnology in animal breeding:

- Improved animal product quality
- Faster growth
- Resistance to diseases
- Increased food production potential

Learn More at Fruit Growers Supply

There's no doubt that biotechnology is here to stay. As scientists continue their efforts to create new technologies, the successful application of these and other examples of biotechnology in agriculture will increase. For instance, farmers who produce fruits, flowers, and vegetables can increase their yields and profits, reduce labor costs, and improve the environment.

Examples include using genetic engineering to develop herbicide-resistant seeds for soybeans, developing genetically engineered apples with extended shelf life, and using CRISPR gene editing to create cows that produce more milk. Learn how biotechnology is changing the agricultural sector at Fruit Growers Supply. Fruit Growers Supply is a one-stop shop for your commercial growing needs. Contact us for a quote.

(Downloaded from https://fruitgrowers.com/5-examples-of-biotechnology-in-agriculture/)

Text 3. What is sequencing?

You may have heard of genomes being sequenced. For instance, the human genome was completed in 2003, after a many-year, international effort. But what does it mean to sequence a genome, or even a small fragment of DNA?

DNA sequencing is the process of determining the sequence of nucleotide bases (As, Ts, Cs, and Gs) in a piece of DNA. Today, with the right equipment and materials, sequencing a short piece of DNA is relatively straightforward.

Sequencing an entire genome (all of an organism's DNA) remains a complex task. It requires breaking the DNA of the genome into many smaller pieces, sequencing the pieces, and assembling the sequences into a single long "consensus." However, thanks to new methods that have been developed over the past two decades, genome sequencing is now much faster and less expensive than it was during the Human Genome Project.

In this article, we'll take a look at methods used for DNA sequencing. We'll focus on one well-established method, Sanger sequencing, but we'll also discuss new ("next-generation") methods that have reduced the cost and accelerated the speed of large-scale sequencing.

Sanger sequencing: The chain termination method

Regions of DNA up to about 900900900 base pairs in length are routinely sequenced using a method called **Sanger sequencing** or the **chain termination method**. Sanger sequencing was developed by the British biochemist Fred Sanger and his colleagues in 1977.

In the Human Genome Project, Sanger sequencing was used to determine the sequences of many relatively small fragments of human DNA. The fragments were aligned based on overlapping portions to assemble the sequences of larger regions of DNA and, eventually, entire chromosomes.

Although genomes are now typically sequenced using other methods that are faster and less expensive, Sanger sequencing is still in wide use for

the sequencing of individual pieces of DNA, such as fragments used in DNA cloning or generated through polymerase chain reaction (PCR).

Ingredients for Sanger sequencing

Sanger sequencing involves making many copies of a target DNA region. Its ingredients are similar to those needed for DNA replication in an organism, or for polymerase chain reaction (PCR), which copies DNA ***in vitro***. They include:

- A DNA polymerase enzyme
- A **primer**, which is a short piece of single-stranded DNA that binds to the template DNA and acts as a "starter" for the polymerase
- The four DNA nucleotides (dATP, dTTP, dCTP, dGTP)
- The template DNA to be sequenced

However, a Sanger sequencing reaction also contains a unique ingredient:

- Dideoxy, or **chain-terminating**, versions of all four nucleotides (ddATP, ddTTP, ddCTP, ddGTP), each labeled with a different color of dye

Dideoxy nucleotides are similar to regular, or deoxy, nucleotides, but with one key difference: they lack a hydroxyl group on the 3’ carbon of the sugar ring. In a regular nucleotide, the 3’ hydroxyl group acts as a “hook," allowing a new nucleotide to be added to an existing chain.

Once a dideoxy nucleotide has been added to the chain, there is no hydroxyl available and no further nucleotides can be added. The chain ends with the dideoxy nucleotide, which is marked with a particular color of dye depending on the base (A, T, C or G) that it carries.

Where is the dye attached? The dye molecule on a dideoxy nucleotide is linked to the nitrogenous base.

Method of Sanger sequencing

The DNA sample to be sequenced is combined in a tube with primer, DNA polymerase, and DNA nucleotides (dATP, dTTP, dGTP, and dCTP).

The four dye-labeled, chain-terminating dideoxy nucleotides are added as well, but in much smaller amounts than the ordinary nucleotides.

The mixture is first heated to denature the template DNA (separate the strands), then cooled so that the primer can bind to the single-stranded template. Once the primer has bound, the temperature is raised again, allowing DNA polymerase to synthesize new DNA starting from the primer. DNA polymerase will continue adding nucleotides to the chain until it happens to add a dideoxy nucleotide instead of a normal one. At that point, no further nucleotides can be added, so the strand will end with the dideoxy nucleotide.

This process is repeated in a number of cycles. By the time the cycling is complete, it's virtually guaranteed that a dideoxy nucleotide will have been incorporated at every single position of the target DNA in at least one reaction. That is, the tube will contain fragments of different lengths, ending at each of the nucleotide positions in the original DNA (see figure below). The ends of the fragments will be labeled with dyes that indicate their final nucleotide.

After the reaction is done, the fragments are run through a long, thin tube containing a gel matrix in a process called **capillary gel electrophoresis**. Short fragments move quickly through the pores of the gel, while long fragments move more slowly. As each fragment crosses the "finish line" at the end of the tube, it's illuminated by a laser, allowing the attached dye to be detected.

The smallest fragment (ending just one nucleotide after the primer) crosses the finish line first, followed by the next-smallest fragment (ending two nucleotides after the primer), and so forth. Thus, from the colors of dyes registered one after another on the detector, the sequence of the original piece of DNA can be built up one nucleotide at a time. The data recorded by the detector consist of a series of peaks in fluorescence intensity, as shown in the **chromatogram** above. The DNA sequence is read from the peaks in the chromatogram.

Uses and limitations

Sanger sequencing gives high-quality sequence for relatively long stretches of DNA (up to about 900900900 base pairs). It's typically used to sequence individual pieces of DNA, such as bacterial plasmids or DNA copied in PCR.

However, Sanger sequencing is expensive and inefficient for larger-scale projects, such as the sequencing of an entire genome or metagenome (the “collective genome” of a microbial community). For tasks such as these, new, large-scale sequencing techniques are faster and less expensive.

Next-generation sequencing

The name may sound like Star Trek, but that’s really what it’s called! The most recent set of DNA sequencing technologies are collectively referred to as **next-generation sequencing**.

There are a variety of next-generation sequencing techniques that use different technologies. However, most share a common set of features that distinguish them from Sanger sequencing:

Highly parallel: many sequencing reactions take place at the same time;

Micro scale: reactions are tiny and many can be done at once on a chip;

Fast: because reactions are done in parallel, results are ready much faster;

Low-cost: sequencing a genome is cheaper than with Sanger sequencing;

Shorter length: reads typically range from 505050 - 700700700 nucleotides in length.

Conceptually, next-generation sequencing is kind of like running a very large number of tiny Sanger sequencing reactions in parallel. Thanks to this parallelization and small scale, large quantities of DNA can be sequenced much more quickly and cheaply with next-generation methods than with Sanger sequencing. For example, in 2001, the cost of sequencing a human genome was almost \$100\$100\$100 million.

Why does fast and inexpensive sequencing matter? The ability to routinely sequence genomes opens new possibilities for biology research and biomedical applications. For example, low-cost sequencing is a step

towards personalized medicine – that is, medical treatment tailored to an individual's needs, based on the gene variants in his or her genome.

(Downloaded from https://www.khanacademy.org/science/biology/biotech-dna-technology/dna-sequencing-pcr-electrophoresis/a/dna-sequencing

Text 4. Reducing Radio Frequency Exposure from Cell Phones

The scientific evidence indicates radio frequency (RF) exposures that are at or below current U.S. safety limits do not cause health problems. There is no established health benefit from reducing an individual's RF exposure from cell phones. Nevertheless, some people still have concerns about RF energy, and there are some simple actions that could help reduce an individual's RF energy exposure from cell phones.

Generally, wireless products emit the most RF energy when you are using them to talk to someone. The closer the device is to you, the more energy you will absorb.

Steps to Reduce Radio Frequency (RF) Exposure:

- Reduce the amount of time spent using your cell phone.
- Use speaker mode, head phones, or ear buds to place more distance between your head and the cell phone.
- Avoid making calls when the signal is weak as this causes cell phones to boost RF transmission power.
- Consider texting rather than talking - but don't text while you are driving.

Claims About Cell Phone Accessories

Manufacturers of certain cell phone accessories may claim that an accessory shields the user from emissions or prevents health problems caused by radio frequency radiation. The FDA does not regulate such products and, given the weight of scientific evidence to show that cell phones are safe for use, the Agency considers these claims to be bogus.

Claims to shield the phone's user from RF radiation: Some products that claim to shield the user from RF absorption use special phone cases, while others involve nothing more than a metallic accessory attached to the

phone. Studies have shown that these products generally do not work as advertised and may interfere with proper operation of the phone.

Claims to "prevent adverse health effects caused by RF radiation:" The manufacturers of these products claim their products have astonishing effects. Claims of protective effects cannot be proven because radio frequency energy from cell phones does not cause health problems. Claims about disease prevention may make the item an illegally marketed medical device. There are no direct protective effects from the use of these products. At best, they are harmless, and, at worst, they might prevent your phone from finding signal when you most need to make a call for your safety.

Examples of specific unprovable and misleading cellphone accessory claims include:

- "the product's frequencies create fields that counter the cell phone radiation's effect on the body."
- "Circuits mirror the structure of the earth's electromagnetic field and amplify your resonance with the Earth.";
- "Shield yourself from harmful frequencies [… with an] inductor coil, which suppresses these frequencies."

(Downloaded from https://www.fda.gov/radiation-emitting-products/cell-phones/reducing-radio-frequency-exposure-cell-phones)

Text 5. FDA's Plant and Animal Biotechnology Innovation Action Plan

Scientific advancements such as genome editing have led to the ability to more efficiently and precisely alter the genomes of plants and animals to produce desired traits. Genome editing in plants and animals has a broad range of potential applications in areas including food, agriculture, and health.

The U.S. Food and Drug Administration is pleased to share the **Plant and Animal Biotechnology Innovation Action Plan.** This plan provides an overview of priorities the FDA will pursue to support innovation in plant

and animal biotechnology and to advance the agency's public health mission.

This Action Plan aims to implement and clarify risk-based policies with the goals of ensuring that developers know what they need to do to efficiently bring a product to market, and that consumers and the public understand how the FDA's regulatory system helps ensure the safety of such products. The Action Plan identifies concrete priorities in three key areas:

I. Advancing public health by promoting innovation
II. Strengthening public outreach and communication
III. Increasing engagement with domestic and international partners

Taken together, these priorities are intended to ensure the safety of plant and animal biotechnology products and avoid unnecessary barriers to future innovation consistent with the FDA's mission to protect and promote public health.

As a first step in the implementation of this Action Plan, FDA is announcing:

- **Public Webinar on Genome Editing in Animals:** The webinar will focus primarily on the current science, promising uses of this technology in animals, and the potential risks.
- **Veterinary Innovation Program (VIP):** A new pilot program, the VIP is intended to facilitate advancements in development of innovative animal products by providing greater certainty in the regulatory process, encouraging development and research, and supporting an efficient and predictable pathway to approval.

(Downloaded from https://www.fda.gov/safety/fdas-regulation-plant-and-animal-biotechnology-products/fdas-plant-and-animal-biotechnology-innovation-action-plan)

Text 6. FDA's Regulation of Plant and Animal Biotechnology Products

The FDA regulates plant and animal biotechnology products in coordination with the U.S. Department of Agriculture (USDA) and U.S. Environmental Protection Agency (EPA), consistent with the U.S. Coordinated Framework for the Regulation of Biotechnology. Each of these regulatory agencies has developed regulations and guidance documents to implement its authority under existing laws to help ensure the safety and, where applicable, the effectiveness of biotechnology products.

As the landscape of biotechnology products evolves along with advances in molecular techniques, the FDA is committed to protecting public and animal health and to working with stakeholders to increase the transparency, coordination, and predictability of the regulatory system to enhance public confidence in the regulatory system while also avoiding unnecessary barriers to innovation.

Plant and Animal Biotechnology Programs and Activities at the FDA

- Report on Stakeholder Comments on the Coordinated Framework for the Regulation of Biotechnology. On November 13, 2023, and in response to President Biden's Executive Order 14081, the Food and Drug Administration (FDA), the Environmental Protection Agency (EPA), and the United States Department of Agriculture (USDA) posted two documents on the Unified Website for Biotechnology Regulation. The agencies issued a report on stakeholder comments on the Coordinated Framework for the Regulation of Biotechnology. The agencies also posted plain-language information on agency roles, responsibilities, and processes for the regulation of products of biotechnology. Each agency provided updates on the availability of the reports to their respective stakeholders.

- **Request for Information Related to the Coordinated Framework for the Regulation of Biotechnology**

On December 19, 2022, the White House Office of Science and Technology Policy (OSTP) — in coordination with the U.S. Food and Drug

Administration (FDA), U.S. Environmental Protection Agency (EPA), and U.S. Department of Agriculture (USDA) announced a request for information related to the Coordinated Framework for the Regulation of Biotechnology. This action requests relevant data and information to help identify regulatory ambiguities, gaps, inefficiencies, or uncertainties in the Coordinated Framework for the Regulation of Biotechnology. The request for information seeks case studies and other data that relate to new and emerging biotechnology products.

- **Executive Order on Advancing Biotechnology and Biomanufacturing Innovation for a Sustainable, Safe, and Secure American Bioeconomy (Executive Order Number 14081)**

The Executive Order signed September 12, 2022, launched a National Biotechnology and Biomanufacturing Initiative (NBBI). This initiative will help drive research and development, improve access to quality federal data, grow domestic manufacturing capacity, expand market opportunities for biobased products, train a diverse and skilled workforce, streamline regulatory processes for products of biotechnology, advance biosafety and biosecurity to reduce risk, protect the U.S. biotechnology ecosystem, and build a thriving and secure global bioeconomy with partners and allies.

- **Feed Your Mind – Agricultural Biotechnology Education and Outreach Initiative**

The FDA continues to work with EPA and USDA to modernize the regulatory system for plant and animal biotechnology products.

- **Food from New Plant Varieties**

Information about the FDA's role in overseeing the safety of human and animal foods derived from genetically engineered plants.

- **Biotechnology Products at the Center for Veterinary Medicine:**

Animals and Animal Food Information about animal-related biotechnology products.

- **Intentional Genomic Alterations in Animals**

Guidance documents, approvals, and other information related to animals with intentional genomic alterations.

(Downloaded from https://www.fda.gov/safety/fdas-regulation-plant-and-animal-biotechnology-products)

Text 7. 23andMe

23andMe is a privately held personal genomics and biotechnology company based in Mountain View, California. The company is named for the 23 pairs of chromosomes in a normal human cell. Its saliva-based direct-to-consumer personal genome test was named Invention of the Year by *Time* magazine in 2008.

The company was founded by Linda Avey, Paul Cusenza and Anne Wojcicki, wife of Google founder Sergey Brin, in 2006 to provide genetic testing and interpretation to individual consumers. In 2007, Google invested $3,900,000 in the company, along with Genentech, New Enterprise Associates, and Mohr Davidow Ventures.

Cusenza left the company in 2007 and was appointed CEO of Nodal Exchange in 2008. Avey left the company in 2009 and co-founded Curious, Inc. in 2011.

In 2012, 23andMe raised $50 million in a Series D venture round, almost doubling its existing capital of $52.6 million. In 2015, 23andMe raised $115 million in a Series E offering, increasing its total capital to $241 million.

Direct to consumer genetic testing

23andMe began offering direct to consumer genetic testing in November 2007. Customers provide a saliva testing sample that is partially SNP genotyped and results are posted online. In 2008, when the company was offering estimates of "predisposition for more than 90 traits and conditions ranging from baldness to blindness", *Time* magazine named the product Invention of the Year.

Uninterpreted raw genetic data is posted online and may be downloaded by customers. Customers who bought tests with an ancestry-related component have online access to genealogical DNA test results and tools including a relative-matching database. US customers who bought tests with a health-related component and received health-related results before November 22, 2013 have online access to an assessment of inherited traits and genetic disorder risks. Health-related results for US customers who purchased the test from November 22, 2013 were suspended until late 2015 while undergoing an FDA regulatory review. Customers who bought tests from 23andMe's Canadian and UK locations have access to some health-related results.

As of June 2015, 23andMe has genotyped over 1,000,000 individuals. FDA marketing restrictions have reduced customer growth.

Product changes

In late 2009, 23andMe split its genotyping service into three products with different prices, an Ancestry Edition, a Health edition, and a Complete Edition. This decision was reversed a year later when the different products were recombined. In late 2010 the company introduced a monthly subscription fee for updates based on new medical research findings. The subscription model proved unpopular with customers and was eliminated in mid-2012.

23andMe sold only raw genetic data and ancestry-related results in the United States due to FDA restrictions from November 22, 2013 until October 21, 2015, when it announced that it would resume providing health information in the form of carrier status and wellness reports with FDA approval. Wojcicki said they still plan to report on disease risk, subject to future FDA approval.

The price of the full direct-to-consumer testing service in the United States reduced from $999 in 2007 to $99 in 2012, and was effectively being sold as a loss leader in order to build a valuable customer database. In October 2015, the US price was raised to $199. In September 2016, an

ancestry-only version was once again offered at a lower price of $99 with an option to upgrade to include the health component for an additional $125 later. The price for international customers was lowered from $199 to $149. To date this kit offers only ancestry information.

The initial price of the product sold in Canada from October 2014, which includes health-related results, was C$199. The initial price of the product sold in the UK from December 2014, which includes health-related results, was £125.

Medical research

Aggregated customer data is studied by scientific researchers employed by 23andMe for research on inherited disorders. The large pool of data in its customer database has also attracted the interest of academics and other partners, including pharmaceutical and biotechnology companies. In July 2012, 23andMe acquired the startup Cure Together, a crowdsourced treatment ratings website with data on over 600 medical conditions.

23andMe provides services related to some specific medical research initiatives, providing confidential customer datasets to and partnering with researchers to establish genetic associations with specific illnesses and disorders. One analysis comparing 23andMe's Parkinson's disease research with a National Institutes of Health initiative suggested that the company's use of large amounts of computational power and datasets might offer comparable results, in much less time. 23andMe has launched research initiatives enrolling patients into study populations for inflammatory bowel disease, myeloproliferative neoplasms, and lupus. Papers on various genetic traits by 23andMe scientists were presented at the 2014 American Society of Human Genetics.

In 2015, 23andMe made a business decision to pursue drug development themselves, under the direction of former Genentech executive Richard Scheller, as opposed to supplying pharmaceutical companies with raw data.

Relationship with government regulators

The new genetic testing service and ability to map significant portions of the genome has raised controversial questions, including whether the results can be interpreted meaningfully and whether they will lead to genetic discrimination. The regulatory environment for testing companies has been uncertain, and anticipated risk-based regulation catering for different types of genetic tests has not yet materialized.

State regulators

In 2008 it was reported that the states of New York and California unsuccessfully attempted to block such tests, provided by 23andMe as well as other companies, on the grounds that they were not properly licensed, and attempted to require tests to be conducted only when ordered by a physician. By August 2008, 23andMe had received licenses that allow them to continue to do business in California.

FDA

According to Anne Wojcicki, 23andMe has been in dialogue with the FDA since 2008. In 2010 the FDA notified several genetic testing companies, including 23andMe, that their genetic tests are considered medical devices and federal approval is required to market them.23andMe first submitted applications for FDA clearance in July and September 2012. On November 22, 2013, after not hearing from 23andMe for six months, the FDA ordered 23andMe to stop marketing its Saliva Collection Kit and Personal Genome Service (PGS), as 23andMe had not demonstrated that they have "analytically or clinically validated the PGS for its intended uses" and the "FDA is concerned about the public health consequences of inaccurate results from the PGS device". As of December 2, 2013, 23andMe has stopped all advertisements for its PGS test but is still selling the product. As of December 5, 2013, 23andMe is selling only raw genetic data and ancestry-related results.

According to science writer Razib Khan, this development ultimately will not matter as raw genetic results can be obtained cheaply from

international genome sequencing firms and open source tools to analyse such data using published scientific research are freely available. Ronald Bailey writes in *Reason Magazine*: "The FDA bureaucrats think that they know better than you how to handle your genetic information. This is outrageous." Technology writer Timothy B. Lee argues in the *Washington Post* against the FDA preventing consumer access to personal health information provided by 23andMe, stating that any risky medical decisions patients made based on 23andMe's services would require the involvement of licensed medical professionals. Tech Freedom promoted a petition asking the FDA not to ban 23andMe's home genome testing kits. Science and medicine writer Matthew Herper was more critical of 23andMe, writing in *Forbes* magazine: "The FDA probably felt it had little choice. This is not the story of a big regulator choosing to squash a small company, but of a company that decided that it didn't have to follow the rules."

23andMe publicly responded to media reports on November 25, 2013, stating, "We recognize that we have not met the FDA’s expectations regarding timeline and communication regarding our submission. Our relationship with the FDA is extremely important to us and we are committed to fully engaging with them to address their concerns." Anne Wojcicki subsequently posted an update on the 23andMe website, stating: "This is new territory for both 23andMe and the FDA. This makes the regulatory process with the FDA important because the work we are doing with the agency will help lay the groundwork for what other companies in this new industry do in the future. It will also provide important reassurance to the public that the process and science behind the service meet the rigorous standards required by those entrusted with the public’s safety."

On December 5, 2013, 23andMe announced that it has suspended health-related genetic tests for customers who purchased the test from November 22, 2013 in order to comply with the FDA warning letter while undergoing regulatory review.

In May 2014 it was reported that 23andMe was exploring alternative locations abroad including Canada, Australia and the United Kingdom in

which to offer its full genetic testing service.23andMe has been selling a product with both ancestry and health-related components in Canada since October 2014, and in the United Kingdom since December 2014.

On February 19, 2015, the FDA announced that it had approved a 23andMe test for Bloom syndrome.

On October 21, 2015, 23andMe announced that it would be including a revised health component in the United States with FDA approval.

On October 26, 2016, CEO Anne Wojcicki said, "There was part of us that didn’t understand how the regulatory environment works" in regards to the distributed laboratory regulatory functions of FDA and CMS.

(Downloaded from https://en.wikipedia.org/wiki/23andMe)

Text 8. Circular mRNA produces 200 times more protein, enhancing precision therapy potential

Imagine a breakthrough in cancer treatment where only malignant cells are targeted, sparing healthy host cells; or patients with abnormal protein synthesis are treated to produce a healthy protein. Hiroshi Abe and his colleagues at Nagoya University have identified two applications, among others, in a new study.

Their innovative approach reported in *Nature Biotechnology,* called the Internal Cap-Initiated Translation (ICIT) mechanism, introduces a novel way to "switch on" protein synthesis only in target cells, creating healthy proteins to treat illnesses or toxic proteins to kill unwanted cells.

Capping circular mRNA in a new way

ICIT builds on the promise of circular mRNAs, a new generation of mRNA treatments known for their stability and reduced inflammatory effects compared to traditional linear mRNAs.

Unlike linear mRNAs, circular mRNAs are less susceptible to enzymatic degradation because of their lack of terminal structures, offering a sustained translation process.

However, one significant challenge with circular mRNAs has been the inefficiency of their translation inside living organisms.

Previous methods relied on long internal ribosome entry sites (IRES) for introducing the mRNA, which were difficult to optimize and often inefficient. Abe's team overcame this hurdle by introducing a cap structure into the circular mRNA itself.

This internal cap structure triggers translation initiation, bypassing the need for IRES sequences, and significantly improves the efficiency of protein synthesis.

Precision therapy

Abe and his colleagues developed two designs. Among these, Cap-circRNA demonstrated superior performance, synthesizing up to 200 times more protein than commonly used circular mRNAs with IRES sequences. Importantly, this synthesis persisted for an extended period, even after traditional mRNA structures began to degrade.

This stability and ability to selectively target cells make Cap-circRNA an ideal candidate for developing precision therapies.

"This technology is expected to revolutionize mRNA medicine, including antibody therapy, genome editing, and protein replacement therapy," Abe said.

"Current mRNA is fundamentally unstable, requiring constant injections to be used for treatments such as protein replacement, a problem that our technique overcomes. Using this, we could treat diseases caused by abnormal protein synthesis, such as Duchenne muscular dystrophy."

Targeting cancer cells

The ICIT mechanism's ability to control protein translation at the single-cell level also offers a transformative approach to the treatment of cancers and other tissue-specific diseases. By targeting specific RNA markers that are highly expressed in diseased cells, such as those found in liver cancer, the mRNA can instruct protein synthesis only in target cells.

This precision reduces the risk of off-target effects and side reactions, which are common challenges in current treatments. To test its efficacy, the team designed a circular RNA using ICIT to target HULC lncRNA, an RNA that is commonly found in liver cancer cells.

HULC lncRNA's presence resulted in over a 50-fold increase in protein synthesis, highlighting ICIT-RNAs' ability to differentiate single cancer cells from normal cells.

"This breakthrough paves the way for developing mRNA drugs that selectively target diseased cells without adverse effects," Abe said.

"Using a biomarker from cancer cells, we could design an mRNA that expresses a toxic protein only in cancer cells. Programmed cell death could then be induced by cytokines."

The study also suggests that similar translation control mechanisms might naturally occur in cells through the interaction of long non-coding RNAs and mRNAs. Understanding these processes may lead to new therapeutic approaches for a variety of diseases.

The team's discovery marks a significant advancement in mRNA medicine, opening exciting possibilities for the future of personalized and precise health care.

(Downloaded from https://phys.org/news/2025-02-circular-mrna-protein-precision-therapy.html

Text 9. Enzymes are the engines of life—machine learning could help scientists design new ones

Enzymes are molecular machines that carry out the chemical reactions that sustain all life, an ability that has captured the attention of scientists like me.

Consider muscle movement. Your body releases a molecule called acetylcholine to trigger your muscle cells to contract. If acetylcholine sticks around for too long, it can paralyze your muscles including your heart muscle cells. This is where the enzyme acetylcholinesterase. For an enzyme

to function, it adopts a shape that perfectly matches the molecule it processes, much like a lock matches a key. The unique grooves in the enzyme – the lock – that interact with the target molecule. The key are found in a region of the enzyme known as the active site.

The active site of the enzyme precisely orients amino acids to interact with the target molecule when it enters. This makes it easier for the molecule to undergo a chemical reaction to turn into a different one, making the process go faster. After the chemical reaction is done, the new molecule is released and the enzyme is ready to process another.

comes in. This enzyme can break down thousands of acetylcholine molecules per second to ensure muscle contraction is stopped, paralysis avoided and life continued. Without this enzyme, it would take a month for a molecule of acetylcholine to break down on its own, about 10 billion times slower.

You can imagine why enzymes are of particular interest to scientists looking to solve modern problems. What if there were a way to break down plastic, capture carbon dioxide or destroy cancer cells as fast as acetylcholinesterase breaks down acetylcholine? If the world needs to take action quickly, enzymes are a compelling candidate for the job if only researchers could design them to handle those challenges on demand.

Designing enzymes, unfortunately, is very hard. It's like working with an atom-sized Lego set, but the instructions were lost and the thing won't hold together unless it's assembled perfectly. Newly published research from our team suggests that machine learning can act as the architect on this Lego set, helping scientists build these complex molecular structures accurately.

What's an enzyme?

Let's take a closer look at what makes up an enzyme. Enzymes are proteins—large molecules that do the behind-the-scenes work that keep all living things alive. These proteins are made up of amino acids, a set of

building blocks that can be stitched together to form long strings that get knotted up into specific shapes.

The specific structure of a protein is key to its function in the same way that the shapes of everyday objects are. For example, much like a spoon is designed to hold liquid in a way that a knife simply can't, the enzymes involved in moving your muscles aren't well suited for photosynthesis in plants.

How do you design an enzyme?

Scientists have spent decades trying to design their own enzymes to make new molecules, materials or therapeutics. But making enzymes that look like and go as fast as those found in nature is incredibly difficult.

Enzymes have complex, irregular shapes that are made up of hundreds of amino acids. Each of these building blocks needs to be placed perfectly or else the enzyme will slow down or completely shut off. The difference between a speed racer and slowpoke enzyme can be a distance of less than the width of a single atom.

Initially, scientists focused on modifying the amino acid sequences of existing enzymes to improve their speed or stability. Early successes with this approach primarily improved the stability of enzymes, enabling them to catalyze chemical reactions at a higher range of temperatures. But this approach was less useful for improving the speed of enzymes. To this day, designing new enzymes by modifying individual amino acids is generally not an effective way to improve natural enzymes.

Researchers found that using a process called directed evolution, in which the amino acid sequence of an enzyme is randomly changed until it can perform a desired function, proved much more fruitful. For example, studies have shown that directed evolution can improve chemical reaction speed, thermostability, and even generate enzymes with properties that aren't seen in nature. However, this approach is typically labor-intensive: You have to screen many mutants to find one that does what you want. In

some cases, if there's no good enzyme to start from, this method can fail to work at all.

Both of these approaches are limited by their reliance on natural enzymes. That is, restricting your design to the shapes of natural proteins likely limits the kinds of chemistry that enzymes can facilitate. Remember, you can't eat soup with a knife.

Is it possible to make enzymes from scratch, rather than modify nature's recipe? Yes, with computers.

Designing enzymes with computers

The first attempts to computationally design enzymes still largely relied on natural enzymes as a starting point, focusing on placing enzyme active sites into natural proteins.

This approach is aking to trying to find a suit at a thrift store: It is unlikely you will find a perfect fit because the geometry of an enzyme's active site (your body in this analogy) is highly specific, so a random protein with a rigidly fixed structure (a suit with random measurements) is unlikely to perfectly accommodate it. The resulting enzymes from these efforts performed much more slowly than those found in nature, requiring further optimization with directed evolution to reach speeds common among natural enzymes.

Recent advances in deep learning have dramatically changed the landscape of designing enzymes with computers. Enzymes can now be generated in much the same way that AI models such as ChatGPT and DALL-E generate text or images, and you don't need to use native protein structures to support your active site.

Our team showed that when we prompt an AI model, called RF diffusion, with the structure and amino acid sequence of an active site, it can generate the rest of the enzyme structure that would perfectly support it. This is equivalent to prompting ChatGPT to write an entire short story based

on a prompt that only says to include the line "And sadly, the eggs never showed up."

We used this AI model specifically to generate enzymes called serine hydrolases, a group of proteins that have potential applications in medicine and plastic recycling. After designing the enzymes, we mixed them with their intended molecular target to see whether they could catalyze its breakdown. Encouragingly, many of the designs we tested were able to break down the molecule, and better than previously designed enzymes for the same reaction.

To see how accurate our computational designs were, we used a method called X-ray crystallography to determine the shapes of these enzymes. We found that many of them were a nearly perfect match to what we digitally designed.

Our findings mark a key advance in enzyme design, highlighting how AI can help scientists start to tackle complex problems. Machine learning tools could help more researchers access enzyme design and tap into the full potential of enzymes to solve modern-day problems.

(Downloaded from https://phys.org/news/2025-02-enzymes-life-machine-scientists.html)

Text 10. AI model generates antimicrobial peptide structures for screening against treatment-resistant microbes

A team of microbiologists, chemists and pharmaceutical specialists at Shandong University, Guangzhou Medical University, Second Military Medical University and Qingdao University, all in China, has developed an AI model that generates antimicrobial peptide structures for screening against treatment-resistant microbes.

In their study published in the journal *Science Advances,* the group developed a compression method to reduce the number of elements needed

in training data for an AI system, which helped to reduce diversification issues with current AI models.

Prior research has suggested that drug-resistant microbes are one of the most pressing problems in medical science. Researchers around the world have been looking for new ways to treat people infected with such microbes—one approach involves developing antimicrobial peptides, which work by targeting bacterial membranes.

Unfortunately, developing or finding peptides has proven to be too slow to address the crisis. So researchers have turned to AI-based approaches to aid in finding such peptides. But that approach has encountered problems, as well, the biggest being the lack of a large training base, which leads to peptide discovery that lacks diversity.

In this new study, the researchers in China found a way around this problem by developing a compression technique that reduces the number of elements needed to train their AI system.

The researchers call their system a two-stage AI pipeline leverage diffusion model. The first stage works by compressing data describing 2.8 million known peptides into a numerical form by amplifying signal noise randomly. The second stage then pulls new peptides from the simplified data, removes the noise, and decompresses the data used to describe its peptide sequence.

In testing their new system, the research team found that it was able to filter peptides listed in a training database down to a reasonable number of those most likely to have antimicrobial properties. In looking at 600,000 of them, the team experimentally tested 40 peptides and found 25 that showed promise in combating bacterial and fungal pathogens.

(Downloaded from https://phys.org/news/2025-02-ai-generates-antimicrobial-peptide-screening.htm))l)

BIOTECHNOLOGY GLOSSARY

Amino acids

Building blocks of proteins. There are 20 common amino acids: alanine, arginine, aspargine, aspartic acid, cysteine, glutamic acid, glutamine, glycine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, proline, serine, threonine, tryptophan, tyrosine and valine. Two more amino acids have been discovered in microbes: selenocysteine and pyrrolysine.

Bioinformatics

The science of informatics as applied to biological research. Informatics is the management and analysis of data using advanced computing techniques. Bioinformatics is particularly important as an adjunct to genomics research, because of the large amount of complex data this research generates.

Biologic

A therapeutic or prophylactic derived from a living source (human, animal or unicellular). Most biologics are complex mixtures that are not easily identified or characterized, and many are manufactured using biotechnology. Biological products often represent the cutting-edge of biomedical research and are sometimes the most effective way to prevent or treat a disease.

Deoxyribonucleic acid (DNA)

The molecule that carries the genetic information for most living systems. The DNA molecule consists of four bases (adenine, cytosine, guanine and thymine) and a sugar-phosphate backbone, arranged in two connected strands to form a double helix. See also Complementary DNA; Double helix; Recombinant DNA.

Double helix

A term often used to describe the configuration of the DNA molecule. The helix consists of two spiraling strands of nucleotides (a sugar, phosphate and

base) joined crosswise by specific pairing of the bases. See also Deoxyribonucleic acid; Base; Base pair.

Gene therapy

The replacement of a defective gene in an organism suffering from a genetic disease. Recombinant DNA techniques are used to isolate the functioning gene and insert it into cells. More than 300 single-gene genetic disorders have been identified in humans. A significant percentage of these may be amenable to gene therapy.

Immunomodulators

A diverse class of proteins that boost the immune system. Many are cell growth factors that accelerate the production of specific cells that are important in mounting an immune response in the body. These proteins are being investigated for use in possible treatments for cancer.

Nucleotides

The building blocks of nucleic acids. Each nucleotide is composed of sugar, phosphate and one of four nitrogen bases. The sugar in DNA is deoxyribose and RNA's sugar is ribose. The sequence of the bases within the nucleic acid determines the sequence of amino acids in a protein. See also Base.

Pluripotent cells

Having the capacity to become any kind of cell or tissue in the body. Embryonic stem cells and cells of the inner cell mass are pluripotent. Adult stem cells are multipotent. The mammalian embryo (blastocyst trophoblast plus inner cell mass) is totipotent because it can become an entire organism. Fully differentiated cells from many plants are totipotent.

Technology transfer

The process of transferring discoveries made by basic research institutions, such as universities and government laboratories, to the commercial sector for development into useful products and services.

Vaccine

A preparation that contains an antigen, consisting of whole disease-causing organisms (killed or weakened) or parts of such organisms, that is used to confer immunity against the disease that the organisms cause. Vaccine preparations can be natural, synthetic or derived by recombinant DNA technology.

Virus

A submicroscopic organism that contains genetic information but cannot reproduce itself. To replicate, it must invade another cell and use parts of that cell's reproductive machinery.

(Adopted from http://www.biotechinstitute.org/go.cfm?do=Page.View&pid=21

Appendix 1

Как написать SUMMARY на английском языке

SUMMARY – краткий обзор объёмного текста. Задача SUMMARY – дать читателю представление об исходном тексте без ознакомления с ним, значительно сэкономив время.

Вот некоторые советы по написанию качественного SUMMARY:

1) Текст должен выглядеть адекватным и понятным для человека, который не читал оригинальный текст.

2) Объём получившегося текста должен составлять примерно одну треть от объема исходного текста.

3) Необходимо перефразировать, а не переписывать предложения!

(Например: The author states that…/ The article mentions/ points out/emphasizes…)

В summary не должно быть прямой речи!

4) Необходимо соблюдать следующую **структуру** написания: введение, основная часть, заключение.

5) Во введении следует обозначить название статьи, автора и источник (если есть) и тему.

6) В основной части повествования необходимо указать основные идеи без подробностей.

7) В заключении должен быть представлен вывод, который делает автор статьи.

8) **НЕ СЛЕДУЕТ** включать своё мнение и не должно быть личных местоимений (я, мы)!

Выражения, используемые для summary

1. Название статьи, автор

The article goes under the headline…/ The author of the article is… /The article comes from…/is taken from…

2. Тема статьи + Логические части.

The topic of the article is… / The key issue of the article is… /The article under discussion is devoted to the problem… / The article can be divided into several logically connected parts which are…

3. Краткое содержание.

The author starts by telling the reader that…

At the beginning of the article the author…describes / touches upon /explains/introduces /mentions

The article begins (opens) with a (the) description of / statement /introduction of/ the mention of /the analysis of…/the classification of…

First of all / first(ly) / second(ly) / then / thus / next / to conclude

4. Отношение автора к отдельным моментам.

The author gives full coverage to…/The author outlines…/ covers / focuses on / highlights / tells about

The article contains the following facts…./ describes in details…

The author asserts that… /dwells on /points out /generalizes

5. Вывод автора.

In conclusion the author says / makes it clear that…/ gives a warning that… – В заключение автор говорит / проясняет, что … / дает предупреждение, что …

The author concludes by saying that../ draws a conclusion that / comes to the conclusion that – В заключение автор говорит, что .. / делает вывод, что / приходит к выводу, что…

Более подробное объяснение с примерами

https://lingua-airlines.ru/articles/kratkoe-izlojenie-teksta-na-angliyskom-vopros-i-otvet/

В дополнение к информации см. видео: *https://youtu.be/QJdYjNCKCj4*

Appendix 2

PREPARING A PRESENTATION

Phrases which help you to make a presentation:

1. Introduction

• Good morning, everybody! (ladies and gentlemen).

• Let me introduce myself. My name is.. ./I am a first year law student.

• The topic of my presentation is.. ./Today I would like to tell you about…

• I have chosen this topic because…, / The purpose of my presentation is to inform/ to persuade…

• The form of my presentation is .. ./The body of my presentation consists of… parts.

• It will take only 5-7minutes of your time.

2. Body

• First..

• I have divided my presentation into 2-3 parts.

• Then…

• After that I'd like to move on to… /-Next I'd like to move on to… /-Finally I'd like to move on to…

3. Conclusion

• Let us summarize briefly what we have looked at.

• Let us briefly summarize the main issues.

• In conclusion I want to say.

• That is the end of my presentation.

• Thank you for your listening/attention.

4. Inviting questions

• You are welcome with your questions.

• I am ready to answer any of your questions.

• Could you repeat your question?

• I am sorry, but I didn't follow your question.

• If there are no more questions thank you again for your attention.

Appendix 3
HOW TO WRITE AN ESSAY IN ENGLISH
Как написать эссе на английском языке
(рекомендации + пример)

Структура:

1) Введение
2) Основная часть
3) Заключение

Введение должно давать ясное представление, о чем пойдет речь далее, и преподаватель должен видеть, что вы даете ответ на конкретный набор поставленных вопросов.

Начните эссе с ключевой фразы, которая обозначит направление вашего ответа. Например:

This essay deals with... («Это эссе посвящено...»)

This assignment will examine...(«В этой работе рассматривается...»)

This report will analyse...(«В этом отчете проводится анализ...»)

Основная часть

Основная часть должна раскрывать каждый из аргументов с использованием примеров и иллюстраций. Информация должна быть четко поделена логически (для этого текст делят на абзацы). Вам нужно продумать структуру эссе и убедиться, что основная часть логически ведет к заключению.

Заключение

Заключение должно подводить итог высказанным идеям. Здесь необходимо дать ответ на вопрос, сформулированный в теме эссе. Или же, в зависимости от темы, указать перспективы или последствия рассматриваемой проблемы.

В качестве общего представления о длине каждого раздела можно воспользоваться следующей формулой (это рекомендация, но не жесткое правило):

Введение – 7-8% от объема эссе

Заключение – 12-15% от объема эссе

Рекомендации по оформлению

- Избегайте элементов разговорной речи:
- Не используйте сокращений (don't, they’re, it’s), всегда используйте полную форму;
- Не используйте сленг и разговорные выражения (kid, a lot of/lots of, cool);

пишите по существу и не отклоняйтесь от темы.

- Старайтесь избегать фразовых глаголов (get off, get away , put in)
- Избегайте слишком общих слов (all, any, every), выражайтесь конкретно и точно;
- Не злоупотребляйте скобками, восклицательными знаками.
- Придерживайтесь академического стиля:
- По возможности избегайте личных местоимений первого лица (I, my, we, our).
- Избегайте слишком категоричных суждений и обобщений.
- Подкрепляйте сказанное цитатами и данными с указанием источников.
- В английском языке важно соблюдение гендерного равенства: если речь идет об абстрактном человеке, используйте person вместо man. По возможности лучше ставить подлежащее во множественное число и употреблять местоимение they вместо he или she.
- По возможности, используйте активный залог, не усложняйте предложения.

Связность

Логический переход от одного абзаца к другому иногда вызывает у автора серьезные затруднения. Чтобы сохранить связность текста, могут помочь вводные и связующие слова, выполняющие различные функции. Например:

противопоставление: but, however, on the other hand, yet;

пример: for example, that is;

дополнение: similarly, moreover, furthermore, in addition;

заключение: therefore, consequently, as a result, thus;
перечисление: then, after that, ultimately.

(Источник - Школа английского языка Skyeng: https://skyeng.ru/articles/kak-pravilno-pisat-esse-na-anglijskom-yazyke/

Пример написания эссе (Sample Essay Assignment)

Write a physics essay on the topic "The 21st Century Has Begun. What Changes Do You Think This New Century Will Bring?". Give reasons for your answer and include any relevant examples from your own experience or knowledge. You should write at least 250 words.

Sample Answer

The beginning of a new era, 21st century, brings the question to anyone's mind 'whether it is the beginning of a great shift?' Well, in my opinion, the changes will definitely bring a revolution to the mankind.

As the world is progressing towards the new and sophisticated technologies and inventions, our lives are becoming easier and more relaxed. The mode of communication is faster and cheaper as compared to early times. In a fraction of a second, information can be transferred to the distant part of the world. All thanks go to the user-friendly applications, like the email feature, that are being invented for the welfare of mankind. In this new century, communication would be free of charge and more interactive.

Secondly, the technology in this century will improve the quality of health care facilities given to an individual beyond expectations. The health care professionals will be more qualified and adept. Due to the advancement of the research facilities, many diseases will be eradicated. The quality of life would be significantly better and our lifespan would increase. Finally, space research in this century would unfurl some answers we have been seeking for a long time. Maybe at the end of this century human would be ready to live on another planet.

But all these improvement and marvel would not come without the cost. There is no doubt that humans would become somewhat slaves in the hand of technology. Their personal lives would be greatly affected by the

over usage of technology. More powerful weapons would be a great concern for the world population in this century.

To conclude, this era would bring many marvelous discoveries to our life but at the same time, the perils would be a great anxiety for people all around the world.

(Adopted from Семенова, А.А., Николаева, Н.Н. English for Students of Applied Physics : Английский язык для студентов физиков. Учебное пособие. – Москва: Издательство МГТУ им. Н.Э. Баумана, 2020. – 270 с.)

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Учебное издание

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PROFESSIONAL ENGLISH: BIOTECHNOLOGY

Профессиональный английский язык: биотехнология

Учебное пособие