МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
КИЇВСЬКИЙ НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ ІМЕНІ ТАРАСА ШЕВЧЕНКА
ЧЕРНІВЕЦЬКИЙ НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ ІМЕНІ ЮРІЯ ФЕДЬКОВИЧА

READING AND TRANSLATION SKILLS: BIOLOGY ENGLISH

Посібник з читання та перекладу галузевого тексту

Навчальний посібник

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The manual focuses on the development of reading and translation skills by the students dealing with the LSP text. The original texts taken from Internet sources are offered for their communicative analysis and translation.

The manual is aimed at the students of Biology and translation students and anyone interested in special text analysis, comprehension and effective communication in the world of technology and science.

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ПЕРЕДМОВА

Навчальний посібник з англійської мови з читання та перекладу галузевого тексту призначений для здобувачів вищої освіти з метою поглиблення навичок читання та перекладу тексту вузької спеціалізації. Серед ключових завдань пропонованої книги – сприяти розвиткові навичок аналітичного читання оригінального наукового тексту; усного і письмового галузевого перекладу; розширенню загальної і лексичної ерудиції студентів освітньо-кваліфікаційного рівня "Бакалавр", які навчаються за природничою чи філологічною спеціальностями шляхом обговорення вивчених тем.

Навчальний посібник закриває навчально-методичну прогалину для студентів спеціальності 035 Філологія, зокрема, вибіркового компоненту "Основи галузевого перекладу", що вивчається студентами-перекладачами. Матеріли посібника також можуть бути використані для викладання англійської мови студентам-біологам та студентам інших природничих спеціальностей, які мають рівень знань мови вище середнього, з метою удосконалення знань англійської мови з їхньої спеціальності, а також розвитку навичок читання оригінального тексту, перекладу і збагачення словникового запасу зі сфери біології.

Структура посібника складається з дванадцяти розділів, матеріалів для додаткового читання і списку використаних джерел англійською мовою. Шістнадцять використаних у посібнику текстів охоплюють теми, які відображають актуальні напрями досліджень у сучасних природничих науках.

Кожний розділ посібника базується на основі текстів оригінальних статей суміжної тематики, що входять до галузі біології та були дібрані зі Інтернет-джерел. Всі оригінальні тексти, що підлягають опрацюванню студентами, подані в окремих додатках. Матеріали розділів у повному обсязі подають інформацію щодо поданої теми та містять перелік основних термінів, які рекомендовані до засвоєння. Тексти та завдання

спрямовані на читання та розуміння галузевого тексту, вилучення необхідної інформації з незнайомих текстів та вдосконалення навичок усного і письмового перекладу прочитаних текстів з біологічної тематики.

На початку розділу подано дві вправи на введення теми (lead-in), які допомагають студенту зорієнтуватися у подальшому вивченні матеріалу. Наступним кроком є прочитання оригінального тексту статті, на основі якого розроблено різноманітні тренувальні вправи. Комплекс вправ на перевірку розуміння тексту (text comprehension) передбачає, зокрема, запитання, що потребують конкретної відповіді на основі тексту статті; вправи, що передбачають вибір правильного чи хибного твердження на основі тексту; завдання множинного вибору; вправи на продовження думки речення, взятого з тексту; завдання заповнення прогалин у твердженнях на основі інформації з тексту.

Наступним блоком тренувальних вправ є вправи для інтеріоризації актуальної лексики та її перекладу з англійської мови на українську та навпаки. До кожного оригінального тексту розроблено блок вправ на переклад слів і словосполучень, що зустрічаються в статті, українською та англійською мовами. На основі цих словосполучень запропоновано вправи на переклад речень українською та англійською мовами, що також може виконуватися у форматі усного послідовного перекладу.

Останнім блоком тренувальних вправ є завдання, що сприяють розвитку мовленнєвих навичок, стимулюють до обговорення вивченої теми і мотивують студентів до комунікації та обміну досвідом. До таких завдань належать опис картинки, дотичної до теми розділу; проходження опитувальника й обговорення результатів у групах; розігрування діалогів за поданими ситуаціями; обговорення загальних питань і питань ширшої тематики, що стосуються теми розділу; перегляд й обговорення англійських тематичних відеоматеріалів; підготовка творчих завдань і проєктів, що передбачає роботу в парах чи невеликих групах.

Широкий вибір стимулюючих текстів для читання, що надають можливість поглибити знання актуальних питань

біології, вправи для самоперевірки, а також максимального залучення студентів до дискусій представлено у прикінцевій частині посібника.

Загалом, завдання посібника привчають студентів аналітично працювати з оригінальним галузевим текстом, сприяють розвитку навичок перекладу англійсько-української мовної пари й уможливлюють здобуття необхідних мовних знань для обговорення вузькоспеціалізованої теми.

Автори висловлюють щиру подяку рецензентам за критичне прочитання навчального посібника, висловлені конструктивні зауваги і побажання, професійні поради та інтелектуальну підтримку.

Автори відкриті і щиро вдячні за подальші зауваження, побажання і рекомендації щодо поліпшення і вдосконалення змісту цього посібника.

UNIT 1
The Methods of Biology

Exercise 1. *Before you read the text, find the key words "hypothesis" and "experiment" to learn the section below. Underline and read the words and their definitions.*

Exercise 2. *Look through the text "The Methods of Biology" (check out Supplement 1), try to get the gist and identify around 10 keywords.*

Exercise 3. *Reading Comprehension. Answer these questions based on the information from the article.*

1. Give the definition of a hypothesis.
2. Name two groups of a controlled experiment.
3. Are safety procedures followed when conducting an experiment.
4. Who is responsible for the experiment?
5. What is the independent variable in the fertilizer experiment?
6. What is the dependent variable in the fertilizer experiment?
7. Why is it important to keep all other conditions the same for both the control and experimental groups?
8. How can scientists determine if their data is reliable?
9. Why is it important to publish experimental results in scientific journals and databases?
10. How does a hypothesis become a theory?

Exercise 4. *Translate these words and phrases from the article into Ukrainian. Compose your own sentences.*

1. Controlled experiment –
2. Control group –
3. Experimental group –
4. Independent variable –

5. Dependent variable –
6. Safety procedures –
7. Hypothesis –
8. Data –
9. Scientific journals –
10. Theory –

Exercise 5. *Translate these words and phrases from the article into English.*

1. Контрольований експеримент –
2. Контрольна група –
3. Експериментальна група –
4. Незалежна змінна –
5. Залежна змінна –
6. Процедури безпеки –
7. Гіпотеза –
8. Дані –
9. Наукові журнали –
10. Теорія –

Exercise 6. *Translate the sentences into Ukrainian, using the words and phrases from the previous exercises.*

1. The controlled experiment involves two groups: the control group and the experimental group.
2. The independent variable in this experiment is the fertilizer used on the plants.
3. Scientists must follow strict safety procedures when conducting experiments.
4. A hypothesis that is supported by many different investigations and observations becomes a theory.
5. The data collected from the experiments must be analyzed carefully.
6. Publishing results in scientific journals allows other scientists to verify the findings.
7. The control group receives no experimental treatment.
8. The experimental group is the test group that receives experimental treatment.

9. It is important to keep all other conditions the same for both the control and experimental groups.

10. Repeating the experiment several times ensures the reliability of the data.

Exercise 7. *Translate the sentences into English, using the words and phrases from the previous exercises.*

1. Контрольна група не отримує експериментального лікування.

2. Дані, зібрані під час експериментів, повинні бути ретельно проаналізовані.

3. Контрольований експеримент включає дві групи: контрольну групу та експериментальну групу.

4. Гіпотеза, яку підтримують багато різних досліджень та спостережень, стає теорією.

5. Повторення експерименту кілька разів забезпечує надійність даних.

6. Незалежна змінна в цьому експерименті – це добриво, яке використовується на рослинах.

7. Вчені повинні дотримуватися суворих процедур безпеки при проведенні експериментів.

8. Експериментальна група – це тестова група, яка отримує експериментальне лікування.

9. Публікація результатів у наукових журналах дозволяє іншим вченим перевірити ці висновки.

10. Важливо підтримувати всі інші умови однаковими для обох груп – контрольної та експериментальної.

Exercise 8. *Arrange the steps used in scientific research and choose the right letter according to each step:*

a) study results data;

b) conduct experiments;

c) identification of a problem;

d) observe a problem to solve;

e) supported hypothesis.

Exercise 9. *Look through the text again and choose one of the question headings to talk about it.*

Exercise 10. *Watch the video and write a summary of 300 words.*
Methods in biology | All Techniques and their Applications list | CSIR-NET JRF | GATE ||
https://www.youtube.com/watch?v=EhpoORxqSko&list=PLLIvWvpvrjO93OOXqadUF6CyE9lmwoIpZ

Exercise 11. *Fill in the gaps in the summary of the video.*

Introduction:

• Host introduces the concept of the _____ _____ and its importance in scientific inquiry.

Steps of the Scientific Method:

1. _____: Gathering data through the senses or tools to notice something of interest.
2. Question: Formulating a question based on the _____.
3. _____: Developing a testable statement predicting the outcome of the investigation.
4. Experiment: Conducting experiments to test the _____while controlling variables.
5. _____: Interpreting the data collected during the experiments.
6. Conclusion: Drawing conclusions based on the analysis to either support or refute the _____.
7. Communication: Sharing the results with the _____ _____for further validation and testing.

Examples:

• The video provides _____ _____ of how the scientific method has been applied in different scientific discoveries.

Application:

• Emphasis on the _____ _____of the scientific method and how it's not always a linear process but involves constant revisiting of steps based on new data and insights.

Conclusion:

• _____ of the importance of the scientific method in advancing scientific knowledge and encouraging critical thinking.

MINI GLOSSARY

control *[kənˈtrəʊl]***:** in an experiment, the standard against which results are compared *контрольний екземпляр, препарат;*

data *[ˈdeɪtə]***:** information gathered from an experiment – *дані, інформація, зведення, факти;*

dependent variable *[dɪˈpendənt ˈvɛərɪəbl]:* the condition in an experiment that results from the changes made to the independent variable – мат. залежна змінна;

experiment *[ɪkˈspɛrɪm(ə)nt]***:** an investigation that tests a hypothesis by collecting information under controlled conditions – дослід, експеримент;

hypothesis (hypotheses plural) *[haɪˈpɒθɪsɪs]***:** an explanation for a question or problem that can be tested – гіпотеза, припущення;

independent variable *[indɪˈpendənt ˈvɛərɪəbl]***:** in an experiment, the condition that is tested because it affects the outcome of the experiment – мат. незалежна змінна;

scientific methods *[saɪənˈtɪfɪk ˈmeθədz]***:** common steps that scientists use to do research and answer questions – наукові методи, принципи;

theory *[ˈθɪəri]***:** an explanation of a natural phenomenon or event that is supported by a large body of scientific evidence obtained from many different investigations and observations – теорія;

UNIT 2
DNA: the Molecule of Heredity

Exercise 1. *Imagine any combination to open a lock with some numbers on it. Write all possible combinations you can think of to compare the work of DNA and how it can carry so much information.*

Exercise 2. *Look through the text "DNA: The Molecule of Heredity" (check out Supplement 2) and be ready to do the following exercises after it.*

Exercise 3. *Reading Comprehension. Answer these questions based on the information from the article.*

1. Name the three components of a nucleotide.
2. What is the process called by which DNA makes a copy of itself?
3. How are new DNA molecules formed during replication?
4. What shape is the DNA molecule?
5. List the four nitrogenous bases found in DNA.
6. Who were the scientists that first described the shape of the DNA molecule?
7. Why is the sequence of nucleotides important in DNA?
8. What process produces sperm and egg cells in organisms?
9. How many strands make up a DNA molecule?
10. What holds the two strands of DNA together in the double helix?

Exercise 4. *Decide if these statements are True or False based on the information from the article.*

1. DNA is made up of nucleotides.

2. Each nucleotide in DNA is composed of a simple sugar, a phosphate group, and a nitrogenous base.

3. Adenine always pairs with thymine in DNA.

4. DNA has a single-stranded structure.

5. The shape of DNA was discovered by James Watson and Francis Crick in 1953.

6. The sequence of nucleotides in DNA does not affect the genetic information it carries.

7. The process by which DNA makes a copy of itself is called DNA replication.

8. Meiosis is the process that produces sperm and egg cells.

9. A fertilized egg contains DNA from both parents.

10. During DNA replication, adenine pairs with cytosine.

Exercise 5. *Read through the text and amplify the following:*

a) DNA components.

b.) DNA molecule unzipping.

c) Sequence of nucleotides.

d) Double helix.

Exercise 6. *Translate into Ukrainian these words and phrases from the article.*

1. Living things –
2. Proteins –
3. Enzymes –
4. DNA (deoxyribonucleic acid) –
5. Nucleotides –
6. Simple sugar –
7. Phosphate group –
8. Nitrogenous base –
9. Adenine –
10. Guanine –
11. Cytosine –
12. Thymine –
13. Double helix –
14. Sequence –
15. Replication –
16. Meiosis –
17. Mitosis –
18. Fertilized egg –
19. Chromosomes –
20. Genetic information –

Exercise 7. *Translate into English these words and phrases from the article.*

1. Фосфатна група –
2. ДНК (дезоксирибонуклеїнова кислота) –
3. Живі організми –
4. Білки –
5. Азотиста основа -
6. Ферменти –
7. Аденін –
8. Нуклеотиди –
9. Простий цукор –
10. Цитозин –
11. Запліднена яйцеклітина –
12. Подвійна спіраль -
13. Гуанін –
14. Мейоз –
15. Генетична інформація -
16. Тимін –
17. Послідовність –
18. Реплікація –
19. Мітоз –
20. Хромосоми –

Exercise 8. *Translate the sentences into Ukrainian, using the words and phrases from the previous exercises.*

1. Living things contain proteins.
2. Enzymes are proteins that help in various bodily functions.
3. DNA contains the instructions to make all the different proteins an organism needs.
4. Nucleotides join together to form long chains, or strands.
5. Each nucleotide is made up of a simple sugar, a phosphate group, and a nitrogenous base.
6. Adenine always pairs with thymine in DNA.
7. The double helix structure of DNA was discovered by Watson and Crick.
8. The sequence of nucleotides forms the unique genetic information for every organism.
9. Meiosis is the process that produces sperm and egg cells.
10. During replication, DNA makes a copy of itself to ensure each new cell has a complete set of genetic information.

Exercise 9. *Translate the sentences into English, using the words and phrases from the previous exercises.*

1. Під час реплікації ДНК створює свою копію, щоб забезпечити кожну нову клітину повним набором генетичної інформації.

2. ДНК містить інструкції для створення всіх різних білків, необхідних організму.

3. Живі організми містять білки.

4. Аденін завжди спарюється з тиміном у ДНК.

5. Мейоз – це процес, який утворює сперматозоїди та яйцеклітини.

6. Ферменти – це білки, які допомагають у різних функціях організму.

7. ДНК містить інструкції для створення всіх різних білків, необхідних організму.

8. Послідовність нуклеотидів утворює унікальну генетичну інформацію для кожного організму.

9. Нуклеотиди з'єднуються, утворюючи довгі ланцюги або нитки.

10. Кожен нуклеотид складається з простого цукру, фосфатної групи та азотистої основи.

11. Подвійну спіральну структуру ДНК відкрили Вотсон і Крик.

Exercise 10. *Fill in the gaps with the correct collocations from the article.*

Living _____
_____ proteins
_____ actions
Eating, running, and _____
Depend _____
Related to _____
Information for _____
_____ all that information
Made up _____
_____ units
Nitrogenous _____
Carbon _____ structure
_____ of nitrogen
_____ group
_____ long chains
Shape of a DNA _____
Double _____

Exercise 11. *Fill in the gaps with the correct collocation from the previous exercise.*

1. _____ _____ like humans and animals rely on DNA for genetic information.

2. The DNA in your cells _____ _____ that are essential for various bodily functions.

3. All the _____ _____ you perform, such as _____, _____, and _____, are driven by proteins.

4. Proteins called _____ are crucial because many biochemical reactions _____ _____ them.

5. The sequence of nucleotides in DNA is known as the _____ _____ _____.

6. DNA is _____ _____ _____ repeating units called nucleotides.

7. A _____ _____ is a key part of the nucleotide's structure, containing nitrogen atoms.

8. The _____ _____ joins together to _____ _____ _____ that form the backbone of DNA.

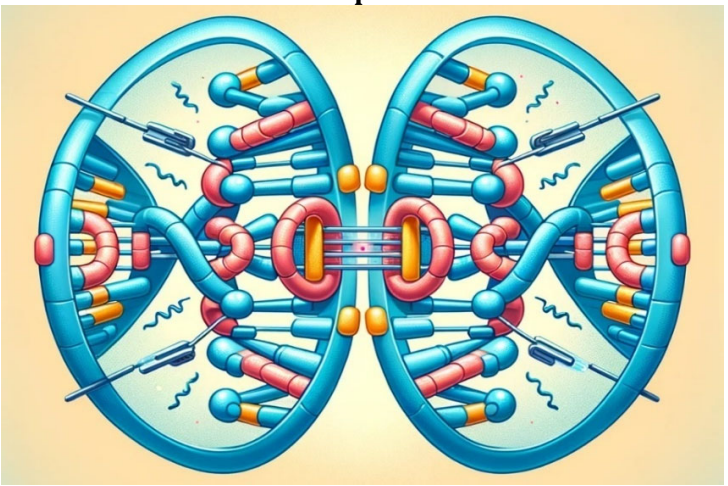
9. Watson and Crick described the _____ _____ _____ _____ _____ in 1953.

10. The unique pairing of _____ _____ ensures the stability and replication of the _____ _____.

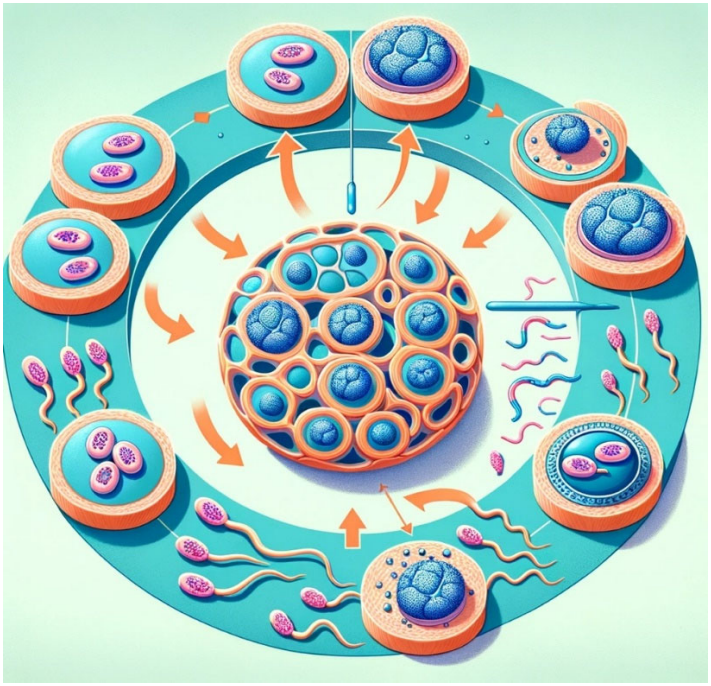
Exercise 12. *Describe the following pictures, using the vocabulary from this unit. Share reports and contribute your ideas in small groups.*

Various Living Things

DNA Replication



Meiosis



MINI GLOSSARY

DNA replication [*rɛplɪˈkeɪʃ(ə)n*]**:** process in which the DNA in the chromosome is copied – копіювання, дублювання;

double helix [ˈ*dʌb(ə)l ˈhiːlɪks*]**:** shape of a DNA molecule consisting of two strands of nucleotides that are twisted into a coil and held together by the nitrogenous bases – подвійна спіраль;

nitrogenous base [*naɪˈtrɒdʒɪnəs beɪs*]**:** carbon ring structure found in DNA molecules that contains one or more atoms – азотиста основа.

UNIT 3
From DNA to Protein

Exercise 1. *Imagine a computer code, give your own definition of this term.*

Exercise 2. *Look through the text "From DNA to Protein" (check out Supplement 3) and try to get its main idea.*

Exercise 3. *Reading Comprehension. Answer the questions based on the article.*

1. Name three types of RNA.
2. Give the definition of codon.
3. Compare the two terms "transcription" and "translation."
4. To which chemical bases do the letters G and T refer?
5. What is the role of mRNA in protein synthesis?
6. What happens during the process of RNA transcription?
7. Explain the difference between RNA and DNA in terms of their structure.
8. Describe the role of tRNA in the translation process.
9. How is the genetic code used to create proteins?
10. What is the central dogma of biology?

Additional Questions

1. What is the role of ribosomal RNA (rRNA) in protein synthesis?
2. How does the mRNA sequence determine the sequence of amino acids in a protein?
3. Why is RNA processing necessary before translation?
4. Explain the importance of the start and stop codons in protein synthesis.
5. How do enzymes participate in RNA processing?
6. Describe the role of amino acids in the formation of proteins.

Exercise 4. *Fill in the blanks with the appropriate words or phrases from the text.*

1. DNA contains information used to make _____.
2. Proteins have many uses; some become _____ and some control _____ functions.
3. The role of RNA in a cell is similar to _____ in a car factory.
4. There are three different kinds of RNA: _____ RNA, _____ RNA, and _____ RNA.
5. The sugar in RNA is different from the sugar in _____.
6. Instead of thymine, RNA has _____.
7. The process of making RNA from part of a DNA strand is called _____.
8. In transcription, RNA pairs guanine with _____ and uracil with _____.
9. The nucleotide sequence transcribed from DNA to a strand of messenger RNA is a genetic _____.
10. Each group of three nitrogenous bases in mRNA that codes for one amino acid is known as a _____.
11. The process of changing the information in mRNA into an amino acid chain in protein is called _____.
12. The central dogma of biology describes the flow of information from _____ to _____ to _____.

Exercise 5. *Define the following terms in English:*

- central dogma,
- the process of replication,
- the amino acid bonds,
- the nucleotide sequence,
- messenger RNA,
- the genetic code,
- anticodon,
- amino acid chains,
- RNA processing.

Exercise 6. *Match words and phrases with their definitions.*

1	Central dogma	A	The connections formed between amino acids during protein synthesis, specifically through peptide bonds that link the carboxyl group of one amino acid to the amino group of another

2	The process of replication	B	The order of nucleotides in a DNA or RNA molecule that determines the genetic information carried by that molecule.
3	Amino acid bonds	C	It describes the flow of genetic information within a biological system, specifically from DNA to messenger RNA (mRNA) to protein
4	The nucleotide sequence	D	The set of rules by which information encoded in mRNA sequences is translated into proteins by living cells.
5	Messenger RNA	E	The process by which DNA makes a copy of itself before cell division, ensuring each new cell has a complete set of DNA
6	The genetic code	F	Chains of amino acids linked together by peptide bonds to form proteins.
7	Anticodon	G	The modification of RNA transcripts, including splicing, capping, and adding a poly-A tail, to produce mature mRNA ready for translation.
8	Amino acid chains	H	A type of RNA that carries genetic information from DNA in the nucleus to the ribosome in the cytoplasm.
9	RNA processing	I	A sequence of three nucleotides in transfer RNA (tRNA) that pairs with the complementary codon in messenger RNA (mRNA) during protein synthesis.

Exercise 7. *Translate into Ukrainian these words and phrases from the article.*

1. Genes
2. Proteins
3. RNA (ribonucleic acid)
4. Messenger RNA (mRNA)
5. Ribosomal RNA (rRNA)
6. Transfer RNA (tRNA)
7. Amino acids
8. Nucleotide
9. Codon
10. Anticodon
11. Transcription
12. Translation

13. Genetic code
14. Central dogma
15. Replication
16. Nucleotide sequence
17. RNA processing
18. Amino acid bonds
19. Amino acid chains

Exercise 8. *Translate into English these words and phrases from the article.*

1. Гени
2. Білки
3. РНК (рибонуклеїнова кислота)
4. Інформаційна РНК (іРНК)
5. Рибосомна РНК (рРНК)
6. Транспортна РНК (тРНК)
7. Амінокислоти
8. Нуклеотид
9. Кодон
10. Антикодон
11. Транскрипція
12. Трансляція
13. Генетичний код
14. Центральна догма
15. Реплікація
16. Послідовність нуклеотидів
17. Обробка РНК
18. Зв'язки амінокислот
19. Ланцюги амінокислот

Exercise 9. *Translate the following sentences into Ukrainian, using the words and phrases from the previous exercises.*

1. Genes contain the instructions for making proteins.
2. Proteins have many functions in the body, including building structures and controlling cell processes.
3. RNA plays a crucial role in the synthesis of proteins.
4. Messenger RNA (mRNA) carries genetic information from DNA to the ribosome.
5. The central dogma of biology states that information flows from DNA to RNA to protein.
6. Amino acids are the building blocks of proteins.
7. A nucleotide is the basic unit of DNA and RNA.
8. A codon is a sequence of three nucleotides that codes for a specific amino acid.
9. An anticodon is a sequence of three nucleotides in tRNA that pairs with a complementary codon in mRNA.
10. Transcription is the process by which RNA is made from a DNA template.

Exercise 10. *Translate the following sentences into English, using the words and phrases from the previous exercises.*

1. Зв'язки амінокислот утворюють структуру білків.
2. Ланцюги амінокислот утворюються під час процесу трансляції.
3. Рибосомна РНК (рРНК) утворює ядро структури рибосоми та каталізує синтез білків.
4. Гени містять інструкції для створення білків.
5. Білки мають багато функцій в організмі, включаючи створення структур та контроль клітинних процесів.
6. Кодон – це послідовність з трьох нуклеотидів, яка кодує певну амінокислоту.
7. Генетичний код – це набір правил, за якими інформація, закодована в мРНК, транслюється у білки.
8. Амінокислоти є будівельними блоками білків.
9. Нуклеотид є основною одиницею ДНК та РНК.
10. Послідовність нуклеотидів визначає генетичну інформацію, яку несе ДНК або РНК.
11. Інформаційна РНК (іРНК) переносить генетичну інформацію від ДНК до рибосоми.
12. Транспортна РНК (тРНК) доставляє амінокислоти до рибосоми для збирання в білок.

Exercise 11. *Create nouns from these adjectives found in the article.*

- Different
- Complicated
- Simple
- Specific
- Genetic
- Various
- Unique
- Single
- Similar
- Important
- Reliable
- Successful
- Central
- Complex
- Mature
- Structural

Exercise 12. *Discuss these questions, using the vocabulary from the unit, in small groups.*

1. How do genes influence the different characteristics of an organism?
2. What role do proteins play in the functioning of cells?

3. Why is RNA considered crucial for protein synthesis?
4. What types of RNA exist and what are their functions?
5. How does the structure of RNA differ from that of DNA?
6. What is a codon and what is its role in the genetic code?
7. How does the process of DNA replication ensure genetic continuity?
8. How do amino acid bonds contribute to protein structure?
9. What is the importance of RNA processing in gene expression?
10. How does transcription differ from translation in protein synthesis?
11. How does the genetic code translate into a specific protein sequence?
12. How do mutations in the nucleotide sequence affect protein synthesis?
13. What mechanisms ensure the accuracy of protein synthesis?

MINI GLOSSARY

codon [*ˈkəʊdɒn*]**:** a group of three nitrogenous bases in mRNA that code for one amino acid – кодон;

messenger RNA [*ˈmɛsɪn(d)ʒə*]**:** RNA that carries information from DNA in the nucleus to the cell's cytoplasm – агент РНК;

ribosomal RNA [*ˈraɪbə(ʊ)səʊməl*]**:** RNA that makes up the ribosomes; binds to mRNA and uses its information to assemble amino acids in the right order – рибосомальний;

transcription [*traːnˈskrɪpʃ(ə)n*]**:** the process in the cell nucleus where a copy of RNA is made from part of a DNA strand – запис;

transfer RNA [*traːnsˈfə*]**:** RNA that delivers amino acids to the ribosomes to be assembled into proteins – передавати РНК;

translation [*transˈleɪʃ(ə)n*]**:** the process of changing the information in mRNA into an amino acid chain in a protein – перетворення.

UNIT 4
Recombinant DNA Technology

Exercise 1. *Give examples of useful changes to organisms made through DNA technology.*

Exercise 2. *Read the text "Recombinant DNA Technology" (check out Supplement 4), write out the new terms and identify 10 keywords.*

Exercise 3. *Reading Comprehension. Answer these questions based on the article.*

1. What are advantages of DNA?
2. Define the term "vector".
3. Why do scientists clone animals?
4. What areas will benefit from DNA technology?
5. What is recombinant DNA?
6. How do restriction enzymes work?
7. What is a transgenic organism?
8. Describe the three-step process for producing a transgenic organism.
9. What is the role of a plasmid in genetic engineering?
10. What is PCR and how is it used in DNA analysis?

Exercise 4. *Decide if these statements are True or False based on the information from the article.*

1. Genetic engineering involves cutting DNA fragments from one organism and inserting them into another organism.
2. Recombinant DNA can only be made from fragments of DNA from the same species.
3. A plasmid is a small ring of DNA found in plant cells.
4. Clones are genetically identical copies of DNA molecules.
5. Scientists can clone entire animals.
6. PCR is used to create genetically identical organisms.

7. DNA technology is only beneficial in the field of medicine.

8. Transgenic organisms contain recombinant DNA from a different species.

9. Restriction enzymes cut DNA at random locations.

10. PCR can make millions of copies of DNA in a day.

Exercise 5. *Choose two any terms that are related and explain why. Give your own examples.*

Exercise 6. *Translate these words and phrases from the article into Ukrainian.*

1. Genetic engineering –
2. Recombinant DNA –
3. Transgenic organism –
4. Restriction enzymes –
5. Plasmid –
6. Vector –
7. Clone –
8. Gene cloning –
9. Polymerase chain reaction (PCR) –
10. DNA fragment –
11. Host cell –
12. Nucleotide sequence –
13. Bacterial chromosome –
14. Replicate –
15. Human growth hormone –
16. Hemophilia –
17. Nutritional value –
18. Pesticides –
19. Insulin –
20. DNA analysis –

Exercise 7. *Translate these words and phrases from the article into English.*

1. Полімеразна ланцюгова реакція (ПЛР) –
2. Рестрикційні ферменти –
3. Вектор –
4. Генетична інженерія –
5. Гемофілія -
6. Рекомбінантна ДНК –
7. Послідовність нуклеотидів –
8. Гормон росту людини –
9. Пестициди –
10. Інсулін –
11. Аналіз ДНК –
12. Трансгенний організм –
13. Плазміда –
14. Клон –
15. Клонування генів –
16. Фрагмент ДНК –
17. Клітина-господар –
18. Бактеріальна хромосома –
19. Реплікувати –
20. Харчова цінність –

Exercise 8. *Translate the sentences into Ukrainian, using the words and phrases from the previous exercises.*

1. Genetic engineering is a method to increase the frequency of a desired allele.
2. Recombinant DNA is created by combining DNA from different sources.
3. A transgenic organism contains recombinant DNA from a different species.
4. A plasmid is a small ring of DNA found in bacterial cells.
5. A vector carries DNA from one organism into a host cell.
6. Using genetically modified plants can reduce the need for pesticides.
7. Hemophilia is a disease where blood cannot clot quickly.
8. Enhancing the nutritional value of crops is a goal of genetic engineering.
9. Clones are genetically identical copies of DNA molecules.
10. The nucleotide sequence determines the specific genetic information.
11. DNA analysis is used in crime investigations and diagnosing diseases.
12. Insulin is produced using recombinant DNA technology.

Exercise 9. *Translate the sentences into Ukrainian, using the words and phrases from the previous exercises.*

1. Підвищення харчової цінності сільськогосподарських культур є кінцевою метою генетичної інженерії.
2. Використання генетично модифікованих рослин може зменшити потребу у використанні пестицидів.
3. Генетична інженерія - це метод підвищення частоти бажаного алеля.
4. Рекомбінантна ДНК створюється шляхом комбінування ДНК з різних джерел.
5. Трансгенний організм містить рекомбінантну ДНК з іншого виду.
6. Фрагмент ДНК вставляється в клітину-господаря з метою реплікації.

7. Послідовність нуклеотидів визначає специфічну генетичну інформацію.

8. Плазміда – це невелике кільце ДНК, що знаходиться в бактеріальних клітинах.

9. Клони – це генетично ідентичні копії молекул ДНК.

10. Клонування генів передбачає створення ідентичних копій певного гена.

11. Аналіз ДНК використовується в кримінальних розслідуваннях і діагностиці захворювань.

12. Рестрикційні ферменти - це бактеріальні білки, які розрізають ДНК у специфічних послідовностях.

Exercise 10. *Complete the quiz on Recombinant DNA Technology*

Recombinant DNA Technology Quiz

Multiple Choice Questions:

1. **What is recombinant DNA technology?**
   - A) The study of plant genetics
   - B) A technique used to combine DNA from different sources
   - C) The process of DNA replication
   - D) The method of producing RNA from DNA
2. **Which enzyme is used to cut DNA at specific sequences during recombinant DNA technology?**
   - A) DNA polymerase
   - B) RNA polymerase
   - C) Ligase
   - D) Restriction enzyme
3. **What is a plasmid?**
   - A) A virus that infects bacteria
   - B) A small, circular DNA molecule found in bacteria
   - C) A segment of RNA
   - D) A protein involved in DNA replication
4. **Which organism is commonly used as a host for producing recombinant proteins?**
   - A) Human cells
   - B) E. coli bacteria
   - C) Viruses
   - D) Yeast

5. **What is the purpose of using a vector in recombinant DNA technology?**

- A) To separate DNA fragments
- B) To introduce recombinant DNA into host cells
- C) To amplify DNA sequences
- D) To synthesize RNA

True/False Questions:

6. **True/False:** Recombinant DNA technology can be used to produce insulin for diabetes treatment.

7. **True/False:** Restriction enzymes cut DNA at random locations.

8. **True/False:** Recombinant DNA technology involves combining DNA from the same species only.

9. **True/False:** The polymerase chain reaction (PCR) is often used to amplify DNA before inserting it into a vector.

10. **True/False:** Gene cloning is a part of recombinant DNA technology.

Short Answer Questions:

11. What is a genomic library, and how is it used in recombinant DNA technology?

12. Explain the role of ligase in the process of creating recombinant DNA.

13. Describe one application of recombinant DNA technology in medicine.

14. What are the ethical concerns associated with recombinant DNA technology?

15. How is recombinant DNA technology used in agriculture?

Exercise 11. *List the steps for producing a transgenic organism.*

MINI GLOSSARY

clone [*kləʊn*]**:** an genetically identical copy of an organism or gene – клон;

genetic engineering [*dʒɪˈnetɪk ɛndʒɪˈnɪərɪŋ*]**:** a method of cutting DNA from one organism and inserting the DNA fragment into a host organism of the same or different species – генна інженерія;

plasmid [ˈ*plazmɪd*]**:** a small ring of DNA found in a bacterial cell that is used as a biological vector – плазміда;

recombinant DNA [*rɪˈkɒmbɪnənt*]**:** DNA made by recombining fragments of DNA from different sources – рекомбінантна ДНК;

restriction enzyme [*rɪˈstrɪkʃ(ə)n ˈɛnzʌɪm*]**:** DNA-cutting enzyme that can cut both strands of a DNA molecule at a specific nucleotide sequence – обмежений фермент;

transgenic organism [*transˈdʒɛnɪk ˈɔːg(ə)nɪz(ə)m*]**:** an organism that contains recombinant DNA from a different species – трансгенний організм;

vector [ˈ*vɛktə*]**:** means by which DNA from another species can be carried into the host cell; may be biological or mechanical – вектор.

UNIT 5
The Human Genome

Exercise 1. *Enumerate the examples of significant achievements that you read about. Present new discoveries and those achievements that were made or never made. Prove your suggestions.*

Exercise 2. *Before reading the text "The Human Genome" (check out Supplement 5), write out new words and word combinations you will come across, learn them.*

Exercise 3. *Reading Comprehension. Answer these questions based on the information from the article.*

1. What is the Human Genome Project?
2. What is gene therapy?
3. How does DNA fingerprinting work?
4. Where can we apply the Human Genome Project? Give your own examples.
5. What is a linkage map?
6. How are genes sequenced using PCR?
7. What are genetic markers and how are they used?
8. What benefits does the Human Genome Project offer to medicine?
9. How can gene therapy be used to treat genetic disorders?
10. How does DNA fingerprinting help in law enforcement?
11. How is DNA technology being used to study ancient life?
12. Why is mapping by linkage data not efficient?
13. What role do restriction enzymes play in gene sequencing?
14. How can doctors diagnose genetic disorders before birth?
15. What are some of the disorders that gene therapy is currently being researched for?

Exercise 4. *Put T for true and F for false statements. Justify your answers.*

1) The Human Genome Project is an international effort to incompletely map and sequence the human genome.

2) The genetic map that shows the relative locations of genes on a chromosome is called a human genome**.**

3) The human genome is the predominantly 45,000 to 50,000 genes on the 48 human chromosomes.

4) Research is also going on to use gene therapy on cancer, heart disease, and AIDS.

5) DNA fingerprinting works because two identical twins have the same DNA sequences, and because all cells of gametes have the same DNA.

Exercise 5. *Translate the following words and phrases from the article into Ukrainian.*

1. Human Genome Project –
2. Genetic map –
3. Linkage map –
4. Polymerase chain reaction (PCR) –
5. Restriction enzymes –
6. Genetic markers –
7. Gene sequencing –
8. Gene therapy –
9. Genetic disorders –
10. DNA fingerprinting –
11. Diagnose –
12. Cystic fibrosis –
13. Sickle-cell anemia –
14. Hemophilia –
15. Cancer –
16. Heart disease –
17. AIDS –
18. Chromosome maps –
19. Inheritance pattern –
20. Genetic map development –

Exercise 6. *Translate the following words and phrases from the article into English.*

1. Серповидноклітинна анемія –
2. Полімеразна ланцюгова реакція (ПЛР) –
3. Серцево-судинні захворювання –
4. Проект геному людини –
5. Діагностувати –
6. Муковісцидоз –
7. Гемофілія –
8. Рак –
9. СНІД –
10. Генетична карта –
11. Карта зчеплення –

12. Рестрикційні ферменти –
13. Генетичні маркери –
14. Хромосомні карти -
15. Схема спадковості –
16. Розвиток генетичної карти –
17. Секвенування генів –
18. Генна терапія –
19. Генетичні порушення –
20. ДНК-дактилоскопія –

Exercise 7. *Translate the following sentences into Ukrainian, using the words and phrases from the previous exercises.*

1. The Human Genome Project aims to completely map and sequence the human genome.
2. A genetic map shows the relative locations of genes on a chromosome.
3. A linkage map does not show the exact location of genes, only their relative positions.
4. Sickle-cell anemia is a genetic disorder that can be treated with gene therapy.
5. Hemophilia is a disorder where blood does not clot quickly.
6. Research is ongoing to use gene therapy to treat cancer, heart disease, and AIDS.
7. Restriction enzymes cut DNA at specific nucleotide sequences.
8. Genetic markers are used to track the inheritance pattern of genes.
9. Inheritance patterns can be tracked using genetic markers.
10. Scientists are developing chromosome maps to improve genetic map development.
11. Gene therapy is used to insert normal genes into human cells to correct genetic disorders.
12. Genetic disorders can be diagnosed before birth using DNA analysis.

Exercise 8. *Translate the following sentences into English, using the words and phrases from the previous exercises.*

1. Проект геному людини має на меті повністю картувати і секвенувати геном людини.
2. Генетична карта показує відносне розташування генів на хромосомі.
3. Карта зчеплення не показує точне розташування генів, лише їх відносні позиції.

4. Генетичні маркери використовуються для відстеження схеми спадковості генів.

5. Секвенування генів включає розміщення фрагментів ДНК у правильному порядку.

6. Проект геному людини має багато застосувань, включаючи медицину та правоохоронні органи.

7. Генна терапія використовується для введення нормальних генів у клітини людини для корекції генетичних порушень.

8. Генетичні порушення можна діагностувати до народження за допомогою аналізу ДНК.

9. Лікарі можуть діагностувати муковісцидоз до народження дитини.

10. Серповидноклітинна анемія - це генетичне порушення, яке можна лікувати за допомогою генної терапії.

11. Схеми спадковості можна відстежувати за допомогою генетичних маркерів.

12. Дослідження ще досі тривають, щоб навчитися використовувати генну терапію для лікування раку, серцево-судинних захворювань та СНІДу.

Exercise 9. *Create nouns from these verbs found in the article.*

- Map
- Know
- Show
- Imagine
- Come
- Help
- Create
- Reproduce
- Mature
- Identify
- Use
- Clone
- Track
- Analyze

Exercise 10. *Do the quiz in small groups. Check your knowledge of the human genome. Answer the questions, using the vocabulary from the unit.*

1. Basics of the Human Genome
   – What is the human genome?
   – How many genes are in the human genome?
   – What chromosomes make up the human genome?

2. The Human Genome Project
   – What were the goals and objectives of the Human Genome Project?
   – When did the Human Genome Project start, and what results has it achieved?
   – How is the information from the Human Genome Project being used today?
3. Genetic Maps
   – What is a genetic map?
   – How are genetic maps created?
   – What types of genetic maps exist, and how are they used?
4. Gene Therapy
   – What is gene therapy?
   – How does gene therapy help in treating genetic disorders?
   – What successes have been achieved in gene therapy to date?
5. DNA Technology
   – What is polymerase chain reaction (PCR)?
   – How is PCR used in genetics and medical research?
   – What are restriction enzymes, and how are they used in genetic research?
6. Genetic Markers
   – What are genetic markers?
   – How are genetic markers used to map genes?
   – What are the practical applications of genetic markers?
7. Diagnosing Genetic Disorders
   – How are genetic disorders diagnosed using DNA analysis?
   – What methods are used to diagnose genetic diseases in fetuses?
   – How does genetic analysis help in the early diagnosis of diseases?
8. Applications of Genome Technology
   – How is genome technology used in medicine?
   – What advancements have been made in agriculture through genome technologies?
   – How do genome studies assist in crime investigations?

MINI GLOSSARY

gene therapy [*dʒiːn ˈθerəpi*]**:** the insertion of normal genes into human cells to correct genetic disorders – генна терапія;

human genome [*ˈhjuːmən ˈdʒiːnəʊm*]**:** a map of the thousands of genes on 46 human chromosomes that when mapped and sequenced may provide information on the treatment and cure of genetic disorders – геном людини;

linkage map [*ˈlɪŋkɪdʒ mæp*]**:** a genetic map that shows the relative locations of genes on a chromosome – карта зв'язку;

UNIT 6
Viruses

Exercise 1. *What associations do you have when you hear the word "virus"? Illustrate some examples of viral diseases.*

Exercise 2. *Before reading the text "What is a Virus?" (check out Supplement 6), memorize new words and word combinations, compose your own sentences with them.*

Exercise 3. *Reading Comprehension. Answer these questions based on the article.*

1. Where does a virus reproduce a cell?
2. Does the virus destroy the host cell or not?
3. What is viral DNA?
4. Give an example of a viroid.
5. Differentiate between "provirus" and "virus".
6. How does a virus attach to a host cell?
7. What is a bacteriophage?
8. How do lysogenic and lytic cycles differ?
9. What is a retrovirus and how does it replicate?
10. What diseases are caused by retroviruses?
11. How is HIV transmitted?
12. What is the difference between HIV and AIDS?
13. How do viruses affect cancer development?
14. What are prions and how do they cause diseases?
15. How do plant viruses infect their host plants?

Exercise 4. *Choose the correct option based on the information from the article.*

1. What is a virus?

   A) A living organism that causes diseases and infections

   B) A particle made up of nucleic acids surrounded by a protein coat

C) A type of bacteria that infects host cells
D) A particle larger than the tiniest bacterium

2. What is the outer protein coat of a virus called?
A) Envelope
B) Capsid
C) Nucleic acid
D) Host cell

3. How does a virus attach to a host cell?
A) By injecting its nucleic acid into the host cell
B) By using a specially shaped attachment protein
C) By surrounding the host cell with its plasma membrane
D) By bursting out of a vacuole inside the host cell

4. What is a bacteriophage?
A) A virus that infects plants
B) A virus that infects humans
C) A virus that infects bacteria
D) A virus that causes the flu

5. What happens during the lytic cycle?
A) The virus integrates its DNA into the host cell's chromosome
B) The host cell continues to carry out its metabolic activity
C) The host cell is taken over and eventually bursts, releasing new viruses
D) The virus remains dormant in the host cell

6. Which virus is known for having a lysogenic cycle?
A) Influenza virus
B) Herpes simplex I virus
C) Hepatitis B virus
D) Both B and C

7. How can viruses be released from the host cell?
A) Lysis
B) Exocytosis
C) Endocytosis
D) Both A and B

8. What is a retrovirus?
A) A virus with DNA as its nucleic acid
B) A virus with RNA that converts into DNA using reverse transcriptase
C) A virus that infects plants only
D) A virus that causes bacterial infections

9. How is HIV transmitted?
A) Through the air
B) By touching surfaces
C) Through the exchange of body fluids
D) By eating contaminated food

10. What are prions?
A) Infectious RNA particles
B) Proteins without genetic material that cause other proteins to malfunction
C) DNA viruses
D) Viruses that infect only plants

11. What causes cold sores?
A) Influenza virus
B) Hepatitis B virus
C) Herpes simplex I virus
D) Human immunodeficiency virus

12. What is the primary characteristic of a virus that enters a lytic cycle?
A) It integrates into the host DNA
B) It remains dormant
C) It immediately replicates and destroys the host cell
D) It becomes a provirus

13. Which process describes the release of viruses by bursting the host cell?
A) Exocytosis
B) Lysis
C) Lysogenic cycle
D) Endocytosis

14. What is the role of reverse transcriptase in retroviruses?
A) To help the virus attach to the host cell
B) To convert viral RNA into DNA
C) To integrate viral DNA into the host cell's chromosome
D) To produce new viral proteins

15. Which virus is associated with the development of AIDS?
A) Hepatitis B virus
B) Human immunodeficiency virus (HIV)
C) Herpes simplex I virus
D) Influenza virus

Exercise 5. *Translate the following words and phrases from the article into Ukrainian.*

- Virus –
- Host cell –
- Nucleic acid –
- Capsid –
- Envelope –
- Attachment protein –
- Bacteriophage –
- Lytic cycle –
- Lysogenic cycle –
- Provirus –
- Retrovirus –
- Reverse transcriptase –
- HIV (human immunodeficiency virus) –
- AIDS (acquired immune deficiency syndrome) –
- Cancer –
- Prion –
- Viroid –
- Plant virus –
- DNA fingerprinting –
- Gene therapy –

Exercise 6. *Match words and phrases with their definitions.*

1	Provirus	A	A type of virus that infects bacteria
2	Lyric cycle	B	Proteins on the surface of a virus that allow it to bind to specific receptor molecules on the surface of a host cell
3	Bacteriophage	C	Viral DNA that has been integrated into the genome of a host cell
4	Attachment protein	D	A small infectious agent that replicates only inside the living cells of an organism
5	Capsid	E	A viral reproductive cycle in which the viral DNA is integrated into the host cell's genome and replicates along with it without causing immediate harm to the host
6	Host cell	F	A viral reproductive cycle in which a virus infects a host cell, replicates, and then causes the cell to burst
7	Lysogenic cycle	G	The protein shell of a virus, which encases the viral genome
8	Virus	H	A cell that harbors foreign molecules, viruses, or microorganisms

Exercise 7. *Translate the following words and phrases from the article into English.*

1. Вірус рослин –
2. ДНК-дактилоскопія –
3. Генна терапія –
4. Вірус –
5. Бактеріофаг –
6. Літичний цикл –
7. Лізогенний цикл –
8. Провірус –
9. Ретровірус –
10. Клітина-господар –
11. СНІД (синдром набутого імунодефіциту) –
12. Рак –
13. Пріон –
14. Віроїд –
15. Нуклеїнова кислота –
16. Капсид –
17. Оболонка –
18. Білок прикріплення –
19. Зворотна транскриптаза –
20. ВІЛ (вірус імунодефіциту людини) –

Exercise 8. *Translate these sentences into Ukrainian, using the words and phrases from the previous exercise.*

1. The host cell is where a virus replicates.
2. The capsid surrounds the virus and gives it its shape.
3. Some viruses have an additional layer called an envelope.
4. The attachment protein helps the virus attach to the host cell.
5. A bacteriophage infects bacteria.
6. The lytic cycle results in the death of the host cell.
7. The lysogenic cycle integrates viral DNA into the host cell's chromosome.
8. HIV is a retrovirus that causes AIDS.
9. AIDS results from the destruction of the immune system by HIV.
10. Certain viruses can cause cancer by disrupting cell growth.
11. Prions cause diseases by misfolding proteins.
12. Plant viruses can reduce the productivity of their host plants.
13. DNA fingerprinting is used in forensic science.
14. Gene therapy aims to correct genetic disorders by inserting normal genes.
15. Viral replication can occur through either the lytic or lysogenic cycle.

Exercise 9. *Translate these sentences into English, using the words and phrases from the previous exercise.*

1. Генна терапія спрямована на виправлення генетичних порушень шляхом введення нормальних генів.
2. Реплікація вірусу може відбуватися шляхом літичного або лізогенного циклу.
3. ВІЛ – це ретровірус, який викликає СНІД.
4. СНІД виникає в результаті руйнування імунної системи ВІЛ.
5. Віруси складаються з нуклеїнових кислот, ДНК або РНК.
6. Клітина-господар – це місце, де реплікується вірус.
7. Деякі віруси мають додатковий шар, що називається оболонкою.
8. Літичний цикл призводить до загибелі клітини-господаря.
9. Лізогенний цикл інтегрує вірусну ДНК в хромосому клітини-господаря.
10. Провірус – це вірусна ДНК, інтегрована в ДНК клітини-господаря.
11. Віроїди - це інфекційні РНК-частинки, які вражають рослини.
12. Віруси рослин можуть зменшити продуктивність їхніх господарських рослин.
13. СНІД виникає в результаті руйнування імунної системи ВІЛ.
14. Деякі віруси можуть викликати рак, порушуючи ріст клітин.
15. Пріони викликають захворювання шляхом неправильного складання.

Exercise 10. *Dwell on these statements, making references to the information from the article and using the vocabulary from the unit.*

1. Viruses are particles that are not alive.
2. Viruses need the help of living cells to copy themselves.
3. Every virus has an inner core of nucleic acid.
4. The outer protein coat surrounding the virus is called a capsid.
5. Viruses differ in size and shape.
6. Some viruses are species-specific.
7. A virus that infects a bacterium is called a bacteriophage.

8. The lytic cycle results in the death of the host cell.
9. The lysogenic cycle can last for many years.
10. Viruses can be released by lysis or exocytosis.
11. HIV infects white blood cells.
12. AIDS is caused by the human immunodeficiency virus (HIV).
13. Prions are made up of proteins but have no genetic material.

Exercise 11. *Arrange the steps in the replication process of the retrovirus in the correct order by placing the letters below.*

Host cell and provirus reproduce; new virus forms

a) Virus enters cell

b) Viral DNA (provirus) integrates into host cell's chromosomes

c) DNA is made from viral RNA

MINI GLOSSARY

bacteriophage [*bəkˈtɪərɪə(ʊ)feɪdʒ*]**:** also called phages, viruses that infect bacteria – бактеріофаг;

capsid [*ˈkæpsɪd*]**:** an outer coat of protein that surrounds a virus's inner core of nucleic acid; arrangement of capsid proteins gives a virus its shape – капсула віруса;

host cell [*həʊst sɛl*]**:** a living cell in which a virus replicates – клітина хазяїна;

lysogenic cycle [*lisoˈdʒɛnɪk ˈsaɪk(ə)l*]**:** a viral replication cycle in which a virus's nucleic acid is integrated into a host cell's chromosome; a provirus is formed and replicated each time the host cell reproduces; the host cell is not killed until the lytic cycle is activated – лізогенний цикл;

lytic cycle [*ˈlɪtɪk*]**:** a viral replication cycle in which a virus takes over a host cell's genetic material and uses the host cell's structures and energy to replicate until the host cell bursts, killing it – літичний цикл;

prion [*ˈpraɪən*]**:** a virus-like infectious agent composed of only protein, with no genetic material – пріон;

provirus [*prəʊˈvaɪrəs*]**:** viral DNA that is integrated into a host cell's chromosome and replicated each time the host cell replicates – провірус;

retrovirus [*ˈrɛtrəʊˌvaɪrəs*]**:** the RNA virus with the most complex replication style – ретровірус;

reverse transcriptase [*rɪˈvəːs tranˈskrɪpteɪz*]**:** enzyme carried in the capsid of a retrovirus that helps produce viral DNA from viral RNA – зворотня транскриптаза;

viroid [*ˈvaɪrɔɪd*]**:** a virus-like infectious agent that is composed of only a single, circular strand of RNA – віроідний;

virus [*ˈvaɪrəs*]**:** a disease-causing, non-living particle made up of nucleic acids enclosed in a protein coat; inside living cells called host cells – вірус.

Exercise 12. *Read the article "5 Cool Things your Immune System Can Do" (check out Supplement 7), identify the main topic and up to 10 keywords.*

Exercise 13. *Answer the questions about the text.*

1. What does Greg Szeto, Ph.D., say about the immune system in relation to human function?

2. How does the immune system keep a lifelong record of past infections?

3. What are memory B cells and T cells, and how long can they live in the body?

4. How do immune cells recognize environmental toxins and compounds from our diet?

5. What role do receptors on B cells and T cells play in the immune system?

6. How does the immune system learn to differentiate between self and non-self cells?

7. What happens to immune cells that detect and react to your own proteins?

8. What is the function of regulatory T cells in the immune system?

9. How does the immune system adapt to rapidly evolving pathogens like viruses and bacteria?

10. What unique mechanism do B cells and T cells use to evolve quickly?

11. How does the immune system handle organ transplants versus pregnancy?

12. What is microchimerism and how does it relate to pregnancy?

13. How does the immune system contribute to cancer detection and elimination?

14. Why are patients with suppressed immune systems more prone to certain cancers?

15. What are cancer immunotherapies and how do they work to combat cancer?

Exercise 14. *Decide if these statements are true or false (T / F).*

1. The immune system only becomes active when there is an infection in the body.

2. Memory B cells and T cells can remember infections for decades.

3. The immune system only recognizes viruses and bacteria but not environmental toxins.

4. Autoimmune diseases occur because the immune system attacks its own cells.

5. Regulatory T cells help prevent the immune system from attacking the body's own cells.

6. The immune system has a mechanism to rapidly evolve in response to pathogens.

7. B cells and T cells have receptors that are among the most diverse and quickly evolving genes in the human genome.

8. The immune system does not differentiate between helpful and harmful bacteria.

9. Pregnant individuals' immune systems do not reject the fetus even though it contains foreign genes.

10. Microchimerism is a phenomenon where maternal and fetal cells can mix across the placenta and persist after birth.

11. Mice with impaired immune systems develop fewer tumors than healthy mice.

12. Patients with HIV are more prone to certain cancers due to a suppressed immune system.

13. Cancer cells have no way of evading the immune system.

14. Immunotherapies can sometimes eradicate cancer cells more thoroughly than traditional treatments like chemotherapy and radiation.

15. Researchers fully understand why immunotherapies work for some patients and not others.

Exercise 15. *Complete the sentences based on the information from the text.*

1. The immune system acts like a _____, maintaining a detailed record of pathogens you've encountered throughout your life.

2. Memory B cells and T cells are types of immune cells that can live for _____ in the body.

3. Immune cells recognize not only viruses and bacteria but also environmental _____ and compounds from your diet.

4. Autoimmune diseases occur when the immune system goes _____, attacking and killing our own cells.

5. Regulatory T cells act as _____, ensuring that the immune system doesn't mistakenly attack your own body.

6. The immune system has a mechanism to rapidly _____ in response to pathogens.

7. B cells and T cells have receptors that are among the most _____ and quickly evolving genes in the human genome.

8. The immune system differentiates between _____ and harmful bacteria.

9. Pregnant individuals' immune systems allow the growth of a _____ without rejecting it.

10. Microchimerism is a phenomenon where maternal and fetal cells can mix across the _____ and persist after birth.

11. Mice with impaired immune systems develop _____ tumors than healthy mice.

12. Patients with HIV are more prone to certain cancers due to a _____ immune system.

13. Cancer cells develop many tricks to _____ the immune system.

14. Immunotherapies can sometimes eradicate cancer cells more thoroughly than traditional treatments like _____ and radiation.

15. Researchers aim to understand why immunotherapies work for some patients and _____ for others.

Exercise 16. *Match words and phrases with their definitions.*

Memory B cells	A structure that forms during pregnancy to provide nutrients and oxygen to the fetus.
Regulatory T cells	Changes in the genetic material of an organism.
Autoimmune diseases	Tiny infectious agents that can replicate only inside living cells.
Receptors	Proteins produced by B cells that help to neutralize pathogens.
Microchimerism	A seasonal respiratory illness caused by a virus.
Immunotherapy	A type of immune cell that helps prevent the immune system from attacking the body's own cells.
Pathogen	A phenomenon where maternal and fetal cells mix and persist after birth.
Placenta	Harmful microorganisms that can cause disease.
Antibodies	A type of immune cell that remembers past infections and can quickly respond if they reappear.
Cancer	A serious disease characterized by uncontrolled cell growth.
Mutation	A disease in which the immune system attacks the body's own cells.
Virus	A treatment that uses the body's own immune system to fight diseases like cancer.

Bacteria	Proteins on the surface of immune cells that detect and respond to pathogens.
DNA damage	Microscopic organisms, some of which can cause infections.
Flu	Damage to the genetic material within cells, often caused by environmental factors.

Exercise 17. *Create nouns from these words from the article.*

- Recognize
- Respond
- Detect
- Protect
- Mutate
- React
- Survive
- Diagnose
- Regulate
- Expose
- Infect
- Suppress
- Eliminate
- Vaccinate
- Treat

Exercise 18. *Translate these phrases from the text into Ukrainian.*

1. Recognize a virus
2. Churn out antibodies
3. Respond to infections
4. Detect environmental toxins
5. Protect the body
6. Mutate quickly
7. React to pathogens
8. Survive without attack
9. Diagnose a disease
10. Regulate immune response
11. Expose to pathogens
12. Infect the body
13. Suppress the immune system
14. Eliminate cancer cells
15. Vaccinate against diseases

Exercise 19. *Translate the following phrases into English.*

1. Визнавати вірус
2. Виробляти антитіла
3. Реагувати на інфекції
4. Виявляти екологічні токсини
5. Захищати організм
6. Швидко мутувати
7. Реагувати на патогени
8. Виживати без нападу
9. Діагностувати хворобу
10. Регулювати імунну відповідь
11. Піддаватися патогенам
12. Інфікувати організм
13. Придушувати імунну систему
14. Усувати ракові клітини
15. Вакцинувати проти хвороб

Exercise 20. *Translate the following sentences into Ukrainian using the phrases from the previous task.*

1. Your immune cells are trained to recognize viruses, bacteria, or other pathogens through infection or vaccination, and they rarely forget this information.
2. Memory B cells, a type of immune cell that remembers past infections and can quickly produce antibodies if the same virus or bacteria invades again, can survive in the body for decades.
3. Autoimmune diseases such as rheumatoid arthritis or type 1 diabetes occur when the immune system malfunctions, attacking and destroying our own cells instead of protecting them.
4. This seemingly impossible task of distinguishing between self and non-self involves multiple layers of regulation.
5. Your immune system even differentiates between helpful and harmful bacteria, allowing the benign bacteria in your gut and on your skin to flourish.
6. Your immune system functions like a biological diary, keeping a detailed record of pathogens you have encountered throughout your life.
7. Researchers still do not fully understand how a pregnant person's immune system permits the growth of a foreign body, the fetus, while continuing to protect both the fetus and the parent from pathogens.
8. As researchers uncover these layers of deception, they can sometimes develop new therapies to combat them.
9. Microchimerism is a phenomenon where maternal and fetal cells mix across the placenta and persist after birth.
10. Receptors respond to infected cells and fragments of viruses and bacteria, but they also detect environmental toxins, compounds from your diet, healthy gut bacteria, and cellular DNA damage from sunlight.
11. Regulatory T cells act as the body's peacekeepers, continually monitoring the rest of the immune system for rogue cells.
12. Memory B cells, which remember past infections and can rapidly produce antibodies if the same pathogen re-enters the body, can live for decades.
13. These therapies, which range from antibodies that recognize tumors to engineered T cells, strip away one or more cloaking layers to enable the immune system to function effectively.

Exercise 21. *Translate the following sentences into English using the phrases from the previous task.*

1. Ваші імунні клітини, як тільки вони навчені розпізнавати вірус, бактерії або інший патоген через інфекцію або вакцинацію, рідко забувають.

2. Клітини пам'яті В, тип імунної клітини, яка запам'ятовує стару інфекцію і може швидко виробляти антитіла, якщо той самий вірус або бактерія знову потраплять у організм, можуть жити в організмі десятиліттями.

3. Аутоімунні захворювання, такі як ревматоїдний артрит або діабет 1 типу, виникають, коли імунна система виходить з-під контролю, атакуючи і вбиваючи наші власні клітини замість того, щоб захищати їх.

4. Ця, здавалося б, неможлива задача, розрізняти свої і чужі клітини, здійснюється через кілька шарів регуляції.

5. Ваша імунна система навіть вчиться розрізняти корисні та шкідливі бактерії, дозволяючи нешкідливим бактеріям у вашому кишечнику та на шкірі процвітати.

6. Ваша імунна система діє як біологічний щоденник, підтримуючи детальний запис патогенів, з якими ви стикалися протягом усього життя.

7. Дослідники досі не повністю розуміють, як імунна система вагітної людини дозволяє рости одному чужорідному тілу – плоду, одночасно захищаючи їх обох від патогенів.

8. Коли дослідники розкривають ці шари обману, вони іноді можуть розробляти нові методи лікування для боротьби з ними.

9. Мікрохімеризм – це явище, коли материнські та плодові клітини можуть змішуватися через плаценту і зберігатися після народження.

10. Рецептори реагують на наші інфіковані клітини та на крихітні частинки вірусів і бактерій, але вони також виявляють екологічні токсини, сполуки з вашого раціону, здорові бактерії в кишечнику, пошкодження ДНК клітин від сонячного світла.

11. Регуляторні Т-клітини потім діють як миротворці організму, постійно перевіряючи всю решту імунної системи на наявність клітин, що вийшли з-під контролю.

12. Клітини пам'яті B, тип імунної клітини, яка запам'ятовує стару інфекцію і може швидко виробляти антитіла, якщо той самий вірус або бактерія знову потраплять у організм, можуть жити в організмі десятиліттями.

13. Ці методи лікування, які варіюються від антитіл, що розпізнають пухлини, до модифікованих Т-клітин, знімають один або кілька з цих захисних шарів, дозволяючи імунній системі виконувати свою роботу.

MINI GLOSSARY

memory B cells – Immune cells that remember previous infections and can quickly produce antibodies in response to re-exposure to the same virus or bacteria. They can live in the body for decades, providing long-lasting immunity: клітини пам'яті B.

regulatory T cells – Immune cells that help prevent the immune system from attacking the body's own cells. They act as peacekeepers, ensuring that the immune response is properly regulated; регуляторні Т-клітини.

autoimmune diseases – Diseases where the immune system mistakenly attacks and destroys the body's own cells, such as rheumatoid arthritis or type 1 diabetes; автоімунні захворювання.

receptors – Proteins on the surface of immune cells that detect and respond to pathogens, environmental toxins, and other molecules. They play a crucial role in identifying threats to the body; рецептори.

microchimerism – A phenomenon where maternal and fetal cells mix across the placenta and can persist in both the parent and child after birth; мікрохімеризм.

immunotherapy – Treatments that use the body's own immune system to fight diseases, such as cancer. These therapies can include tumor-recognizing antibodies or engineered T cells; імунотерапія.

pathogen – Harmful microorganisms, such as viruses and bacteria, that can cause disease; патоген.

placenta – An organ that forms during pregnancy to provide nutrients and oxygen to the developing fetus, while also acting as a partial barrier to protect against infections; плацента.

antibodies – Proteins produced by B cells that help neutralize pathogens by binding to them and marking them for destruction by other immune cells; антитіла.

cancer – A serious disease characterized by uncontrolled cell growth and the ability to invade other tissues. The immune system can sometimes detect and eliminate cancer cells; рак.

mutation – Changes in the genetic material of an organism, which can occur naturally or due to environmental factors. In immune cells, controlled mutations can help them adapt to new threats; мутація.

virus – Tiny infectious agents that can only replicate inside living cells. They are one of the primary targets of the immune system; вірус.

bacteria – Microscopic organisms, some of which can cause infections in humans. The immune system works to detect and eliminate harmful bacteria; бактерії.

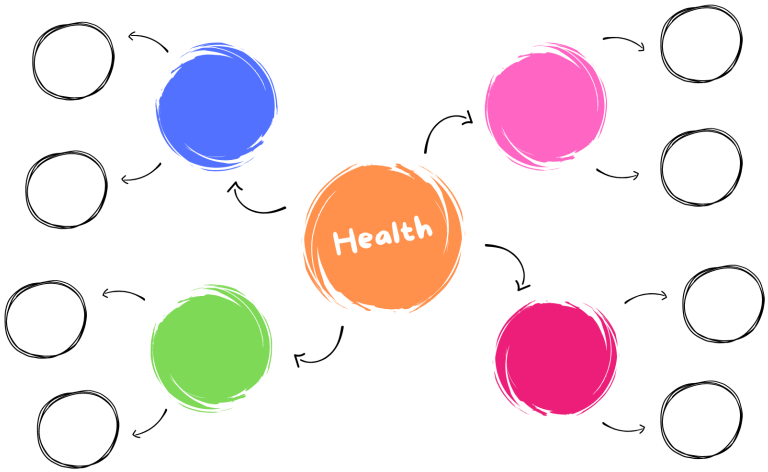
DNA damage – Harm to the genetic material within cells, often caused by environmental factors like UV radiation. The immune system can sometimes detect and repair DNA damage; пошкодження ДНК.

flu – A common respiratory illness caused by influenza viruses. The immune system's memory cells help protect against future infections after exposure or vaccination; грип.

UNIT 7
Health Care. Health and Diseases

Exercise 1. *What are the most wide-spread diseases in the world? How can people cope with different diseases?*

Exercise 2. *Create a mind map of associations on the topic 'Health and Disease'.*



Exercise 3. *Read the text "Health versus Disease" (Part 1, check out Supplement 8), identify the main topic and up to 10 keywords.*

Exercise 4. *Answer the questions about the text.*

1. What must be considered before discussing human disease?
2. How could health be theoretically defined according to the text?
3. What are some examples of normal measurable characteristics that might define a healthy person?
4. How is "normal" established in terms of body temperature?

5. How might health be better defined, beyond just measurable values?

6. How does the definition of health vary between a construction worker and a bookkeeper?

7. Why might a bookkeeper be unable to perform manual labor like a construction worker?

8. What additional aspects does health involve besides physical fitness?

9. Why would an emotionally unstable person in excellent physical condition not be considered healthy?

10. According to the text, what does true health involve beyond the absence of illness or disease?

Exercise 5. *Decide if these statements are true or false (T / F).*

1. The healthy construction worker expects not to be able to do manual labour all day.

2. Health involves more than physical fitness, since it also implies mental and emotional well-being.

3. Health is not merely the absence of illness or disease but involves the ability to function in harmony with one's environment.

4. It is well known that if the temperatures are taken of a large number of presumably healthy individuals, the temperatures will generally come close to 37° C.

5. A bookkeeper is generally perfectly capable of performing sedentary work.

6. A person having normal body temperature, pulse and breathing rates, blood pressure, height, weight, sensitivity of hearing, and other normal measurable characteristics might not be termed healthy.

7. An angry, frustrated, emotionally unstable person in excellent physical condition be called healthy.

8. Health is often interpreted in terms of the individual's environment.

Exercise 6. *Complete the sentences based on the information from the text.*

1. Health, then, is not merely the absence of illness or disease but… .

2. The healthy construction worker expects to be able to do manual labour all day, while… .

3. A person having normal body temperature, pulse and breathing rates, blood pressure, … .

4. Health might be defined better as the ability to function effectively in … .

5. It is well known that if the temperatures are taken of a large number of active individuals, … .

6. Before human disease can be discussed, the meanings of … .

Exercise 7. *Match the terms from the article with their definitions.*

1.	Wellness	A	the number of breaths taken per minute
2.	Manual labour	B	the state of being physically healthy and strong
3.	Blood pressure	C	lacking the ability to do something
4.	Breathing rate	D	physical work done by hand, often involving strength and skill
5.	Acuity of vision	E	stress or pressure on the body due to physical exertion
6.	Physical fitness	F	the state or condition of being in good physical and mental health
7.	Be incapable of	G	the force exerted by circulating blood on the walls of blood vessels
8.	Physical strain	H	sharpness or clarity of vision

Exercise 8. *Create nouns from these words.*

e.g. sick – sickness

- Incapable
- Well
- To breathe
- Fit
- Physical
- Healthy
- To construct
- Sensitive
- Acute
- To press
- Absent
- Able

Exercise 9. *Translate these phrases from the text into Ukrainian.*

measured values
to come close to
sedentary work
to function in complete harmony with
to meet demands of

to be termed	to have a dimension different from
to be capable of good judgment	to collapse from physical strain
normal measurable characteristics	

Exercise 10. *Translate the following phrases into English.*

1. наближатися до
2. відповідати вимогам
3. сидяча робота
4. знепритомніти від фізичного виснаження
5. називатися
6. вимірювані значення / величини
7. здійснювати життєдіяльність у повній гармонії з
8. бути розсудливим
9. мати значення, що відрізняється від
10. нормальні вимірювані характеристики

Exercise 11. *Translate the following sentences into English using the phrases from the previous task.*

1. Спортсмен знепритомнів від фізичної напруги під час марафону, тому його негайно госпіталізували.
2. Нормальні вимірювані характеристики крові можуть вказувати на загальний стан здоров'я пацієнта.
3. Для того щоб бути розсудливим, важливо підтримувати ментальне здоров'я за допомогою регулярних тренувань і правильного харчування.
4. Це захворювання часто називається "тихим вбивцею" через відсутність симптомів на ранніх стадіях.
5. Наше тіло функціонує в повній гармонії з природними біоритмами, якщо ми дотримуємося здорового способу життя.
6. Сидяча робота може призвести до проблем зі здоров'ям, якщо не виконувати регулярних перерв для фізичних вправ.
7. Сидяча робота може призвести до проблем зі здоров'ям, якщо не робити регулярних перерв для фізичних вправ.
8. Під час тренування я намагався наблизитися до своєї ідеальної ваги.
9. Після марафону кілька учасників знепритомніли від фізичної напруги і потребували медичної допомоги.

Exercise 12. *Translate the following sentences into Ukrainian using the phrases from the previous task.*

1. To meet the demands of a healthy lifestyle, it's essential to exercise regularly.
2. This condition is termed hypertension and requires careful monitoring.
3. Normal measurable characteristics of blood pressure indicate good cardiovascular health.
4. After the marathon, several participants collapsed from physical strain and required medical attention.
5. For the body to function in complete harmony with natural rhythms, it's important to maintain a consistent sleep schedule.
6. Sedentary work can negatively impact the health of your back and neck.
7. This new prosthetic limb has a dimension different from the previous model, making it more comfortable.
8. The measured values of the patient's blood sugar levels indicated that a change in diet was necessary.
9. Regular exercise helps me come close to my desired physical fitness level.

Exercise 13. *Think of the preventive methods, avoiding different and related injuries. Discuss them with your partner.*

Exercise 14. *Role-play the dialogues in the classroom using the words and word combinations from this unit.*

MINI GLOSSARY

physical fitness *[ˈfɪzɪkəl ˈfɪtnɪs]*: the state of being physically healthy and strong – фізична підготовка;

body temperature *[ˈbɒdi ˈtɛmprɪʧə]*: the degree of heat maintained by the body - температура тіла;

a breathing rate *[ə ˈbriːðɪŋ reɪt]*: the number of breaths taken per minute - частота дихання;

blood pressure *[blʌd ˈprɛʃə]*: the force exerted by circulating blood on the walls of blood vessels - артеріальний тиск;

acuity of vision *[əˈkjuːɪti ʌv ˈvɪʒən]*: sharpness or clarity of vision - гострота зору;

manual labour *[ˈmænjuəl ˈleɪbər]*: physical work done by hand, often involving strength and skill - ручна праця;

physical strain *[ˈfɪzɪkəl streɪn]*: stress or pressure on the body due to physical exertion - фізичне напруження;

to be incapable of smth *[ɪnˈkeɪpəbl]*: lacking the ability to do something: бути неспроможним до чогось;

wellness [ˈ*welnəs*]**:** the state or condition of being in good physical and mental health – фізичне здоров'я;

well-being [ˌ*welˈbiːɪŋ*]**:** the state of being comfortable, healthy, or happy- благополуччя, добробут.

Exercise 15. *Read the text "Health versus Disease" (Part 2, check out Supplement 9), identify the main topic and up to 10 keywords.*

Exercise 16. *Answer the questions about the text.*

1. What prevents you from taking care of your health?
2. What diseases have a long incubation period?
3. Why is it important to have annual medical examinations?
4. What does the concept of health mean?
5. What is the main difference between illness and disease?
6. What is the relationship between illness and disease?
7. What role does stress play in the manifestation of certain diseases?
8. How does the text define disease? What criteria are used to classify diseases?
9. What are the consequences of early detection and prevention in healthcare?
10. What is the significance of implementing a universal health coverage system?

Exercise 17. *Decide if these statements are true or false (T / F).*

1. The term illness implies discomfort or inability to function optimally.
2. Disease, defined as any deviation from normal form and function, may be trivial if the deviation is maximal.
3. If only one parent has sickle cell anemia, the child may inherit the disease.
4. The child who is infected with measles does not become ill until approximately 20 days after exposure.
5. A person may have a disease for many years without even being aware of its presence.
6. Universal health and treatment of sickness and disease have not improved globally yet.
7. A latent disease means that it will either become apparent at some later time or will render the individual more susceptible to illness.
8. Many diseases escape detection and possible cure because they remain symptomless for long years.

Exercise 18. *Complete the sentences based on the information from the text.*

1. During this incubation period the child is not ill but… .
2. An individual who has cancer is often totally unaware of… .
3. Any departure from the state of health, then, is a disease, whether health be measured in… .
4. Regrettably, many diseases escape detection and possible cure because… .
5. Some diseases may consist of extremely subtle defects in cells that… .
6. Universal health and treatment of sickness and disease have improved globally, but… .
7. The child of a mother and father who both have sickle cell anemia will probably… .
8. Definitions of the terms disease, illness and health are discussed… .

Exercise 19. *Match the terms from the article with their definitions.*

1. health	a) physical harm or damage to someone's body caused by an accident or an attack
2. disease	b) the condition of being ill
3. illness	c) the state of being healthy, especially when it is something that you actively try to achieve
4. injury	d) not understanding or realizing something
5. wellness	e) caused by infection or a failure of health rather than by an accident
6. well-being	f) not in the place where you are expected to be
7. sickness	g) a condition in which the body or mind is harmed because an organ or part is unable to work as it usually does
8. absent	h) the condition of being sound in body, mind, or spirit
9. deviation	i) the state of feeling healthy and happy
10. unaware	j) different from the usual or common way

Exercise 20. *Create nouns from these words.*

e.g. sick – sickness

- To injure
- To impede
- To impair
- To function
- Unaware
- To deviate
- To infect
- To measure
- Ill
- To depart
- To assess
- Susceptible

Exercise 21. *Translate these phrases from the text into Ukrainian.*

1. used interchangeably
2. to be equated with
3. to function optimally
4. to escape detection and possible cure
5. to remain symptomless
6. to impair function

7. hereditary abnormality
8. universal healthcare system
9. an overt form
10. departure from the state of health

Exercise 22. *Translate the following phrases into English.*

1. спадкова аномалія
2. уникнути виявлення та можливого лікування
3. використовуватися взаємозамінно
4. бути прирівняним до
5. явна форма
6. функціонувати оптимально
7. залишатися безсимптомним
8. погіршувати функцію
9. загальноприйнята система охорони здоров'я
10. відхилення від стану здоров'я

Exercise 23. *Translate the following sentences into English using the phrases from the previous task.*

1. Еволюція є природним процесом, який може спричинити складні спадкові аномалії.
2. Клітини тканини організму функціонують оптимально лише за умов правильного живлення.
3. Науковці виявили новий вид бактерій, які можуть уникнути виявлення традиційними методами.
4. Багато хвороб можуть залишатися безсимптомними протягом декількох поколінь.
5. Коли вірус потрапляє в організм, він може погіршити функцію імунної системи.
6. Вчені використовують різні методи, які часто взаємозамінні, щоб досліджувати ДНК.
7. Відхилення від нормального стану здоров'я може бути спричинене стресом, емоційним вигоранням, фізичним виснаженням.
8. Багато вірусів мають явну форму, яку легко виявити за допомогою мікроскопа.

Exercise 24. *Translate the following sentences into Ukrainian using the phrases from the previous task.*

1. The discovery of new genes can lead to a better understanding of hereditary abnormalities.

2. Biologists study how organisms function optimally in their natural habitats.

3. Some bacteria can escape from detection, so this creates a challenge for researchers.

4. Genetic mutations often impair the normal function of cells in the organism.

5. The universal healthcare system must adapt to the advent of new and enxpected diseases, like the pandemic of COVID-19.

6. The overt form of the disease forced doctors to resort to immediate quarantine measures.

7. The study of biodiversity helps to understand why departures from the state of health within ecosystems can occur.

8. Regular exercise and a balanced diet are essential for the body to function optimally.

Exercise 25. *Think of the preventive methods, avoiding different and related injuries. Discuss them with your partner.*

MINI GLOSSARY

tumor [*ˈtjuːmə(r)*]**:** a mass of cells growing in or on a part of the body where they should not, usually causing medical problems – пухлина, новоутворення;

disease [*dɪˈziz*]**:** a disorder of structure or function in a human, animal, or plant, especially one that has a known cause and a distinctive group of symptoms, signs, or anatomical changes – хвороба, захворювання;

injury [*ˈɪndʒəri*]**:** an instance of being injured – ушкодження, рана, травма;

susceptible [*səˈsep.tə.bəl*]**:** likely or liable to be influenced or harmed by a particular thing – чутливий, сприйнятливий;

to impede [*ɪmˈpiːd*]**:** to make it more difficult for something to happen or more difficult for someone to do something – перешкоджати, заважати, затримувати;

to impair *[ɪmˈpɛər]*: to weaken or damage something, especially a function or ability – погіршувати;

deviation [ˌ*diːviˈeɪʃn*]**:** the deflection of a vessel's compass needle caused by iron in the vessel, which varies with the vessel's heading – порушення, відхилення;

advent [ˈædˌvɛnt]: the arrival of a notable person, thing, or event – прихід;

unaware [ˌ*ʌn.əˈweər*]**:** not knowing or realizing that something is happening or that something exists – той, що не підозрює;

tissue *[ˈtɪʃuː, ˈtɪsjuː]*: a group of similar cells that perform a specific function in an organism – тканина.

UNIT 8
Antibiotic Resistance: a Threat to Our Health?

Exercise 1. *Before you read the article, think about these questions*

1. What do you know about antibiotic resistance?
2. Why do you think antibiotic resistance is threatening our health?
3. Why is it difficult to develop new types of antibiotics?
4. Why don't pharmaceutical companies want to invest in developing new antibiotics?

Exercise 2. *Read the article "Antibiotic resistance is threatening our health. Will bacterial infection send us back to the medical dark ages?" (check out Supplement 10). Identify the main topic, subtopics and up to 10 keywords.*

Exercise 3. *Answer the questions based on the information from the article.*

1. What is the significance of the antibiotic named QPX9003 developed by Velkov and Li?
2. Why are polymyxins considered important in the fight against bacterial infections?
3. What challenges have Velkov and Li faced in their research on QPX9003?
4. Why is antibiotic resistance considered a significant threat to global health?
5. What historical event led to the discovery of the first antibiotic, penicillin?
6. How do bacteria develop resistance to antibiotics, and why is this process accelerating?
7. What are some of the economic challenges faced by pharmaceutical companies in developing new antibiotics?
8. Why is there a need for government-backed funding bodies to support antibiotic research, according to Velkov and Cooper?
9. What are some alternative strategies being explored to combat antibiotic resistance besides developing new antibiotics?
10. What concerns does Professor Matt Cooper have about the future of bacterial research and antibiotic development?

Exercise 4. *Check your understanding of these idioms/expressions.*

Vocabulary

a blob	a bloke
(to) brainstorm	on the cusp of
the dark ages	(to) dash off
Down Under	geeky
golden staph	to be hard to come by
the holy grail	(to) muck around
(to) pop pills	(to) raise an eyebrow
(to) run rampant	a stash
(to) stump up (money)	superbugs
(to) supercharge	thankless job / thankless task
(to) tip in (money)	(to) trip over yourself (to do something)
(to) tweak (something)	

Exercise 5. *Use expressions in the vocabulary list to complete the definitions.*

1. _____ bacteria or fungi that have developed the ability to withstand commonly prescribed drugs.
2. _____: everyday term for a common bacterium that lives on the skin or in the nose and has a yellow color under the microscope.
3. _____: something that is not appreciated
4. _____: make something more powerful
5. _____ and _____: spend your own money doing something
6. _____: make small changes to make something more accurate
7. _____: slang expression for Australia
8. _____: slang expression meaning a fellow, a man
9. _____: a hoard or secret supply
10. _____: join in a group to solve a problem by sharing ideas
11. _____: difficult period of time, period of ignorance
12. _____: appear to be surprised or shocked by something
13. _____: describes a person who is fascinated by new technology and computers
14. _____: at the point when something is about to change
15. _____: grow without any checks or hindrance
16. _____: something that people look for because it is very important
17. _____: soft mass, shapeless object
18. _____: be very keen to do something so that you rush to do it
19. _____: to write something quickly
20. _____: take medication without considering the consequences
21. _____: difficult to obtain
22. _____: play around with something

Exercise 6. *Translate the following phrases into English.*

1. Загроза антибіотикорезистентності
2. Повернення в медичну темну епоху
3. Лікування смертельних "супербактерій"
4. Розробка внутрішньовенного препарату
5. Зростання людського населення
6. Бактерії стають резистентними
7. Явище повільної пандемії
8. Проблеми пошуку та розробки нових антибіотиків
9. Використання природних ресурсів
10. Уряди повинні зробити це пріоритетом

Exercise 7. *Translate the following sentences into Ukrainian using the phrases from the text:*

1. The development of new antibiotics is crucial for fighting bacterial infections.
2. Researchers often struggle with securing funding for their projects.
3. The rise of antibiotic-resistant bacteria is a global health crisis.
4. New antibiotics need to be developed to prevent a return to the medical dark ages.
5. Government investment is essential for the future of antibiotic research.
6. The collaboration between Velkov and Li has been essential to their progress.
7. Antibiotic resistance could lead to a significant increase in mortality rates.
8. The medical community must prioritize finding solutions to antibiotic resistance.
9. Phage therapy is one of the innovative approaches being explored.
10. The economic impact of antibiotic resistance is substantial.

Exercise 8. *Translate the following sentences into English:*

1. Антибіотикорезистентність загрожує нашому здоров'ю.
2. Ми на шляху до повернення в медичну темну епоху до 2050 року.

3. Їхній внутрішньовенний препарат спрямований на смертельні "супербактерії".

4. Вони розробляють новий антибіотик, який нещодавно розпочав першу фазу клінічних випробувань.

5. Зі зростанням людського населення бактерії мають більше можливостей стати резистентними.

6. Деякі бактерії стають резистентними ще до завершення клінічних випробувань.

7. Антибіотикорезистентність описується як повільна пандемія.

8. Технічні труднощі пошуку та розробки нових антибіотиків є реальними.

9. Більшість наших ліків є природними продуктами, і ми навіть не наблизилися до використання всіх цих природних ресурсів.

10. Уряди повинні зробити цю проблему пріоритетною.

Exercise 9. *Describe the pictures using the vocabulary from this unit. Discuss your ideas and associations in pairs or small groups.*

Antibiotic resistance

Superbugs

Gram-negative bacteria

Exercise 10. *Watch the video. Establish relations between the ideas from the video and those from the pictures.*

MINI GLOSSARY

antibiotic resistance – The ability of bacteria to survive and grow in the presence of antibiotics that once killed them; резистентність до антибіотиків.

superbugs – Bacteria that have become resistant to multiple antibiotics and are difficult to treat; мікроби, стійкі до ліків.

clinical trials – Research studies conducted with human participants to evaluate the effectiveness and safety of medical treatments; клінічні випробування.

gram-negative bacteria – A category of bacteria that have a more complex cell wall structure, making them resistant to many antibiotics; грам-негативні бактерії.

sepsis – A severe and potentially life-threatening condition caused by the body's response to an infection; сепсис, системне запалення.

polymyxins – A class of antibiotics that target gram-negative bacteria; поліміксини.

intravenous drug – Medication administered directly into a vein; внутрішньовенні ліки.

inflammation – The body's response to injury or infection, often causing redness, heat, and swelling; запалення.

antimicrobial resistance – The ability of microbes to resist the effects of drugs, making infections harder to treat; опірність мікробів.

phase 1 clinical trials – The first stage of clinical trials where a new drug is tested in a small group of people to evaluate its safety and determine a safe dosage range; перша стадія клінічних випробувань.

UNIT 9
Nanotechnology in Medicine

Exercise 1. *Discuss questions with your partner or group.*

1. What do you know about nanotechnology?
2. How can nanotechnology be used in the medical field?
3. What does the prefix nano-mean?

Exercise 2. *Read the text "Nanomaterials for Craniofacial and Dental Tissue Engineering" (check out Supplement 11). Identify the main topic, subtopics and up to 10 keywords.*

Exercise 3. *Answer the questions based on the information from the article.*

1. What is the text about?
2. Why might tissue engineering be useful for craniofacial injuries or defects?

3. What sort of regeneration do nanoparticles provide a structure for?

4. What secondary function do nanofibers and nanoparticles perform?

5. Are nanomaterials ready for use?

6. What do you know about these examples of nanotechnology? Discuss your ideas.

Exercise 4. *Discuss if these statements are True or False, making references to information from the article:*

1. Nanomaterials have worse biocompatibility compared to bulk materials.

2. Autologous bone is the most commonly used bone substitute due to its perfect biocompatibility.

3. The primary challenge with artificial bone is its immunogenicity.

4. Nano-hydroxyapatite (nHA) is the main inorganic component in natural bone.

5. Electrospun nanofibrous scaffolds have pore sizes that are too small for cell migration.

Exercise 5. *Read the words, check their pronunciation and find their equivalents in Ukrainian.*

biomimetic	bioactive agent
craniofacial	nanofiber
nanomaterial	nanoparticle
nanosheet	tissue engineering

Exercise 6. *Complete the definitions using words from the previous exercise.*

1. _____ : material which is made of extremely tiny particles

2. _____ : production of new tissues using biomedical engineering

3. _____ : particles of matter that is so small that it cannot be seen by the naked eye

4. _____ : substance that can influence how an organism, cell or tissue works

5. _____ : describes a synthetic method to copy a biological process

6. _____ : length of extremely small particles which has very strong properties

7. _____ : layered substance made up of extremely small particles

8. _____ : describes the head and neck including the skull, jaws, teeth and face

Exercise 7. *Translate these sentences from the text into Ukrainian:*

1. The oral and maxillofacial regions are complex areas in the human body.
2. Nanomaterials have gradually become favored for tissue engineering research.
3. The scaffold provides a microenvironment for cell adhesion, proliferation, and differentiation.
4. Researchers have developed composite scaffold materials containing nHA and other natural biological materials.
5. Electrospinning is one of the most common methods for preparing nanofibers.

Exercise 8. *Translate the following phrases into English:*

- відновлення тканини
- наноматеріали
- механічні властивості
- кісткова тканина
- електрообприскування
- зразки для клінічних випробувань
- полігідроксибутират
- фізико-хімічні властивості
- тимчасові імпланти

Exercise 9. *Translate the following phrases into Ukrainian:*

- Craniofacial and dental tissue engineering
- Oral and maxillofacial regions
- Complicated structure and function

- Intravenous drug delivery
- Human tissue growth
- Bacteria enter cells
- Slow healing process
- Finding and developing new nanomaterials
- Natural bone components
- Governments need to support research

Exercise 10. *Translate the following sentences into Ukrainian using the phrases from the text:*

1. Nanomaterials are being used to enhance bone tissue engineering strategies.
2. The poor mechanical properties of nHA alone make it insufficient for large load-bearing applications.
3. Electrospun nanofibrous scaffolds mimic collagen fibrils in cartilage ECM.
4. The development of new scaffold materials is crucial for tissue engineering.
5. Composite scaffolds are designed to improve biocompatibility and mechanical strength.

Exercise 11. *Translate the following sentences into English using the phrases from the text:*

1. Відділ ротової порожнини та щелепи є складними ділянками людського тіла.
2. Поява тканинної інженерії показує великий потенціал для майбутнього лікування черепно-лицевих та зубних дефектів.
3. При тканинній інженерії слід враховувати три основні фактори: клітини, каркаси та фактори росту.
4. Каркас створює мікросередовище для адгезії, проліферації та диференціації клітин.
5. Наноматеріали мають кращу біосумісність і широкий спектр біологічної активності.
6. Наночастинки часто використовуються як носії для цільової та контрольованої доставки факторів росту.

7. Наногідроксиапатит (нГА) є основним неорганічним компонентом природної кістки.

8. Колаген є головним органічним компонентом природної кістки.

9. Порівняно з великими матеріалами, зменшений розмір наноматеріалів призводить до значного збільшення жорсткості та площі поверхні.

10. Електроспінінг є одним із найпоширеніших методів виготовлення нановолокон.

Exercise 12. *Expand and complete the dialogues with your own ideas based on these scenarios. Roleplay them in class.*

Dialogue 1: Discussing Nanoparticle Scaffolds

– We've been exploring the use of nanoparticles as scaffolds. They seem promising for cell growth.

– Indeed, their large surface area could enhance cell adhesion. Have we considered the biodegradability aspect?

– Yes, we're testing various materials to find the optimal balance between strength and degradability.

Dialogue 2: Electrospinning Nanofibers

– I'm reading about electrospinning nanofibers for ECM reconstruction. It's fascinating!

– Absolutely, the technique allows us to mimic the natural structure of tissues. What materials are you focusing on?

– I'm looking at a combination of collagen and synthetic polymers to improve tissue integration.

Dialogue 3: Nanomaterials for Drug Delivery

– I've heard about nanotubes in drug delivery. How can they be applied in dental treatments?

– Their structure allows for controlled release of medication, which could be useful for periodontal therapy.

– That could revolutionize post-surgical care. Let's collaborate on a pilot study.

MINI GLOSSARY

nanomaterials – Materials with structures on the nanometer scale, providing unique properties useful in tissue engineering; наноматеріали.

scaffold – A framework that supports cell growth and tissue formation in tissue engineering; карскас, матриця.

tissue engineering – A scientific field focused on creating biological substitutes to restore or improve tissue function; тканинна інженерія.

osteoconductivity – The ability of a material to support the growth of new bone cells; остеокондуктивність.

electrospinning – A technique for creating nanofibers used in tissue engineering scaffolds; електропрядіння.

nano-hydroxyapatite (nHA) – A nanomaterial that mimics the inorganic component of natural bone, used in bone tissue engineering; наногідроксіапатит.

composite scaffolds – Scaffold materials made from a combination of different substances to improve their properties; композитні каркаси.

biocompatibility – The ability of a material to be compatible with living tissue without causing an immune response; біосумсність.

proliferation – The rapid multiplication of cells; проліферація, розростання тканини.

differentiation – The process by which cells develop into distinct types with specific functions; диференціація.

UNIT 10
Medical Futility

Exercise 1. *Discuss these topics in small groups.*

a) Future of Nanomaterials in Medicine

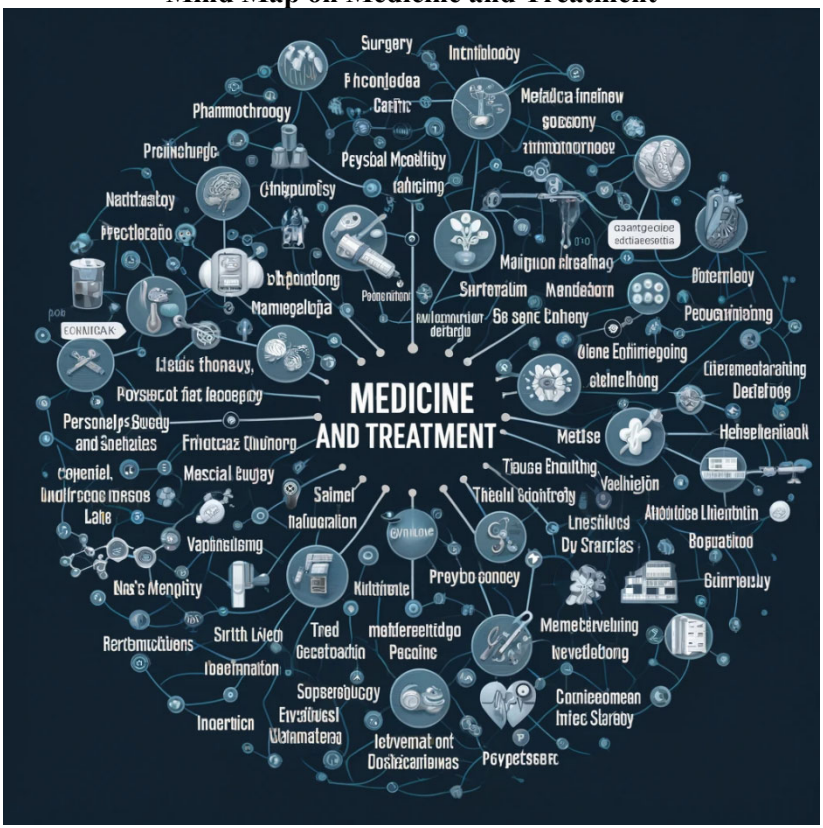
- What do you think are the biggest advantages of nanomaterials in medicine?
- What potential risks are associated with using nanomaterials in medical applications?
- How might nanomaterials change approaches to treating various diseases in the future?
- Do you support research in this field? Why or why not?

b) Challenges and Opportunities of Tissue Engineering

- What are the main challenges faced by researchers in the field of tissue engineering?
- What opportunities are presented by advancements in tissue engineering?
- What ethical issues might arise from the use of tissue engineering?
- Do you support the development of this field? Why or why not?

Exercise 2. *Study the mind map. Share your ideas and associations based on the mind map.*

Mind Map on Medicine and Treatment



Exercise 3. *Read the article "Medical Futility" (Part 1, check out Supplement 12). Identify the main topic, subtopics and up to 10 key words.*

Exercise 4. *Answer the following questions based on the information from the article:*

1. What is the definition of medical futility as described in the article?
2. Why is it challenging for hospitals to establish guidelines for medical futility?
3. What ethical principles are foundational to the physician-patient relationship, according to the article?
4. How does the concept of patient autonomy influence decisions about medical futility?
5. What are the four basic concepts of futility identified in bioethical literature?
6. Can you describe an example of physiological or strict futility?
7. What is clinical or overall futility, and how does the case of Nancy Cruzan illustrate this concept?
8. How does imminent demise futility differ from other concepts of futility?
9. What distinguishes qualitative futility from quantitative futility?
10. How does the case of Baby K illustrate the challenges of defining medical futility in the context of individual choice and ethical considerations?

Exercise 5. *Fill in the blanks based on the text.*

1. Medical _____ can best be defined as an instance when a terminally ill patient and others for whom everything medically plausible, including heroic methods, has been tried, or a situation in which a patient has exhausted the course of innovative and tested therapeutic interventions, and nevertheless will die or live endlessly in a persistent vegetative state (PVS).

a) Success b) Futility
c) Treatment d) Recovery

2. An intervention is considered medically _____ when there is no therapeutic benefit to the patient nor will the treatment return the patient back to an acceptable level of continued existence.

a) Beneficial b) Plausible
c) Futile d) Effective

3. When comparing the quality of the outcome to the intervention, the outcome falls below the minimally established _____ determined by the social standards set in the community.

a) Costs b) Benefits
c) Guidelines d) Procedures

4. This article seeks to clarify medical _____ together with the rationale for creating a policy.

a) Ethics b) Practices
c) Treatments d) Futility

5. Autonomy gives the patient the right to determine what course of action is preferable, based on their own _____.

a) Values b) Health
c) Physician's advice d) Treatment options

6. Treating the patient with interventions that will not improve _____ functioning could be construed as unethical.

a) Mental b) Physical
c) Emotional d) Physiologic

7. The first concept is based on _____, and emphasizes physiological or strict futility.

a) Justice b) Autonomy
c) Beneficence d) Nonmaleficence

8. An example of clinical or overall futility is one where the patient is in a _____ who has irreversibly lost the capacities to interact with the environment and resume human development.

a) Coma b) Persistent vegetative state
c) Deep sleep d) Temporary unconsciousness

9. _____ futility is when an intervention is unlikely to restore the patient's ability to interact with the environment and resume human development.

a) Imminent demise b) Qualitative
c) Clinical d) Physiological

10. _____ futility considers treatment futile if the quality of life after treatment is unacceptable to the patient.

a) Quantitative b) Beneficial
c) Physiological d) Qualitative

Exercise 6. *Translate following phrases into Ukrainian.*

1. Medical futility
2. Terminally ill patient
3. Heroic methods
4. Persistent vegetative state (PVS)
5. Therapeutic benefit
6. Acceptable level of continued existence
7. Minimally established guidelines
8. Social standards
9. Autonomy
10. Physiologic functioning
11. Ethical principles
12. Beneficence
13. Nonmaleficence
14. Clinical setting
15. Bioethical literature
16. Qualitative futility
17. Quantitative futility
18. Imminent demise futility
19. Intervention
20. Physiological improvement

Exercise 7. *Translate following phrases into English:*

1. Соціальні стандарти
2. Героїчні методи
3. Медична безглуздість
4. Термінально хворий пацієнт
5. Біоетична література
6. Стан стійкої вегетативної існування (PVS)
7. Неушкодження
8. Терапевтична користь
9. Прийнятний рівень подальшого існування

10. Якісна безглуздість
11. Кількісна безглуздість
12. Мінімально встановлені керівні принципи
13. Автономія
14. Безглуздість неминучої смерті
15. Втручання
16. Фізіологічне покращення
17. Фізіологічне функціонування
18. Етичні принципи
19. Благодіяння
20. Клінічні умови

Exercise 8. *Translate these sentences from the text into Ukrainian:*

1. Medical futility is a complex and often obscure concept that frequently complicates decision-making within the medical community.

2. Medical futility refers to situations where a terminally ill patient has undergone all possible medical treatments, including extreme measures, or when a patient has tried every innovative and proven therapy but will still die or remain in a permanent vegetative state.

3. An intervention is considered medically futile if it provides no therapeutic benefit to the patient or fails to restore the patient to an acceptable level of continued life.

4. Medical futility is defined as a scenario where a terminally ill patient has received every feasible medical treatment, including extreme measures.

5. Providing treatments that do not enhance physiological function can be seen as unethical.

6. When comparing the intervention's outcome to its quality, the result falls short of the minimal standards set by the community's social guidelines.

7. An intervention is futile if it offers no therapeutic benefit to the patient and does not restore the patient to an acceptable level of ongoing existence.

8. In bioethical literature, four main concepts of futility have been identified.

9. Qualitative futility, the fourth element of the concepts of medical futility, was presented by Tomlinson and Brody.

10. Medical futility involves interventions unlikely to produce significant benefits.

Exercise 9. *Translate these sentences from the text into English:*

1. Медична безглуздість є складним і часто неясним поняттям, яке часто ускладнює прийняття рішень у медичній спільноті.

2. Лікування пацієнта за допомогою втручань, які не покращують фізіологічне функціонування, може вважатися неетичним.

3. Втручання є безглуздим, коли безсумнівно очікується смерть пацієнта і він не може свідомість до виписки з клінічних умов.

4. Втручання вважається медично безглуздим, коли немає терапевтичної користі для пацієнта і лікування не поверне пацієнта до прийнятного рівня подальшого існування.

5. Автономія дає пацієнту право визначати, який курс дій є бажаним, виходячи з їх власної системи цінностей.

6. У біоетичній літературі було визначено чотири основні концепції безглуздості.

7. Згідно з Кодексом етики Американської медичної асоціації, лікарі не зобов'язані пропонувати безглузді втручання на основі етичного принципу благодіяння.

8. Медична безглуздість пов'язана з втручаннями, які навряд чи принесуть значну користь пацієнту.

9. Це ставить перед лікарнями завдання встановити керівні принципи медичної безглуздості та розробити політику, яка підтримує етичні принципи поваги до пацієнтів.

Exercise 10. *Read the article "Medical Futility" (Part 2, check out Supplement 13), identify the main topic and subtopics, and up to 10 keywords.*

Exercise 11. *Choose the correct answer for each question.*

1. In cases of medical futility, physicians may decide to stop certain treatments
   A. because patients request them to do so.
   B. because patients' relatives insist on their continuing.
   C. because it is not in the best interests of the patient.
2. In some cases, physicians discontinue treatment
   A. before looking at evidence about its benefit to the patient.
   B. after developing an opinion that it might be pointless.
   C. after reading an overview of its advantages.
3. In paragraph 2, the words no unanimity means
   A. the statistics are not the same.
   B. doctors do not share the same opinion.
   C. the level of futility is anonymous.
4. Some patients and surrogates think doctors
   A. have too much influence in decisions about continuing treatment.
   B. do not have the necessary authority to make treatment decisions.
   C. want to emerge as the most important figure in all decisions.
5. Suggested solutions to the medical futility dilemma include
   A. more accurate prognosis of conditions.
   B. transfer to palliative care units.
   C. honest, sensitive discussions with all parties.

Exercise 12. *Decide if these statements are True or False based on the information from the article:*

1. Medical futility refers to any medical intervention that fails to provide a therapeutic benefit to the patient.
2. Patient autonomy requires physicians to provide any treatment plan that the patient or surrogate desires.
3. The concept of medical futility is universally accepted and clearly defined within the medical community.
4. The case of Nancy Cruzan is an example of imminent demise futility.
5. Palliative care can improve the quality of life even if it does not prolong it.

For some vocabulary practice, scan QR code go to the Quizlet flashcards and do the activities.

Exercise 13. *Translate these words and phrases into Ukrainian.*

1. Quantitative futility
2. Benefit
3. Justification
4. Brain death criteria
5. Guidelines
6. Advanced directives
7. Palliative care
8. Unilateral decision
9. Conflict resolution
10. Goals of care

Exercise 14. *Translate these words and phrases into English.*

1. Кількісна безглуздість
2. Користь
3. Обґрунтування
4. Критерії смерті мозку
5. Керівні принципи
6. Попередні директиви
7. Паліативна допомога
8. Одностороннє рішення
9. Вирішення конфліктів
10. Цілі догляду

Exercise 15. *Translate these sentences using the words and phrases from the previous exercises:*

1. Quantitative futility is when the likelihood or probability that an intervention will benefit the patient is unlikely.

2. Physicians must provide a clear justification for any treatment plan they recommend.

3. Brain death criteria are used to determine the irreversible cessation of brain function.

4. The majority of patients have not designated advanced directives to guide their end-of-life care.

5. Palliative care can improve the quality of a patient's life even though it may not prolong it.

6. A patient's physician should have initial authority to consider treatment futile, although it should not be solely a unilateral decision.

7. A policy that includes conflict resolution guidelines would aid physicians in cases where they arrive at a decision of futility when the family is in complete opposition.

8. The Goals of Care Assessment Tool is used to collect relevant clinical and narrative information crucial to the formulation of rational goals of care.

Exercise 16. *Translate these sentences into English, using the words and phrases from the previous exercise.*

1. Політика, яка включає керівні принципи вирішення конфліктів, допоможе лікарям у випадках, коли вони приймають рішення про безглуздість, а сім'я повністю не погоджується.

2. Кількісна безглуздість має місце тоді, коли ймовірність або шанс, що втручання принесе користь пацієнту, є малоймовірними.

3. Лікарі повинні надати чітке обґрунтування будь-якого лікувального плану, який вони рекомендують.

4. Критерії смерті мозку використовуються для визначення незворотного припинення функції мозку.

5. Якщо лікування не принесе користі пацієнту, яке ж тоді обґрунтування має лікар для призначення ліків?

6. Встановлення керівних принципів медичної безглуздості повинно починатися з припинення невідповідного лікування.

7. Паліативна допомога може покращити якість життя пацієнта, навіть якщо вона не продовжить його.

8. Лікар пацієнта повинен мати право вважати призначене лікування безглуздим, та водночас це не повинно бути одностороннім рішенням.

Exercise 17. *Complete these scenarios with your own ideas. Roleplay them in class.*

Scenario 1: Annual Check-Up

– Good morning! I see it's time for your annual check-up. How have you been feeling overall this past year?

– Hello, Doctor. I've been doing okay, but I've noticed I get tired more easily lately.

– Let's go over your diet and exercise routine to see if there are any areas we can improve for your energy levels.

Scenario 2: Discussing Test Results

– We've got your test results back. Let's discuss what they mean for your health going forward.

– I'm a bit nervous about them. Is everything alright?

– There are a few areas we need to address, but with some lifestyle changes, we should see improvement.

Scenario 3: Managing a Chronic Condition

– How have you been managing with your diabetes since our last visit?

– It's been challenging to keep my blood sugar levels stable. I could use some advice.

– Let's review your current management plan and see where we can make adjustments.

Scenario 4: Post-Surgery Follow-Up

– It's been two weeks since your surgery. Tell me, how is your recovery process going?

– The pain is manageable, but I'm concerned about the swelling that hasn't gone down.

– Swelling can be normal, but let's take a look to ensure it's part of the healthy healing process.

Scenario 5: Lifestyle Consultation

– I'm glad you're taking proactive steps towards a healthier lifestyle. What goals would you like to focus on?

– I want to lose weight and increase my fitness level but don't know where to start.

– We'll work on a plan together that includes nutrition and exercise tailored to your needs.

MINI GLOSSARY

medical futility – An intervention that provides no therapeutic benefit to the patient; медична марність, безглуздість.

persistent vegetative state (PVS) – A condition where a patient is awake but not aware due to severe brain damage; тривалий вегетативний стан.

nonmaleficence – The ethical obligation to avoid causing harm to the patient; ненашкодження, нездійснення шкоди.

beneficence – The ethical principle of acting in the best interest of the patient by providing benefits and balancing them against risks; благодіяння.

autonomy – The right of patients to make informed decisions about their medical care; автономія.

goals of care assessment tool (GCAT) – A structured tool used to collect relevant clinical information and guide end-of-life care decisions; інтсрумент оцінки якості цілей догляду.

palliative care – Medical care focused on providing relief from the symptoms and stress of serious illness to improve quality of life; паліативна медична допомога.

ethical principles – Fundamental guidelines that influence decision making and ethical behavior in healthcare; етичні принципи.

quality of life – The overall enjoyment of life and sense of well-being experienced by an individual; якість життя.

end-of-life care – Support and medical care given during the time surrounding death; передсмертний догляд.

UNIT 11
Quality-Adjusted Life Year

Exercise 1. *Memorize new words and word combinations, and compose your own sentences with them. Examples include:*

- disease burden
- utility value
- cost-effectiveness analysis
- health states

Exercise 2. *Skim through the text "What is a Quality-Adjusted Life Year (QALY), and why is it important in health economics?" (check out Supplement 15) and try to get its main idea. Identify up to 10 key words.*

Exercise 3. *State the main idea of each passage of the article and support your ideas. Look through the article and write down its summary.*

Exercise 4. *Answer the questions based on the information from the article.*

1. Describe the two main inputs required to calculate a QALY.
2. What are the different methods used to measure utility values in QALY calculations? Explain each method briefly.
3. Provide an example of how QALY is calculated when a patient's quality of life changes over a period of years.
4. How does QALY differ from Disability-Adjusted Life Year (DALY), and what does each measure?

Exercise 5. *Complete the statements based on the information from the article.*

1. Quality-adjusted life year (QALY) is a measure of health outcomes that combines the length of life and _____.

2. In health economics, QALY is essential for assessing the value of _____.

3. To calculate QALY, two inputs must be considered: the utility value and _____.

4. The QALY scale ranges from 0 to 1, where 0 means death and 1 means _____.

5. The time-trade-off (TTO) method involves respondents choosing between remaining in ill health for a specific period of time or _____.

6. An example of QALY calculation is if a patient lives with a utility of 0.5 for one year, this is equivalent to living half a year in _____.

7. Palliative care aims to improve the quality of a patient's life even if it does not _____ it.

8. A policy including conflict resolution guidelines helps physicians when they arrive at a decision of futility and _____.

9. The use of QALY in health economics is crucial for evaluating the cost-effectiveness of _____.

10. DALY, unlike QALY, quantifies the burden of disease by summing the years of life lost due to premature mortality and _____.

Exercise 6. *Decide if these statements are true or false.*

1. QALY stands for Quality-Adjusted Life Year.

2. QALY only measures the quantity of life without considering the quality of life.

3. A QALY value of 1 represents perfect health for one year.

4. The visual analog scale (VAS) rates ill health on a scale from 0 to 100, where 100 represents being dead.

5. QALY calculations help in determining the cost-effectiveness of medical interventions.

6. DALY and QALY can be used interchangeably to measure health outcomes.

7. The National Institute for Health and Care Excellence (NICE) uses QALY to evaluate health technologies in the United Kingdom.

8. Palliative care can only prolong life and has no impact on the quality of life.

9. QALY calculations are not influenced by the severity of the disease.

10. QALY is a widely accepted metric in health economics despite some criticism of its theoretical assumptions.

Exercise 7. *Translate these phrases from the text into Ukrainian:*

- Quality-Adjusted Life Year (QALY)
- Health economics –
- Medical interventions –
- Cost-effectiveness analysis –
- Utility value –
- Time-trade-off (TTO) –
- Standard gamble (SG) –
- Visual analog scale (VAS) –
- Empirical evidence –

Exercise 8. *Translate these phrases from the text into English:*

- Якість скоригованого життя
- Економіка охорони здоров'я
- Медичні втручання
- Аналіз рентабельності
- Корисність
- Часовий компроміс
- Стандартний ризик
- Візуальна аналогова шкала
- Емпіричні докази

Exercise 9. *Translate the sentences into English, using the words and phrases from the previous exercise.*

1. Якість скоригованого життя є мірою результатів здоров'я, яка поєднує тривалість життя та якість життя.

2. В економіці охорони здоров'я QALY є важливим для оцінки вартості медичних втручань.

3. Для розрахунку QALY необхідно врахувати два вхідні дані: корисність і тривалість життя людей у різних станах здоров'я.

4. Візуальна аналогова шкала (VAS) оцінює стан хвороби за шкалою від 0 до 100, де 0 означає смерть, а 100 – ідеальне здоров'я.

5. Емпіричні докази, що документують результат лікування, визначать, чи є лікування безглуздим чи ні.

6. В економіці охорони здоров'я QALY використовується для оцінки рентабельності медичних втручань.

7. Емпіричні докази є критичними для визначення ефективності конкретного медичного втручання.

Exercise 10. *Translate the sentences into Ukrainian, using the words and phrases from the previous exercise.*

1. Quality-Adjusted Life Year (QALY) is a measure of health outcomes that combines the length of life and quality of life.

2. In health economics, QALY is essential for assessing the value of medical interventions.

3. To calculate QALY, two inputs must be considered: the utility value and the amount of time people live in various health states.

4. The time-trade-off (TTO) method involves respondents choosing between remaining in ill health for a specific period of time or perfect health with a shorter life expectancy.

5. Empirical evidence documenting the outcome of treatment will establish whether a treatment is futile or not.

6. Palliative care can improve the quality of a patient's life even though it may not prolong it.

7. The standard gamble (SG) method involves respondents choosing between remaining in ill health or taking a medical intervention that could either restore perfect health or result in death.

Exercise 11. *Complete the survey and find out your quality-of-life level. Share your results in small groups.*

Health Quality Assessment Questionnaire

1. How often do you engage in physical activity?
   – [ ] Daily
   – [ ] Several times a week
   – [ ] Rarely
   – [ ] Never

2. How would you rate your stress level?
   – [ ] Low
   – [ ] Moderate
   – [ ] High
   – [ ] Very high
3. How would you rate the quality of your sleep?
   – [ ] Excellent
   – [ ] Good
   – [ ] Fair
   – [ ] Poor

Dietary Habits:

4. How many servings of fruits and vegetables do you consume daily?
   – [ ] 5 or more
   – [ ] 3–4
   – [ ] 1–2
   – [ ] None
5. How often do you eat processed or fast foods?
   – [ ] Rarely or never
   – [ ] Occasionally
   – [ ] Frequently
   – [ ] Very frequently

Lifestyle Choices:

6. Do you smoke tobacco products?
   – [ ] Yes
   – [ ] No
7. How often do you consume alcoholic beverages?
   – [ ] Never
   – [ ] Monthly or less
   – [ ] 2–4 times a month
   – [ ] 2–3 times a week
   – [ ] 4 or more times a week

Mental Well-being:

8. Do you feel you have someone to talk to when you're feeling down?
   – [ ] Always
   – [ ] Usually
   – [ ] Sometimes

– [ ] Rarely
– [ ] Never

9. How often do you engage in activities that you enjoy?
– [ ] Daily
– [ ] Several times a week
– [ ] Once a week
– [ ] Less than once a week
– [ ] Never

MINI GLOSSARY

QALY (Quality-Adjusted Life Year): A measure of the value of health outcomes, combining both quantity and quality of life; якість скоригованого життя.

DALY (Disability-Adjusted Life Year): A measure of overall disease burden, expressed as the number of years lost due to ill-health, disability, or early death; рік життя з поправкою на інвалідність.

utility value: A measure of the preference for a particular state of health, used in calculating QALYs; користь, корисне значення.

cost-effectiveness analysis: A method of comparing the relative expenses and outcomes of different courses of action; аналіз рентабельності.

health states: Different levels of health quality that a person may experience over time; стан здоров'я.

Time-Trade-Off (TTO): A method for measuring utility value where respondents choose between living longer in a less desirable health state or shorter in perfect health; часовий компроміс.

standard gamble (SG): A method for measuring utility value involving a choice between a certain less desirable health state and a gamble between perfect health and death; стандартний ризик.

visual analog scale (VAS): A method for measuring utility value by rating health states on a scale from 0 (worst) to 100 (best); візуальна аналогова шкала.

EuroQol EQ-5D: A standardized instrument for measuring health outcomes; опитувальник здоров'я EuroQol EQ-5D.

health economics: The study of how health care resources are allocated, including the costs and outcomes of health care services.; економіка охорони здоров'я.

UNIT 12
Fighting Influenzas

Exercise 1. *Before reading the text, memorize new words and word combinations, and compose your own sentences with them. Examples include:*

- antiviral drugs
- prescription medication
- flu complications
- side effects

Exercise 2. *Read, translate, and be ready to retell the following text "What You Should Know About Influenza (Flu) Antiviral Drugs" (Part 1, check out Supplement 15). Identify up to 10 keywords.*

Exercise 3. *Answer these questions based on the information from the article.*

1. What are antiviral drugs and how do they work against the flu?
2. Can flu illness be treated with antiviral drugs and how effective are they?
3. What should a person do if they think they have the flu?
4. Should people still get a flu vaccine even if antiviral drugs are available?
5. What are the benefits of starting antiviral treatment within two days of getting flu symptoms?
6. What are the four FDA-approved antiviral drugs recommended by the CDC for this flu season?
7. What are the common side effects of oseltamivir and zanamivir?
8. How long should antiviral drugs be taken for the treatment of flu?
9. Are antiviral drugs safe for children and what are the age recommendations for each drug?
10. Why is oral oseltamivir recommended for pregnant women with the flu?

Exercise 4. *Choose the correct option based on the information from the article.*

1. What are antiviral drugs?
   a) Over-the-counter medications
   b) Prescription medicines that fight against flu in your body
   c) Antibiotics for treating bacterial infections
   d) Vitamin supplements
2. Can flu illness be treated with antiviral drugs?
   a) No
   b) Only if there are no other options
   c) Yes
   d) Only in severe flu cases
3. When do antiviral drugs work best?
   a) After 5 days of symptoms
   b) Within two days of symptoms
   c) A week before symptoms
   d) A month before symptoms

4. Are antiviral drugs a substitute for the flu vaccine?
   a) Yes
   b) No
   c) Only for children
   d) Only for pregnant women
5. What are the benefits of antiviral drugs?
   a) Reduce fever and symptoms
   b) Shorten the time you are sick by about one day
   c) Prevent serious flu complications
   d) All of the above
6. What antiviral drugs are recommended by the CDC this season?
   a) Aspirin and paracetamol
   b) Ibuprofen and amoxicillin
   c) Oseltamivir, zanamivir, peramivir, baloxavir marboxil
   d) Vitamin C and zinc
7. What are the possible side effects of oseltamivir?
   a) Headache and sore throat
   b) Nausea and vomiting
   c) Dry skin and itching
   d) Increased appetite
8. Can children take antiviral drugs?
   a) Yes, but it varies by medication
   b) No, only adults
   c) Only teenagers
   d) Only infants
9. Which antiviral drug is not recommended for pregnant and breastfeeding women?
   a) Oseltamivir
   b) Zanamivir
   c) Peramivir
   d) Baloxavir
10. Who should take antiviral drugs first and foremost?
   a) People with mild flu
   b) People at high risk of serious flu complications
   c) All people regardless of health status
   d) Only children and pregnant women

Exercise 5. *Match the terms with their correct meanings.*

1. strain	a) habitat in which an infectious agent lives
2. bivalent	b) careful watching of something
3. surveillance	c) describes a vaccine that stimulates a response to 2 influenza strains
4. cross-contamination	d) way in which genes change and produce permanent changes
5. trivalent	e) influenza infection that is usually self-limiting and does not cause complications
6. mutation	f) class of antiviral that block the enzyme responsible for influenza virus reproduction
7. neuraminidase inhibitor	g) particular type of something
8. uncomplicated flu	h) describes a vaccine that stimulates a response to 2 influenza A and 2 influenza B strains
9. reservoir	i) describes a vaccine that stimulates a response to 2 influenza A and 1 influenza B strains
10. quadrivalent	j) process by which a harmful substance spreads from one area to another.

Exercise 6. *Translate the following words and phrases into Ukrainian.*

1. Antiviral drugs
2. Prescription medicines
3. Flu symptoms
4. Flu vaccine
5. High risk of serious flu complications
6. Side effects
7. Oseltamivir phosphate
8. Zanamivir
9. Peramivir
10. Baloxavir marboxil

Exercise 7. *Translate the following words and phrases into English.*

1. Рецептурні ліки
2. Симптоми грипу
3. Осельтамівір фосфат
4. Противірусні препарати
5. Перамівір
6. Вакцина проти грипу
7. Високий ризик серйозних ускладнень грипу
8. Побічні ефекти
9. Занамівір
10. Балоксавір марбоксил

Exercise 8. *Translate the following sentences into Ukrainian.*

1. Antiviral drugs are prescription medicines that fight against flu in your body.
2. Prescription medicines can only be obtained with a prescription from a healthcare provider.
3. Flu symptoms can include fever, cough, sore throat, runny or stuffy nose, body aches, headache, chills, and fatigue.
4. Flu vaccine is the first and best way to prevent influenza.
5. People at high risk of serious flu complications should consider taking antiviral drugs.
6. Side effects vary for each medication.
7. Oseltamivir phosphate is available as a pill or liquid.
8. Zanamivir is a powder that is inhaled.
9. Peramivir is given intravenously by a healthcare provider.
10. Baloxavir marboxil is a pill given as a single dose by mouth.

Exercise 9. *Translate the following sentences into English.*

1. Рецептурні ліки можна отримати тільки за рецептом від медичного працівника.
2. Побічні ефекти відрізняються для кожного препарату.
3. Вакцина проти грипу є першим і найкращим способом запобігти грипу.
4. Противірусні препарати – це рецептурні ліки, які борються проти грипу в вашому організмі.

5. Осельтамівір фосфат доступний у вигляді таблетки або рідини.

6. Занамівір – це порошок, який вдихається.

7. Люди з високим ризиком серйозних ускладнень грипу повинні розглянути можливість прийому противірусних препаратів.

8. Симптоми грипу можуть включати лихоманку, кашель, біль у горлі, нежить або закладеність носа, ломоту в тілі, головний біль, озноб та втому.

9. Балоксавір марбоксил – це таблетка, яка приймається одноразово через рот.

Exercise 10. *Agree or disagree with these topics in small groups.*

1. Antiviral drugs should be available over-the-counter to improve accessibility.

2. Everyone should get a flu vaccine every year, regardless of their health status.

3. The benefits of antiviral drugs outweigh the potential side effects.

4. Children should always be treated with antiviral drugs when they get the flu.

5. Pregnant women should avoid all antiviral drugs due to potential risks to the baby.

6. Flu vaccines are more effective than antiviral drugs in preventing flu-related complications.

7. Healthcare providers should focus more on preventive measures, like vaccines, rather than treatments, like antiviral drugs.

8. Antiviral drugs should be prescribed only to high-risk patients to prevent overuse and resistance.

9. Flu symptoms can always be managed effectively without the use of antiviral drugs.

10. Public awareness campaigns should focus more on the availability and benefits of antiviral drugs.

Exercise 11. *Look at the picture and share your associations based on personal experience.*

Exercise 12. *Read and translate the text "Antiviral Treatment of Influenza" (check out Supplement 16). Identify up to 10 keywords.*

Exercise 13. *Answer the questions based on the information from the article.*

1. Why are antivirals important for individuals at risk of developing severe influenza?
2. What are the three antiviral drugs authorized for the treatment of influenza in Europe, and what are their specific uses?
3. Why are Matrix-2 (M2) inhibitors such as adamantanes not recommended for the treatment of influenza?
4. How is antiviral resistance monitored in Europe, and which organizations are involved in this process?
5. Under what circumstances might everyone exposed to influenza be given antivirals, and why?

Exercise 14. *Decide if these statements are True or False. Justify your answers.*

1. Antivirals can replace influenza vaccination.
2. Oseltamivir (Tamiflu) and Zanamivir (Relenza) are neuraminidase inhibitors.
3. Adamantanes are effective against influenza B strains.
4. Baloxavir marboxil (Xofluza) is used for treatment and post-exposure prophylaxis of influenza in individuals aged one year and older.
5. Antivirals are available over the counter without a prescription.
6. Zanamivir and Oseltamivir are effective on the neuraminidases of influenza A and B viruses.
7. Antivirals are most effective when taken within the first 48 hours of symptom onset.
8. Excessive use of antivirals can lead to the development of drug-resistant influenza viruses.
9. All people, including those not at risk, should have antivirals at home for immediate use.
10. In a proven influenza outbreak in a long-term care facility, antivirals may be given to all at-risk individuals.

Exercise 15. *Translate these phrases from the text into Ukrainian:*

1. Antivirals
2. Duration of disease
3. Severity of symptoms
4. Antigenic mismatch
5. Waning immunity
6. Avian influenza
7. Emerging pandemic
8. Influenza-specific antiviral drugs
9. Influenza A and B viruses
10. Prescription
11. Underlying conditions
12. Symptom onset
13. Resistance to antiviral drugs
14. High risk for complications
15. National guidelines

Exercise 16. *Translate the following phrases into English.*

1. Противірусні засоби
2. Тривалість хвороби
3. Зниження імунітету
4. Пташиний грип
5. Виникаюча пандемія
6. Тяжкість симптомів
7. Початок симптомів
8. Противірусні препарати, специфічні для грипу
9. Віруси грипу А та В
10. Стійкість до противірусних препаратів
11. Високий ризик ускладнень
12. Національні керівництва
13. Рецепт
14. Основні захворювання
15. Антигенна невідповідність

Exercise 17. *Translate the following sentences into English.*

1. Ефективність противірусних препаратів зменшується з часом від початку симптомів.
2. Противірусні засоби можуть бути корисними для зменшення тривалості хвороби або тяжкості симптомів, спричинених інфекцією вірусу грипу.
3. Зниження імунітету у літніх людей може зробити їх більш вразливими до грипу.
4. У разі спалаху пташиного грипу необхідно вжити суворих заходів.
5. Під час виникаючої пандемії своєчасна постконтактна профілактика може допомогти уникнути швидкого поширення вірусу.
6. Противірусні препарати, специфічні для грипу, є важливим доповненням до вакцини проти грипу.
7. Жоден з цих препаратів не можна отримати без рецепта.
8. Стійкість до противірусних препаратів контролюється шляхом аналізу стійкості до противірусних препаратів.

9. Особи з високим ризиком ускладнень повинні розглянути можливість противірусного лікування і своєчасної вакцинації.

10. Національні агенції з питань охорони здоров'я надають рекомендації щодо використання противірусних препаратів.

Exercise 18. *Translate the following sentences into Ukrainian.*

1. Antivirals can be useful to reduce the duration of disease or severity of symptoms due to influenza virus infection.
2. Waning immunity in the elderly population can make them more susceptible to influenza.
3. In case of an avian influenza outbreak, strict measures must be taken.
4. Immunocompromised patients are particularly vulnerable to severe influenza infections.
5. Influenza-specific antiviral drugs are an important addition to the influenza vaccine.
6. These medications are effective against both influenza A and B viruses.
7. None of these medications can be obtained without a prescription.
8. Individuals with underlying conditions should consult a doctor at the onset of symptoms.
9. The effectiveness of antivirals decreases with the time elapsed from the symptom onset.
10. National guidelines provide recommendations for the use of antivirals.

Listening

Exercise 19. *Watch the video at Fighting influenza.*

Video Transcript

2018 marked the 100th anniversary of the flu pandemic, often referred to as The Spanish Influenza Pandemic. This devastating event claimed the lives of an estimated 50 million people worldwide. Since then, significant milestones have been reached in both the prevention and treatment of influenza. In 1903, fifteen years before the 1918

pandemic, Johnson & Johnson started to mass-produce hypodermic needles and syringes. The needles were designed to fit a standard syringe, as the company recognised the need to administer medication as an injectable form to a large number of people, for example, during vaccination programmes. Prior to this, most drugs were administered orally. In 1933, British researchers isolated and identified influenza A, the flu strain most likely to cause a pandemic. In fact, the discovery was accidental, as the researchers had been working with ferrets to produce a distemper vaccine, when one of the animals caught the flu from a researcher.

During the testing period of the vaccine, researchers noticed that some patients did not develop antibodies to the influenza A strain. This led to the discovery of another strain, influenza B, which while not responsible for pandemics can still cause localised endemics. In 1942, a new bivalent vaccine was produced which protected against both strains of the influenza virus. In 1944, this whole-virus, inactivated influenza A and B vaccine was tested in military recruits and college students in the US and approved for use in the general population the following year. Despite initial enthusiasm for the vaccine, by the time of the 1947 flu season it was clear that the vaccine was not effective against currently circulating flu viruses. As a result, the WHO set up a worldwide surveillance system in 1952 to monitor globally circulating influenza strains, so that a targeted vaccine could be made each year in response. The mass production of disposable needles and syringes in 1954 helped to reduce cross-contamination during the administration of vaccines and the development of a trivalent vaccine containing two influenza A and one influenza B strain in 1978 further improved the protection against the most common circulating strains. In 2003 a nasal vaccine was licensed for healthy, non-pregnant people between the ages of 5 and 49. In 2007, its use was extended to children between 2 and 5 years of age. Finally, in 2012, a quadrivalent vaccine against 2 Influenza As and 2 Influenza Bs was released. Apart from research into vaccines which prevent infection with influenza, developments

have been made in therapeutics which treat influenza infections once they occur. Medications used to treat flu illnesses are called antivirals. This type of drug works by binding to proteins on the surface of viruses stopping viruses from spreading to healthy cells. Unfortunately, when viruses change their proteins, they can become resistant to antivirals. The first antiviral drug to be released into the US market was amantadine, after its antiviral properties were reported in 1963. Although gaining approval in 1976 in the treatment of influenza A infection, it is no longer recommended due to its side effects and resistance issues. In 1999, a new class of antiviral medications called neuraminidase inhibitors was introduced. Two antivirals, oseltamivir phosphate and zanamivir, were approved by the Food and Drug Administration (FDA) for the treatment of influenza A and B. Oseltamivir phosphate, brand name Tamiflu, is the most commonly used oral antiviral flu drug that can be taken at any age. Common side effects may include nausea, vomiting and headache. Zanamivir, brand name Relenza, is an inhaled oral drug which can be taken by people 7 years and older except by people with asthma or chronic obstructive pulmonary disease (COPD). Common side effects include wheezing, sinusitis and dizziness. In 2014, Peramivir, brand name Rapivab, was developed for people admitted to the Emergency Department who are not able to take antivirals orally. Peramivir is administered intravenously as a single dose to patients two years old, or older. The most common side effect is diarrhoea. Baloxavir marboxil, brand name xofluza, is a single-dose, oral antiviral drug approved in the US and Japan in 2018 and in the UK in 2021. It is used to treat uncomplicated flu in adults and children 1 year or older. The most common side effects of the drug are diarrhoea, bronchitis, nausea, sinusitis and headache. Over the past hundred years, influenza has caused four global pandemics and the constant changes in the influenza genome pose a continual threat to novel emergent strains. The 2009 swine flu pandemic was caused by the same strain of influenza that resulted in the 1918 pandemic. It exposed weaknesses in pandemic preparedness that were somewhat improved by increased surveillance and the development of pandemic risk assessment tools. The monitoring of pre-pandemic influenza viruses, such as the case of bird flu, provides public health

bodies with an advantage should the viruses transition from pre-pandemic to pandemic status. Continuing routine surveillance in animal populations known to be influenza reservoirs may also reveal important patterns in mutations and recombination events. Despite this, there still remains the threat of a completely new strain emerging, highlighted by the recent Covid pandemic

Exercise 20. *Complete the timeline of information about influenza treatment and prevention.*

1903 mass-production of _____ needles and syringes

1918 estimated 50 million people die _____ in Spanish Influenza Pandemic

1933 influenza A identified – _____ most likely to cause a pandemic

1942 vaccine produced against both strains of the influenza virus

1944 influenza A and B vaccine _____ in US military recruits &college students

1945 vaccine _____ for use in the general population

1947 vaccine deemed not effective against currently _____ flu viruses

1952 sets up worldwide surveillance system

1954 mass production of _____ needles and syringes

1963 amantadine - first _____ drug released

1976 amantadine approval for treatment of _____ infection

1978 development of a _____ vaccine

1999 (new antiviral drugs) introduced

2003 licensing of nasal vaccine for healthy, _____ people aged 5 to 49

2007 _____ vaccine use extended to between 2 and 5 years old

2009 _____ pandemic

2012 _____ vaccine was released

2014 Peramivir developed for use in _____ (IV not oral)

2018 Baloxavir marboxil – _____, oral antiviral drug approved in the US & Japan in 2018

2021 Baloxavir marboxil _____ in the UK.

MINI GLOSSARY

antiviral drugs: Prescription medicines used to treat flu by fighting the influenza virus in the body; противірусні препарати.

oseltamivir phosphate (Tamiflu®): An antiviral drug available as a pill or liquid, used to treat and prevent influenza; осельтамівір фосфат.

zanamivir (Relenza® and Dectova): An antiviral drug in the form of an inhaled powder or intravenous injection, used to treat and prevent influenza; занамівір.

baloxavir marboxil (Xofluza®): An antiviral drug taken as a single dose by mouth, used to treat and prevent influenza; балоксавір.

flu complications: Serious health issues that can arise from influenza, such as pneumonia; ускладнення від грипу.

prescription medication: Medicines that require a prescription from a health care provider to be obtained; ліки, що відпускаються за рецептом.

side effects: Unwanted symptoms caused by medical treatment; побічні ефекти.

intravenous: Administered through a vein; внутрішньовенний.

high risk factors: Conditions or situations that increase the likelihood of severe flu complications, such as age or chronic medical conditions; фактори високого ризику.

neuraminidase inhibitors: A class of antiviral drugs that block the neuraminidase protein on the surface of the influenza virus, preventing it from spreading; інгібітори нейрамінідази.

SUPPLEMENT 1

THE METHODS OF BIOLOGY

Observing and Hypothesizing

Even though biologists and other scientists study many different types of things, they all use the same basic steps. The common steps they use to do research and answer questions are called **scientific methods.** Scientists often figure out questions to ask and answer just by observing the world around them.

What is a hypothesis?

Forming a **hypothesis** is a research method scientists use.

A hypothesis is an explanation for a question or problem that can be tested. For example, imagine that the number of birds in an area decreased after snakes came into the area. A scientist might make the hypothesis that the snakes were the reason the number of birds decreased.

A scientist who forms a hypothesis must be certain that it can be tested. Before testing a hypothesis, scientists make observations and do research. The results of the experiment will help the scientist answer whether or not the hypothesis is supported.

Experimenting

To a scientist, an **experiment** is a test of a hypothesis by collecting information under controlled conditions.

What is a controlled experiment?

Controlled experiments involve two groups: the control group and the experimental or test group. The **control** is the part of an experiment that represents the standard conditions.

In other words, the control receives no experimental treatment. The experimental group is the test group that receives experimental treatment. For instance, imagine an experiment to learn how fertilizer affects plant growth. Fertilizer would be used in the experimental group but not in the control group. All other conditions – soil, light, and water – would be the same for both groups. In this experiment, using fertilizer is the independent variable. The **independent variable** is the one condition in an experiment that is tested. How much the plants grow is the dependent variable. The **dependent variable** is the condition that changes because of a change in the independent variable. Safety is another important factor that scientists think about when carrying out investigations and experiments. It is important to know about dangers that may exist from doing an experiment before you begin it. Anyone doing an experiment has a responsibility to follow safety procedures. They must keep themselves and others out of danger.

How are theories formed?

The information gathered from experiments is called **data.** A scientist carefully reviews or analyzes experimental results to decide if the data support the hypothesis. Scientists repeat their experiments in order to gather more data. Data are considered reliable only when repeating the experiment several times produces similar results. Scientists also compare the results of their experiments with the results of other studies. They research published information in scientific journals and computer databases. It is important to have details of an experiment presented in scientific journals and databases so that scientists can compare their results with those of similar studies. It lets other scientists test the results by repeating the experiment. If many scientists get the same results, it helps support the hypothesis. A hypothesis that is supported by many different investigations and observations becomes a **theory.**

SUPPLEMENT 2

DNA: THE MOLECULE OF HEREDITY

What is DNA?

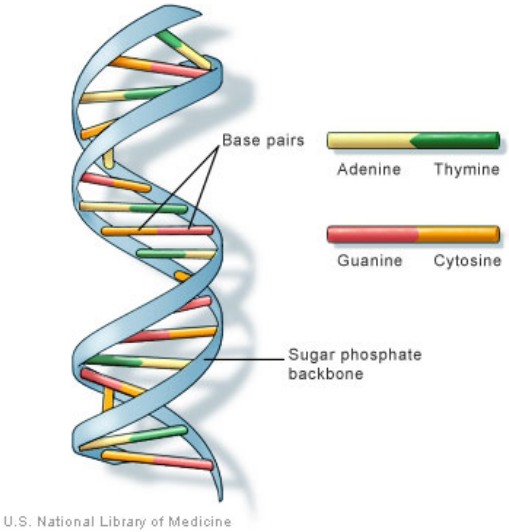
Living things contain proteins. Your skin, muscles, and bones contain protein. All the actions you perform such as eating, running, and thinking depend on proteins called enzymes. How is this related to DNA? Within DNA is the information for life. DNA contains the instructions to make all the different proteins an organism needs.

How can DNA hold all that information?

DNA can contain amazing amounts of information because of its structure. It is a very long molecule made up of repeating units called nucleotides. Each nucleotide is made up of a simple sugar, a phosphate group, and a nitrogenous base. A **nitrogenous base** is a carbon ring structure that contains one or more atoms of nitrogen. In DNA, there are four of these bases: adenine (A), guanine (G), cytosine (C), and thymine (T). Because each nucleotide contains just one of these nitrogenous bases, there are only four different nucleotides in DNA. Nucleotides join together to form long chains, or strands. The phosphate groups and the sugar form the backbone of the strand and the nitrogenous bases stick out like the teeth of a zipper.

What does the DNA molecule look like?

In 1953, James Watson and Francis Crick published a paper correctly describing the shape of a DNA molecule for the first time. They said that DNA is made of two strands of nucleotides held together by the nitrogenous bases, the parts that stick out like zipper teeth. Adenine on one strand always joins with thymine on the other strand. Likewise, guanine always joins with cytosine. They also noted that DNA was shaped like a long zipper that is twisted into a coil like a spring. Something twisted into a coil is called a helix. DNA is made of two strands that are twisted into a coil, so it is called a **double helix.** The figure at the right shows an example of a double helix.

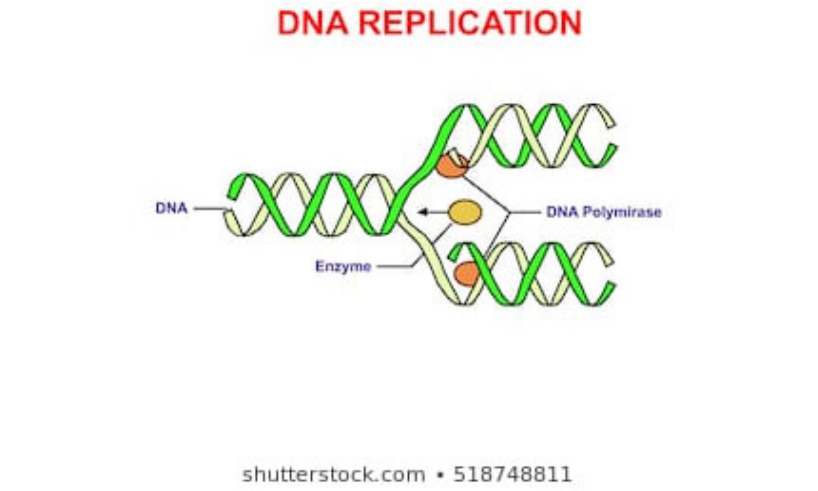


How can DNA do so much with so little?

If every organism is made up of the same four nucleotides, how can organisms be so different from one another? The key to variety in organisms is the sequence, or order, of the four nucleotides. For example, a nucleotide sequence of A-T-T-G-A-C carries different information than the sequence T-C-C-A-A-A. It is the sequence of nucleotides that forms the unique genetic information for every organism. In a similar way, words that have the same letters but in different order have different meanings. TEA is not the same as EAT or ATE.

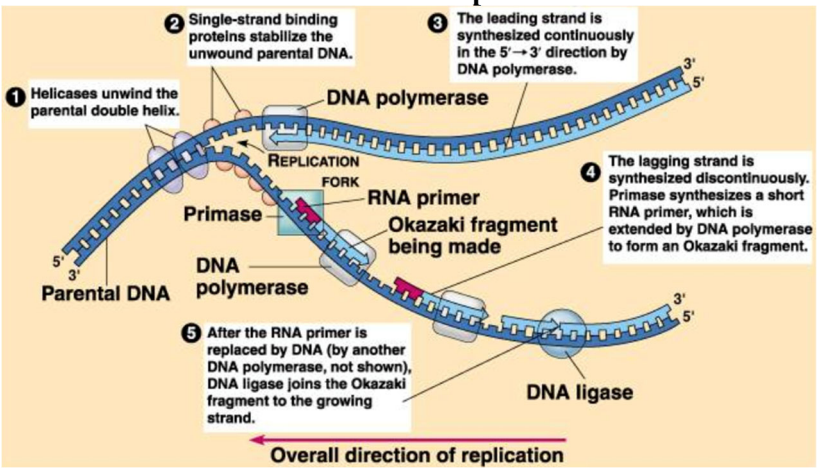
Replication of DNA

For most organisms to reproduce, a sperm cell and an egg cell, both produced through meiosis, must unite to form a fertilized egg. From one fertilized egg, an organism with millions of cells is produced through mitosis. Each cell in that organism has a copy of the DNA that was in the original fertilized egg. As you may recall, before a cell can divide, it must first make a copy of its chromosomes. The DNA in the chromosomes is copied in a process called **DNA replication.** If the DNA did not make a copy of itself, new cells would have only half the amount of DNA of their parents and could not grow and reproduce successfully.



Species could not survive. All organisms replicate DNA.

How does DNA replicate?



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Remember that a DNA molecule is made of two strands of nucleotides joined together like a zipper at the nitrogenous bases. As you know, adenine on one strand always pairs with thymine on the other strand. In the same way, guanine on one strand.

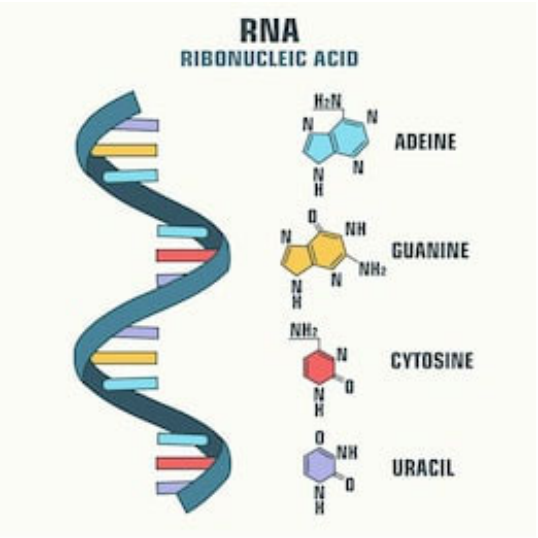
SUPPLEMENT 3

FROM DNA TO PROTEIN

Genes and Proteins

DNA contains information used to make proteins. Proteins have many uses. Some proteins become structures and some control cell functions. Since DNA has the information for making proteins, DNA controls cells. Remember that all this information is based on the sequence of nucleotides in the DNA molecule.

RNA



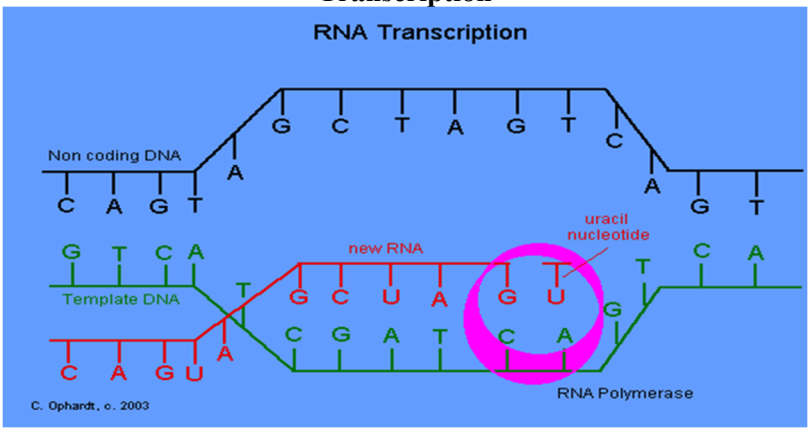
What is the role of RNA in a cell? Think of a car factory and an assembly line. A car is a complicated piece of machinery. But cars are built by following simple steps. Engineers tell workers how to make the cars, and workers follow the directions to build the cars on the assembly line. Suppliers bring parts to the assembly line so they can be used to build the cars. This is similar to the role of DNA and RNA

in a cell. DNA gives the instructions to make proteins. Workers build proteins. Other workers bring the parts, in this case, amino acids, to the assembly line. In our example, the workers are the RNA. Just as in a typical factory, workers have specific tasks. So does RNA. There are three different kinds of RNA. One type is **messenger RNA** (mRNA). It brings instructions from DNA to the cytoplasm. A second type of RNA is called the ribosome, or **ribosomal RNA** (rRNA). It binds to the mRNA and uses the instructions to assemble the amino acids in the right order. The third type of RNA is **transfer RNA** (tRNA). It delivers amino acids to the ribosome to be made into a protein.

What does RNA look like?

RNA, like DNA, is a nucleic acid. But the structure of RNA is quite different. RNA is a single strand. It looks like one half of a zipper. DNA is a double strand. The sugar in RNA is different than the sugar in DNA. Finally, both RNA and DNA have four nitrogenous bases, but instead of thymine, RNA has uracil. Remember that in DNA, guanine binds with cytosine, and thymine binds with adenine. In RNA uracil (U) binds with adenine. The structure of RNA helps it do all the work of building proteins.

Transcription



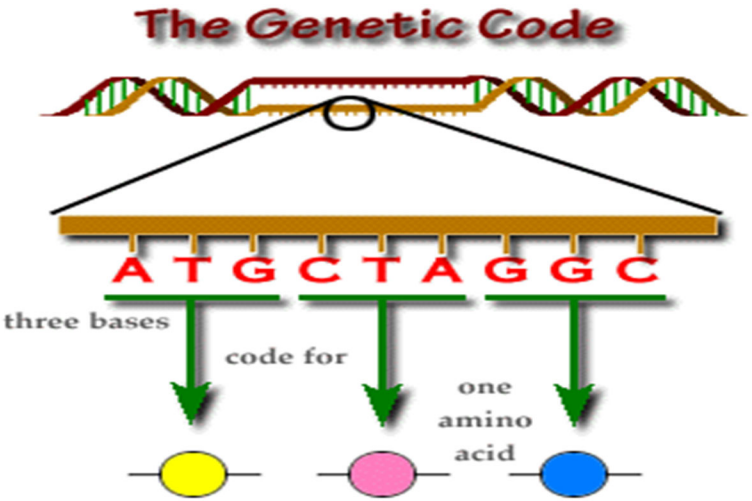
In order to get the information to the cytoplasm, first messenger RNA has to be made. In this process, called **transcription**, RNA is made from part of a DNA strand. Use the illustration on the next page to help you understand the process after you read the following description.

First, a portion of the DNA molecule unzips. Free RNA nucleotides pair with the nucleotides on the DNA strand. The mRNA strand is complete when the RNA nucleotides form a strand by bonding together. The mRNA strand breaks away and the DNA strands rejoin. The mRNA strand leaves the nucleus and enters the cytoplasm. You can see that transcription is similar to replication with one important difference – a single strand RNA molecule is created rather than a double strand DNA molecule. You can also see from the illustration that mRNA pairs guanine with cytosine, but pairs uracil with adenine.

RNA Processing

Not all of a DNA strand carries information to make proteins. There are long sequences of noncoding nucleotides on DNA strands. Enzymes cut out any noncoding sequences that may have been transcribed. In this way, the mRNA carries only information it needs to make protein.

The Genetic Code



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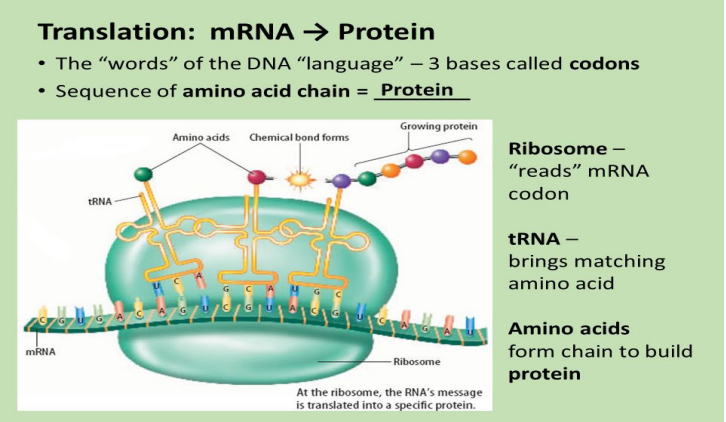
The nucleotide sequence transcribed from DNA to a strand of messenger RNA is a genetic message that has all the information needed to build a protein. The message is in a special language that uses nitrogenous bases as the alphabet. Remember that proteins are made up of amino acid chains. There are 20 different amino acids. These amino acids are made from only four nitrogenous bases. Scientists wondered how four nitrogenous bases could make a code for 20 amino acids. Scientists were able to crack the genetic code when they discovered that it takes a group of three nitrogenous bases in mRNA to code for one amino acid. Each group of three nitrogenous bases is known as a **codon.** For example, the codon for the amino acid alanine is G-C-U. The codon for lysine is A-A-A. Every amino acid has a three-letter codon, each letter representing one of the four nitrogenous bases. That is how four nitrogenous bases can code for 20 amino acids. There is even a codon that tells the mRNA that this is the start of the amino acid chain and another codon that says this is the end. To simplify, those codons are called *start* and *stop.*

Translation: From mRNA to Protein

Remember the factory example? Messenger RNA is the worker that brings the instructions for making protein to the cytoplasm. It takes two more kinds of RNA to actually make the protein. The process of changing the information in mRNA into an amino acid chain in protein is called **translation.** Here is how it works.



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1. The mRNA moves to the cytoplasm. **2.** A ribosome (rRNA) attaches itself to the start codon, A-U-G, on the mRNA. **3.** Transfer RNA (tRNA) molecules, carrying amino acids, approach the ribosome. The nitrogenous base sequence that is the complement to the mRNA sequence is the anticodon. If the mRNA codon is G-C-C, the tRNA anticodon is C-G-G. For every codon on mRNA there is an anticodon on tRNA. **4.** The ribosome attaches the anticodon to the codon and the amino acids bond. The ribosome then slides to the next codon. **5.** Again the ribosome attaches the anticodon to the codon, amino acids bond, and the ribosome slides over. **6.** This translation process continues until the stop codon is reached. At this point, the amino acids have formed a chain; and when the stop codon is reached, the chain is released. As soon as the amino acid bonds to the amino acid next to it, the tRNA that brought it moves away to bring another amino acid.

C

What is the central dogma?

If you were to summarize the process of replication, transcription, translation, and protein formation you might say simply that the pathway of information flows from DNA to mRNA to protein. This process is called the central dogma of biology. This means that the same process occurs in every living thing, from the simplest bacteria to the most complex animal.

SUPPLEMENT 4

RECOMBINANT DNA TECHNOLOGY

Genetic Engineering

There is a faster and more reliable way to increase the frequency of a desired allele in a population. It is called genetic engineering. In **genetic engineering,** very small pieces or fragments of DNA are cut from one organism and placed inside another organism. When DNA is made by connecting, or recombining, fragments of DNA from different sources, it is called **recombinant DNA.** An organism uses the recombinant DNA as if it were its own. The DNA of two different species can even be combined. For example, inserting a specific part of the DNA of a firefly into the DNA of a plant will cause the plant to glow. When an organism contains recombinant DNA from a different species, it is called a **transgenic organism.** The growing plant is an example of a transgenic organism.

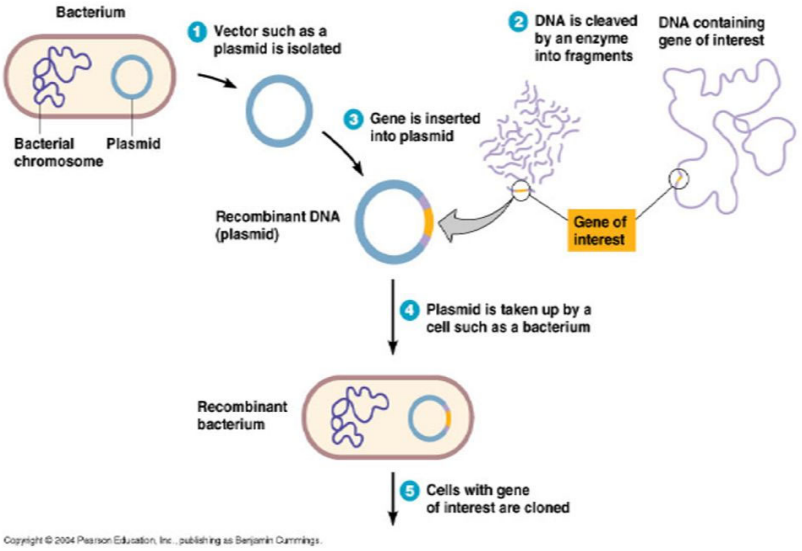
What is the process for producing a transgenic organism?

Producing a transgenic organism is a three-step process. The first step is to cut the DNA fragment out of one organism. The second step is to connect the DNA fragment to a carrier. The third step is to insert the DNA fragment and its carrier into a new organism. Let's take a closer look at each step.

How is a DNA fragment cut from an organism?

Scientists have discovered that there are proteins called **restriction enzymes** that cut DNA. They are bacterial proteins that can cut both strands of the DNA molecule at a specific nucleotide sequence. There are hundreds of different restriction enzymes.

Each one cuts DNA in a different place. In our example, Step 1 is picking a restriction enzyme that cuts the firefly DNA strand at the sequence that codes for making the enzyme that lights up the firefly.



Organisms do not easily accept loose fragments of DNA from other organisms. For this reason, the DNA fragment needs a carrier to take it into the host cell. This is Step 2. In our example, the firefly DNA gets inserted into the carrier or vector DNA. A **vector** is the means by which DNA from another species can be carried into a host cell. Biological vectors include viruses and plasmids. A **plasmid** is a small ring of DNA found in a bacterial cell. The genes of a plasmid are different from those on the bacterial chromosome. In our example, the firefly DNA strand was inserted into a plasmid in a bacterial cell in Step 2. Now, in Step 3, the plasmid vector is inserted into a plant.

What are clones?

With the firefly DNA now a part of it, the plasmid reproduces within the bacterial cell, making up to 500 copies of itself. Every time the host cell divides, it copies the recombinant DNA as it copies its own DNA. Such genetically identical copies are called **clones.** Each identical recombinant DNA molecule is called a gene clone. Because the bacterial host cells in the plant will continue to copy the recombinant DNA, the plant will always have the firefly's DNA – and its light – within it.

In some experiments, scientists insert particular types of recombinant DNA into host cells. This DNA has code within it to make a certain type of protein.

Scientists then study what this protein does in cells that do not ordinarily produce it. At other times, scientists produce mutant forms of a protein. They then study how the mutation affects the function of the protein within a cell. Technology has made gene cloning fairly simple. Scientists have built upon gene cloning to clone an entire animal. The most famous cloned animal was Dolly the sheep, cloned in 1997. The cloning process is not efficient, but scientists hope someday to use it so that ranchers and farmers can clone the most productive, healthy animals to increase and improve the food supply. Scientists developed a method of replicating DNA outside of living organisms, called polymerase chain reaction (PCR). This method uses heat to separate DNA strands from each other. An enzyme from a heat-loving bacterium is used to replicate the DNA when the correct nucleotides are added to a PCR machine. The PCR machine can make millions of copies of DNA in a day. Scientists analyze bacterial, plant, animal, and human DNA. Scientists use this type of DNA analysis in crime investigations and in the diagnosis of disease. Scientists also use PCR to provide pure DNA that is used to determine the correct sequence of DNA bases. This information helps scientists identify mutations.

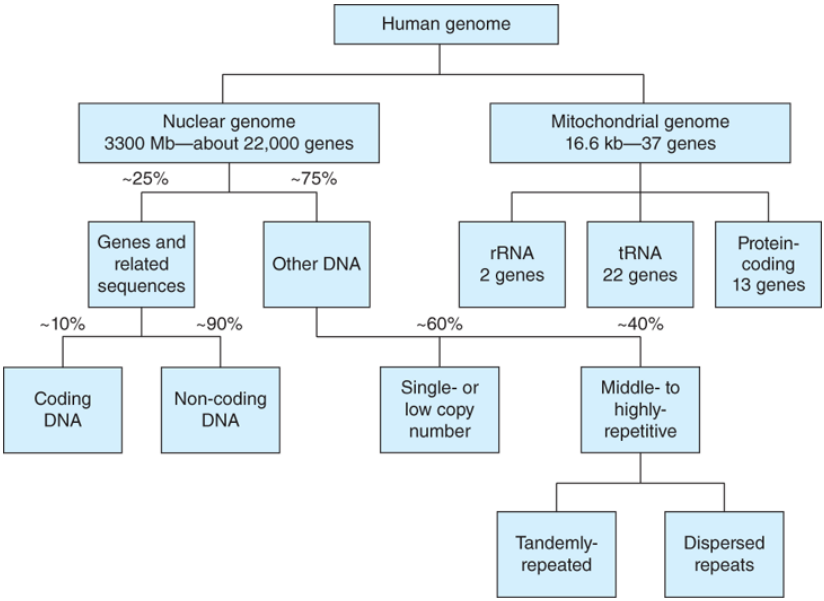
Applications of DNA Technology

How can humans benefit from DNA technology? Three main areas seem to offer the greatest promise: industry, medicine, and agriculture. For example, scientists have changed the *E. coli* bacteria to produce the expensive blue dye used to color denim blue jeans. Scientists are also trying to develop corn that contains as much protein as beef. In medicine, recombinant DNA is used to produce insulin and the human growth hormone. The human gene responsible for clotting blood has been inserted into sheep chromosomes. The sheep produce the clotting protein, which is then used for patients with hemophilia, a disease in which blood cannot clot quickly. Researchers are discovering ways to increase the amount of vitamins in certain crops. That will help provide better nutrition. Some plants have already been developed that produce toxins to make them resistant to insects. That will limit the use of dangerous pesticides.

SUPPLEMENT 5

THE HUMAN GENOME

Mapping and Sequencing the Human Genome



Source: G. Bradley Schaefer, James N. Thompson, Jr.:
Medical Genetics: An Integrated Approach
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The Human Genome Project is an international effort to completely map and sequence the human genome. The **human genome** is the approximately 35,000 to 40,000 genes on the 46 human chromosomes. Sequencing means putting each of these genes in the right order. The project began in 1990. Today, thousands of genes have been mapped to particular chromosomes.

Half of the genome has been sequenced. But scientists still do not know the exact location of all the genes on the chromosomes. The genetic map that shows the relative locations of genes on a

chromosome is called a **linkage map.** Imagine a map of your state that shows cities as being north, south, east, or west of each other, but does not show the exact location of each city. That is how a linkage map works. It shows relative location, not exact location. Originally, the information used to assign genes to particular chromosomes came from linkage data of human pedigrees. Remember that in meiosis, genes sometimes cross over onto different chromosomes. Scientists know that genes that are farther apart cross over more often than genes that are close together. That information helps scientists create a linkage map. But mapping by linkage data is not efficient because scientists had to wait for individual humans to reproduce and mature in order to identify which genes were passed on.

Now, a faster more efficient way to map genes is available. Using polymerase chain reaction (PCR), millions of copies of DNA fragments are cloned in a day. Since scientists know the location of some genes and some segments of DNA, they are used as genetic markers. Because DNA segments that are near each other on a chromosome are often inherited together, markers are used to track the inheritance pattern of a gene that has not yet been identified. Genes are sequenced by cutting DNA into fragments using restriction enzymes. The fragments are cloned, then put in the right order. The order is determined by overlapping matching sequences. Machines can perform this work, increasing the speed of map development.

Applications of the Human Genome Project

How will these chromosome maps be used? Doctors will be able to diagnose genetic disorders even in unborn babies. Gene therapies might be developed to correct genetic disorders. Law enforcement workers will be able to link suspects to evidence left at crime scenes.

Diagnosing genetic disorders has been an important benefit of the Human Genome Project. A diagnosis can be made before birth. Doctors take cells from the fluid surrounding the fetus and analyze the DNA. They can determine if the fetus will develop a genetic disorder. Now, thanks to DNA technology, doctors can use gene therapy to help individuals with genetic disorders. **Gene therapy** is the insertion of normal genes into human cells to correct genetic disorders. Doctors are conducting experiments involving gene therapy for cystic fibrosis, sickle-cell anemia, and hemophilia. Research is also going on to use

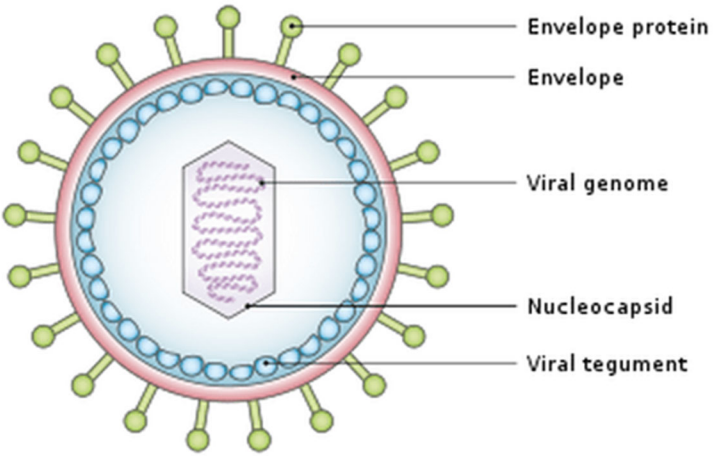
gene therapy on cancer, heart disease, and AIDS. It is hoped that gene therapies will be developed to treat many different disorders. DNA technology is also helping law-enforcement workers solve crimes using DNA fingerprinting. All it takes is a small sample of hair, skin, blood, or other body tissue found at a crime scene. This sample's DNA is then compared with a DNA sample from a suspect. If the DNA samples match, the suspect most likely is guilty. DNA fingerprinting works because no two individuals (except identical twins) have the same DNA sequences, and because all cells of an individual (except gametes) have the same DNA. Geneticists are using polymerase chain reaction (PCR) to clone DNA from mummies to better understand ancient life. The DNA from fossils has been studied to compare extinct species with living species, or even two extinct species with each other. The uses of DNA technology are unlimited.

SUPPLEMENT 6

WHAT IS A VIRUS?

Viruses are particles that are not alive. They cause diseases and infections. Viruses are made up of nucleic acids, either DNA or RNA, surrounded by a protein coat. They are smaller than the tiniest bacterium. Most biologists agree that viruses are not alive because they don't grow, develop, or carry out respiration. All viruses replicate, or make copies of themselves. However, viruses need the help of living cells to copy themselves. In order to copy itself, a virus must enter a living cell. The cell in which a virus replicates is called the **host cell.**

What is the structure of a virus?



courtesy www.andrew.cmu.edu

Viruses differ in size and shape. Some viruses contain as few as four genes. Other viruses have hundreds of genes. Every virus has an inner core of nucleic acid. This core contains the virus's genetic material. Some viruses contain RNA, some contain DNA. The nucleic acid contains the instructions for making copies of the virus.

The outer protein coat surrounding the virus is called a **capsid.** The arrangement of proteins in the capsid gives the virus its shape. The protein arrangement also determines what cell can be infected and how the virus infects the cell. Some large viruses contain another layer called an envelope.

How does a virus attach to a host cell?

Before a virus can replicate, it has to enter a host cell. In order to do this, it must first attach itself to the host cell. Every virus has a specially shaped device called an attachment protein. Because of the specific shape, each virus can only attach to a few kinds of cells. The attachment process is like two pieces of a jigsaw puzzle fitting together. A virus that infects a bacterium is called a **bacteriophage,** or phage for short. A protein located in the tail fibers of the bacteriophage recognizes and attaches to its bacterial host cell.

Do viruses infect more than one species?

Many viruses are species specific. They infect only certain species. For example, smallpox infects only humans. Other viruses are not species specific. The virus that causes the flu infects both humans and animals. Viruses that are not species specific are more difficult for scientists to eliminate.

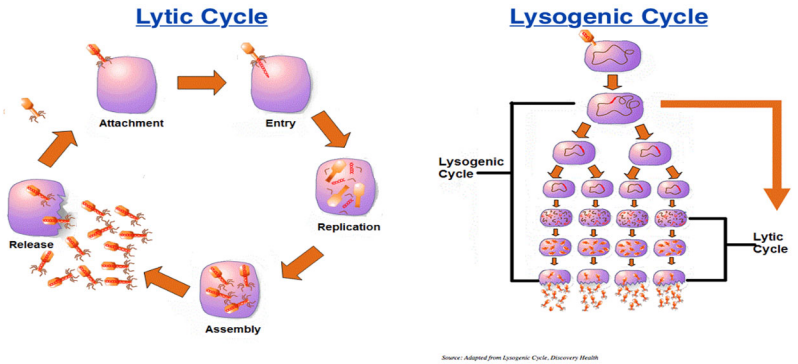
Viral Replication Cycles

Once a virus attaches itself to the host cell, the virus enters the cell and takes over its metabolism. Only then can the virus replicate itself. There are two ways that viruses get into the cells. First, the virus can inject its nucleic acid into the host cell. When this takes place, the capsid of the virus stays attached to the outside of the host cell. An enveloped virus enters a host cell in another way.

After attachment, the plasma membrane of the host cell surrounds the virus. This produces a virus-filled vacuole inside the host cell's cytoplasm. Recall that a vacuole is a membrane-bound compartment used for temporary storage of materials within a cell. Once the vacuole is in the cytoplasm, the virus bursts out of the vacuole and releases its nucleic acid into the cell.

What is a lytic cycle?

Once the virus is inside the host cell, the virus's genes are expressed. The substances that are produced take over the host cell's genetic material.



When viruses take over the cell, the cell stops producing the materials it needs to live. It uses its own enzymes and energy to make new viruses. The new viruses then burst from the host cell and the host cell dies. The new viruses can then infect and kill other host cells. This process is called a **lytic cycle.** A lytic cycle is illustrated at left.

What happens during a lysogenic cycle?

Not all viruses kill the cells they infect. Some viruses go through a lysogenic cycle. A **lysogenic cycle** is a replication cycle in which the virus's nucleic acid is integrated into the chromosome of the host cell. The cycle begins in the same way as a lytic cycle. The virus attaches to the host cell and its nucleic acid enters the cell. Instead of taking over the genetic material of the host, the viral DNA is included in the host cell's chromosome. Once that happens, the viral DNA is called a **provirus.** The cell continues to carry out its own metabolic activity, but every time the host cell reproduces, the provirus is replicated as well. This means that every cell that comes from an infected host cell has a copy of the provirus.

The lysogenic cycle can last for many years. At any time, though, the provirus can be activated and enter a lytic cycle. When that happens, the virus will replicate and kill the host cell.

What are some of the diseases caused by proviruses?

Have you ever had a cold sore? Cold sores are caused by the herpes simplex I virus. Reoccurring cold sores are an example of the lysogenic process. Even though a cold sore heals, the virus remains in your cells as a provirus. When the provirus enters a lytic cycle, another cold sore erupts. No one knows for sure what causes a provirus to be

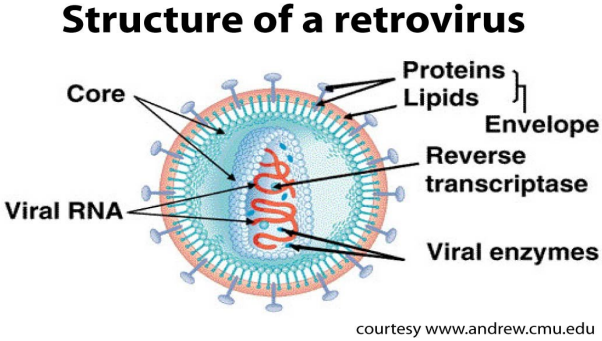
activated. Some scientists think that physical stress, such as a sunburn, and emotional stress, such as anxiety, play a role.

Many viruses have lysogenic cycles. For example, the viruses that cause hepatitis B and chicken pox are lysogenic viruses.

How are viruses released?

Viruses can be released in two ways. Lysis, the bursting of a cell, is one way viruses can be released. Exocytosis, the active transport process by which materials are expelled from a cell, is the second way. Both ways release new viruses from the host cell.

What is a retrovirus?



Many viruses are RNA viruses, meaning that RNA is their only nucleic acid. The human immunodeficiency virus (HIV) that causes AIDS is an example of an RNA virus. The RNA virus with the most complex replication cycle is the **retrovirus** (reh tro VY rus). Retroviruses have an enzyme that changes their RNA into DNA.

How does that happen? Once inside a host cell, the retrovirus makes DNA from its RNA. To do this, it uses **reverse transcriptase**, an enzyme it carries inside its capsid. This enzyme helps produce DNA from viral RNA. The viral DNA is integrated into the host cell's chromosome and becomes a provirus. If reverse transcriptase is found in a person, it is evidence for infection by a retrovirus.

What is HIV?

Once it gets into a human host, HIV infects white blood cells. Because the viral genetic material is a provirus, new viruses are produced slowly.

An HIV-infected person might experience no AIDS symptoms for a long time. Most people with an HIV infection eventually get AIDS because more and more white blood cells are infected and produce new viruses over time. Infected host cells function until the proviruses enter a lytic cycle and kill their host cells. White blood cells are part of the body's disease-fighting system. When they are lost, a body cannot protect itself from organisms that cause disease. This is a symptom of AIDS.

Basic things about AIDS and HIV

In 1985, scientists discovered the human immunodeficiency virus (HIV). HIV is a virus that is transmitted from person to person through the exchange of body fluids such as blood, semen, breast milk and vaginal secretions. Sexual contact is the most common way to spread HIV, but it can also be transmitted by sharing needles when injecting drugs, or during childbirth and breastfeeding. As HIV reproduces, it damages the body's immune system and the body becomes susceptible to illness and infection. There is no known cure for HIV infection nowadays.

Acquired immune deficiency syndrome, or AIDS, is a condition that describes an advanced state of HIV infection. With AIDS, the virus has progressed, causing significant loss of white blood cells or any of the cancers or infections that result from immune system damage.

Once inside the body the virus attacks specialized immune system cells known as CD4 cells. The virus attaches to these cells and infects them by injecting HIV nucleic acids (DNA and RNA) into the cell. New HIV virus then infects other CD4 cells as the cycle repeats itself.

Is HIV and AIDS the same thing?

HIV is the virus which damages the body's immune system. While AIDS defining infections means a person is diagnosed with AIDS. A person can be infected for years without having AIDS. Having HIV infection does not mean you have AIDS. Simply put, HIV and AIDS are not the same thing, but they are related to one another.

Before HIV infection became widespread in the human population, AIDS defining infections were rare, and almost exclusively in individuals with immune suppression, such as chemotherapy and certain types of cancers. AIDS was first recognized in the early 1980s in healthy homosexual men. Adding to the oddity, these men had no recognized cause for immune suppression. An infectious cause of

AIDS was suggested by geographic clustering of cases, links among cases by sexual contact, mother-to-infant transmission, and transmission by blood transfusion.

Later, isolation of HIV from patients with AIDS strongly suggested that this virus was the cause of AIDS.

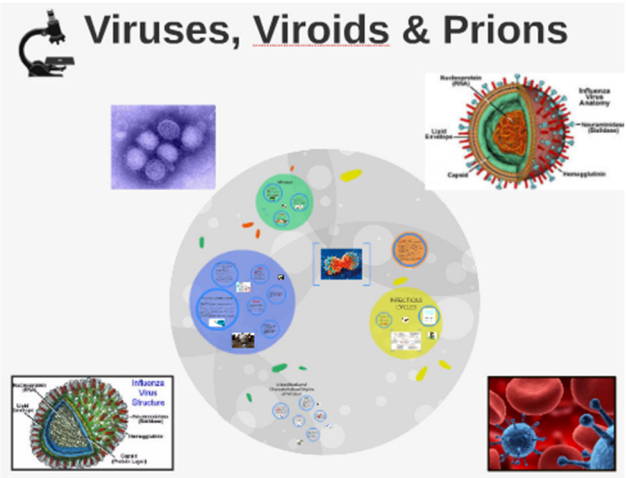
Medications can successfully treat many of the symptoms of early symptomatic HIV infection. Antiretroviral therapy slows the growth of the HIV virus in the body. It works very well in reducing the number of HIV particles in the bloodstream. Although people have suppressed levels of HIV, they can still spread the virus to others through sex or sharing needles. Antiretroviral therapy is not a cure for HIV, but the treatment slows disease progression and may strengthen the immune system. People should never forget that HIV/AIDS is more than a physical ailment; it affects the whole person, emotional and physical. Often our treatments focus on the physical only but the emotional needs addressed as well.

Cancer and Viruses

Some viruses have been linked to cancer in humans and animals.

The viruses disrupt the normal growth and division of cells in a host. This causes abnormal growth and can create tumors. Examples of viruses that have been linked to cancer include the hepatitis B virus, which has been shown to play a role in causing liver cancer.

What are prions and viroids?



Researchers have recently found particles that behave somewhat like viruses and cause infectious diseases. **Prions** are made up of proteins but have no genetic material. They are thought to cause other proteins to malfunction. Prions are responsible for many animal diseases, such as mad cow disease and its human equivalent. **Viroids** are a single circular strand of RNA with no protein coat. They have been found to cause infectious diseases in several plants.

What is a plant virus?

More than 400 viruses infect a variety of plants. These viruses cause diseases that stunt growth and reduce production in their host plants. Plant viruses enter and infect a host plant through wounds or insect bites. However, not all viral plant diseases are harmful or fatal. Some mosaic viruses cause beautiful patterns of color in the flowers of plants.

Origin of Viruses

Because they are relatively simple in structure, you might think that viruses represent an early form of life. This is probably not true. Since viruses need host cells to replicate, scientists suggest that viruses might have originated from their host cells. Some scientists suggest that viruses may be nucleic acids that break free from their host cells while still being able to replicate parasitically within the host cells.

SUPPLEMENT 7

5 COOL THINHS YOUR IIMUNE SYSTEM CAN DO

Like many things in life that we take for granted, we tend to notice our immunity most when something slips through the gaps. A challenge to our human immune system is visible on a grand scale right now, as the novel coronavirus is wreaking havoc around the world, but these breakdowns also happen on the smaller scale every day, when cancer takes hold, when an autoimmune disease flares up over and over.

You might think about your immune system as a first line of defense – a commonly used, if imperfect, metaphor. If you extend that analogy, in peacetime, the immune system is armed and waiting for something to fight. But that concept fails to capture so much of what your immune system does, day in and day out, to keep you healthy and alive.

The immune system is "how humans function and don't self-destruct, basically," said Greg Szeto, Ph.D., an immunologist and investigator at the Allen Institute for Immunology, a division of the Allen Institute. "It touches every single organ system, and as a function of that, it also touches every type of disease."

We asked Szeto and other Allen Institute immunologists to share some of the coolest feats the immune system pulls off, when it's working at top condition.

By no means a complete list, your immune system can…

Keep a lifelong record of nearly everything you've ever encountered

Greg Szeto, Ph.D., an immunologist and investigator at the Allen Institute for Immunology in front of the lab.

Your immune system is kind of your shadow self, Szeto said. Like us, it has a memory. Your immune cells, once trained to recognize a virus, bacteria or other pathogen through infection or vaccination, rarely forget.

Memory B cells, the type of immune cell that remembers an old infection and can quickly churn out antibodies if that same virus or bacteria enters the body again, can live for decades in the body. These

long-lived immune cells, and related cells known as memory T cells, are the reason the measles vaccine you got as a young child still protects you today – and that's also what researchers are searching for as people are recording from COVID-19 or in the large-scale trials for a SARS-CoV-2 vaccine. Now add to that every other vaccine and many of the colds, flus and other infections you've had over your life. The end result: a continuously updated microscopic most-wanted list of your body's past invaders.

But your immune system recognizes more than just infections. Among a myriad of ways immune cells sense danger, the outer shells of B cells and T cells are studded with proteins known as receptors. These molecular feelers allow the cells to sense and respond to their environs, like microscopic sea anemones. The receptors react to our infected cells and to tiny pieces of viruses and bacteria, but they also detect environmental toxins, compounds from your diet, the healthy bacteria in your gut, cellular DNA damage from sunlight.

"Over a lifetime, the immune system holds a cumulative diary of exposure," Szeto said. "Every person's immune system is a unique fingerprint of their own personal exposure history."

Learn the difference between your own cells and everything else

Autoimmune diseases like rheumatoid arthritis or type 1 diabetes happen when the immune system goes rogue, attacking and killing our own cells instead of protecting them. Although these diseases can be devastating, the fact that they don't happen more often is pretty amazing, said Troy Torgerson, M.D., Ph.D., Director of Experimental Immunology at the Allen Institute for Immunology.

"Our immune system is designed to respond to an almost infinite list of harmful invaders," Torgerson said. "That should be an impossible task, because if the immune system can respond to absolutely anything, how do we make sure it doesn't respond to us?"

This seemingly impossible job, distinguishing self from non-self, happens with multiple layers of regulation. As new B cells and T cells are born, they are quickly screened – and cells that detect and react to your own proteins are destroyed. Immune cells known as regulatory T cells then act as the body's peacekeepers to surveil all the rest of the immune system, continually checking for cells gone rogue. Your immune system even learns the difference between helpful and harmful bacteria, allowing the harmless bacteria in your gut and on your skin to thrive.

Hack evolution

Your immune system contends with a paradox: Humans have to defend ourselves against pathogens that evolve much more rapidly than we do. Evolution on the human scale takes thousands of years, if not more, while the flu virus, for example, can mutate quickly enough to evade a year-old vaccine. Viruses and bacteria both mutate and reproduce far faster than we do, which should give them an insurmountable lead in any evolutionary arms race.

So how do we keep up? One answer is that B cell and T cell receptors, the cells' molecular feelers, are among the most diverse and most quickly evolving genes in the human genome. The receptors, which are different across almost every T and B cell, are constructed piecemeal, built from Lego-like pieces to create a protein that's unique among neighboring cells' receptors.

But there's an even weirder trick your immune cells use to hack evolution. B cells and T cells have special machinery to either add extra random bits of DNA to receptor genes, or, in the case of antibody-generating B cells, to ramp up mutation rates only in the genes that code for B-cell receptors and antibodies. In essence, this machinery speeds up evolution – but only in these certain cells in our body.

Anywhere else, in any other cell, this would be heresy. You don't want random mutations in your genes," said Adam Savage, Ph.D., an immunologist with the Allen Institute for Immunology. "The reason we can keep up with a highly mutating pathogen is because there's this huge array of potential receptors for anything. It's sort of anticipating the unknown."

Allow one specific foreign body to survive without attack

Torgerson posed another immune-system conundrum: "Say your significant other donated you a kidney, and doctors transplanted it into your body without checking to see if you were a match or without giving you immunosuppressive drugs – your immune system would attack that kidney like crazy and eventually kill it," he said. "But if you get pregnant, half of those same genes from your significant other are in your body, growing not only a pair of kidneys, but a whole being that in most cases doesn't get rejected."

Researchers still don't fully understand how a pregnant person's immune system allows the growth of one foreign body, the fetus, while still working to protect them both from pathogens. The body makes a

partial barrier by way of the placenta, but scientists know that barrier is incomplete: Maternal and fetal cells can sometimes mix across the placenta, persisting after birth in both parent and child in a phenomenon known as microchimerism. And mysteriously, certain autoimmune diseases get worse during pregnancy, while some, like multiple sclerosis and rheumatoid arthritis, may temporarily go into remission.

Form the basis for better cancer treatments

You might be surprised to learn that immune cells are actually extremely good at detecting and eliminating cancer. Mice genetically engineered to lack key parts of the immune system develop more tumors than immunologically healthy mice, studies have found. The same thing can happen in humans; for example, patients whose immune systems are suppressed by HIV are more prone to certain cancers than the rest of the population. But cancers – or the ones that survive the immune system's watchful eye – develop many tricks to suppress and evade the immune system.

"The number of ways in which cancers are able to outwit or repurpose the immune system against itself is profound," Szeto said. "It's layers upon layers; it's just mind-boggling."

As researchers uncover these layers of deception, they are sometimes able to design new therapies to combat them. Cancer immunotherapy, which uses a patient's own immune system as the basis for treatment, is showing promise for a number of different cancers. These therapies, which range from tumor-recognizing antibodies to souped-up engineered T cells, peel back one or more of those cloaking layers to let the immune system do its job.

In part because tumors have multiple ways of evading immune attack, immunotherapies don't work for all patients – they don't even work for all patients with the same type of cancer, and researchers don't fully understand why. But when they do work, in many cases they can eradicate the cancer cells more thoroughly and completely than older treatments like chemotherapy and radiation. One of the Allen Institute for Immunology's goals is to understand what's different about the immune response when certain immunotherapies work and when they don't, with the hope of broadening these new treatments' reach to many more patients.

SUPPLEMENT 8

HEALTH VERSUS DISEASE (PART 1)

Before human disease can be discussed, the meanings of the terms of health, physical fitness, illness, and disease must be considered. Health could be defined theoretically in terms of certain measured values; for example, a person having normal body temperature, pulse and breathing rates, blood pressure, height, weight, acuity of vision, sensitivity of hearing, and other normal measurable characteristics might be termed healthy. But what does normal mean, and how is it established? It is well known that if the temperatures are taken of a large number of active, presumably healthy, individuals the temperatures will all come close to 98.6° F (37° C).

Health might be defined better as the ability to function effectively in complete harmony with one's environment. Implied in such a definition is the capability of meeting – physically, emotionally, and mentally – the ordinary stresses of life. In this definition, health is interpreted in terms of the individual's environment. Health to the construction worker would have a dimension different from health to the bookkeeper. The healthy construction worker expects to be able to do manual labour all day, while the bookkeeper, although perfectly capable of performing sedentary work, would be totally incapable of

such heavy labour and indeed might collapse from the physical strain; yet both individuals might be termed completely healthy in terms of their own way of life.

Health involves more than physical fitness, since it also implies mental and emotional well-being. Should the angry, frustrated, emotionally unstable person in excellent physical condition be called healthy? Certainly, this individual could not be characterized as effectively functioning in complete harmony with the environment. Indeed, such an individual is incapable of good judgment and rational response. Health, then, is not merely the absence of illness or disease but involves the ability to function in harmony with one's environment and to meet the usual and sometimes unusual demands of daily life.

SUPPLEMENT 9

HEALTH VERSUS DISEASE (PART 2)

The definitions of illness and disease are equally difficult problems. Despite the fact that these terms are often used interchangeably, illness is not to be equated with disease. A person may have a disease for many years without even being aware of its presence. Although diseased, this person is not ill. Similarly, a person with diabetes who has received adequate insulin treatment is not ill. An individual who has cancer is often totally unaware of having the disorder and is not ill until after many years of growth of the tumour, during which time it has caused no symptoms. The term illness implies discomfort or inability to function optimally. Hence it is a subjective state of lack of well-being produced by disease. Regrettably, many diseases escape detection and possible cure because they remain symptomless for long years before they produce discomfort or impair function.

Disease, which can be defined at the simplest level as any deviation from normal form and function, may either be associated with illness or be latent. In the latter circumstance, the disease will either become apparent at some later time or will render the individual more susceptible to illness. The person who fractures an ankle has an injury – a disease – producing immediate illness. Both form and function have been impaired. The illness occurred at the instant of the development of the injury or disease. The child who is infected with measles, on the other hand, does not become ill until approximately 10 days after exposure (the incubation period). During this incubation period the child is not ill but has a viral infectious disease that is incubating and will soon produce discomfort and illness. Some diseases render a person more susceptible to illness only when the person is under stress. Some diseases may consist of only extremely subtle defects in cells that render the cells more susceptible to injury in certain situations. The blood disease known as sickle cell anemia, for example, results from a hereditary abnormality in the production

of the red oxygen-carrying pigment (hemoglobin) of the red cells of the blood. The child of a mother and father who both have sickle cell anemia will probably inherit an overt form of sickle cell anemia and will have the same disease as the parents. If only one parent has sickle cell anemia, however, the child may inherit only a tendency to sickle cell anemia. This tendency is referred to by physicians as the sickle cell trait. Individuals having such a trait are not anemic but have a greater likelihood of developing such a disease. When they climb a mountain and are exposed to lower levels of oxygen in the air, red blood cells are destroyed and anemia develops. This can serve as an example of a disease or a disease trait that renders the affected person more susceptible to illness.

Disease, defined as any deviation from normal form and function, may be trivial if the deviation is minimal. A minor skin infection might be considered trivial, for example. On the eyelid, however, such an infection could produce considerable discomfort or illness. Any departure from the state of health, then, is a disease, whether health be measured in the theoretical terms of normal measured values or in the more pragmatic terms of ability to function effectively in harmony with one's environment.

The most widely used classifications of disease are (1) topographic, by bodily region or system, (2) anatomic, by organ or tissue, (3) physiological, by function or effect, (4) pathological, by the nature of the disease process, (5) etiologic (causal), (6) juristic, by speed of advent of death, (7) epidemiological, and (8) statistical. Any single disease may fall within several of these classifications.

Definitions of the terms disease, illness and health are discussed against health concepts as a means of assessing the most effective approach toward achieving an effective universal healthcare system.

Universal health and treatment of sickness and disease have improved globally, but the target of achieving total wellness still remains as a goal for the future and may be impeded by diseases that have not yet evolved. The implementation of a universal health coverage system is a positive step toward achieving the goals of health and wellness for the present times.

SUPPLEMENT 10

ANTIBIOTIC RESISTANCE IS THREATENING OUR HEALTH

Will bacterial infection send us back to the medical dark ages?

On quiet weekends at the Monash University science labs 20 years ago, the pair discovered they were the only ones crazy – or obsessed – enough to be working on their projects while everyone else wasat home enjoying a few days off.

Then, when Velkov and Li realised they shared not only a work ethic but a passion for researching bacteria, their personal and professional friendship was sealed. "We were the only guys working Saturday and Sunday and we kept running into each other," Velkov remembers. "From then on it's just been fun, you know, we sit around for hours talking and brainstorming. We have been a really good team." Over the past 12 years, the two scientists have been developing a new antibiotic that recently began phase 1 clinical trials in the US.

Their intravenous drug targets deadly "superbugs" that are difficult to treat but can run rampant in hospital settings, causing pneumonia, blood infections, urinary tract infections, peritonitis and meningitis. This promising new drug, with the uninspiring name QPX9003, has placed the pair on the cusp of achieving something that hasn't been done for decades. No new antibiotics in this class – polymyxins, which target hard-to-kill "gram-negative" bacteria – have been approved since the 1950s. In March, their research was published in the journal Nature. For anyone researching bacteria and antibiotics, getting a new drug to a clinical trial is the holy grail. But it's been a lonely, gruelling process for Velkov and Li, who have at times stumped up their own cash to keep the research going. "It can be a thankless job," Velkov says matter-of-factly. But why? Without new antibiotics, the world is on track to re-enter the medical dark ages by 2050, when a simple cut could kill 10 million people a year. So why are they so hard to find?

A hidden crisis

For most of us, antibiotics don't feel like a big deal. At the slightest sign of a cough or a rash many GPs will dash off a prescription for antibiotics and we're all "popping them like Tic Tacs", Velkov says. While our medical and pharmaceutical resources have been (importantly) absorbed in solving the COVID-19 pandemic, the problem of antibiotic resistance is continuing to gain pace. Each year in Australia more than 55,000 people are diagnosed with sepsis – when an uncontrollable bacterial infection triggers inflammation throughout the body. If it can't be managed, sepsis can lead to organ failure. And effective antibiotics are a key component of treatment. About 8,500 Australians die from sepsis every year. It's a huge figure, far above the annual road toll and higher than deaths from specific cancers, and it has a huge economic impact too: antibiotic resistance costs the economy about $700 million a year.

Many scientists, Velkov included, argue the threat ahead from bacteria is equally as serious as that posed by the SARS-CoV-2 virus. So why is money to invest in antibiotic research so hard to come by? A medical miracle Just 100 years ago, as many as one in three deaths was caused by bacterial infections developing from injuries that would barely raise an eyebrow these days. Back then, if bacteria entered a cut or infection took hold after surgery, the wounds were doused in bromide – hugely painful and deadly to healthy cells too – or treated with bloodletting and leeches. Then, in September 1928, British scientist Alexander Fleming returned from his summer holiday to find one of the petri dishes of Staphylococcus bacteria in his lab had a big blob of mould growing in the middle of it. Yet the area around the mould was free of bacteria and Fleming wanted to know why. The answer led to the development of the first antibiotic – penicillin – and by the mid-1940s it had become widely available. Medical care was transformed. It used to take a particular bacterial strain a few decades to evolve to overcome the antibiotic designed to kill it. But these days, says Dr Maytham Hussein, a researcher in alternatives to antibiotics from the University of Melbourne, it takes some bacteria only two or three years to learn to resist a particular antibiotic. Some bacteria become resistant before clinical trials have even been completed. The problem is that bacteria reproduce faster than just about anything on the planet, some strains doubling their numbers in under five minutes.

As the human population increases (giving bacteria more places to multiply) and more and more of these people use antibiotics to get over their infections or keep them safe after surgery – or agriculture uses antibiotics to keep infection in animals at bay – bacteria have many more opportunities to become resistant. And as this process speeds up, the probability that bacteria will find a way to overcome antibiotics increases. The result is that our stash of usable antibiotics is dwindling. Those golden staph outbreaks we hear of invading hospitals provide a glimpse of what a post-antibiotic world could look like. Or worse still, a return to the bubonic plague pandemic that devastated Europe, Asia and North Africa in the 1300s. Has the post-antibiotic era already arrived? There are plenty of medical experts who believe the post-antibiotic era is already here and COVID has supercharged the need to address the problem. Ventilators that are relied on to treat many of COVID's sickest patients in ICU also place those patients at increased risk of bacterial infection. Before COVID, ventilator-associated pneumonia (VaP) was already a widely noted medical phenomenon, affecting between 5 and 40 per cent of intubated patients. Of those diagnosed with VAP, up to 10 per cent die from a bacterial infection, not the illness that brought them to ICU in the first place. But it's not just desperately ill COVID patients who are vulnerable. Without effective antibiotics, the healthcare we take for granted – from giving birth and knee replacements to heart bypass operations and surgery for cancer – would carry the risk, once again, of exposing the patient to a life-threatening infection.

"This is the slow pandemic," says Professor Matt Cooper from the Institute of Molecular Bioscience at the University of Queensland. "Politicians and funding bodies [respond to] acute crises, and don't get me wrong COVID is a serious disease, but with antibiotic resistance we are like a frog, slowly boiling on a stove." So where are the new antibiotics coming from? With so much at stake, you might think that pharmaceutical companies would be tripping over themselves to invest in the next great antibiotic and back the next Alexander Fleming or Tony Velkov.

But there's a problem.

The speed with which bacteria challenge and overcome new antibiotics isn't just a scientific problem. It is also an economic one:

pharmaceutical companies don't have time to make a profit. Of the antibiotics that do make it to market, most are lucky to have a 10-year life span before bacteria become resistant, Velkov says. And when it costs up to $1 billion to develop a marketable drug, a decade isn't enough time for pharmaceutical companies to get their money back and deliver a profit. Tweaking the drugs to give them longevity isn't much help because when global patent laws run out, typically after about 25 years, the generic manufacturers move in. "There's not much money in antibiotics," Velkov says. "For pharmaceutical companies, it's literally like a charity, a pro-bono activity for them, and they are not investing." Cooper agrees: "It is really simple, [the problem is] money, and everyone is leaving the field because it's so depressing. It's really, really hard to stay motivated." Instead, big pharma is investing in drugs for conditions like rheumatoid arthritis, melanoma and blood clots – which made up three of the top five biggest-selling drugs of 2021. Pfizer's COVID vaccine came in at number one. Moderna at number three.

'A thankless job'

Velkov's close relationship with Li has sustained them both through the long years of research with little but their own scientific curiosity to keep them going. But Velkov says he also found motivation from something deeper: the idea that his work could make a difference. "He's a very good friend of mine and we work really well together," Valkov says of Li. "Many professions become about reputation, ego and achievement, whereas we don't really care what other people think of us. If our work can actually change the way people live, or help them live better, then our work means something. That's what science and medicine is about. When you lose touch with that central philosophy, you're in trouble." Nevertheless, he admits matter-of-factly that a career devoted to bacteria and developing antibiotics can be "a thankless job". The two scientists years ago gave up expecting R&D funding from Australia.

Of course, they had support from the university sector and then tipped in more of their own cash at critical moments, but the big investment required to make their new drug a reality came from overseas. "It's just all about investment and development, that's all it is," says Velkov of the difficulty finding new antibiotics. "We can fix this

problem [of antimicrobial resistance] but governments need to prioritise it. They can't rely on drug companies and they can't rely on Jian Li and myself mucking around in the lab on our days off. We are just two blokes trying to scrounge together materials to build something." With pharmaceutical companies wary of the financial risk of significant investment, a number of government-backed funding bodies have been set up in other countries to support drug development.

Velkov and Li received two $US4.5 million donations from a US-government investment fund known as BARDA, the Biological Advanced Research and Development Authority, that enabled them to finish the research for their intravenous antibiotic. He wishes the Australian government had similar investment capacity: "That's not even possible in Australia. We don't even have grants that size. Down Under, we just do things too small," he believes. Even better, Velkov says, would be establishing a global alliance – in particular, partnering with China where significant research is underway – that can pool medical developments for the greater good. It's an idea Cooper has tried several times, currently as a not-for-profit project that screens compounds for antimicrobial activity with a goal to help researchers discover new compounds that are effective against drug-resistant infections. 'Really, really hard' Funding difficulties are only one part of the problem. "I want to stress that this is tough," says Cooper, pointing out that the technical difficulties of finding and developing new antibiotics are real. Researchers have scoured nature to find new antibiotics from coral reefs, soil and even bat dung but "there hasn't been much success", says Cooper, who is preparing to publish his findings outlining the key problems facing the development of antibiotics and flags key areas of promising research. Notwithstanding disappointing results from searching the environment for new sources of antibiotics, the importance of protecting nature remains the key, says Velkov. "Most of our medicines are natural products and we haven't come close to tapping into all of these natural resources," he says. Solutions to the superbug Four avenues are being explored to combat the rise of the superbug.

One is to continue to push the message that existing antibiotics must be used sparingly and carefully to minimise the potential for bacteria to become immune. Another is reviving antibiotics that were

previously passed over because something better came along. Returning to these discoveries saves research and development money, making them a more attractive investment. Scientists are also searching for ways to support or boost the effectiveness of existing antibiotics by using other drugs and therapies, known as "potentiators". Maytham Hussein's work looks at the effect of cannabinoids, which if taken in tablet form can boost the performance of antibiotics. Cooper is undertaking associated research that uses peptides as potentiators. Then there is the phage therapies, a branch of medical science that harnesses viruses to attack and kill bacteria. Finally, there is immune modulation known as "inflabiotics", which uses similar strategies to the immune therapies being used successfully in cancer treatment.

"These get the ancient part of our immune system, our innate immunity, to stop making 'bad' inflammation and instead clear the infection with 'good' inflammation," Cooper says. He anticipates this therapy would face fewer issues with drug resistance because it targets the immune system, not the bug itself. "If it is viable, it could be broadly applied," he says. Is time running out? Cooper is confident more antibiotics can be found or alternative therapies discovered. But he fears the struggle for funding has made bacterial research a disappearing field. He calculates that fewer than 1,400 researchers – experts in bacteria and antibiotics – remain working around the world. Of those, he estimates most are in their 50s and 60s and due to retire in the next decade. "At some stage, not only will there be no money for research but all those experts will leave the field," he says. "Ninety years of knowledge about how to discover and develop antibiotics, these miracle drugs that have saved more lives than any other drug, will be gone."

SUPPLEMENT 11

NANOMATERIALS FOR CRANIOFACIAL AND DENTAL TISSUE ENGINEERING

The oral and maxillofacial regions are complex areas in the human body. They are composed of several tissues, including bone, cartilage, and teeth, among others. Treatment of damage in these regions has always been a great challenge because of their complicated structure and function. The emergence of tissue engineering shows great potential as a future treatment for craniofacial and dental defects caused by trauma, tumors, and other diseases.

Three main factors must be considered with tissue engineering: 1) cells, which are the most basic structural unit of all organisms; 2) scaffolds, which are framework materials to support the growth of cells into a complete organization; and 3) growth factors, which influence cellular activity. The scaffold provides a microenvironment for cell adhesion, proliferation, and differentiation, ultimately forming a new organization and playing an important role in tissue regeneration. Therefore, the choice of scaffold materials is important in the formation of new tissue. Ideal scaffold materials should not only have biocompatibility, controllable degradability, and proper physicochemical properties but also simulate the structure of extracellular matrix (ECM) in native tissues.

Nanomaterials are presently undergoing rapid development in the field of nanotechnology. Compared with bulk materials, the decreased size of nanomaterials leads to an exponential increase in effective stiffness, surface area, and surface area to volume ratio. Nanomaterials also possess quantum size, macroscopic quantum tunneling, and small size effects that are absent in bulk materials, resulting in altered physiochemical properties (Padmanabhan and Kyriakides 2015). Owing to the ultra-sized structure, better biocompatibility, and a wide range of biological activities, nanomaterials have gradually become favored for tissue engineering research.

There are several types of nanomaterials used in tissue engineering, including nanoparticles, nanofibers, nanotubes, and nanosheets. Nanoparticles differ from the original bulk in terms of physical, chemical, biological, electrical, and optical characteristics. Because of their small size and large surface area, they facilely enter into cells and promote various molecular changes. Thus, they are often used as carriers for targeted and controlled delivery of growth factors, drugs, and oligonucleotides in vivo (Kumar et al. 2014). Besides, nanoparticles can be used in composite scaffolds to improve biodegradability, corrosion rates, mechanical properties, and other traits. Nanofibers, manufactured primarily by electrospinning techniques, have been used to reconstruct the architecture of the ECM and provide a scaffold for cell adhesion and growth (Li et al. 2014). In addition, the high specific surface area of nanofibers provides an ideal platform for the release of bioactive factors. Nanotubes and nanosheets can reinforce both mechanical strength and electrical conductivity, as well as assist in controlled drug delivery in tissue engineering scaffolds.

In this review, we focus on the current progress of nanomaterials used frequently in craniofacial and dental tissue engineering, especially in the reconstruction of bone, cartilage, and dental and periodontal tissues in the oral and maxillofacial regions.

Bone Tissue Engineering

Maxillofacial bone defect caused by malformation, trauma, infection, tumor, and other diseases often leads to different degrees of deformity and dysfunction in patients. At present, treatments mainly use bone substitutes, including autologous, heterogeneous, artificial, allograft, and tissue-engineered bone. Clinically, autologous bone is the most commonly used bone substitute because of its perfect biocompatibility. However, its limited availability and the wound on the donor site restrict its clinical application. Heterogeneous and allograft bone has immunogenicity and pathogenicity challenges. Artificial bone, such as ceramet and polymers, is mostly used as permanent implants and cannot participate in normal metabolism of the human body.

Nanomaterials have been used increasingly to enhance bone tissue engineering strategies. Nanoparticles have especially been used to overcome some of the limitations of scaffold materials in bone regeneration, including insufficient mechanical strength, poor cell growth

and differentiation at the bone defects, and instability of growth factors released to stimulate bone formation (Gong et al. 2015).

Nano-hydroxyapatite (nHA) is the main inorganic component in natural bone. It has wide application as a bone-repair material in biomedical science, owing to its adsorbability, osteoconductivity, biocompatibility, and biosafety. However, in recent years, researchers have found limitations when using nHA as a single component for bone tissue engineering. These limitations include its poor mechanical properties and insufficient toughness that make it unable to bear larger loads or impacts. To overcome these disadvantages, composite scaffold materials containing nHA and other natural biological materials or synthetic polymer materials have been developed. Compounding nHA with high molecular weight polymers overcomes the shortcomings of a single material by antagonistic functions, thereby improving biocompatibility and mechanical strength of the scaffold. Collagen (Han et al. 2013), polylactic acid (PLA) (Wang, Xing, et al. 2016), poly lactide-glycolic acid (PLGA) (Huang et al. 2010), polyamide (Zhang et al. 2010) and coralline (Du et al. 2015), chitosan, and polycaprolactone (PCL) (Su et al. 2013) have so far been combined with nHA and used widely in bone tissue engineering

Collagen is the main organic component of natural bone that has outstanding performance because of the fibrous structure of collagen and the orientation arrangement of nHA. To re-create the architecture of native bone, the design of nHA/collagen composite scaffolds has been brought to the forefront. Numerous studies have demonstrated that nHA/collagen composite scaffolds possess adjustable mechanical properties and osteoinductivity (Han et al. 2013; Wang, Wang, et al. 2016). Collagen fiber provides a scaffold for infiltration of osteoblast cells, and then the cells replace collagen materials. However, the nonabsorbable nHA reduces the effect of replacement, so the ratio of nHA and collagen in composite materials is important for bone regeneration. Wang et al. studied 2 composites with different constituent ratios to repair the extraction socket of dogs. The results showed that a greater proportion of collagen could accelerate bone tissue formation but decrease the mechanical property and vice versa (Wang, Wang, et al. 2016).

PLA is a biomaterial approved for use by the US Food and Drug Administration based on its histocompatibility and nontoxicity. The

final degradation products of PLA are carbon dioxide and water, and the intermediate product is lactic acid, which is a normal product of glucose metabolism. However, the poor initial strength of PLA, insufficient hydrophilicity, and partial acidity of the degradation products resulting in aseptic inflammation are not conducive to tissue regeneration. The addition of nHA can increase compressive strength, cellular affinity, osseointegration, and biocompatibility, as well as neutralize the acid degradation products of PLA by forming a slightly alkaline environment when increasing its solubility. Wang et al. used an nHA/collagen/PLA scaffold combined with human alveolar bone marrow–derived stem cells (BMSCs) to restore a critical-size mandibular bone defect in rabbits. Their results demonstrated that engineered bone composed of an nHA/collagen/PLA scaffold, together with osteogenic preinduced BMSCs, was a valid alternative for correcting mandibular bone defects (Wang, Xing, et al. 2016).

Mineral trioxide aggregate (MTA) is a gray powder preparation composed of tricalcium aluminate, tricalcium silicate, dicalcium silicate, calcium sulfate dihydrate, and bismuth oxide that has been applied in the clinical treatment of dental pulp diseases. Due to its composition and release of Ca2+ and OH ions during hydration, MTA can increase pH to neutralize the acidic metabolites of macrophages and osteoclasts, as well as affect mineralization. To study the effects of micro- or nano-size MTA on histopathological responses during bone regeneration, Saghiri et al. (2015) implanted MTA and nano-modified white MTA, with or without nano-3CaO.Al2O3, into right mandibular bone defects of male rabbits. They obtained encouraging results with nano-modified white MTA containing 2% nano-3CaO.Al2O3 and demonstrated that the composite of nano-scale particle size and tricalcium aluminate could improve histopathological reactions in terms of the inflammatory response, bone regeneration, and foreign body reaction (Saghiri et al. 2015). The mechanism might involve an increase of the specific surface area, leading to higher reactivity and release of Ca2+ and OH ions.

Graphene is a 1-atom-thick film with a honeycomb structure composed of carbon atoms created by sp2 hybridization. It is the basic structural element of other carbon allotropes, such as graphite, charcoal, carbon nanotubes, and fullerenes. Graphene and its

derivatives have unique physical, chemical, and biological properties that can promote adhesion, proliferation, and osteogenic differentiation of BMSCs (Shih et al. 2011). The induction of odontogenic and osteogenic differentiation by graphene on dental pulp stem cells (DPSCs) has also been investigated. That study compared the effect of graphene with glass and found that the mineralization levels induced by graphene were higher than those induced by glass. Furthermore, graphene significantly induced osteogenic differentiation of DPSCs without any chemical inducers of osteogenesis while downregulating odontogenic differentiation (Xie et al. 2017). The reason for these effects might involve the increased stiffness caused by graphene because it has been the strongest and stiffest material used up to now. The increase of substrate stiffness could stimulate osteogenic differentiation of BMSCs by increasing the expression of OCN and RUNX2 (Shih et al. 2011). Apart from stiffness, graphene can upregulate the expression of bone morphogenetic protein 2 (BMP-2), which is related to osteogenesis upon cytoskeleton tension. This can enhance the sensitivity of pathways to mechanical stimulation. Research about the utility of graphene in bone tissue engineering is currently at the initial stage. Thus, understanding the potential long-term toxicity and mechanisms of enhancing osteogenic differentiation by graphene is incomplete. Further research will be needed to find the answers and realize the potential of graphene in bone tissue engineering.

Electrospinning is one of the most common methods for preparing nanofibers. Numerous materials have been electrospun into nanofibrous scaffolds for bone tissue engineering (Li et al. 2014). Such scaffolds are mainly used to repair critical-sized cranial bone defects in the oral and maxillofacial region. BMP-2–loaded electrospun PCL-gelatin fibrous scaffolds with nano-biphasic calcium phosphate particles enhanced cell adhesion and proliferation behavior in vitro and remarkably repaired rat skull defects after 8 wk in vivo (Li et al. 2014). However, the pore size of electrospun nanofibrous scaffolds, which is less than 5 μm, is too small to allow cells to migrate within its dense structure, as the average cellular diameter is 5 to 20 μm (Kim et al. 2010).

To overcome these challenges, newly designed nano/microfibrous composite scaffolds were fabricated through a hybrid electrospinning system that combined traditional solution electrospinning with melt electrospinning. Kim et al. (2015) investigated composite scaffolds created from silk fibroin nanofibers by melt electrospinning and PCL microfibers by solution electrospinning for bone regeneration in vitro and in vivo. Their results showed that the silk fibrion/PCL nano/microfibrous composite scaffolds supplied a suitable environment for adhesion, proliferation, and differentiation into osteoblasts of human mesenchymal stem cells in vitro. Furthermore, the nano/microfibrous composite scaffolds stimulated new bone formation in a rabbit skull defect model in vivo (Kim et al. 2015).

Several newly developed nanomaterials are used in bone tissue engineering, such as carbon nanotubes (Yan et al. 2016) and magnetite nanoparticles (Aliramaji et al. 2017).

Cartilage Tissue Engineering

Cartilage tissues in the oral and maxillofacial regions contain 3 main parts: temporomandibular joint cartilage, auricular cartilage, and nasal cartilage. These tissues maintain the appearance and function of relevant areas. Similar to cartilage tissues from other parts of the human body, the self-repair ability of these cartilage tissues is poor because of the lack of blood supply and absence of stem cells. The success of autologous chondrocyte implantation and tissue engineering shows the possibility of cartilage repair, resulting in many methods being investigated to repair or replace damaged cartilage.

To date, most cartilage tissue engineering research has focused on articular cartilage, especially the knee joint. Because of the special hierarchical structure of articular cartilage and important physiological function of subchondral bone, scaffolds with a single composition and structure are insufficient to repair articular cartilage defects (Zhong et al. 2016). It is a further challenge to repair combined defects and accomplish stable integration between both cartilage-cartilage and cartilage–subchondral bone interfaces (Liao et al. 2017, Shao et al. 2017).

Similar to its effects in bone tissue engineering, nHA also improves regeneration when reconstructing subchondral bone. Furthermore, the content of nHA has an impact on the degradation speed of composite materials and the mechanical properties of the scaffold. nHA has,

therefore, been used to prepare composite nanoscale biomimetic materials for articular cartilage regeneration (Gonzalez-Fernandez et al. 2016). Researchers also used other nanoparticles to improve the mechanical properties of the scaffolds. For example, Lin et al. (2009) incorporated nano-silicon dioxide with poly (acrylic acid) and alginate and found that the performance of the composite scaffolds was identical to natural cartilage because of the hydrophilicity of alginate, the great increase of compressive strength and fracture toughness, and reduction of the friction factor.

Nanofibrous scaffolds prepared by electrospinning mimic collagen fibrils in cartilage ECM and have been also used as a scaffold in cartilage tissue engineering. Numerous materials have been electrospun into nanofibrous scaffolds, including PCL (Jakubova et al. 2011), PLA (Zhang et al. 2013), PLGA (Toyokawa et al. 2010), chitosan (Liverani et al. 2012), gelatin, hyaluronic acid, and other materials. These materials can be used to enhance the differentiation of chondrocytes and mesenchymal stem cells. The adhesion and proliferation of cells cultured on electrospun 3-dimensional (3D) scaffolds are better than on 2-dimensional scaffolds. Our group has developed electrospun nanofibrous poly (3-hydroxybutyrate-co-4-hydroxybutyrate) (P3HB4HB) scaffolds that are the fourth generation of polyhydroxyalkanoates. These scaffolds exhibit excellent flexibility and complete biodegradability (Fu et al. 2016). The in vivo studies demonstrated that improvements in ASC-based electrospun 3D P3HB4HB scaffolds may ultimately lead to better repair of cartilage injury (Li et al. 2015; Shi et al. 2016).

Different from articular cartilage, the cartilage in oral and maxillofacial regions has a unique structure that is difficult to re-create by electrospun nanofibers alone. To obtain the unique shape of auricle cartilage, sandwich-model scaffolds with a carrier of a particular shape have been developed. Xue et al. (2013) designed a 3D ear-shaped scaffold with an electrospun PCL/gelatin (50:50) nanofibrous membrane and a titanium alloy model that mimicked the shape of the human ear (Fig. 1). Newly formed cartilage tissue was found on the PCL/gelatin membrane with chondrocytes. The PCL/gelatin membrane was then used to cover the entire titanium alloy model to construct a sandwich scaffold in the shape of an ear. After culturing

with chondrocytes in vitro and in vivo, the ear-shaped scaffolds maintained their original shape; the similarity was as high as 91.4% compared with the titanium alloy mold. Furthermore, the engineered cartilage had good mechanical strength and flexibility. These results indicated that the construction of 3D engineered cartilage using a sandwich model with an electrospun nanofibrous membrane is a simple and effective method that can also be used to construct scaffolds for the regeneration of other complex tissues and organs (Xue et al. 2013). Combining electrospin and 3D printing technologies may be a promising future research direction.

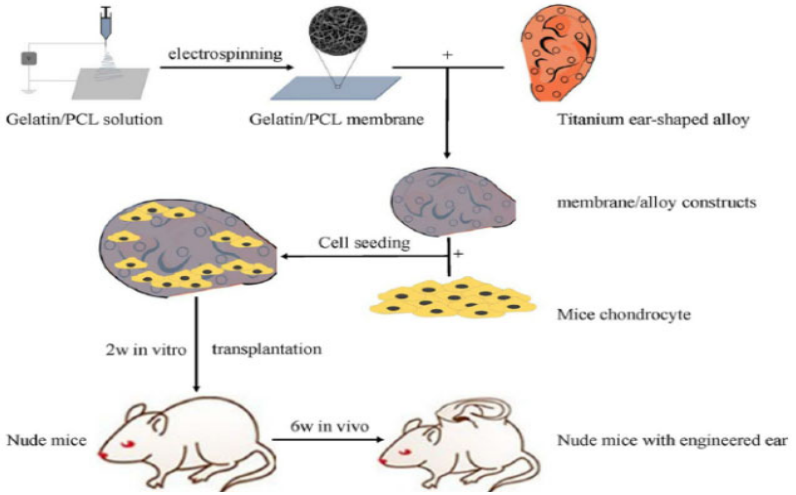


Figure 1. Schematic illustration of the 3-dimensional ear-shaped scaffold with electrospun polycaprolactone (PCL)/gelatin nanofibrous membrane and a titanium alloy model that had a designed human ear shape. It was cultured in vitro for 2 wk with chondrocytes and then implanted subcutaneously into the nude mouse for 6 wk.

SUPPLEMENT 12

MEDICAL FUTILITY (PART 1)

Medical futility falls into the void of obscure conduits that often plague the medical community in the decision-making process. Medical futility can best be defined as an instance when a terminally ill patient and others for whom everything medically plausible, including heroic methods, has been tried; or a situation in which a patient has exhausted the course of innovative and tested therapeutic interventions, and nevertheless will die or live endlessly in a persistent vegetative state (PVS). An intervention is medically futile when there is no therapeutic benefit to the patient nor will the treatment return the patient back to an acceptable level of continued existence. When comparing the quality of the outcome to the intervention, the outcome falls below the minimally established guidelines determined by the social standards set in the community. In addition, the likelihood of medical treatment offering any positive physiological benefit to the patient would not be measurable.5 This article seeks to clarify medical futility together with the rationale for creating a policy. It will also examine the importance of having guidelines in place and what guidelines should be embraced in order to avoid nonmaleficence and promote respect for persons and justice in the medical arena. The concept of medical futility continues to elude the medical community. It is as individual in meaning to patients as their diagnoses. This challenges hospitals to establish medical futility guidelines and develop a policy that not only encompasses a patient's autonomy, but also supports the ethical principles of respect for persons, beneficence and justice. These principles are the basis of the physician-patient relationship. Autonomy gives the patient the right to determine what course of action is preferable, based on their own value system. The ethics of medicine refers not only to the rules, customs and beliefs of a society; it also attempts to enunciate and evaluate those rules, customs and beliefs.9 Englehardt and Beauchamp elaborated on the

ethical principles that have become the foundation of the physician-patient relationship.9 233 AUGUST 2003 CATEGORY 1 For more than a decade, bioethics and health care professionals have struggled to define the exact meaning of medical futility.14 Often, by the time the physician is comfortable in labeling a patient's treatment medically futile, success of the treatment is nonexistent. The word "futile" is derived from the Latin word "futilis," meaning that which easily melts. The common usage developed from the Greek legend in which the daughters of Danaus, King of Argos, murdered their husbands and as punishment, were condemned to collect water for eternity in leaking buckets. To arrive at a destination with an empty bucket, when the goal was to bring water, offers the definition of futile as something that is useless or ineffective.1 Two questions often arise. 1) Have we taken the respect for patient autonomy too far? 2) Does patient autonomy automatically require the physician to provide any treatment plan that the patient or surrogate desires? Treating the patient with interventions that will not improve physiologic functioning could be construed as unethical. Hippocrates advised us to refuse to treat those who are overmastered by their disease. According to the American Medical Association's Code of Ethics, physicians have no obligation to suggest futile intervention based upon the ethical principle of beneficence. We can also ascertain that nonmaleficence disallows physicians from harming patients with futile interventions that could infer injury to the patient.3 Yet the challenge remains: define and incorporate medical futility guidelines into the continuum of care, while offering medical interventions that provide positive physiological benefit for the patient.

Four concepts of futility In bioethical literature, four basic concepts of futility have been identified. As presented by Tomlinson and Brody from Michigan State University, the first concept is based on beneficence, and emphasizes physiological or strict futility.10 The intervention is considered futile in the sense that it is unlikely to produce a physiological benefit. For example, a patient with a Glasgow Coma Score of 3 after an intracerebral bleed is strictly futile as there is no expectation for spontaneous brain function to be re-established.10 Therefore, the procedure is unlikely to be successful in achieving its objective. The second concept introduced by

Schneiderman identifies clinical or overall futility. The intervention is futile when it is unlikely to restore the patient's ability to interact with the environment and resume human development. An example is one where the patient is in a persistent vegetative state (PVS) who has irreversibly lost these capacities. Even though parenteral nutrition or the dispensing of fluids is physiologically effective, the patient will not benefit.10 An example of this would be a patient in a PVS state who has received parenteral nutrition and remains in a PVS state indefinitely. The case of Nancy Cruzan falls under this concept of medical futility. Nancy Cruzan, at the age of 24, lost control of her car, leaving her in a water-filled ditch. Paramedics arrived on the scene to find her heart had stopped. Although they were able to shock her heart into action, her brain had been deprived of oxygen too long, and Nancy was PVS. Nancy was kept alive with a respirator and feeding tube for seven years. Her care cost the state of Missouri $112,000 per year. In those seven years, Nancy never interacted with family or friends again. The feeding tube and respirator were merely apparatuses that connected Nancy to this world, keeping only her body, but not her mind, in the present time. The third concept is imminent demise futility, which has been identified by Brody and Halevy.10 An intervention is futile when the patient is unfailingly expected to die without recovering consciousness before being discharged from the clinical setting. Studies have shown that patients who have arrested outside the clinical setting and were not successfully resuscitated on arrival in the emergency department were dead at discharge, and few ever regained consciousness.10 Qualitative futility, the fourth element of the concepts of medical futility, was presented by Tomlinson and Brody. The intervention may be deemed futile if the quality of life after treatment is unacceptable to the patient.10 Other guidelines extend the scope to include when the quality of life resulting from the treatment is exceedingly poor by the minimum standards, thereby substantiating medical futility. Clinical paradigms of futile care will often involve life-sustaining intervention for patients in a persistent vegetative state or resuscitation efforts.11 This concept can also be illustrated by treatment that is so unlikely to succeed that many people would state that it is not worth the cost. Qualitative versus quantitative futility Further defined in the fourth element are the distinctive aspects

that differ between qualitative and quantitative futility. Medical futility is associated with interventions that are unlikely to produce any significant benefit for the patient.8 Qualitative futility is treatment that is considered futile: if "it offers no reasonable hope of recovery or physiological improvement or because the person is permanently unable to "16 experience any benefit. One such example of qualitative futility is the case of a 65-year-old retired corporate vice president who became ill with pneumonia, needed mechanical ventilation and was admitted to the intensive care unit (ICU). His treatment in the ICU became complicated by adult respiratory distress syndrome, prolonged ventilation requiring tracheostomy and subsequent chronic pulmonary insufficiency. During his stay in the ICU, cardiopulmonary arrest occurred. Resuscitation efforts were successful, but the patient suffered severe anoxic encephalopathy secondary to the cardiac arrest and remained in a persistent vegetative state. Three months after the cardiac arrest, the neurologist concluded that the patient's chances for a meaningful recovery were slim. The caregivers spoke to the Orthodox Jewish family about a do-not-resuscitate (DNR) order, but the family refused the order, stating religious obligations to preserve life. After lengthy discussions, the health care team called in a bioethicist. Ultimately, CPR was determined to be physiologically futile, the DNR was written AUGUST 2003 11 against the family's wishes, and the family sought a court injunction to remove the DNR. The decision was upheld based on the Joint Statement on Resuscitative Interventions, a position paper published by the Canadian Medical Association. A second case of qualitative futility is that of Helga Wanglie (see sidebar). The physician felt that ventilation was futile since it could not heal her lungs, palliate her suffering, or enable the unconscious patient to reap the benefit of the life enhanced by respirator support.3 The husband claimed the patient only wanted to extend her life and valued any life, therefore, she was entitled to ventilation even though she was in a vegetative state. This case is one of a value judgment as the physician and the patient differ in opinion. The treatment was not futile from the husband's point of view, since the physiological effect was the extension of her life. The patient's autonomy to choose continued treatment was respected, albeit the physician felt there was no benefit to the treatment and deemed it

futile. Both views are value laden. Medical futility is rooted in the belief that medical treatment will offer no physiological benefit to the patient. When addressing medical futility, many have found there is no clear, concise answer. To better understand qualitative futility, it is more explicable to assign it a value. When determining if a treatment is futile using documented futility guidelines, health care professionals can look at the percentage or value determined for the probability of the treatment. For example, a surgeon might deem a treatment futile, unless it has at least a 10% chance of success, while the dilemma arises when the patient's family or surrogate might be willing to accept a 0% or 1% chance of success.14 Baby K is a classic case of medical futility based on a value system. Baby K was born with the terminal condition of anencephaly. The family felt the continuation of artificial respiration was a benefit even though there was a 0% chance of Baby K becoming conscious or having any quality of life. The mother felt that the ongoing condition of life was benefit enough. According to Dr Shelton, "Our society allows people to make irrational decisions in many areas of their lives, even if the life plans they have chosen have no chance of being achieved."14 Can medical futility be defined in a society with such a tolerance for individual choice? This raises the ethical issue of allocating scarce resources. If we allowed scarce resources to be used on Baby K, is treatment denied to others who would benefit?

SUPPLEMENT 13

MEDICAL FUTILITY (PART 2)

Quantitative futility is when the likelihood or probability that an intervention will benefit the patient is unlikely. This concept, more evident in everyday clinical settings, is more likely to be received as standard everyday practice. A physician who prescribes antibiotics for a viral infection is practicing quantitative futility. The treatment will not benefit the patient; therefore, what justification does the physician have for prescribing the drugs? Is it accurate to assume that quantitative futility is influenced by the economics of treating patients? The physician is likely to prescribe antibiotics, since not doing so might compel the patient to seek treatment from another physician. Would the physician be culpable of medical futility if the patient did receive benefit from the antibiotic although the outcome was not anticipated when the drug was prescribed? Another illustration of quantitative medical futility can be recognized in brain death criteria. According to Dr Doty, "The diagnosis of death is uncontroversial when made at the bedside by establishing the irreversible cessation of heart, lung and brain functions. When CPR and life support systems are used, brain death often occurs despite the reversal of cardiac and respiratory arrest." It is conceivable that each time CPR is administered on a patient showing signs of brain death, the functions of heart, lung and brain are still reversible. The use of chemotherapy for incurable cancer is a clear case of quantitative futility. Despite the administration of chemotherapy treatment, the patient will die. The empirical evidence documenting the outcome of treatment will establish whether a treatment is futile or not. Establishing guidelines In the 16th and 17th centuries, Roman Catholic moral theology created a distinction between ordinary and extraordinary care that states treatment was no longer obligatory, when it was extraordinary.4 One defines extraordinary care as treatment that is inappropriate. Administering CPR to a person with a

cardiac rupture would be futile and inappropriate treatment. Guidelines for medical futility should begin with the cessation of inappropriate treatment. The process of death is different today than it was 100 years ago. End-of-life care was regularly administered at the bedside of the patient in their residence, but the advancement of technologies has moved the location to the health care setting. It is possible to prolong life due to the significant advances of medical technology, yet this intervention may not lead to a meaningful realization of goals for the patient.12 Another complication is the fact that the majority of patients have not designated advanced directives to guide their end-of-life care, thereby challenging the physician administering care to act in the patient's best interest. It is also plausible that surrogate decision making and family disagreements will cause further debate when determining medical treatment by caregivers. The acceptance of medical futility by the physician, patient and family should not lessen medical care. Futility has been established as a concept to guide physicians in avoiding the provision of inappropriate care that could be harmful.4 Guidelines of futility should incorporate considerations for the chance of success, cost, life expectancy and the quality of life after treatment into the decision-making process when determining whether therapeutic treatments should be offered to patients. Once treatment is deemed futile, a shift in the continuum of care should be initiated with attention to the provision of palliative care. Palliative care can improve the quality of a patient's life even though it may not prolong it. While assuring the patient's autonomy is respected, the issue of pain management should be considered the standard of care. Hospice care can be instituted to deal with endof-life pain and symptom management. In establishing guidelines, a patient's physician should possess initial authority to consider treatment futile, although it should not be solely a unilateral decision. When the physician deems treatment futile, written guidelines will clarify issues that could arise, since each physician has different thresholds for determining futility. First, established treatment options should guide the physician when explaining the reasons supporting the futility judgment. Second, written procedures should be established for the family, if they choose to challenge the futility judgment. Also, educating the family to the conditions of

medical futility is essential before a policy can be enforced. Finally, ultimate authority to determine if treatment is futile should be decided by the medical profession and should conform to the well-established standards of care. The institution should also recognize the need to address the core element of the American health care system which asserts that all Americans will be provided with adequate health care. Good communication with the family is essential to promoting beneficence and nonmaleficence. The design of a medical futility policy should meet the needs of a community as a whole and not be construed as a custom designed policy for a particular hospital. Many hospitals are afraid of any futility policy that could be construed as a method of saving money over providing quality health care. If possible, the medical community should establish a community-wide policy that would eliminate the possibility of hospitals being accused of practicing health care rationing and cost containment as the basis of their medical futility policy. In 1991, the Patient Self Determination Act established advance directives to give patients and surrogates a voice in the determination of care. While this aided patients, it also opened the door for a new set of problems. With this principle, a new trend evolved as families began demanding treatment and aggressive interventions that a physician deemed inappropriate. A policy that includes conflict resolution guidelines would aid physicians in cases where they arrive at a decision of futility when the family is in complete opposition. A physician making a judgment of futility might use documented empirical evidence that reveals the outcome of an intervention for the different groups of patients. The evidence in futility should show that no significant likelihood exists for a significant benefit. This approach should be supplemented with continual dialogue with the family throughout the course of treatment. According to Solomon, studies show that physicians who are involved in decisions with end-of-life care find improvement in advance care planning, quality of endof-life decision making and lower resource utilization, when they have established an institutional routine that requires conversation about the goals of care. Without these guidelines in place, medical staff often communicate unrealistic hope to the family when they fail to provide honest information regarding the patient's condition. This can produce extremely harmful discord and

lack of trust between the family and caregivers. Goals of care assessment tool (GCAT) "The use of structure instruments that gather and organize data needed to make judgment about appropriate goals of care can be beneficial for clinicians and families." The Goals of Care Assessment Tool (GCAT) is used to collect relevant clinical and narrative information crucial to the formulation of rational goals of care at the end of life. The GCAT directs the clinician to estimate the patient's prognosis and convey whether the patient or surrogate knows the diagnosis and prognosis. It also lists the presence or absence of do-not-resuscitate orders and advance directives, family support and involvement, as well as pertinent psychosocial or cultural issues. Pain and symptom management are also addressed. Once the information is assembled, the caregiver is instructed to formulate goals for care and interventions that will help achieve the goals. The GCAT can also be utilized when a change occurs in the patient's prognosis. Directions prompt for information about patient or surrogate knowledge regarding a terminal diagnosis or prognosis, preferences for palliative care and whether there is an expressed desire for death. It also includes information to complete a do-not-resuscitate order. Instruments like the GCAT can promote a collaborative process for end-of-life decision making in institutional settings by providing a structure for caregivers to work with patients and families. This will assist clinicians in obtaining pertinent information that is essential to adequate decision making to minimize futility disputes and facilitate palliative care interventions. Conclusion As the medical community struggles to establish acceptable medical futility guidelines, it is important to incorporate community values in the continuum of care and emphasize the quality of life that will be provided by that treatment. It is possible to provide care for the medically futile patient and yet maintain the patient's right for autonomy? Physicians or institutions should have the right to refuse treatment they deem to be inappropriate or extraordinary as long as the patient's family has been informed of these guidelines. Physicians should be honest with their patients and family members, as this would direct treatment that would be most conducive to the patient and alleviate much of the unrealistic hope family members have as they accept the reality of treatment being medically futile. Even though it has been unfeasible to agree on the terms and

guidelines of medical futility in the past, the medical community should continue to pursue this goal. As medical technology advances, it provides opportunity to treat the untreatable and thus it will become even more important to carefully designate care only to those who will benefit and not provide tunity to those by treating medically futile patients, forcing physicians to spend valuable medical resources on patients who cannot benefit from them. Perhaps, health care professionals can look to Aristotle for wisdom when creating a discipline for medical futility, for it is he who said, "What lies in our power to do, it lies in our power not to do."

SUPPLEMENT 14

WHAT IS A QUALITY ADJUSTED LIGE YEAR (QALY), and why is it important in health economics?

The term "quality-adjusted life year" or "QALY" is a measure of health outcomes pertaining to disease burden and is used to assess the value of medical interventions. As health can be defined as the length of life and the quality of life, the QALY combines the two factors into a single figure.

In other words, quality-adjusted life year measures how many additional months or years of life of a reasonable quality a patient or person may gain due to treatment.

The QALY metric is essential in health economics, medical costs calculations, program evaluations, and insurance coverage determinations.

How Is Quality-Adjusted Life Year (QALY) Calculated?

In order to calculate the QALY and conduct an adequate cost-effectiveness analysis for treatments and clinical trials, two inputs must be considered: the utility value and amount of time people live in various health states. The quantifiable nature of QALY helps to understand the quantity and quality of a patient's life, and its calculation is based on one year of their health status.

Thus, the QALY results range from 0 to 1, where 0 means death and 1 means perfect health in this period. In some circumstances, the calculation may also reflect health states that would be "worse than dead," with a value of less than 1.

The methods that measure people's willingness to trade time in different states of health make up the utility values used in this calculation. The following are factors proposed in the Journal of Health Economics and are based on the answers of patients:

Time-trade-off (TTO): respondents choose between remaining in ill health for a specific period of time or choosing perfect health with a shorter life expectancy. Standard gamble (SG): respondents choose

between remaining in ill health for a specific period of time or medical intervention that could restore them to perfect health or kill them. Visual analog scale (VAS): respondents rate a state of ill health on a scale from 0 to 100, where 0 represents being dead, and 100 represents perfect health. The answers can have a solid subjective factor. The weighting of a particular health state can also be determined using standard descriptive systems, such as the EuroQol Group's EQ-5D questionnaire.

Examples of QALY's Calculation

For example, if a patient lived in a situation with a utility of 0.5 or 0.5 QALYs, that person is only experiencing 50% of the possible value of that year. The patient living in less than perfect health for a period of time of one year is valued as much as the value of living half a year in perfect health.

In the next approach, let us think about an intervention that results in a patient living for four extra years rather than dying within one year. In this case, their quality of life would have dropped from 1 to 0.6. The following formula would be generated:

4 years of extra life with a quality of life of 0.6 = 2.4

Reduced quality of life in less than 1 year (1 – 0.6)= 0.4

QALY value after the intervention = 2.0

This calculation serves as an indication of the benefits of medical procedures regarding the quality of life and survival of the patient. Therefore, it weighs the total life-years lost due to a disease or condition and those gained by a treatment on yearly basis.

Another example would be a patient that has enjoyed 2 years of perfect health, equaling a value of 2 QALYs. If this patient has 2 years of a health status valued at 0.5 and followed by another two years of perfect health, the calculation equals 3 QALYs.

Uses of QALY in Health Economics

The application and uses of QALY are mainly related to health economic evaluations as a measure of treatment outcomes. For example, most recently, the QALY measure has proven fundamental to the calculation and assessment of the cost-effectiveness of the COVID-19 vaccines in the United States. Moreover, the Pfizer-BioNTech COVID-19 vaccine is estimated to have increased the number of QALYs by over a million in the US, mostly by avoiding deaths.

The data shown on medical cost evaluations are often combined with QALYs to estimate the cost-per-QALY associated with a health care procedure. Hence, this information can be used to produce a cost-effectiveness study for any treatment and/or model, and properly allocate healthcare resources. With more evidence, policymakers can review a treatment's health benefits and health-related quality of life for individuals with a specified health condition. Cost-benefit research can then be developed with greater emphasis placed on different life-extending procedures and reducing the burden of disease with a better cost-utility analysis.

In recent years, the use of QALYs has become increasingly utilized in different European countries. For instance, The National Institute for Health and Care Excellence (NICE) has used it to evaluate the utility of health technologies in the United Kingdom. In the Netherlands, the use of QALY is present on highways, local roads, and railway crossings' security measures.

What Is the Difference Between QALY and DALY?

While Quality-Adjusted Life Year (QALY) was invented in the 1970s and has been a tool to measure life expectancy combined with the quality of life-years remaining, Disability-Adjusted Life Year (DALY) is a tool that emerged in the early 1990s and quantifies the burden of disease.

DALY sums the years of life lost due to premature mortality and the patient's years in disability or disease. Unlike QALY, DALY uses a severity scale where 0 means perfect health and 1 means death. Both cannot be used interchangeably and produce different results depending on age at disease onset and disease duration.

In Conclusion

Although there is criticism about Quality-Adjusted Life Year regarding its theoretical assumptions–utility independence, risk neutrality, and constant proportional tradeoff behavior–and the difficulty to define perfect health, it is an increasingly used measure in health economics.

It is easy to calculate and it works as a measure of the value of health outcomes. In the future, the data used to calculate it might be extended to include factors such as well-being to value outcomes, and explore further improvements or replacements.

SUPPLEMENT 15

WHAT YOU SHOULD KNOW ABOUT INFLUENZA (FLU) ANTIVIRAL DRUGS

Can flu illness be treated? Yes. There are prescription medications called "antiviral drugs" that can be used to treat flu illness. What are antiviral drugs? Influenza antiviral drugs are prescription medicines (pills, liquid, or an inhaled powder) that fight against flu in your body. Antiviral drugs are not sold over-the-counter. You can only get them if you have a prescription from a health care provider. Antiviral drugs are different from antibiotics, which fight against bacterial infections. What should I do if I think I have the flu? If you get sick with flu, antiviral drugs are a treatment option. Check with your health care provider promptly if you are at high risk of serious flu complications (see the next page for full list of high-risk factors) and you get flu symptoms. Flu symptoms can include fever, cough, sore throat, runny or stuffy nose, body aches, headache, chills, and fatigue. Your doctor may prescribe antiviral drugs to treat your flu illness. Should I still get a flu vaccine? Yes. Antiviral drugs are not a substitute for getting a flu vaccine. While flu vaccine can vary in how well it works, a flu vaccine is the first and best way to prevent influenza. Antiviral drugs are a second line of defense to treat the flu if you get sick. What are the benefits of antiviral drugs? Antiviral treatment works best when started within two days of getting symptoms. Antiviral drugs can lessen fever and other symptoms, and shorten the time you are sick by about one day. They also can prevent serious flu complications, like pneumonia. For people at high risk of serious flu complications, treatment with an antiviral drug can mean the difference between having a milder illness versus a very serious illness that could result in a hospital stay. For adults hospitalized with flu illness, some studies have reported that early antiviral treatment can reduce the risk of death. What antiviral drugs are recommended this flu season? There are four FDA-approved antiviral drugs recommended by CDC this

season: oseltamivir phosphate (available as a generic version or under the trade name Tamiflu®), zanamivir (trade name Relenza®), peramivir (trade name Rapivab®), and baloxavir marboxil (trade name Xofluza®). Oseltamivir is available as a pill or liquid and zanamivir is a powder that is inhaled. (Zanamivir is not recommended for people with breathing problems like asthma or COPD). Peramivir is given intravenously by a health care provider, and baloxavir is a pill given as a single dose by mouth. What are the possible side effects of antiviral drugs? Side effects vary for each medication. For example, the most common side effects for oseltamivir are nausea and vomiting, zanamivir can cause bronchospasm, and peramivir can cause diarrhea. Other less common side effects also have been reported. Your health care provider can give you more information about these drugs or you can check the Food and Drug Administration (FDA) website for specific information about antiviral drugs, including the manufacturer's package insert. When should antiviral drugs be taken for treatment? Studies show that flu antiviral drugs work best for treatment when they are started within two days of getting sick. However, starting them later can still be helpful, especially if the sick person is at high risk of serious flu complications or is very sick from the flu. Follow instructions for taking these drugs. How long should antiviral drugs be taken? To treat flu, oseltamvir and zanamivir are usually prescribed for 5 days, although people hospitalized with flu may need the medicine for longer than 5 days. Rapivab® is given intravenously for 15 to 30 minutes. Baloxavir is given in a single dose. Can children take antiviral drugs? Yes, though this varies by medication. Oseltamivir is recommended by CDC for treatment of flu in children beginning from birth and the American Academy of Pediatrics (AAP) recommends oseltamivir for treatment of flu in children 2 weeks old or older. Zanamivir is recommended for early treatment of flu in people 7 years and older, though it is not recommended for use in children with underlying respiratory disease, including asthma and other chronic lung diseases. Peramivir is recommended for early treatment of flu in people 6 months and older. Baloxavir is recommended for early treatment of flu in children aged 5 to less than 12 years without chronic medical conditions and in all persons aged 12 years and older. Can pregnant and breastfeeding

women take antiviral drugs? Oral oseltamivir is recommended for treatment of pregnant women with flu because compared to other recommended antiviral medications, it has the most studies available to suggest that it is safe and beneficial during pregnancy. Baloxavir is not recommended for pregnant women or breastfeeding mothers. Who should take antiviral drugs? It's very important that antiviral drugs be used early to treat people who are very sick with flu (for example, people who are in the hospital) and people who are sick with flu who are at high risk of serious flu complications, either because of their age or because they have a high risk medical condition. Other people also may be treated with antiviral drugs by their health care provider this season. Most people who are otherwise healthy and get the flu, however, do not need to be treated with antiviral drugs.

SUPPLEMENT 16

ANTIVIRAL TREATMENT OF INFLUENZA

Antivirals can be useful to reduce the duration of disease or severity of symptoms due to influenza virus infection. This is important, especially for persons at risk of developing severe disease, as well as situations in which the vaccine fails, for example, due to:

- antigenic mismatch with the circulating virus;
- waning immunity in the elderly population;
- immunocompromised patients;
- current unavailability of the vaccine;
- an outbreak of ‘avian' influenza or an emerging pandemic, as post-exposure for exposed people and in particular possible cases of avian influenza infection according to national guidelines.

Influenza-specific antiviral drugs administered as therapy or prophylaxis are an important addition to the influenza vaccine, but they cannot be used to replace influenza vaccination. Which are the antivirals we use in Europe against seasonal influenza, and who should get them?

Currently, three drugs are authorised and recommended for the treatment of influenza in Europe:

- oseltamivir (Tamiflu)
- zanamivir (Relenza and Dectova)
- baloxavir marboxil (Xofluza).

In addition, Matrix-2 (M2) inhibitors such as adamantanes are authorised at the national level in the EU. However, adamantanes are not active against influenza B strains and there is widespread resistance among all currently circulating influenza A strains. Therefore, M2 inhibitors should not be used for the treatment of influenza.

None of these medications can be obtained without a prescription. They are often only recommended as treatment for influenza for individuals considered to be ‘at risk' of developing more serious complications: the elderly or those living with underlying conditions, like asthma or heart disease. Individuals ‘at risk' may particularly

benefit from starting the treatment within 48 hours of the onset of symptoms of an influenza-like illness.

Zanamivir and oseltamivir belong to the neuraminidase inhibitor family of drugs. Neuraminidase is a protein on the surface of the virus. When the neuraminidases are blocked, the virus cannot spread. Both oseltamivir and zanamivir are effective on the neuraminidases of influenza A and B viruses.

Oseltamivir (e.g.Tamiflu) can be used for the treatment of influenza in adults and children, including full-term neonates, when the influenza virus is circulating in the community. For post-exposure prophylaxis, to prevent flu, it can be used in adults and children aged one year and older who have been in contact with someone who has flu. The decision to use oseltamivir is generally taken on a case-by-case basis. In exceptional circumstances, e.g., a pandemic situation, seasonal prevention could be considered, also in infants younger than one year.

Relenza (inhaled Zanamivir) is approved for the treatment of adults and children aged five years and older. It is also approved for the post-exposure prophylaxis of influenza in adults and paediatric patients aged 5 years and older, who have been in contact with someone who has flu. In exceptional circumstances, e.g., a pandemic situation, seasonal prevention could be considered. Dectova (intravenous Zanamivir) can be used in adults and children from 6 months of age for the treatment of complicated and potentially life-threatening influenza.

Baloxavir marboxil inhibits an enzyme known as cap-dependent endonuclease (CEN) in the acidic subunit of the viral polymerase complex, resulting in the disruption of viral RNA transcription and virus replication. Xoflusa (Baloxavir marboxil) can be used for the treatment or post-exposure prophylaxis of individuals aged one year and older. Can influenza viruses develop resistance to antiviral drugs?

Neuraminidase inhibitors (oseltamivir and zanamivir) constitute the primary type of antiviral drugs against influenza. Strains that are no longer sensitive to the neuraminidase inhibitors are sporadically detected each season due to mutations in the neuraminidase (NA) gene. However, resistant viruses that spread to others are very rare.

Matrix-2 (M2) inhibitors such as adamantanes (amantadine and rimantadine) are authorised at the national level in the EU. However, resistant mutants to the Matrix-2 (M2) inhibitors have been detected

and spread globally. All currently circulating influenza type A viruses are resistant to M2 inhibitors and therefore should not be used for the treatment of influenza.

The polymerase (PA) inhibitor baloxavir marboxil, which belongs to a new class of antivirals with different mechanisms of action, has been approved in the EU/EEA. Reduced sensitivity to this drug due to mutations in the PA gene has also been observed sporadically.

The analysis of resistance is performed phenotypically by measuring IC50 values and/or by genotyping of viruses for detection of known drug resistance mutations, or genotypically by looking for specific mutations that have been associated with reduced susceptibility to the drugs.

Antiviral resistance in Europe is monitored by ECDC and the World Health Organization Regional Office for Europe (WHO/Europe) based on the reports sent by influenza national reference laboratories to The European Surveillance System (TESSy). ECDC routinely collects, analyses and disseminates information on antiviral resistance from influenza viruses isolated from all the EU/EEA countries through the European respiratory virus surveillance summary (ERVISS).

How are antivirals used against seasonal influenza? The practice regarding the use of antivirals varies between European countries, with 21 EU/EEA Member States having national recommendations in place for influenza antiviral use. According to the ECDC technical report, 'Seasonal influenza vaccination and antiviral use in EU/EEA Member States' (2018), 16 EU/EEA countries recommended the use of neuraminidase inhibitors as treatment for outpatients who might have a higher risk of severe outcomes of influenza and they are usually not recommended for otherwise healthy adults with ordinary influenza. Health professionals typically assess each case individually to determine the necessity and potential benefits of antiviral treatment.

For people in risk groups (people with chronic disease, pregnant women, immunocompromised persons, or persons 65 years and above), the most effective way of preventing serious complications of influenza is to get vaccinated against influenza. However, people belonging to a risk group who have contracted an influenza infection should seek early advice from healthcare professionals who can

provide guidance on the need for antivirals, as they can shorten the duration of the illness or reduce the severity of the symptoms.

When are antivirals effective? If I need them, how quickly should I take them?

Scientific evidence suggests that antivirals are more effective if they are taken early on during the illness. Antiviral drugs should be taken within the first 48 hours of the symptom onset as this is a key period to inhibit the replication of the virus. The effectiveness of the antivirals decreases with the time elapsed from the symptom onset. Early administration of antivirals after contracting an influenza infection has greater benefits.

However, according to the ECDC expert opinion on the use of neuraminidase inhibitors for treatment and prevention of influenza, there is also evidence to suggest they can be beneficial even when started later than 48 hours after symptom onset, especially in certain settings. This is particularly relevant in cases involving severe influenza, hospitalized patients, or those at high risk for complications from influenza. In these cases, the benefits of starting antiviral treatment may outweigh the reduced efficacy due to the delayed initiation.

If antivirals are so good, why don't doctors give them out more often?

There are good reasons for this. If doctors use antivirals a lot, then the influenza viruses that are circulating may develop resistance to them. Also, like many other medicines, antivirals against influenza should be prescribed by doctors based on their clinical assessment and in adherence to national guidelines and recommendations. Excessive, inappropriate use of antivirals may also affect their availability during crises e.g. an influenza pandemic. Some European countries have policies in place that allow or recommend doctors to use antivirals against influenza only when it has been shown that influenza is circulating in the population at a certain level.

Would it not be best if we all had antivirals at home to use when we need them?

As with antibiotics, antivirals require a medical prescription and are not over-the-counter drugs. They should be given according to the national guidelines and taken only under medical supervision. I heard

that sometimes everyone exposed to influenza has been given antivirals – why is that?

This may happen in special circumstances where people in a risk group have been exposed to influenza. The most common situation is when there is a proven influenza outbreak in a long-term care facility, a nursing home or a hospital ward. Then antivirals may be given to all the people at risk as prophylaxis or early treatment.

Do people who have been immunised against influenza still need antivirals?

Yes, in specific cases as foreseen/indicated by the national guidelines on the use of antivirals against influenza and according to medical advice.

SUPPLEMENTARY READING

Exercise 1. *Read and translate the following article.*

MICROORGANISMS AS CELLS

The cell is the fundamental unit of life. A single cell is an entity, isolated from other cells by a cell membrane (and perhaps a cell wall) and containing within it a variety of chemicals and subcellular structures. The cell membrane is the barrier that separates the inside of the cell from the outside. Inside the cell membrane are the various structures and chemicals that make it possible for the cell to function. Key structures are the nucleus or nucleoid, where the genetic information, deoxyribonucleic acid (DNA), needed to make more cells is stored, and the cytoplasm, where the machinery for cell growth and function is present.

All cells are made up of four chemical components: proteins, nucleic acids, lipids, and polysaccharides. Collectively, these are called macromolecules. It is the chemical nature and arrangement of macromolecules in a cell of one organism that makes it distinct from those of another. Although each kind of cell has a definite structure and size, a cell is a dynamic unit, constantly undergoing change and replacing its parts. Even when it is not growing, a cell may be acquiring materials from its environment and incorporating them into its own fabric. At the same time, it discards waste products into its environment. A cell is thus an open system, forever changing yet generally remaining the same.

Where did the first cells come from? In some way the first cell must have come from a noncell, something before the cell, a procellular structure. Although evolution of the first cell over 3.8 billion years ago was an improbable event that may have taken several hundred million years to occur, once the first cell arose, a series of highly probable events followed, including growth and division to form populations of cells from which evolution could select for improvements and diversification. Then, through billions of years of evolutionary change, the tremendous diversity of extant cell types that exist today

arose. And, because all cells are constructed from the four basic classes of macromolecules mentioned earlier and share many other traits in common, it is hypothesized that all cells have descended from a common ancestor, the universal ancestor of all life.

Exercise 2. *Put 5 different types of questions to the article to reveal its main idea.*

Exercise 3. *Make up the abstract of the following text.*

* * * * *

Exercise 1. *Read, translate and be ready to retell the following texts.*

THE FANTASTIC WORLD

Microbiology is the study of microorganisms, which are microscopic and unicellular organisms. This includes eukaryotes such as fungi and protists, and prokaryotes. Viruses, though not classed as living organisms, are also studied. Microbiology typically includes the study of the immune system, or Immunology. And immune systems obviously interact with pathogenic microbes.

Microbiology includes virology, mycology, parasitology, bacteriology and other branches. Microbiological procedures usually must be aseptic, and use a variety of tools such as light microscopes with a combination of stains and dyes, agar plates in petri dishes, biochemical test and running tests against particular growth conditions.

Microbiology is researched actively. Many microbes are responsible for beneficial processes such as industrial fermentation, antibiotic production and others.

Bacteria can be used for the industrial production of amino acids. Corynebacterium glutamicum is one of the most important bacterial species with an annual production of more than two million tons of amino acids.

A variety of biopolymers, such as polysaccharides, polyesters, and polyamides, are produced by microorganisms. Microorganisms are used for the biotechnological production of biopolymers with tailored

properties suitable for high-value medical application such as tissue engineering and drug delivery.

Microorganisms are beneficial for microbial biodegradation of domestic, agricultural and industrial wastes. The ability of each microorganism to degrade toxic waste depends on the nature of each contaminant.

There are also various claims concerning the contributions to human and animal health by consuming probiotics (bacteria potentially beneficial to the digestive system) and/or prebiotics (substances consumed to promote the growth of probiotic microorganisms). Recent research has suggested that microorganisms could be useful in the treatment of cancer.

THE CELL CYCLE

Despite differences between prokaryotes and eukaryotes, there are several common features in their cell division processes. Replication of the DNA must occur. Segregation of the "original" and its "replica" follow. Cytokinesis ends the cell division process. Whether the cell was eukaryotic or prokaryotic, these basic events must occur.

Cytokinesis is the process where one cell splits off from its sister cell. It usually occurs after cell division. The Cell Cycle is the sequence of growth, DNA replication, growth and cell division that all cells go through. Beginning after cytokinesis, the daughter cells are quite small and low on ATP. They acquire ATP and increase in size during the G1 phase of Interphase. Most cells are observed in Interphase, the longest part of the cell cycle. After acquiring sufficient size and ATP, the cells then undergo DNA Synthesis (replication of the original DNA molecules, making identical copies, one "new molecule" eventually destined for each new cell) which occurs during the S phase. Since the formation of new DNA is an energy draining process, the cell undergoes a second growth and energy acquisition stage, the G2 phase. The energy acquired during G2 is used in cell division (in this case mitosis).

Regulation of the cell cycle is accomplished in several ways. Some cells divide rapidly (beans, for example take 19 hours for the complete cycle; red blood cells must divide at a rate of 2.5 million per second). Others, such as nerve cells, lose their capability to divide once they

reach maturity. Some cells, such as liver cells, retain but do not normally utilize their capacity for division. Liver cells will divide if part of the liver is removed. The division continues until the liver reaches its former size.

Cancer cells are those which undergo a series of rapid divisions such that the daughter cells divide before they have reached "functional maturity". Environmental factors such as changes in temperature and pH, and declining nutrient levels lead to declining cell division rates. When cells stop dividing, they stop usually at a point late in the G1 phase, the R point (for restriction).

PROKARYOTIC CELL DIVISION

Prokaryotes are much simpler in their organization than are eukaryotes. There are a great many more organelles in eukaryotes, also more chromosomes. The usual method of prokaryote cell division is termed binary fission. The prokaryotic chromosome is a single DNA molecule that first replicates, then attaches each copy to a different part of the cell membrane. When the cell begins to pull apart, the replicate and original chromosomes are separated. Following cell splitting (cytokinesis), there are then two cells of identical genetic composition (except for the rare chance of a spontaneous mutation).

The prokaryote chromosome is much easier to manipulate than the eukaryotic one. We thus know much more about the location of genes and their control in prokaryotes.

One consequence of this asexual method of reproduction is that all organisms in a colony are genetic equals. When treating a bacterial disease, a drug that kills one bacteria (of a specific type) will also kill all other members of that clone (colony) it comes in contact with.

EUKARYOTIC CELL DIVISION

Due to their increased numbers of chromosomes, organelles and complexity, eukaryote cell division is more complicated, although the same processes of replication, segregation, and cytokinesis still occur.

MITOSIS

Mitosis is the process of forming (generally) identical daughter cells by replicating and dividing the original chromosomes, in effect making a cellular xerox. Commonly the two processes of cell division

are confused. Mitosis deals only with the segregation of the chromosomes and organelles into daughter cells.

Eukaryotic chromosomes occur in the cell in greater numbers than prokaryotic chromosomes. The condensed replicated chromosomes have several points of interest. The kinetochore is the point where microtubules of the spindle apparatus attach. Replicated chromosomes consist of two molecules of DNA (along with their associated histone proteins) known as chromatids. The area where both chromatids are in contact with each other is known as the centromere the kinetochores are on the outer sides of the centromere. Remember that chromosomes are condensed chromatin (DNA plus histone proteins).

During mitosis replicated chromosomes are positioned near the middle of the cytoplasm and then segregated so that each daughter cell receives a copy of the original DNA (if you start with 46 in the parent cell, you should end up with 46 chromosomes in each daughter cell). To do this (cells utilize microtubules (referred to as the spindle apparatus) to "pull" chromosomes into each "cell". The microtubules have the 9+2 arrangement discussed earlier. Animal cells (except for a group of worms known as nematodes) have a centriole. Plants and most other eukaryotic organisms lack centrioles. Prokaryotes, of course, lack spindles and centrioles; the cell membrane assumes this function when it pulls the by-then replicated chromosomes apart during binary fission. Cells that contain centrioles also have a series of smaller microtubules, the aster, that extend from the centrioles to the cell membrane. The aster is thought to serve as a brace for the functioning of the spindle fibers.

The phases of mitosis are sometimes difficult to separate. Remember that the process is a dynamic one, not the static process displayed of necessity in a textbook.

MEIOSIS

Sexual reproduction occurs only in eukaryotes. During the formation of gametes, the number of chromosomes is reduced by half, and returned to the full amount when the two gametes fuse during fertilization.

PLOIDY

Haploid and diploid are terms referring to the number of sets of chromosomes in a cell. Gregor Mendel determined his peas had two

sets of alleles, one from each parent. Diploid organisms are those with two (di) sets. Human beings (except for their gametes), most animals and many plants are diploid.

We abbreviate diploid as 2n. Ploidy is a term referring to the number of sets of chromosomes. Haploid organisms/cells have only one set of chromosomes, abbreviated as n. Organisms with more than two sets of chromosomes are termed polyploid. Chromosomes that carry the same genes are termed homologous chromosomes. The alleles on homologous chromosomes may differ, as in the case of heterozygous individuals. Organisms (normally) receive one set of homologous chromosomes from each parent.

Meiosis is a special type of nuclear division which segregates one copy of each homologous chromosome into each new "gamete". Mitosis maintains the cell's original ploidy level (for example, one diploid 2n cell producing two diploid 2n cells; one haploid n cell producing two haploid n cells; etc.). Meiosis, on the other hand, reduces the number of sets of chromosomes by half, so that when gametic recombination (fertilization) occurs the ploidy of the parents will be reestablished.

Most cells in the human body are produced by mitosis. These are the somatic (or vegetative) line cells. Cells that become gametes are referred to as germ line cells. The vast majority of cell divisions in the human body are mitotic, with meiosis being restricted to the gonads.

LIFE CYCLES

Life cycles are a diagrammatic representation of the events in the organism's development and reproduction. When interpreting life cycles, pay close attention to the ploidy level of particular parts of the cycle and where in the life cycle meiosis occurs. For example, animal life cycles have a dominant diploid phase, with the gametic (haploid) phase being a relative few cells. Most of the cells in your body are diploid, germ line diploid cells will undergo meiosis to produce gametes, with fertilization closely following meiosis. Plant life cycles have two sequential phases that are termed alternation of generations. The sporophyte phase is "diploid", and is that part of the life cycle in which meiosis occurs. However, many plant species are thought to arise by polyploidy, and the use of "diploid" in the last sentence was

meant to indicate that the greater number of chromosome sets occur in this phase. The gametophyte phase is "haploid", and is the part of the life cycle in which gametes are produced (by mitosis of haploid cells). In flowering plants (angiosperms) the multicelled visible plant (leaf, stem, etc.) is sporophyte, while pollen and ovaries contain the male and female gametophytes, respectively. Plant life cycles differ from animal ones by adding a phase (the haploid gametophyte) after meiosis and before the production of gametes.

Many protists and fungi have a haploid dominated life cycle. The dominant phase is haploid, while the diploid phase is only a few cells (often only the single celled zygote, as in Chlamydomonas). Many protists reproduce by mitosis until their environment deteriorates, then they undergo sexual reproduction to produce a resting zygotic cyst.

PHASES OF MEIOSIS

Two successive nuclear divisions occur, Meiosis I (Reduction) and Meiosis II (Division). Meiosis produces 4 haploid cells. Mitosis produces 2 diploid cells. The old name for meiosis was reduction/ division. Meiosis I reduces the ploidy level from 2n to n (reduction) while Meiosis II divides the remaining set of chromosomes in a mitosis-like process (division). Most of the differences between the processes occur during Meiosis I.

COMPARISON OF MITOSIS AND MEIOSIS

Mitosis maintains ploidy level, while meiosis reduces it. Meiosis may be considered a reduction phase followed by a slightly altered mitosis. Meiosis occurs in a relatively few cells of a multicellular organism, while mitosis is more common.

Exercise 2. *Provide the evaluative aspects of the given texts.*

Exercise 3. *Answer the following questions.*

1. *What is the fundamental structural unit of all organisms?*
2. *Where do reside the genetic material?*
3. *What is mitosis?*
4. *What are the activities performed by all organisms?*

* * * * *

Exercise 1. *Read and translate the text in writing.*

CONCENTRATION GRADIENTS

Cells have a pretty sophisticated cell membrane, which acts as a barrier to the outside world. We've described this membrane as selectively permeable, meaning not just anything can get through it. The key to this phrase is that the cell membrane is selective, but not impermeable. This is something like how you would keep your home. The walls of your house create a boundary and define the space, but there are still doors and there are windows through which you can let in your friends or some fresh air on a summer's day.

So, what crosses a cell membrane and why? There are several types of ways to transport things across a cell membrane. When and how things travel depends largely on the concentration of solutes in your cells, or the dissolved molecules. Let's present the methods of transporting solutes across a concentration gradient.

A concentration gradient is a gradual difference in solute concentration between two areas. In this case, it's the difference in solute concentration between the outside of the cell and the inside of the cell. Solutes here would move by diffusion, or movement from a higher concentration of solutes to a lower concentration of solutes in order to equalize solute concentration. This evens out the concentration on both sides.

This is like what happens when you leave the windows of your house open while your neighbor is having a barbeque. The smell might diffuse from next door, where the smell is stronger in the air, into your house, where, unfortunately, there are no hamburgers on the grill. Diffusion occurs until the inside of your house smells like the outside.

PASSIVE TRANSPORT: SIMPLE DIFFUSION

Diffusion across a cell membrane is a type of passive transport, or transport across the cell membrane that does not require energy. Remember that the cell membrane is a phospholipid bilayer. Although the inside and the outside of a cell are both water-based, there is a hydrophobic region in the middle, and this is an important barrier to anything large, charged, or hydrophilic. Molecules that are

hydrophobic, just like the hydrophobic region, can pass through the cell membrane by simple diffusion.

Therefore, simple diffusion is the unassisted passage of small, hydrophobic, nonpolar molecules from higher concentration to a lower concentration. Very small molecules can slip through the cell membrane, too, even if they are hydrophilic – just like a few ants might crawl through a crack in the wall just because they're tiny.

PASSIVE TRANSPORT: FACILITATING DIFFUSION

So how do large, charged, or hydrophilic molecules pass through the cell membrane if they can't simply just diffuse in? Think of how your friends come into your house. Under most circumstances, they'll use a door. A package delivered at your residence would come through your door, too, but it would need someone to carry it in. A fly might come through an open window on its own, while a squirrel could come down your chimney! There are different types of passageways into the cell just like there are different ways to get into your home, depending on who or what is trying to get through. Each method of passage through the cell membrane might be useful to different molecules.

Facilitated diffusion is passive transport that uses integral membrane proteins to help larger, charged, hydrophilic, and polar molecules across a concentration gradient. Remember that integral membrane proteins span the phospholipid bilayer, connecting the inside and the outside of the cell.

There are two types of integral membrane proteins that help transport molecules, like ions and polar molecules, that can't diffuse on their own through the hydrophobic layer. The first are carrier proteins, which are proteins that bind a molecule to facilitate transport through a cell membrane. The second are channel proteins, which are proteins that create a passageway to transport molecules and ions through the cell membrane. This channel protein creates a pore through the hydrophobic region that allows polar molecules to just pass right through.

Exercise 2. *Discuss with your partner informative aspect of the text.*

Exercise 3. *Make up an abstract of the following text in Ukrainian.*

* * * * *

Exercise 1. *Read the following text.*

EVOLUTION. THEORY OF EVOLUTION

Morgan was interested in evolution throughout his life. He wrote his thesis on the phylogeny of sea spiders (pycnogonids) and wrote four books about evolution. In Evolution and Adaptation (1903), he argued the anti-Darwinist position that selection could never produce wholly new species by acting on slight individual differences. He rejected Darwin's theory of sexual selection and the Neo-Lamarckian theory of the inheritance of acquired characters. Morgan was not the only scientist attacking natural selection. The period 1875–1925 has been called "The eclipse of Darwinism". After discovering many small stable heritable mutations in Drosophila, Morgan gradually changed his mind. The relevance of mutations for evolution is that only characters that are inherited can have an effect in evolution. Since Morgan (1915) solved the problem of heredity', he was in a unique position to examine critically Darwin's theory of natural selection.

In "A Critique of the Theory of Evolution" (1916), Morgan discussed questions such as: "Does selection play any role in evolution? How can selection produce anything new? Is selection no more than the elimination of the unfit? Is selection a creative force?" After eliminating some misunderstandings and explaining in detail the new science of Mendelian heredity and its chromosomal basis, Morgan concludes, "The evidence shows clearly that the characters of wild animals and plants, as well as those of domesticated races, are inherited both in the wild and in domesticated forms according to the Mendel's Law". Evolution has taken place by the incorporation into the race of those mutations that are beneficial to the life and reproduction of the organism" Injurious mutations have practically no chance of becoming established. Far from rejecting evolution, as the title of his 1916 book may suggest, Morgan laid the foundation of the science of genetics. He also laid the theoretical foundation for the mechanism of evolution: natural selection. Heredity was a central plank of Darwin's theory of natural selection, but Darwin could not provide a working theory of heredity. Darwinism could not progress

without a correct theory of genetics. By creating that foundation, Morgan contributed to the neo-Darwinian synthesis, despite his criticism of Darwin at the beginning of his career. Much work on the Evolutionary Synthesis remained to be done.

Evolution is the change in the inherited characteristics of biological populations over successive generations. Evolutionary processes give rise to diversity at every level of biological organization, including species, individual organisms and molecules such as DNA and proteins. All life on Earth is descended from a last universal ancestor that lived approximately 3.8 billion years ago. Repeated speciation and the divergence of life can be inferred from shared sets of biochemical and morphological traits, or by shared DNA sequences. These homologous traits and sequences are more similar among species that share a more recent common ancestor, and can be used to reconstruct evolutionary histories, using both existing species and the fossil record. Existing patterns of biodiversity have been shaped both by speciation and by extinction.

Charles Darwin was the first to formulate a scientific argument for the theory of evolution by means of natural selection. Evolution by natural selection is a process inferred from three facts about populations: 1) more offspring are produced than can possibly survive, 2) traits vary among individuals, leading to different rates of survival and reproduction, and 3) trait differences are heritable. Thus, when members of a population die, they are replaced by the progeny of parents better adapted to survive and reproduce in the environment in which natural selection takes place. This process creates and preserves traits that are seemingly fitted for the functional roles they perform. Natural selection is the only known cause of adaptation, but not the only known cause of evolution. Other, nonadaptive causes of evolution include mutation and genetic drift.

In the early 20th century, genetics was integrated with Darwin's theory of evolution by natural selection through the discipline of population genetics. The importance of natural selection as a cause of evolution was accepted into other branches of biology. Moreover, previously held notions about evolution, such as orthogenesis and "progress" became obsolete. Scientists continue to study various aspects of evolution by forming and testing hypotheses, constructing

scientific theories, using observational data, and performing experiments in both the field and the laboratory. Biologists agree that descent with modification is one of the most reliably established facts in science. Discoveries in evolutionary biology have made a significant impact not just within the traditional branches of biology, but also in other academic disciplines (e.g., anthropology and psychology) and on society at large.

HEREDITY. FURTHER INFORMATION: INTRODUCTION TO GENETICS, HEREDITY AND NORMS OF REACTION.

Evolution in organisms occurs through changes in heritable traits – particular characteristics of an organism. In humans, for example, eye colour is an inherited characteristic and an individual might inherit the "brown-eye trait" from one of their parents. Inherited traits are controlled by genes and the complete set of genes within an organism's genome is called its genotype.

The complete set of observable traits that make up the structure and behaviour of an organism is called its phenotype. These traits come from the interaction of its genotype with the environment. As a result, many aspects of an organism's phenotype are not inherited. For example, suntanned skin comes from the interaction between a person's genotype and sunlight; thus, suntans are not passed on to people's children. However, some people tan more easily than others, due to differences in their genotype; a striking example are people with the inherited trait of albinism, who do not tan at all and are very sensitive to sunburn.

Heritable traits are passed from one generation to the next via DNA, a molecule that encodes genetic information. DNA is a long polymer composed of four types of bases. The sequence of bases along a particular DNA molecule specify the genetic information, in a manner similar to a sequence of letters spelling out a sentence. Before a cell divides, the DNA is copied, so that each of the resulting two cells will inherit the DNA sequence. Portions of a DNA molecule that specify a single functional unit are called genes; different genes have different sequences of bases. Within cells, the long strands of DNA form condensed structures called chromosomes. The specific location of a

DNA sequence within a chromosome is known as a locus. If the DNA sequence at a locus varies between individuals, the different forms of this sequence are called alleles. DNA sequences can change through mutations, producing new alleles. If a mutation occurs within a gene, the new allele may affect the trait that the gene controls, altering the phenotype of the organism. However, while this simple correspondence between an allele and a trait works in some cases, most traits are more complex and are controlled by multiple interacting genes.

Recent findings have confirmed important examples of heritable changes that cannot be explained by changes to the sequence of nucleotides in the DNA. These phenomena are classed as epigenetic inheritance systems. DNA methylation marking chromatin, self-sustaining metabolic loops, gene silencing by RNA interference and the three-dimensional conformation of proteins (such as prions) are areas where epigenetic inheritance systems have been discovered at the organismic level. Developmental biologists suggest that complex interactions in genetic networks and communication among cells can lead to heritable variations that may underlay some of the mechanics in developmental plasticity and canalization. Heritability may also occur at even larger scales. For example, ecological inheritance through the process of niche construction is defined by the regular and repeated activities of organisms in their environment. This generates a legacy of effects that modify and feed back into the selection regime of subsequent generations. Descendants inherit genes plus environmental characteristics generated by the ecological actions of ancestors. Other examples of heritability in evolution that are not under the direct control of genes include the inheritance of cultural traits and symbiogenesis.

CAUSES AND RESULTS OF THE CHROMOSOME THEORY OF INHERITANCE

We take it for granted today that DNA is the genetic material, and therefore our genes must be located on chromosomes. But like all facts in science, this idea had to be repeatedly tested and found to be true before it could be accepted as fact. The chromosome theory of inheritance, or the idea that genes are located on chromosomes, was proposed based on experiments by Thomas Hunt Morgan using

Drosophila melanogaster, or fruit flies. Drosophila are like humans in that an individual with two X chromosomes is female and an individual with one X and one Y chromosome is male (many organisms have other ways of determining gender).

The results of Morgan's experiment support the chromosome theory of inheritance because the only way to explain them is if the eye color gene is on the X chromosome. This is sex-linkage, or inheritance of genes that are on the sex chromosomes (X and Y). Sex-linked traits show interesting inheritance patterns in part because females have two copies of each X chromosome, but males only have one. This inheritance pattern means that a male with the recessive allele will always show the recessive trait, because he only has one copy of the allele. In contrast, most genes are located on the autosomes, or non sex chromosomes, where both males and females have two copies of each gene. Recall that all the patterns of inheritance observed by Mendel, including the principle of segregation and the principle of independent assortment are explained by the behavior of chromosomes during meiosis. These principles are part of the chromosome theory of inheritance.

Thus, one of the important steps in the development of genetics associated with the success of cytological studies, complete the proof of the fact that the carriers of hereditary factors are the chromosomes. Morgan formulated and experimentally proved the position of linked genes in the chromosomes. In particular, genetic methods were found four linkage groups in Drosophila melanogaster, which coincided with the data of cytology. Next in line was a question about the order of genes in the chromosomes.

VARIATION

An individual organism's phenotype results from both its genotype and the influence from the environment it has lived in. A substantial part of the variation in phenotypes in a population is caused by the differences between their genotypes. The modern evolutionary synthesis defines evolution as the change over time in this genetic variation. The frequency of one particular allele will become more or less prevalent relative to other forms of that gene. Variation disappears when a new allele reaches the point of fixation – when it either disappears from the population or replaces the ancestral allele entirely.

Natural selection will only cause evolution if there is enough genetic variation in a population. Before the discovery of Mendelian genetics, one common hypothesis was blending inheritance. But with blending inheritance, genetic variance would be rapidly lost, making evolution by natural selection implausible. The Hardy-Weinberg principle provides the solution to how variation is maintained in a population with Mendelian inheritance. The frequencies of alleles (variations in a gene) will remain constant in the absence of selection, mutation, migration and genetic drift. Variation comes from mutations in genetic material, reshuffling of genes through sexual reproduction and migration between populations (gene flow). Despite the constant introduction of new variation through mutation and gene flow, most of the genome of a species is identical in all individuals of that species. However, even relatively small differences in genotype can lead to dramatic differences in phenotype: for example, chimpanzees and humans differ in only about 5% of their genomes.

Gregor Mendel's principles of inheritance form the cornerstone of modern genetics: explain the significant importance of Mendel's discovery and enumerate Mendel's Laws of Inheritance.

The way in which traits are passed from one generation to the next-and sometimes skip generations-was first explained by Gregor Mendel. By experimenting with pea plant breeding, Mendel developed three principles of inheritance that described the transmission of genetic traits, before anyone knew genes existed. Mendel's insight greatly expanded the understanding of genetic inheritance, and led to the development of new experimental methods.

Mendel's laws form the theoretical basis of our understanding of the genetics of inheritance. Mendel made two innovations to the science of genetics: developed pure lines, counted his results and kept statistical notes. After eight years of tedious experiments with these plants, Mendel proposed three foundational principles of inheritance. Today, whether you are talking about pea plants or human beings, genetic traits that follow the rules of inheritance that Mendel proposed are called Mendelian, these are Mendel's First Law of Genetics (Law of Segregation), Mendel's Second Law (Law of Independent Assortment) and finally, Mendel's Third Law or Law of Dominance.

Not all organisms pass on genes in the same way as the garden pea plant. However, many organisms do indeed show inheritance patterns similar to the seminal ones described by Mendel in the pea. In fact, the three principles of inheritance that Mendel laid out have had far greater impact than his original data from pea plant manipulations. To this day, scientists use Mendel's principles to explain the most basic phenomena of inheritance.

Exercise 2. *Write the summary of the article.*

Exercise 3. *State the main idea of each passage of the article given above and support your ideas. Look through the article and write down its summary.*

* * * * *

Exercise 1. *Read and render the article.*

ENGINEERED PEA SEEDS PROTECT AGAINST PARASITES

A breed of pea seeds has been created that contains antibodies against coccidiosis, a disease caused by a parasite that attacks chickens. Researchers writing in the open access journal BMC Biotechnology describe the development of the GM seeds, and demonstrate their effectiveness in preventing this economically important illness.

Sergej Kiprijanov worked with a team of researchers from Novoplant GmbH, Germany, to develop the seeds. He said, "There are a few major issues precluding the use of monoclonal antibodies for passive immunization of chickens against infectious diseases, primarily the costs of antibody production and treatment. Treatment costs are high because antibodies must normally be given intravenously; otherwise, they are destroyed in the animal's gut. By expressing the antibodies inside pea seeds, they are protected from this degradation – allowing our system to dramatically reduce treatment costs".

The researchers found that chickens infected with the parasite and allowed to eat the antibody-containing pea seeds, shredded into their

feed, were significantly less likely to contract coccidiosis than chickens fed ordinary pea seeds in their fodder. Kiprijanov said, "Compared with methods of active vaccination, the passive immunization strategy described here is an easy and non-invasive method to use in commercial settings. The cost of production is comparatively low, utilizing current agriculture technologies, and the strategy can be used in combination with other antiparasitic agents".

www.biology-online.org

Exercise 2. *Define the main parts of the article given above (introduction, methods, results and conclusion).*

Exercise 3. *Translate the following sentences.*

1. Генетична інженерія допомагає отримати ліки, які неможливо приготувати традиційними технологіями.

2. Біотехнології можуть врятувати людей від хвороб

3. Працюйте з цими добривами в лабораторії обережно та під наглядом викладача.

4. Селекціонери застосовують традиійні біотехнологічні методики підвищення врожаїв.

5. Обов'язково вимикайте усі прилади, коли покидаєте лабораторію.

* * * * *

Exercise 1. *Read and translate the article.*

BASIC THINGS ABOUT HIV AND AIDS.
THE MOST COMMON WAYS OF HIV TRANSMISSION

HIV enters the body through open cuts, sores or breaks in the skin; through mucous membranes, such as those inside the anus or vagina; or through direct injection. There are several ways by which this can happen:

a) Sexual contact with an infected person. Anal or vaginal intercourse without a condom with a partner who is either positive or does not know his or her HIV status account for the vast majority of sexually-transmitted HIV cases in the U.S. and elsewhere. Oral sex is

not an efficient route of HIV transmission. To learn more about the "theoretical risk" of oral sex and HIV transmission, click here. Kissing, massage, masturbation and "hand jobs" do not spread HIV. More information about safer sex to help prevent HIV transmission can be found here.

b) Sharing needles, syringes or other injection equipment with someone who is infected. Information on safer injecting to help prevent the spread of HIV can be found here.

c) Mother-to-child transmission. Babies born to HIV-positive women can be infected with the virus before or during birth, or through breastfeeding after birth. More information about HIV and pregnancy can be found here.

d) Transmission in health care settings. Healthcare professionals have been infected with HIV in the workplace, usually after being stuck with needles or sharp objects containing HIV-infected blood. As for HIV-positive healthcare providers infecting their patients, there have only been six documented cases, all involving the same HIV-positive dentist in the 1980s.

e) Transmission via donated blood or blood clotting factors. However, this is now very rare in countries where blood is screened for HIV antibodies, including in the United States.

HOW HIV INFECTS CELL

HIV is a retrovirus, which means it carries single-stranded RNA is its genetic material rather than the double-stranded DNA human cells carry. Retroviruses also have the enzyme reverse transcriptase, which allow it to copy RNA into DNA and use that DNA "copy" to infect human, or host, cells. When HIV infects a cell, it first attaches to and fuses with the host cell. Then the viral RNA is converted into DNA and the virus uses the host cell's machinery to replicate itself during a process called reverse transcription. The new copies of HIV then leave the host cell and move on to infect other cells.

Exercise 2. *Write a synopsis using the content words of the following article.*

Exercise 3. *Answer the questions.*

1. *What is similar between HIV and AIDS?*
2. *What are the common ways of HIV transmission?*
3. *Is HIV a retrovirus or double0stranded DNA cell?*
4. *What is the viral RNA?*

* * * * *

Exercise 1. *Read and translate the article.*

APPLICATION OF NANOBIOTECHNOLOGY

Applications of nanobiotechnology include creation of targeted nanomachines for use in nanomedicine, applications of self-assembly to create new biomaterials, creation of molecular motors, DNA computers, artificial life, and biosensors. Nanoparticles can be loaded with various drugs in order to increase the efficiency of their delivery allowing targeted delivery to a specific place in the body. Due to their small size nanoparticles are able to remain in the blood circulation for a longer duration of time as compared to microparticles and other traditional drug delivery systems.

WHAT ARE THE BENEFITS OF NANOPARTICLES, COMPARING TO THE MACROPARTICLES?

Nanomedicine uses nano sized materials in an innovative ways to develop new approaches and treatments. Because of its small size, structure and large surface area, nanoscale materials acquire different physical and chemical properties. These properties allow systems of nanoparticles to overcome existing limitations of conventional forms, as they facilitate intracellular transport to specific cellular targets.

Nanostructured materials have dimensions from 1 to 100 nm and show unique properties and functions because of the "size effect". Since the most biologically active macromolecules and substances such as viruses and membrane protein complexes are natural nanostructures, it is assumed that nanoscale structures are capable of enhanced interaction with cell membranes and proteins. Nanomaterials in medicine are used for targeted drug delivery, cancer treatment and clinical bioanalytical diagnosis and therapy.

There are limitations in the amount of the particles passage through the barrier of the intestinal mucosa of the gastrointestinal (GI) tract after oral administration of drugs. Macroparticles often do not pass through the barrier mucosa due to their large size, which makes it impossible for their uptake by cells. Nanoparticles have an advantage in comparison to macroparticles due to their nanoscale size.

What are the base and the use of nanobiotechnology?

The basic factors that influenced the occurrence, formation and development of nanobiotechnology are: high growth in the development of scientific disciplines such as microbiology, molecular biology, and engineering, protein engineering, and, in fact, biotechnology, which combines data subjects, as well as strong growth in development of materials science, electronics and other areas of nanotechnology and nanoscience nanoengineering, which is the fundamental basis of physics.

Currently, nanobiotechnology has formed three areas, the development of which is now at a rapid rate. These are: nanomedicine and biomimetics.

Molecular nanomedicine. Basic research in this area are the study and creation of the following: lab on a chip, targeted delivery of drugs to diseased cells, new bactericidal and antiviral drugs and diagnose diseases by using quantum dots.

Biomimetics includes the creation of nanostructures of protein use in the construction of DNA and RNA molecules and work with viruses when creating nanomachines.

BIOCHEMISTRY LABORATORY

Part One

What is a biochemistry laboratory?

A biochemistry lab is a facility in which people can perform tasks related to the study of biochemistry. Biochemistry labs have equipment which can be used to explore various topics in biochemistry, along with space for storage of specimens, experiments, and other activities. Such labs can be found in colleges and universities with biochemistry departments, along with institutions which perform biochemistry research, and as standalone structures which perform research and analysis. Basic facilities for biochemistry can also be

found in some criminal laboratories, as many topics in biochemistry are useful in the analysis and evaluation of evidence.

What are the basic components of science research labs?

All biochemistry labs have the basic components of science research labs, such a pH meter, a balance for weighing out chemicals, a variety of buffers and other chemicals, and refrigerators and freezers for storing supplies. They also have a special freezer kept at -94° F (-70° C) for the long-term storage of proteins and tissues. Such facilities have centrifuges and access to an ultracentrifuge. An ice machine is generally essential for generating ice to keep enzymes and reagents chilled and stable. Virtually all biochemistry labs have gel electrophoresis supplies for examining proteins, along with the equipment for running Western blots.

What is FPLC?

A protein biochemistry laboratory may have a fast-pressure liquid chromatography (FPLC) system to purify large amounts of protein to study. It would have a variety of gel matrices, with differing chemical properties to use with the FPLC to separate the proteins. There would be glass columns of varying proportions to hold the matrices. Protein biochemistry laboratories generally have a cold room, so that proteins can be isolated and purified at cold temperatures to keep them stable.

Do the biochemistry labs have special equipment to work with microorganisms?

The lab would have agar, which forms a gel that the microorganisms grow on. There would be a variety of other of supplies for media, and antibiotics for growing up the genetically-altered microorganisms. It would have incubators and shakers that could be warmed up to grow bacteria or yeast. Also necessary is access to an autoclave, to sterilize the supplies for growth and RNA manipulation, and to destroy the recombinant material after the experiments are finished.

What does clinical biochemistry usually receive?

Clinical Biochemistry usually receives serum or plasma. They test the serum for chemicals present in blood. These include a wide array of substances, such as lipids, blood sugar, enzymes, and hormones.

A biochemistry lab is a facility in which people can perform tasks related to the study of biochemistry. Biochemistry labs have equipment which can be used to explore various topics in biochemistry, along with space for storage of specimens, experiments,

and other activities. Such labs can be found in colleges and universities with biochemistry departments, along with institutions which perform biochemistry research, and as standalone structures which perform research and analysis. Basic facilities for biochemistry can also be found in some criminal laboratories, as many topics in biochemistry are useful in the analysis and evaluation of evidence. A typical biochemistry lab includes workbenches for people to use, with equipment like spectrometers, microscopes, DNA sequencers, imagers, chromatographs, computers, and electrophoresis equipment, along with tools which can be used to manipulate samples. The lab also has protections such as fume hoods and isolation boxes to protect people from hazardous substances, along with storage space and specially equipped facilities like cold rooms and negative pressure rooms. The biochemistry lab may be attached to offices used by scientists affiliated with the lab Accidents and Injuries.

Accident is an unexpected event, typically sudden in nature and associated with injury, loss, or harm. Accidents are a common feature of the human experience and result in injury or permanent disability to large numbers of people worldwide every year. Many accidents also involve damage to or loss of property. Accidents can occur anywhere, including in the home, during transportation, in the hospital, on the sports field, or in the workplace. With appropriate safety precautions and awareness of one's actions and environment, many accidents can be avoided or prevented.

Exercise 2. *Put 5 special questions to the text to cover the details of revealed information.*

Exercise 3. *Answer the following questions.*

1. *What types of laboratories do you know?*
2. *What is biochemistry laboratory?*
3. *Do the biochemistry labs have special equipment?*
4. *What are the components of science research labs?*
5. *What is nanobiotechnology and how can we apply it?*
6. *What is the main difference between nanoparticles and macroparticles?*

* * * * *

Exercise 1. *Read and retell the following article.*

Motor VEHICLE ACCIDENTS

Worldwide, motor vehicle accidents are a major cause of death, and, despite improvements in automobile safety, projections have indicated that deaths from traffic crashes will increase significantly by 2030 because of increased motor vehicle ownership. Examples of causes of traffic accidents include speeding, drunk driving, distracted driving, and inexperienced driving. Although seat belts can save lives, millions of people fail to use them. Likewise, helmets are an effective means of protecting motorcyclists from traumatic brain injury and death, yet many riders choose not to wear a helmet.

Motor vehicle accidents result in a wide range of injuries and often in permanent disability. In an attempt to limit some of this damage, laws in places around the world have been enacted specifically to improve road safety. For example, some U.S. states have imposed universal helmet laws, requiring all motorcycle riders and passengers to wear protective helmets. Some governments impose fines on automobile drivers and passengers who do not use seat belts. Accidents involving buses are also responsible for injuries to large numbers of people, and this has led to mandatory seat belt use in some places. Safety features on cars, including seat belts, side-impact reinforcement, and air bags, have contributed to fewer injuries and deaths. Certain changes in the design of car bumpers and windshields have been aimed at causing less harm to pedestrians who may be hit. Preventive measures, such as campaigns on the dangers of drunk driving, enforcement of speed limits, the use of cameras to catch traffic law violators, and education of children about road safety, have helped raise public awareness about the importance of safety precautions on the road.

SPORTS ACCIDENTS

Accidents during sports have long been the cause of debilitating injuries. Since the rise of modern organized sports in the 18th century, all sports–especially those involving contact, such as boxing, American football, and rugby–have witnessed crippling injuries, disability, and death. Sports in which an individual is elevated off the ground, such as horseback riding, mountain climbing, and rappelling,

account for a high number of head and spinal injuries as well as fractures. From the latter part of the 20th century, the number of sports that deliberately court danger, the so-called extreme sports, grew rapidly and resulted in a concomitant number of injuries.

For some sports, changes in rules and safety equipment have helped to reduce the incidence and severity of accidents on the sports field. However, such action does not eradicate injury. For example, despite more stringent penalties for illegal checking in ice hockey and helmet-to-helmet contact in American football, concussion remains a major source of long-term disability in those sports.

ACCIDENTS IN THE HOME

The home is a site for many accidents. Stairways, bathrooms, and kitchens pose special hazards, as do utility closets, medicine cabinets, gardens, and swimming pools. Among children under age five, falls, burns, choking, poisoning, and drowning are common causes of injury or death at home. Falls are also common among older individuals.

A number of factors may precipitate accidents in the home. Poor supervision or poor housing conditions can increase the risk of accidents in the home for children. For example, unsupervised children may choke on small objects that have been within their reach. Likewise, poor electrical wiring and a lack of fire safety can result in significant injury and loss of property to fire.

ACCIDENTS IN THE HOSPITAL

Accidents involving procedures or medication can occur in hospitals and sometimes lead to permanent disability. For example, the use of instruments such as forceps can in rare instances result in brain trauma at birth. In some cases, medication errors may occur in which patients are given the wrong medication or too much or too little of a medication while in a hospital. Such errors can have severe adverse effects on patients. Hospitalized individuals also are susceptible to nosocomial, or health care-associated, infections, which in extreme cases can end in death.

ACCIDENTS IN THE WORKPLACE

Occupational hazards have always existed, but they became especially pronounced with the rise of modern factories, mines, and foundries in the 19th century. Industries such as construction and mining, in which heavy equipment is used, are associated with an elevated risk for severe injury. Constant and repetitive work can

produce injuries such as prepatellar bursitis (or beat knee, caused by constant kneeling) and hand-arm vibration syndrome (or vibration white finger, caused by the handling of vibrating tools for long periods). Long-term exposure to materials such as asbestos can lead to chronic diseases such as mesothelioma. Occupations that involve sitting for long periods or typing constantly come with their own sets of risks. Carpal tunnel syndrome, for example, which can be caused by leaning the wrists on a desk while working at a computer, is one of the most-common repetitive stress injuries in the modern workplace.

Historically, there was little in the way of safety equipment to prevent accidents, and long-term exposure to dangerous chemicals could cause severe disablement and death. Before factory owners were called on to make their workplaces safer, many workers were injured in accidents. When permanent disability was the result, often that worker was doomed to a life of poverty, since there was often little in the way of compensation for his or her injury. The rise of occupational medicine in the industrial era, accompanied by an increased recognition of occupational hazards, led to improved measures of protection for workers.

The most effective instruments to prevent and minimize the injures in different spheres remain the attentiveness and following the safety rules. But if the accidents are very possible a good idea will be to have a casualty insurance. Casualty insurance is a provision against loss to persons and property, covering legal hazards as well as those of accident and sickness. Major classes of casualty insurance include health insurance and workers' compensation.

Health insurance may apply to a limited or comprehensive range of medical services and may provide for full or partial payment of the costs of specific services. Benefits may consist of the right to certain medical services or reimbursement to the insured for specified medical costs. Some types of health insurance may also include income benefits for working time lost because of sickness (i.e., disability leave).

Workers' compensation insurance, financed by employers' contributions, compensates workers for losses suffered as a result of work-related injuries; compensation may include medical benefits, temporary incapacity benefits, permanent disability benefits, and, in an increasing number of countries, retraining benefits.

Exercise 2. *Explain the above-given article in one sentence.*

Exercise 3. *Answer the following questions from the article.*

1. *What are the consequences of an accident?*
2. *What are motor vehicle accidents?*
3. *What are sports accidents?*
4. *What are accidents in the home?*
5. *What are accidents in the hospital?*
6. *What are accidents in the workplace?*
7. *What is the health insurance?*
8. *What types of insurance do you remember? What are their similarities and differences?*

* * * * *

Exercise 1. *Read and translate the article.*

GOOD AND BAD HABITS AFFECTING YOUR LIFE SPAN

In recent years we have made great strides in discovering how the aging process works. However, we still are several medical discoveries away from finally being able to stop or reverse this process. In the meanwhile, is there anything we can do to possibly increase our life span and specifically our health span? The key is in our habits**.** It has been proven that various behaviors can help us stay young longer or, on the contrary, develop diseases and age faster. When we include these behaviors in our habits, we can influence our life spans positivey or negatively. Let's take a look together at the good and bad practices to live (possibly) longer and healthier.

Good habits

What are the good habits we can adopt to positively influence our longevity? In recent years, thanks to our increased scientific knowledge, we have realized how we can actually try to influence the functioning of our bodies by eating a specific type of food, sleeping at specific intervals and doing a certain amount of exercise. As a consequence, there has been a boom of publications on diets, workouts

and longevity tips. These recommendations are not always based on accurate scientific assumptions.

Mind your nutrition

Since every food is different, not only in appearance and taste but also in its nutritional properties, different foods provide different amounts of energy and nutrients to your body. An incorrect nutrition can lead to heart diseases, diabetes, osteoporosis and some cancers, to name a few.

Eat the food your body needs

Eat a varied amount of whole-grains, legumes, seeds and nuts, fruit and vegetables to make sure your body receives the fibers, proteins, glucose, vitamins and minerals needed.

Reduce the amount of food containing saturated fats, trans fats, added salt and added sugar. Your body needs way less dairy, meat, sugary drinks, snacks and processed food than most people consume.

Remember to move

Technological innovations have enabled us to achieve incredible things. However, there is one negative consequence: people today tend to spend more and more time in front of a screen, while moving less. To overcome the fact that we no longer have to run after prey in order to survive, we have taken up sport.

Train your brain to think positive

Despite knowing that emotions are simply responses produced by specific parts of our brain, it is often not easy to control them. Feelings, both positive and negative, influence our life decisions and, apparently, even our health span. While the connection is not yet completely certain, it is clear that positive thinking and optimisms can have positive health effects.

Get your healthy dose of social interaction

While sociability is an instinctive trait of our species, it is also able to influence our life spans. Firstly, it influences our mental health**.** Social interaction helps also reduce the risk of Alzheimer's disease and other types of dementia.

BAD HABITS

Now that we have some good habits to start adopting, what are the ones we should leave behind? There are many behaviors that, taken individually, are no big deal. Yet, in the long term, they could damage our health. For

example, if you eat fast food once per month, it is very likely that your body will manage to deal with it. But what if you did it every day?

Smoke

Smoking is one of the most common forms of recreational drug use and is by far the most deadly. Life expectancy for smokers is at least 10 years shorter than for nonsmokers. This also applies to people subjected to passive smoke.

Underestimate your level of stress

For many, having a certain level of stress helps us to be productive. Setting deadlines allows us to finish our projects and move forward in life. For this reason, stress itself is not always a problem. The key is to recognize your stress level and not to underestimate it.

Being constantly under stress, anxiety and worry might shorten your lifespan. When you are chronically stressed your level of hormones (and therefore heart rate and blood pressure) don't go back to normal levels.

Additionally, to release the stress, people could adopt bad behaviors that provoke instant gratification, such as drug use, overeating, gambling etc.

Get comfortable and do not stop learning

While the brain is not a muscle (it's actually an organ) it is correct to say that, like a muscle, you have to exercise it to keep it healthy and functioning at its best. When you learn and exercise your brain you improve your memory, executive functions, and processing speeds.

The effort of mastering a new discipline or starting a new hobby as an adult may help you slow age-related changes in the brain and those associated with neurological conditions.

Conclusion

It is not easy to start adopting a new habit or to leave an old one behind. Yet, sometimes it may be worth trying. Especially when it could help you live a healthier and longer life. You can start simple, setting a sleeping schedule for the next few days or eating healthier food at least twice a week.

Exercise 2. *Role play with your partner informative and evaluative aspects of the above-given article.*

Exercise 3. *Answer the following questions*

1. *What is the connection between good and bad habits?*
2. *What good habits are mentioned in the article?*
3. *What bad habits are described in the article?*
4. *Can you add other good or bad habits to the list?*

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Навчальне видання

READING AND TRANSLATION SKILLS: BIOLOGY ENGLISH

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