K A Z A N  F E D E R A L  U N I V E R S I T Y

# *Essential English for Biology students*

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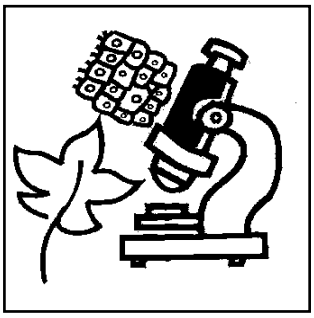
Основная цель пособия “Essential English for Biology Students” – помочь студентам естественно-научного профиля, изучающим биологию, усовершенствовать свои знания английского языка. Пособие состоит из 8 разделов, посвященных некоторым из основных проблем биологии, 24 уроков, 10 текстов для дополнительного чтения, кроме того, приводится перечень лексических единиц, часто вызывающих у студентов трудности в употреблении, также дается глоссарий основных биологических терминов.

Материал данного учебного пособия призван помочь студентам, изучающим английский язык специальной области «Биология» овладеть лексическим запасом, необходимым для чтения и перевода текстов научного характера, а также отработать навыки устных выступлений и проведения презентаций.

# The Content

# UNIT I. WHAT IS BIOLOGY?

## Text 1.1 The Characteristics Of Life



■ **Essential targets:**

By the end of this text you should be able to:

- discuss the main features of living things;
- discuss the stages of development of the science of biology.

*Pre-reading*

**■With your partner try to match the definition with the correct word. Guess if you are not sure! Then scan the text quickly to see if you were right.**

**Exercise A.**

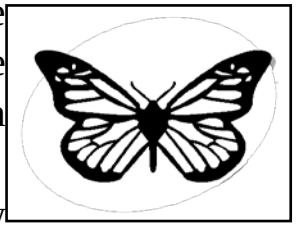
| | | | |
|---|---|---|---|
| **1.** | feature | **A.** | a substance in general that everything in the world consists of |
| **2.** | matter | **B.** | a useless material or substance |
| **3.** | heat | **C.** | natural world in which people and animals live |
| **4.** | chemical | **D.** | the smallest unit of living matter |
| **5.** | cell | **E.** | outer form or outline |
| **6.** | environment | **F.** | a form of energy |
| **7.** | shape | **G.** | substance used in chemistry |
| **8.** | waste product | **H.** | something important or typical of a place or thing |

■ **Read the given text and make your essential assignments:**

Biology is the study of life and living organisms. For as long as people have looked at the world around them, people have studied biology. Even in the days before recorded history, people knew and passed on information about plants and animals.

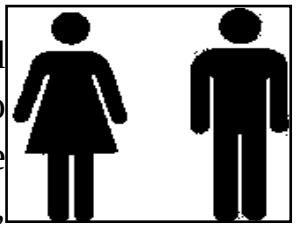
Modern biology really began in the 17$^{th}$ century. At that time, Anton van Leeuwenhoek, in Holland, invented the microscope and William Harvey, in England, described the circulation of blood. The microscope allowed scientists to discover bacteria, leading to an understanding of the causes of disease, while new knowledge about how the human body works allowed others to find more effective ways of treating illnesses. All these new knowledge needed to be put into order and in the 18$^{th}$ century the Swedish scientist Carl Linnaeus classified all living things into the biological families we know and use today.

In the middle of the 19th century, unnoticed by anyone else, the Austrian monk Gregor Mendel, created his Laws of Inheritance, beginning the study of genetics that is such an important part of biology today. At the same time, while traveling around the world, Charles Darwin was formulating the central principle of modern biology – natural selection as the bases of evolution.



It is hard to believe, but the nature of viruses has become apparent only within the last half of the 19th century and the first step on this path of discovery was taken by the Russian botanist Dmitry Ivanovsky in 1892.

In the 20th century biologists began to recognize how plants and animals live and pass on their genetically coded information to the next generation. Since then, partly because of developments in computer technology, there have been great advances in the field of biology; it is an area of ever-growing knowledge.



During the past few hundred years biology has changed from concentrating on the structure of living organisms to looking more at how they work or function. Over this time biologists have discovered much about health and disease, about the genes which control the activities of our bodies and how humans can control the lives of other organisms. We need to understand how our activities affect the environment, how humans can take responsibility for their own health and welfare and how we must be careful to make appropriate rules for the use of our genetic information.

Nowadays biologists are making fantastic discoveries which will affect all our lives. These discoveries have given us the power to shape our own evolution and to determine the type of world we will live in. Recent advances, especially in genetic engineering, have dramatically affected agriculture, medicine, veterinary science, and industry, and our world view has been revolutionized by modern developments in ecology. There has never been a more exciting nor a more important time to study biology.

Biology is the scientific study of life. But what is life? When we see a bird on a rock it may seem obvious that the bird is alive and the rock is not, but what precisely makes the bird alive and the rock not? Throughout history, thinkers in many fields tried to define life. Although they have failed to provide a universally accepted definition, most scientists agree that all living things share certain basic characteristics:

- Living things are made of organized structures.
- Living things reproduce.
- Living things grow and develop.
- Living things feed.
- Living things respire.
- Living things excrete and waste.
- Living things respond to their surroundings.
- Living things move.
- Living things control their internal conditions.
- Living things are able to evolve.

Non-living systems may show some of the characteristics of living things, but life is the combination of all these characteristics.

**Organization.** All things are made of chemicals, but in living things the chemicals are packaged into highly organized structures. The basic structure of life is the cell. Cells themselves contain small organelles that carry out specific functions. A cell may exist on its own or in association with other cells to form tissues and organs. Because of their highly organized structure, living things are organisms.

**Reproduction.** Reproduction is the ability to produce other individuals of the same species. It may be sexual or asexual. Reproduction involves the replication of DNA. This chemical contains genetic information which determines the characteristics of an organism, including how it will grow and develop. The continued existence of life depends on reproduction, and this is perhaps the most characteristic feature of living things. Reproduction allows both continuity and change. Over countless generations this has allowed species to become well suited to their environment, and life to evolve gradually to more complex forms.

**Growth and development.** All organisms must grow and develop to reach the size and level of complexity required to complete their life cycle. Growth is a relatively permanent increase in size of an organism. It is brought about by taking in substances from the environment and incorporating them into the internal structure of the organism. Growth may be measured by increases in linear dimensions (length, height, etc.), but is best measured in terms of dry weight as this eliminates temporary changes due to intake of water which are not regarded as growth. Development involves a change in a shape and form of an organism as it matures. It is usually accompanied by an increase in complexity.

**Feeding.** Living things are continually transforming one form of energy into another to stay alive. Although energy is not destroyed during these

transformations, heat is always formed. Heat is a form of energy which cannot be used to drive biological processes, so it is sometimes regarded as `wasted energy`.

Living things have to renew their energy stores periodically from their environment, to continue transforming energy and to replace the `wasted energy`. They also have to obtain nutrients – chemicals that make up their bodies or help them carry out their biological processes. Living things acquire energy and nutrients by feeding, either by eating other organisms, or by making their own food out of simple inorganic chemicals using energy from sunlight or from chemical reactions.

**Respiration.** Living things need energy to stay alive and to do work. Although food contains energy, this is not in a directly usable form. It has to be broken down.

The energy released during the breakdown is used to make ATP (adenosine triphosphate) in a process called respiration. ATP is an energy rich molecule and is the only fuel that can be used directly to drive metabolic reactions in living organisms.

**Excretion.** The energy transformations that take place in an organism involve chemical reactions. Chemical reactions that occur in organisms are called metabolic reactions.

Waste products are formed in these reactions, some of which are poisonous, so they must be disposed of in some way. The disposal of metabolic waste products is called excretion.

**Responsiveness.** All living things are sensitive to certain changes in their environments (stimuli) and respond in ways that tend to improve their chances of survival.

The degree of responsiveness depends on an organism`s complexity: a bacterium may be limited to simple responses, such as moving towards favorable stimuli or away from harmful ones; people can make highly sophisticated responses to a wide variety of stimuli which they may perceive either directly or with the aid of technological devices.

**Movement.** Responses usually involve some form of movement. Movement of whole organisms from one place to another is called locomotion. Plants and other organisms that are fixed in one place do not display locomotion, but they can move parts of their bodies. Movements of living things differ from those of non-living things by being active, energy-requiring processes arising from within cells.

**Homeostasis.** All living things are, to some extend, able to control their

internal conditions so that their cells have a constant chemical and physical environment in which they can function effectively. The regulation and maintenance of a relatively constant set of conditions within an organism is called homeostasis. Homeostasis is a feature of all living systems, from a single cell to a whole biosphere (the part of Earth containing life).

**Evolution.** Living things are able to change into new forms of life. This evolution usually takes place gradually over successive generations in response to changes in the environment.

**■ Glossary of essential terms for you to know**

| № | English term | Russian equivalent |
|---|---|---|
| 1. | to accept | принимать |
| 2. | to accompany | сопровождать |
| 3. | to acquire | приобретать |
| 4. | advance | продвижение (вперед), прогресс |
| 5. | to allow | позволять |
| 6. | apparent | очевидный , явный |
| 7. | to arise | возникать; появляться |
| 8. | arrangement | устройство; расположение |
| 9. | to arrange | располагать; устраивать |
| 10. | because of | из-за, вследствие |
| 11. | blood | кровь |
| 12. | to bring about | вызывать |
| 13. | capacity | способность |
| 14. | to carry out | выполнять; осуществлять |
| 15. | cause (n.) | причина |
| 16. | to cause (v.) | вызывать |
| 17. | certain | определенный; некий; некоторый |
| 18. | circumstance | обстоятельство |
| 19. | coded information | закодированная информация |
| 20. | to complete (v.) | заканчивать; завершать; |
| 21. | complete (adj.) | полный |
| 22. | to contain | содержать |
| 23. | to define | определять |
| 24. | to determine | определять; решать; устанавливать |
| 25. | to develop | развивать |
| 26. | to describe | описывать |
| 27. | to destroy | уничтожать; разрушать |
| 28. | dimension | размер, величина; измерение |
| 29. | to display | показывать; проявлять; обнаруживать |

| | | |
|---|---|---|
| 30. | to dispose | избавляться от чего-либо; располагать |
| 31. | due to | из-за, вследствие |
| 32. | either … or | или…или; либо…либо |
| 33. | to eliminate | уничтожать |
| 34. | internal | внутренний |
| 35. | to evolve | развивать |
| 36. | to fail | отсутствовать; не хватать |
| 37. | feature | особенность; характерная черта |
| 38. | to govern | регулировать; управлять |
| 39. | to grow | расти, увеличиваться |
| 40. | gradually | постепенно |
| 41. | generation | поколение |
| 42. | height | высота, вышина, рост |
| 43. | harmful | вредный |
| 44. | inheritance | наследственность |
| 45. | to involve | включать; вовлекать |
| 46. | to increase | увеличивать; усиливать |
| 47. | in terms of | исходя из; на основании чего-либо |
| 48. | input of sth. | потребление чего-л. |
| 49. | to include | включать |
| 50. | law | закон |
| 51. | matter | вещество, материя |
| 52. | to move | двигать, передвигаться |
| 53. | to occur | случаться, происходить |
| 54. | to pass | 1.проходить; переходить; 2. (on) передавать |
| 55. | to put into order | привести в порядок; упорядочить |
| 56. | to perform | выполнять, совершать |
| 57. | to possess | обладать |
| 58. | starch | крахмал |
| 59. | to survive | выжить; пережить |
| 60. | way | способ |

## ■ Your Essential Assignments

## I. Quick check

### A. Decide if the following statements are true or false.

1.) The earliest people must have known about plants or they would have died.

2.) The microscope allowed biologists to treat illnesses.

3.) Darwin`s theory was one of the most important in biology.

4.) The study of biology has not changed at all over the centuries.

**B. What is the difference between:**

1.) the growth of a crystal and the growth of a plant

2.) the movement of a cloud and the movement of an animal?

## II. Fill in the missing words:

| Term (verb) | Noun |
|---|---|
| respond | ..... |
| transform | ..... |
| move | ..... |
| develop | ..... |
| respire | ..... |
| create | ..... |
| define | ..... |

## III. Use monolingual English dictionary and write down what could the words given below mean:

nutrient; sunlight; poison; breakdown; harmful.

## IV. Find English equivalents to the following word combinations:

| № | Russian term | English equivalent |
|---|---|---|
| 1. | общепринятое определение | |
| 2. | выполнять (проводить) специальные функции | |
| 3. | тот же самый вид растения; животного | |
| 4. | постоянное увеличение размера | |
| 5. | исходя из (на основании) сухого веса | |
| 6. | из-за количества потребляемой воды | |
| 7. | ускорять обмен веществ | |
| 8. | улучшать шансы на выживание | |
| 9. | с помощью технологических приборов | |
| 10. | до некоторой степени | |
| 11. | поддерживание постоянных условий | |
| 12. | происходить постепенно | |
| 13. | определять характеристики организма | |
| 14. | реагировать на условия окружающей среды | |
| 15. | известен как | |

## V. Give Russian equivalents to the following English terms:

| № | English term | Russian equivalent |
|---|---|---|
| 1. | living things share certain basic characteristics | |
| 2. | to reach the size and level of complexity | |
| 3. | to measure by increase in linear dimensions (length; heights) | |
| 4. | temporary changes | |
| 5. | transform one form of energy into another | |
| 6. | to obtain nutrient chemicals | |
| 7. | to make their own food | |
| 8. | energy–rich molecule | |
| 9. | sensitive to certain changes in their environment | |
| 10. | degree of responsiveness | |
| 11. | moving toward favourable stimuli | |
| 12. | wide variety of stimuli | |
| 13. | energy–requiring processes | |
| 14. | to be known as | |

## VI. Find synonyms among the pool of words:

| Pool of words | Synonyms |
|---|---|
| **1)** 1.determine/2.start/3.change/4.alter/5.define/6.begin | |
| **2)** 1.breath/2.initiate/3.happen/4.respiration/5.occur/6.start | |
| **3)** 1.investigation /2.dimension /3.research /4.size | |
| **4)** 1.due to/2.possess/3.ruin/4.because of/5.have/6.destroy | |

## VII. Answer the following questions. Use all information given before:

1. Have scientists provided a universally accepted definition of life?
2. What is a living thing?
3. What is a non-living thing?
4. What can living things do that non-living things can not?
5. What do cells contain?
6. What does genetic information determine?
7. How is growth brought about?
8. Can heat be used to drive biological processes?
9. How do living things acquire energy and nutrients?
10. What do living things need to stay alive?
11. What does the degree of responsiveness depend on?
12. How do movements of living things differ from those of non-living?
13. What is homeostasis?

## VIII. Match the sentence halves. Make complete sentences:

| | | | |
|---|---|---|---|
| **1.** | Biologists are making discoveries | **A.** | those of non-living things by being energy-requiring processes arising from within cells. |
| **2.** | Growth is accompanied by | **B.** | one of the main features of living things. |
| **3.** | DNA contains genetic information which | **C.** | are transforming one form of energy into another. |
| **4.** | Movements of living things differ from | **D.** | all living things share certain basic characteristics. |
| **5.** | Reproduction is | **E.** | chemicals are packed into highly organized structures. |
| **6.** | To stay alive living thing | **F.** | an increase in complexity. |
| **7.** | Most scientists think that | **G.** | determines the characteristics of an organism, including how it will grow and develop. |
| **8.** | In living things | **H.** | which will affect all our lives. |

## IX. Read and translate the short text without any dictionary:

**Fact of life:**

The continued existence of life depends on reproduction, and this is perhaps the most characteristic feature of living things. Reproduction allows both continuity and change. Over countless generations this has allowed species to become well suited to their environment, and life to evolve gradually to more complex forms.

## X. Food for thought:

**a)** You might be familiar with the mnemonic (memory aid) `Richard Of York Gave Battle In Vain` for remembering the colors of the spectrum – red, orange, yellow, green, blue, indigo, and violet. Suggest a mnemonic for the ten characteristic features of living things described in this unit. You can change the order of the features.

**b)** Robots can move and respond, and require energy to maintain their organization and a constant internal environment. How would you argue that robots are non-living objects? A robot could be made that has all the characteristic features of living things. Would it still be non-living?

## XI. Translate into English using all the active possible:

1. Биологическая наука изучает все живые организмы, населяющие нашу планету.

2. Даже в самые отдаленные времена люди пытались понять окружающий их мир и обладали довольно обширными знаниями о растениях и животных.

3. Современная биология начала развиваться в XVII веке.

4. Микроскоп, изобретенный Левенгуком, позволил ученым обнаружить мир микроорганизмов.

5. В XVIII веке Карл Линней заложил основы современной классификации живых существ.

6. Законы наследственности и принцип естественного отбора были сформулированы в XIX веке.

7. В наши дни знания человека в области биологии растут очень быстро благодаря компьютерным технологиям.

## Text 1.2. What Do Biologists Do?

■ **Essential targets:** By the end of this text you should be able to:

- describe what biologists do;
- define the different levels of biological organization;
- list the main elements of a scientific method.

*Pre-reading*

**■ Working in pairs, discuss these questions with your partner. Then scan the text to find the answers and compare them with your discussion.**

1. What do biologists study?
2. What careers in biology can you think of?
3. What areas of biology do you consider as the most important for human society nowadays? Give your reasons.
4. Could you name the key elements of biological investigations?

■ **Read the given texts and make your essential assignments**:

*Part A.* **The levels of biological organization:**

Biologists study every aspect of life at every level of its organization, from the atoms that make up biological molecules to the ecosystems that form the biosphere.

Here are the levels of biological organization from atoms, the smallest

components of living things, to the biosphere, the entire living planet:

- *Biosphere*
- *Ecosystem*
- *Population*
- *Individual*
- *Organ system: digestive system*
- *Organ: stomach*
- *Tissue: smooth muscle*
- *Cell: smooth muscle cell*
- *Organelle: Mitochondrion*
- *Macromolecules: proteins*
- *Chemical building blocks or monomers: amino acid*
- *Atoms: carbon*

*Part B.* **Aspects of biology:**

Modern biology is an enormous subject that has many branches. Specialists in some branches include:

● molecular biologists and biochemists who work at the chemical level, with the aim of revealing how DNA, proteins, and other molecules are involved in biological processes;

● geneticists who study genes and their involvement in inheritance and development;

● cell biologists who study individual cells or groups of cells, often by culturing them outside organisms; thee investigate how cells interact with each other and their environment;

● physiologists who find out how organ systems work in a healthy body;

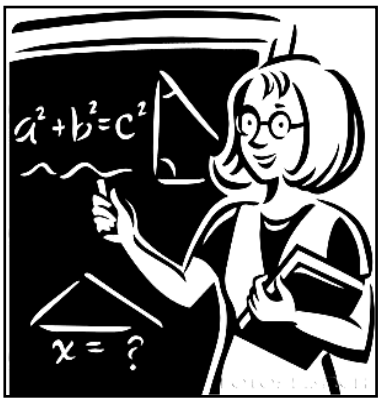
● pathologists who study diseased and dysfunctional organs;

● ecologists who study interactions between organisms and their environment. Some focus their attention on whole organisms; others study populations, individuals of the same species living together at one location.

There are also biologists who specialize in particular groups of organisms; for example, bacteriologists study bacteria, botanists study plants, and zoologists study animals.

Biologists are employed in many fields including conservation and wildlife management, industry, health care, horticulture, agriculture, zoos, museums, information science, and marine and freshwater biology. In addition, many biologists are employed as teachers, lecturers, or research workers.

*Part C.* **A letter to students who study biology:**




*Dear Students,*

*I am writing this letter to welcome all of you who are about to begin your first year course in Biology here at the university. You might think it is a little early for me to ask you to think about what you will do when you leave here in three years` time. However, our science, like any other, has so many different areas it is impossible to study them all. The first thing you will have to think about is specializing. This letter is to offer you some suggestions to think about for your future.*

*As you know, there are four main areas of biology that we shall concentrate on in the coming years. Biology can be divided into zoology, the study of animal life, and botany, the study of plant life. We shall also study molecular biology, the study of how the building blocks of living things, the cells, work. Another topic of interest is genetics, how biological information is passed on from one generation to the next: that is, inheritance. You should specialize, but you will also need to know about all of these four areas of study. Plants and animals do not live separately from each other; all living things are made up of cells and one of things genetics tells us is how plants and animals adapt to the conditions around them.*

*So what about after the course is over and you have graduated in Biology? Can you have a career in biology? For those who choose to specialize in genetics or molecular biology there are important career opportunities in medicine. At the present time, there is a great deal of research going on in gene therapy where biologists are working with doctors and chemists to find new ways of treating diseases. Other biologists are looking at ways of changing the genetic composition of the plants we grow for food; of making them more able to fight diseases and at the same time produce more food.*

*We are experiencing a period of climatic change too, and this is having an effect on the way animals and plants live. The science of ecology is becoming more and more important; biologists who specialize in zoology are working in many parts of the world. Some are working to protect species like the tiger,*

*which are seriously threatened by climate change. Others are investigating wildlife from the smallest insects to the largest mammals, trying to understand how they all live together. Botanists are looking at the effect new types of food crops have on the environment and how changes in that area can affect our general health. There is even a new area of biology called astrobiology, which is looking at the possibilities of life on other planets – but perhaps that is something for the more distant future.*

*Whatever you specialize in, as long as there is life on this (or any other) planet, there is work for a biologist.*

*Good luck and enjoy your studies!*

*Jean Shearer*
*Professor of Biology.*

*Part D.* **The scientific method:**

The definition of biology states that it is a `scientific study`. This distinguishes biology from other ways of studying life. However, there is no single rigid scientific method that biologists use: there are numerous ways of studying life scientifically. Nevertheless, biological investigations usually include one or more of the following key elements:

- observing: making observations and taking measurements
- questioning: asking questions about observations and posing a problem
- hypothesizing: formulating a hypothesis, a statement that explains a problem and can be tested
- predicting: stating what would happen if the hypothesis were true
- testing: testing the hypothesis, usually by carrying out a controlled experiment aimed at producing data that will either support or contradict the hypothesis
- interpreting: interpreting the test results objectively and drawing conclusions that accept, modify, or reject the hypothesis.

A biologist may start an investigation by making observations or by using observations described by other biologists. Such observations may be obtained directly by the senses, such as listening to a bird song, or indirectly through instruments such as recording the song on a computer system. On the other hand, an investigation may start simply by a biologist having an idea that something happens in a particular way, and then the idea will be tested by

making observations or carrying out experiments to see if it is valid. A hypothesis is suggested and then tested in all investigations. One essential aspect of a scientific experiment is that it can be repeated by other scientists working independently.

A typical hypothesis makes a clear link between an independent or manipulated variable and a dependent variable. Variables are conditions or factors (such as light, temperature, or time) that can vary or may be varied. In an experiment, the independent or manipulated variable is the one that is systematically changed; the dependent variable is the effect or outcome that is measured. For example, when investigating the activity of an enzyme at different temperatures, temperature is the independent variable that is manipulated by the scientist; rate of reaction is the dependent variable that is measured at each temperature. Other variables called controlled variables are kept constant or controlled at set levels.

At the end of an experiment, the results must be interpreted as objectively as possible. Sometimes they are so clear that it is obvious whether they support or contradict the hypothesis. Often, however, results are variable and need statistical analysis before conclusions can be made. The conclusions may lead to the hypothesis being accepted, modified, or rejected. Even if results support hypothesis, it is accepted only tentatively because it can never be proved completely. However, it only needs a single contrary observation to refute a hypothesis (prove it wrong or incomplete). A hypothesis is therefore only the best available explanation at any time. This makes biology a highly dynamic subject and not merely a collection of facts.

**A typical sequence of events in a scientific investigation:**

- *Observations*
- *Questions*
- *Hypothesis (accept, modify, reject)*
- *Predictions*
- *Experiments*
- *Test experiments*
- *Control experiments*
- *Results*
- *Interpretation*
- *Conclusion (accept, modify, reject)*

**■ Glossary of essential terms for you to know**

| № | English term | Russian equivalent |
|---|---|---|
| 1. | enormous | огромный |
| 2. | branch | ветка; отрасль; филиал |
| 3. | to be involved (in sth) | участвовать (в ч.-л.) |
| 4. | involvement | участие |
| 5. | inheritance | наследование |
| 6. | individual (n) | особь |
| 7. | the same | тот же самый |
| 8. | species | вид |
| 9. | to be employed | работать |
| 10. | conservation | заповедник |
| 11. | horticulture | садоводство |
| 12. | in addition | кроме того |
| 13. | to state | заявлять, утверждать |
| 14. | to distinguish | отличать |
| 15. | way | способ, образ |
| 16. | rigid | жесткий, негибкий |
| 17. | nevertheless | тем не менее |
| 18. | to pose a problem | поставить задачу |
| 19. | to predict | предсказывать |
| 20. | to contradict | противоречить |
| 21. | to draw a conclusion | делать вывод |
| 22. | to modify | видоизменять |
| 23. | to reject | отвергать, отбрасывать |
| 24. | to observe | наблюдать |
| 25. | to obtain (syn. to get, to receive) | получать |
| 26. | to happen | случаться, происходить |
| 27. | valid | веский, обоснованный |
| 28. | essential | существенный, необходимый |
| 29. | to manipulate | переменная |
| 30. | effect (n) | результат |
| 31. | outcome | следствие |
| 32. | to measure | измерять |
| 33. | rate | скорость, ход, темп |
| 34. | at set levels | при заданных уровнях |
| 35. | obvious | очевидный |

| | | |
|---|---|---|
| 36. | tentatively | экспериментально |
| 37. | to refute | опровергать |
| 38. | merely | только, просто |

## ■ Your Essential Assignments

### I. Quick check

1 What is the difference between a physiologist and a pathologist?
2 Which is the highest level of biological organization on Earth?
3 In an experiment in which the rate of photosynthesis of a plant is measured at different light intensities, which is the independent (manipulated) variable and which is the dependent variable?
4 How can biologists help animals in the wild?
5 What is astrobiology?

### II. Find synonyms among the pool of words:

| Pool of words | Synonyms |
|---|---|
| **1)** 1.enormous/2.valid/3.reject/4.great/5.refute/6.important | |
| **2)** 1.reveal/2.open /3.differ/4. take place/5.vary/6.happen | |
| **3)** 1.work /2.be involved /3.take part /4.be employed | |
| **4)** 1.carry out /2.experimentally /3.fulfill /4.tentatively | |
| **5)** 1.change /2.investidation /3.modify /4.research | |

### III. Fill in the missing words:

| № | Term (verb) | Noun |
|---|---|---|
| 1. | employ | …… |
| 2. | inherit | …… |
| 3. | modify | …… |
| 4. | observe | …… |
| 5. | measure | …… |
| 6. | predict | …… |
| 7. | understand | …… |
| 8. | discover | …… |
| 9. | know | …… |
| 10. | contradict | …… |

### IV. Use monolingual English dictionary and write down what could the words given below mean:

inheritance, interpretation, species, hypothesis, to refute.

**V. Match the words with their definitions:**

| № | Word | | Definition |
|---|---|---|---|
| **1.** | individual | **A.** | very strict and difficult to change |
| **2.** | horticulture | **B.** | the protection of natural environment |
| **3.** | rigid | **C.** | the natural world in which people, animals and plants live |
| **4.** | predict | **D.** | to say that sth a person has said or written is wrong or untruthful |
| **5.** | conservation | **E.** | a single person or thing, considered separately from the class or group to which he, she, or it belongs |
| **6.** | contradict | **F.** | to say that sth will happen in the future |
| **7.** | variable | **G.** | the art, practice or science of growing fruit, flowers and vegetables |
| **8.** | environment | **H.** | a thing or quantity that can change and be changed |

**VI. Find English equivalents to the following word combinations from the text:**

| N | Russian term | English equivalent |
|---|---|---|
| 1. | Особи одного вида, живущие в одном месте. | |
| 2. | Кроме того, многие биологи работают учителями, преподавателями вузов или исследователями. | |
| 3. | Существует много способов научного изучения жизни. | |
| 4. | Что произошло бы, если бы эта гипотеза оказалась верной? | |
| 5. | Ученые могут повторить эксперимент, используя наблюдения, полученные другими биологами. | |
| 6. | С другой стороны. | |
| 7. | Результат необходимо интерпретировать как можно объективнее. | |
| 8. | Очевидно. | |
| 9. | Гипотеза принимается только экспериментально. | |
| 10. | Поддержать гипотезу или опровергнуть ее. | |

## VII. Find Russian equivalents for the following word combinations

| № | English term | Russian equivalent |
|---|---|---|
| **1.** | Such observations may be obtained directly or indirectly. | |
| **2.** | To carry out a controlled experiment aimed at producing data. | |
| **3.** | Culturing cells outside organisms. | |
| **4.** | To refute a hypothesis. | |
| **5.** | Dysfunctional organs. | |
| **6.** | In addition. | |
| **7.** | An essential aspect of a scientific experiment. | |
| **8.** | Factors that can vary or may be varied. | |
| **9.** | To draw conclusions that accept or reject the hypothesis. | |

## VIII. Read and translate the short text without any dictionary.

**Fact of life:**

No matter how dramatic it is, any discovery must be shared before it can make a contribution to our scientific knowledge. Biologists communicate with each other mainly by means of concise reports called papers.

Typically, a paper contains the aims of investigation, a description of the method used, the results obtained, and a discussion of the significance of the results. The method is described in enough detail to allow someone else to repeat the investigation. Well over one million original papers are published in the biological sciences each year, in subjects ranging from the behavioural interactions of different animal populations to the analysis of chemical reactions taking place in cells.

## IX. Food for thought.

The life sciences have made an enormous contribution to human welfare, especially through their applied branches of medicine, agriculture, and biotechnology. However, an important part of understanding biology and the other sciences is realising their limitations. Science does not, for example, deal with hypotheses that are not testable. Suggest questions that might not be possible to answer using a scientific method.

## X. Traslate into English using all the active possible

1. В наши дни насчитывается такое множество биологических дисциплин, что один человек не может изучить их все.
2. Студенты должны изучить основы четырех главных разделов биологии: зоологии, ботаники, молекулярной биологии и генетики.
3. Генетика изучает законы наследственности и то, как живые существа приспосабливаются к окружающим условиям.
4. Выпускникам биологических факультетов предоставляется множество возможностей для карьерного роста.
5. Медицине нужны талантливые ученые, которые могли бы вести исследования в областях генной терапии, вирусных инфекций и пр.
6. Человечество переживает период климатических изменений, и задача ученых – предсказать возможные последствия этих процессов.
7. Экология изучает окружающую среду и то, каким образом растения, животные и люди существуют вместе и влияют друг на друга.

## XI. Prepare a short presentation to answer the question:

**'What is biology?' Use the information in both texts.**

**Talk about:**

- what the study of biology includes
- the four main areas of biology
- where biologists work
- what biology informs us about

**First complete these notes. Use them in your presentation.**

Biology: The study of …… .
There are four main areas:
…… is about …….. .
…… is about …….. .
Molecular biology is about ……. .
…….....is about inheritance.
Biologists work in……..,
……and …… .
In conclusion, biology is about …… .

**Remember to:**

- read the texts again
- select information that is relevant
- add examples where you can

**Speaking tips**

- Speak from notes.
- Don't write out everything you plan to say, use key words.
- Introduce each new idea clearly.

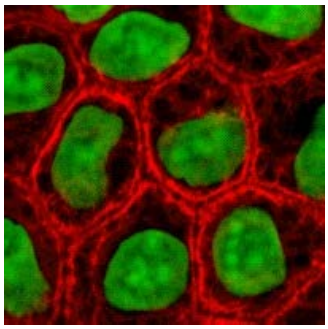
**XII. Write a letter to your tutor telling him or her which areas of Biology you would like to specialize in and why. Use these notes to help you.**

Dear Mr / Mrs (**tutor's surname**),
Writing to tell you choices I have made
Specialize in (**one or two of the main areas**)
Reasons for choosing: interested in (**plants / animals / latest ideas** / **laboratory work / your own ideas**)
Possible career choices: what I hope to do when I graduate
(**medicine / ecology / agriculture / your own idea**)
Offer to meet and discuss choices: I would like your advice and hope we can …….
Yours sincerely,
(**your full name: first name + surname**)
**Write 100 – 140 words**.

**XIII. Prepare a short presentation to answer the question: 'What is the scientific method?'**
**Talk about:**

- What is the essential aspect of a scientific experiment?
- What is constantly changed in an experiment?
- What is to be done at the end of an experiment?

# Unit II. CELL
## Text 2.1 Cell Theory



■ **Essential targets**

By the end of this text you should be able to:
- describe the main ideas of the cell theory
- compare the structures of animal and plant cells as seen with a light microscope.

*Pre-reading*

**■ With a partner consider the following questions and try to answer them. Then quickly scan the text to check your answers.**

1. What is a cell?
2. Who discovered cells?
3. Do plant cells differ from animal cells?

■ **Read the given text and make your essential assignments:**

Cells were discovered in 1665 by the English scientist and inventor Robert Hooke. Hooke designed his own compound light microscope to observe structures too small to be seen with the naked eye. Among the first structures he examined was a thin piece of cork (the outer surface of bark from a tree). Hooke described the cork as being made of hundreds of little boxes, giving it the appearance of a honeycomb. He called these little boxes cells. It soon became clear that virtually all living things are made of cells, and that these cells have certain features in common.

**The cell theory**

The concept that cells are the basic units of life became embodied in a theory called the cell theory, which embraces the following main ideas:

- cells form the building blocks of living organisms
- cells arise only by the division of existing cells
- cells contain inherited information which controls their activities
- the cell is the functioning unit of life; metabolism (the chemical reactions of life) takes place in cells
- given suitable conditions, cells are capable of independent existence.

**A typical animal cell**

The structure of a typical animal cell:

- the cell has a cell surface membrane which encloses the cell contents
- the contents consist of a central ball-shaped nucleus surrounded by material called cytoplasm
- the nucleus contains a fibrous material called chromatin
- this condenses to form chromosomes during cell division
- chromatin contains DNA, the material which controls the various activities inside the cell
- scattered within the cytoplasm are mitochondria, small rod-like structures. They have been described as the “power-houses” of the cell because they supply energy.
- smaller dots within the cytoplasm are particles of stored food. Many consist of glycogen, which is a food storage polysaccharide.

**A typical plant cell**

Like an animal cell, a typical plant cell has a cell surface membrane, cytoplasm, and a nucleus. However, plant cells differ from animal cells in several ways:

- most plant cells have a large sap-filled cavity called the vacuole. Sap is a watery fluid containing salts and sugars. The vacuole surrounded by a membrane called the tonoplast.
- the cytoplasm contains starch grains, the food storage products of plants
- many plant cells have chloroplasts in the cytoplasm. These contain the pigments used in photosynthesis. Chlorophyll, which is green, is the main pigment. Chloroplasts occur only in the parts of plants exposed to light – the green parts. They are absent from underground structures such as roots.

## ■ Glossary of essential terms for you to know

| № | English term | Russian equivalent |
|---|---|---|
| 1 | cork | пробка |
| 2 | honeycomb | соты пчелиные |
| 3 | cell | клетка |
| 4 | to embody | воплощать, олицетворять |
| 5 | to enclose | окружать |
| 6 | contents | содержимое |
| 7 | surface | поверхность |
| 8 | membrane | мембрана |
| 9 | nucleus | ядро |
| 10 | to surround | окружать |
| 11 | cytoplasm | цитоплазма |
| 12 | fibrous | волокнистый, фиброзный |
| 13 | division | деление |

| | | |
|---|---|---|
| 14 | to scatter | разбрасывать, рассыпать |
| 15 | to supply | обеспечивать, снабжать |
| 16 | storage | хранение |
| 17 | sap | сок растения |
| 18 | cavity | полость |
| 19 | starch | крахмал |
| 20 | root | корень |
| 21 | compound | сложный |
| 22 | to observe | наблюдать |
| 23 | to examine | исследовать |
| 24 | feature | черта |
| 25 | suitable | подходящий |
| 26 | existence | существование |
| 27 | fluid | жидкость |
| 28 | grain | зерно |

## ■ Your Essential Assignments

### I. Quick check

1. Briefly state the main concept of the cell theory.
2. List the features:
   a) that only animal cells have
   b) that only plant cells have
   c) that both animal and plant cells have.

### II. Fill in the missing words:

| Term (verb) | Noun | Adjective |
|---|---|---|
| exist | ..... | ..... |
| store | ..... | ..... |
| form | ..... | ..... |
| divide | ..... | ..... |
| act | ..... | ..... |
| suit | ..... | ..... |
| differ | ….. | …… |

### III. Use monolingual English dictionary and write down what could the words given below mean:

surface, honeycomb, cavity, plant, sap.

## IV. Match these words with their definitions:

| | | | |
|---|---|---|---|
| **1.** | cell | **A.** | a scientific instrument that makes extremely small things look larger |
| **2.** | to observe | **B.** | the amount of a substance that is contained in something |
| **3.** | microscope | **C.** | the contents consist of a central ball-shaped nucleus surrounded by material |
| **4.** | metabolism | **D.** | parts of plants that can you eat but cannot digest, which help food to move quickly through your body |
| **5.** | independent | **E.** | the central part of an atom, made up of neutrons, protons, and other elementary particles |
| **6.** | contents | **F.** | to watch something or someone carefully |
| **7.** | nucleus | **G.** | in something |
| **8.** | cytoplasm | **H.** | the act of keeping or putting something in a special place while is not being used |
| **9.** | fibre | **I.** | the chemical reactions of life |
| **10.** | inside | **J.** | existing separately and not connecting with or influenced by any others |
| **11.** | storage | **K.** | the green-coloured substance in plants |
| **12.** | chlorophyll | **L.** | the smallest part of a living thing that can exist independently |

## V. Find English equivalents to the following word combinations:

| № | Russian term | English equivalent |
|---|---|---|
| 1. | ученый и изобретатель | |
| 2. | слишком маленький, чтобы увидеть невооруженным глазом | |
| 3. | сделаны из клеток | |
| 4. | живые организмы | |
| 5. | деление существующих клеток | |
| 6. | наследственная информация | |
| 7. | подходящие условия | |
| 8. | окружает содержимое клетки | |
| 9. | во время деления клетки | |
| 10 | снабжать энергией | |
| 11 | отличаться от ч.-л. | |
| 12 | содержать соли и сахара | |
| 13 | быть окруженным мембраной | |
| 14 | пигменты, используемые в фотосинтезе | |

## VI. Give Russian equivalents to the following English terms:

| № | English term | Russian equivalent |
|---|---|---|
| 1 | a compound light microscope | |
| 2 | to serve structures | |
| 3 | to have certain features in common | |
| 4 | the basic units of life | |
| 5 | the cell theory | |
| 6 | the functioning unit of life | |
| 7 | it takes place in cells | |
| 8 | independent existence | |
| 9 | a typical animal cell | |
| 10 | a cell surface membrane | |
| 11 | a ball-shaped nucleus | |
| 12 | a fibrous material | |
| 13 | inside the cell | |
| 14 | small rod-like structures | |
| 15 | a food storage | |
| 16 | a sap-filled cavity | |
| 17 | starch grains | |
| 18 | exposed to light | |

## VII. Find synonyms among the pool of words:

| Pool of words | Synonyms |
|---|---|
| **1)** 1.occur /2.scatter /3. take place /4. spread | |
| **2)** 1.cavity /2.sap /3.juice /4.contents /5.hole /6.ingredients | |
| **3)** 1.nucleus/2.division/3.core/4.naked/5.separation/6. bare | |
| **4)** 1.unit /2.part /3.fluid /4.grain /5.solution /6.corn | |

## VIII. Answer the following questions. Use all information given before:

1. When were cells discovered?
2. How did Robert Hooke discover cells?
3. What is called the cell theory?
4. What are the main ideas of the cell theory?
5. What is the structure of a typical animal cell?
6. How do plant cells differ from animal cells?

## IX. Match the sentence halves. Make complete sentences:

| | | | |
|---|---|---|---|
| **1.** | Hooke designed his own compound light microscope | **A.** | a membrane is called the tonoplast. |
| **2.** | The concept that cells are the basic units of life | **B.** | of living organisms. |
| **3.** | Cells form the building blocks | **C.** | which controls their activities. |
| **4.** | Cells arise only by | **D.** | to observe structures too small to be seen with the naked eye. |
| **5.** | Cells contain inherited information | **E.** | called chromatin. |
| **6.** | The contents consist of a central ball-shaped nucleus | **F**. | the division of existing cells. |
| **7.** | The nucleus contains a fibrous material | **G**. | called the vacuole. |
| **8.** | Chromatin contains DNA, the material which controls | **H.** | became embodied in a theory called the cell theory. |
| **9.** | Most plant cells have a large sap-filled cavity | **I.** | surrounded by material called cytoplasm. |
| **10.** | The vacuole surrounded by | **J.** | in the cytoplasm. |
| **11.** | Many plant cells have chloroplasts | **K.** | the various activities inside the cell. |
| **12.** | Chloroplasts occur only in the parts of plants | **L.** | exposed to light – the green parts. |

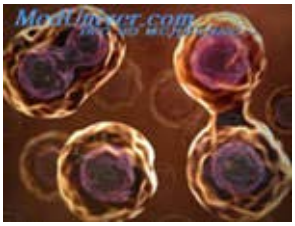
## X. Read and translate the short text without any dictionary:

**Fact of life:**

Robert Hooke described his observations of the cork cells: “I counted several lines of these pores, and found that there were usually about three-score of these small Cells placed end-ways in the eighteenth part of an inch in length, whence I concluded that there must be near eleven hundred of them, or somewhat more than a thousand in length of an inch and therefore in a square inch above a Million, or 1 166 400, and in a Cubick Inch, above twelve hundred million, or 1 259 712 000, a thing almost incredible, did not our Microscope assure us of it by ocular demonstration.

**XI. Food for thought:** Suggest why red blood cells appear to contradict the cell theory.

# Text 2.2. Introduction To Cell Division



■ **Essential targets:**

By the end of this text you should be able to:

- describe the main stages of the cell cycle
- distinguish between mitosis and meiosis.

*Pre-reading*

■ **Working in pairs discuss these questions with your partner. Then scan the text to find the answers and compare them with your discussion.**

1. Is cell division essential to life?
2. What is the basis of reproduction in every organism?
3. What provides continuity between one generation of cells and the next?
4. How many chromosomes does each human cell have?

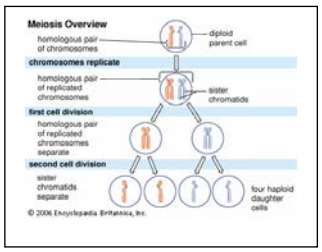
■ **Read the given text and make your essential assignments:**

One of the most important concepts in biology is that cells arise only by the division of existing cells. Cell division is essential to all life. It enables a multicellular organism to grow and to replace worn out or damaged cells. It is also the basis of reproduction in every organism. Cell division starts with the division of the nucleus. There are two forms of nuclear division: mitosis and meiosis.

**Chromosomes: carrying information**

Chromosomes are the structures that provide continuity between one generation of cells and the next. Their name comes from the Greek: *chroma* = coloured, *soma* = body, because of their affinity for certain stains used in microscopy. Chromosomes consist of DNA, the genetic material of the cell, wrapped in protein. They become visible in the nucleus where the more dispersed chromatin existed before. Whole chromosomes can be examined microscopically after breaking a dividing cell open and staining it with a suitable dye.

## Chromosomes form homologous pairs




If the chromosomes are cut out they can be arranged into matching pairs according to their size and certain other features. These are called homologous pairs. Apart from the sex chromosomes, both chromosomes in a pair normally contain the same genes (for example, for eye or hair colour). However, these may be different forms of the gene (for example, one chromosome carries the form for green eyes, the other for brown eyes).

Human cells each have 46 chromosomes (23 pairs). Other species have different numbers, for example, chimpanzee cells each have 48 (24 pairs) and cabbage plant cells each have 18 (9pairs).

One chromosome in each pair comes from the individual's mother and the other from the father.

- Cells that have the normal two sets of chromosomes are called diploid.

- Cells that give rise to gametes (eggs and sperm) have only one chromosome of each pair, so they have half the normal number of chromosomes. Such cells are called haploid.

- In humans, n =23, so normal diploid cells have 46 chromosomes and the haploid gametes have 23 chromosomes.

**Mitosis: two identical daughter cells**

In mitosis, the nucleus divides once and produces two identical nuclei. The new daughter cells are genetically identical to the parental cell (unless their DNA has been changed in some way, for example by a mutation). So mitosis doubles the number of cells without changing the genetic information. New cells for growth of a multicellular organism, asexual reproduction, and wound healing, for example, are produced by mitosis.

**The cell cycle**

The cell cycle is the sequence of events that occurs between one cell division and the next. It consists of three main stages:

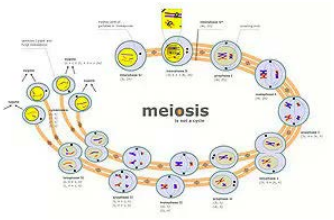
1. During interphase, the cell grows, carries out its functions, and replicates its DNA. After the DNA is replicated, new protein becomes attached to it. The chromosome now consists of two strands called sister chromatids which contain identical genetic information. Sister chromatids are joined at some point along their length by a centromere. These become visible under the light microscope only during mitosis. Typically, interphase lasts for about 90 per cent of the cell cycle.

2. Nuclear division takes place during mitosis. The chromatids containing replicated DNA are separated from each other and are redistributed as chromosomes in the nuclei of the two new daughter cells.

3. In cell division (also called cytokinesis) the cytoplasm divides to form two daughter cells.

The duration of the cell cycle varies according to conditions such as temperature and the type of cell. The cell cycle of some plant cells (for example, stamen cells of *Tradescantia)* takes less than 30 minutes at 45°C, but more than two hours at 10°C. Cells in the growing root tip of an onion divide every 22 hours at 20°C. Some cells such as human nerve cells do not divide at all once they have become specialized.

**Meiosis: four different daughter cells**




In meiosis, the nucleus divides twice. This produces four haploid nuclei. The number of chromosomes is therefore halved during meiosis. Moreover, homologous chromosomes within a pair can exchange genetic material before being separated. The daughter cells are therefore genetically different from the parent cell (and from each other).

Meiosis is the basis of sexual reproduction, occurring at some point in the life cycle of organisms that reproduce sexually. The haploid gametes produced by meiosis fuse during fertilization. This means that the new fertilized cell has the diploid number of chromosomes. Without meiosis in the life cycle, the number of chromosomes of a sexually reproducing species would be doubled in each generation.

**■ Glossary of essential terms for you to know**

| № | English term | Russian equivalent |
|---|---|---|
| 1 | essential | необходимый |
| 2 | reproduction | воспроизведение, размножение |
| 3 | generation | поколение |
| 4 | affinity | сходство, родство |
| 5 | dye | краска |
| 6 | to cut out | вытеснять, отбрасывать |
| 7 | mutation | мутация |
| 8 | to double | удваивать |
| 9 | asexual | бесполый |
| 10 | multicellular | многоклеточный |
| 11 | to carry out | выполнять |
| 12 | to replicate | дублировать |

| | | |
|---|---|---|
| 13 | division | деление |
| 14 | to attach | прикреплять |
| 15 | strand | нить |
| 16 | according to | согласно |
| 17 | to fuse | сплавляться, сливаться |
| 18 | fertilization | оплодотворение, удобрение |
| 19 | to damage | повреждать |
| 20 | nucleus | ядро |
| 21 | mitosis | митоз, непрямое деление ядра |
| 22 | meiosis | мейоз, редукционное деление |
| 23 | to provide | обеспечивать |
| 24 | continuity | непрерывность, неразрывность |
| 25 | stain | краситель, пятно |
| 26 | to wrap | обертывать |
| 27 | apart from | кроме, помимо |
| 28 | gene | ген |
| 29 | species | вид |
| 30 | gamete | половая клетка |
| 31 | give rise to | давать начало |
| 32 | sequence | последовательность |
| 33 | to occur | происходить |
| 34 | duration | длительность |
| 35 | to vary | различаться |

## ■ Your Essential Assignments

### I. Quick check:

**1.** a) List the main stages of mitosis, starting with interphase.

b) At which stage is DNA replicated?

**2.** Compare mitosis and meiosis in terms of number of cell divisions and number of daughter cells.

### II. Fill in the missing words:

| Term (verb) | Noun | Adjective |
|---|---|---|
| replace | ..... | ..... |
| continue | ..... | ..... |
| condition | ..... | ..... |
| fuse | ..... | ..... |
| mutate | ..... | ..... |
| double | ….. | …… |

**III. Use monolingual English dictionary and write down what could the words given below mean:**

affinity, give rise to, division, asexual, generation.

**IV. Match these words with their definitions:**

| | | | |
|---|---|---|---|
| **1.** | cell | **A.** | not having sexual organs or having sex |
| **2.** | multicellular | **B.** | to make sperm join an egg so that a young baby or animal develops |
| **3.** | reproduction | **C.** | a change in the genetic structure of an animal or plant, that makes it different from others of the same type |
| **4.** | gamete | **D.** | the sequence of events that occurs between one cell division and the next cycle |
| **5.** | fertilization | **E.** | the central part of an atom, made up of neutrons, protons, and other elementary particles |
| **6.** | chromosome | **F.** | a group of animals or plants which are all similar and can breed together to produce young animals or plants of the same kind as them |
| **7.** | nucleus | **G.** | to become twice |
| **8.** | asexual | **H.** | the act or process of producing young animals or plants |
| **9.** | mutation | **I.** | a part of every living cell that is shaped like a thread which controls the character, shape etc. that a plant or animal has |
| **10.** | species | **J.** | a type of cell which joins with another cell, starting the development of a baby or other young creature |
| **11.** | to double | **K.** | more than one cell |
| **12.** | cell cycle | **L.** | the smallest part of a living thing that can exist independently |

**V. Find English equivalents to the following word combinations:**

| № | Russian term | English equivalent |
|---|---|---|
| 1. | деление клеток | |
| 2. | многоклеточный организм | |
| 3. | поврежденные клетки | |
| 4. | основа размножения | |
| 5. | генетический материал | |
| 6. | согласно их размеру | |
| 7. | дочерняя клетка | |
| 8. | родительская клетка | |
| 9. | бесполое размножение | |

| | | |
|---|---|---|
| 10. | выполняет свои функции | |
| 11. | становится видимым | |
| 12. | длительность клеточного цикла | |
| 13. | во время оплодотворения | |
| 14. | жизненный цикл организмов | |

## VI. Give Russian equivalents to the following English terms:

| № | English term | Russian equivalent |
|---|---|---|
| 1 | to consist of DNA | |
| 2 | wrapped in protein | |
| 3 | matching pairs | |
| 4 | two sets of chromosomes | |
| 5 | identical nuclei | |
| 6 | to be identical to sth. | |
| 7 | without changing the genetic information | |
| 8 | for growth of a multicellular organism | |
| 9 | nuclear division | |
| 10 | human nerve cells | |
| 11 | sexual reproduction | |
| 12 | fertilized cell | |
| 13 | the light microscope | |
| 14 | to contain the same genes | |
| 15 | can exchange genetic material | |
| 16 | genetically different from | |

## VII. Find synonyms among the pool of words:

| Pool of words | Synonyms |
|---|---|
| **1)** 1.concept /2.damaged /3. injured /4. idea | |
| **2)** 1.arise /2.appear /3.vary /4. occur /5.change | |
| **3)** 1.sex /2.mutation /3.gender /4.change /5.alteration | |
| **4)** 1.essential/2.reproduce/3.important/4.breed/5.necessary | |

## VIII. Answer the following questions. Use all information given before.

1. What enables a multicellular organism to grow and replace worn out or damaged cells?
2. What does cell division start with?
3. What two forms of nuclear division do you know?
4. What are chromosomes?
5. What do chromosomes consist of?
6. What is known as homologous pairs?
7. What is the difference between diploid and haploid?

8. What are three main stages of the cell cycle?
9. How does the duration of the cell cycle vary?

## IX. Match the sentence halves. Make complete sentences:

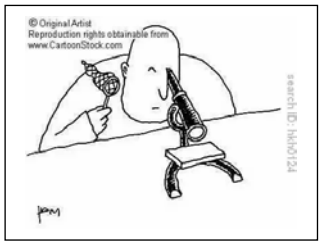
| | | | |
|---|---|---|---|
| **1.** | Cell division starts | **A.** | the individual's mother and the other from the father. |
| **2.** | Chromosomes are the structures that provide | **B.** | and produces two identical nuclei. |
| **3.** | Chromosomes consist of | **C.** | occurring at some point in the life cycle of organisms that reproduce sexually. |
| **4.** | One chromosome in each pair comes from | **D.** | DNA, the genetic material of the cell, wrapped in protein. |
| **5.** | In mitosis, the nucleus divides once | **E.** | according to conditions such as temperature and the type of cell. |
| **6.** | The cell cycle is the sequence of events | **F.** | with the division of the nucleus. |
| **7.** | The duration of the cell cycle varies | **G.** | that occurs between one cell division and the next. |
| **8.** | Meiosis is the basis of sexual reproduction, | **H.** | would be doubled in each generation. |
| **9.** | Without meiosis in the life cycle, the number of chromosomes of a sexually reproducing species | **I.** | continuity between one generation of cells and the next. |

## X. Read and translate the short text without any dictionary:

**Fact of life:** Some laboratory-grown mammalian cells appear to obey an internal "biological clock" that allows them to divide by mitosis a maximum number of times. For example, a fibroblast (connective tissue cell) taken from a fetus divides on average about 50 times; the same type of cell taken from an adult divides only 14 to 19 times.

**XI. Food for thought:**Although meiosis occurs at some stage in the life cycle of sexually reproducing plants, their gametes are usually formed by mitosis. Suggest reasons for this.

# Text 2.3. Microscopes




■ **Essential targets:**

By the end of this text you should be able to:

- describe the main features of a light microscope and an electron microscope
- distinguish between the terms magnification and resolving power
- give the approximate size of different biological structures using an appropriate unit of measurement.

*Pre-reading*

■ **Discuss these questions with your partner.**
**Then find the answers in the text.**

1. Who invented a microscope?
2. What types of microscopes are used today?

■ **Read the given text and make your essential assignments:**

A microscope is used to produce a magnified image of an object or specimen. Anton van Leeuwenhoek (1632-1723) was the first to invent a microscope powerful enough to explore the world of microbes. His discoveries stimulated an explosion of interest in the scientific use of microscopes. Since the 18th century many new types have been invented, of which the most commonly used today are the compound light microscope and the electron microscope.


**The compound light microscope**

The compound light microscope is also called a light microscope or optical microscope. The compound light microscope is also called a light microscope or optical microscope. The lenses refract (bend) the light to give a magnified image of the object. The image may be projected directly into the viewer's eye or into photographic film. A photograph taken through a light microscope is called a photomicrograph or light micrograph.

**Magnification and resolution**

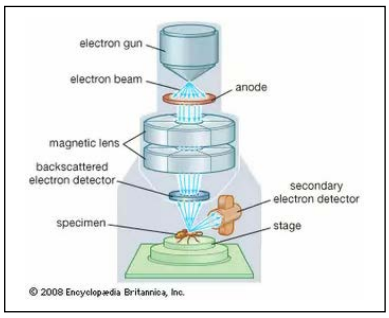
The magnification of an instrument is the increase in the apparent size of the object. The total magnification of a compound microscope is worked out by multiplying the magnification of the objective lens by that of the ocular lens.

There is virtually no limit to the magnification produced by a light microscope; it depends on the power of the lenses used. However, above a certain magnification the image becomes blurred and it is impossible to distinguish structures lying close together. This limit of effective magnification is called the resolving power or resolution of the microscope. It is defined as the ability of a microscope to show two objects as separate. The resolving power of the light microscope is limited by the wavelength of light. Light microscopes can magnify objects up to about 1500 times without losing clarity.

**The electron microscope**

Electron microscopes use a beam of electrons instead of a beam of light. Electron beams have a much smaller wavelength than light rays, so electron microscopes have greater resolving powers and can produce much higher effective magnifications than light microscopes. There are two main types of electron microscopes: the transmission electron microscope (TEM), and the scanning electron microscope (SEM).

**The transmission electron microscope**



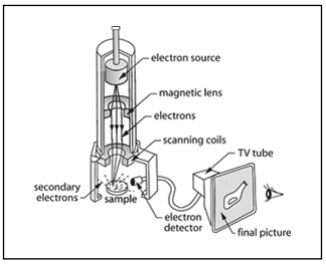

The TEM is used to study the details of the internal structure of cells. Extremely thin samples of the specimen are needed. To make these the specimen is supported in a resin block to prevent in collapsing during cutting, and is sliced with a diamond or glass knife. The section is then impregnated with a heavy-metal stain, such as osmium tetroxide.

As the beam passes through the specimen, electrons are absorbed by heavily stained parts but pass readily through the lightly stained parts. Electromagnets bend the electron beam to focus an image onto a fluorescent screen or photographic film. Photograph taken through an electron microscope is called an electron micrograph.

The most modern TEMs distinguish objects as small as 0.2nm. This means that they can produce clear images magnified up to 250 000 times. The magnification is varied by changing the strength of the electromagnets.

**The scanning electron microscope**

The SEM is used to produce three-dimensional images of the surface of specimens. Electron are reflected from the surface of a specimen stained with a




heavy metal. This enables the SEM to produce images of whole specimens: cells, tissues, or even organisms.

Although electron microscopes have revolutionized cell biology, they have not completely replaced light microscopes. Light microscopes are used to examine living and unstained specimens. Preparation of specimens for electron microscopy is complicated and time-consuming. Electron microscopes are very expensive and can be used only to study dead specimens stained with heavy metal, which might well produce artifacts.

**■ Glossary of essential terms for you to know.**

| № | English term | Russian equivalent |
|---|---|---|
| 1 | magnified | увеличенный |
| 2 | specimen | образец, особь |
| 3 | to explore | исследовать |
| 4 | to invent | изобретать |
| 5 | lens | линза |
| 6 | to refract | преломлять |
| 7 | magnification | увеличение |
| 8 | apparent | видимый |
| 9 | compound | составной, сложный |
| 10 | blurred | смазанный |
| 11 | to distinguish | различать |
| 12 | resolution | разрешение |
| 13 | wavelength | длина волны |
| 14 | clarity | ясность, четкость |
| 15 | beam | луч, пучок лучей |
| 16 | ray | луч |
| 17 | internal | внутренний |
| 18 | sample | образец |
| 19 | to impregnate | оплодотворять, пропитывать, насыщать |
| 20 | stain | пропитка |
| 21 | readily | легко |
| 22 | to reflect | отражать |
| 23 | to enable | позволять |
| 24 | tissues | ткани |
| 25 | to replace | заменять |

**■ Your Essential Assignments**

**I. Quick check**

1. How is the magnification varied in:

a) a light microscope
b) an electron microscope?

2. Why is the resolving power of an electron microscope so much better than of a light microscope?

3. What is the approximate size of the smallest structure that can be observed with a light microscope?

**II. Fill in the missing words:**

| Term (verb) | Noun | Adjective |
|---|---|---|
| magnify | ..... | ..... |
| multiply | ..... | ..... |
| reflect | ..... | ..... |
| absorb | ..... | ..... |
| prevent | ..... | ..... |

**III. Use monolingual English dictionary and write down what could the words given below mean:**

microscope, to refract, magnification, sample, ray.

**IV. Match these words with their definitions:**

| | | | |
|---|---|---|---|
| **1.** | beam | **A.** | a piece of curved glass which makes things look bigger or smaller |
| **2.** | to invent | **B.** | the power of a microscope to give a clear picture of things, or a measure of this |
| **3.** | eyepiece | **C.** | to change the position of the lens on a microscope so that you can see something clearly |
| **4.** | lens | **D.** | to make a substance spread completely through something |
| **5.** | resolution | **E.** | a shining line of light from the sun, a lamp |
| **6.** | to focus | **F.** | a picture of a subject in a mirror or in the lens of a camera |
| **7.** | specimen | **G.** | easily noticed |
| **8.** | to impregnate | **H.** | to make, design, or produce something new for the first time |
| **9.** | image | **I.** | made up of two or more parts or substances |
| **10.** | apparent | **J.** | a small amount or piece of something that is taken from a plant or animal, so that can be tested or examined |
| **11.** | compound | **K.** | the glass piece that you look through in a microscope |

## V. Find English equivalents to the following word combinations:

| № | Russian term | English equivalent |
|---|---|---|
| 1. | научное использование микроскопов | |
| 2. | электронный микроскоп | |
| 3. | стеклянные линзы | |
| 4. | окуляр | |
| 5. | видимый размер объекта | |
| 6. | зависеть от ч.-л. | |
| 7. | длина волны света | |
| 8. | без потери четкости | |
| 9. | сканирующий электронный микроскоп | |
| 10. | внутренняя структура клетки | |
| 11. | легко проходить через ч.-л. | |
| 12. | трехмерное изображение | |
| 13. | поверхность образца | |

## VI. Give Russian equivalents to the following English terms:

| № | English term | Russian equivalent |
|---|---|---|
| 1 | a magnified image of sth. | |
| 2 | a compound light microscope | |
| 3 | to pass through | |
| 4 | to refract (bend) the light | |
| 5 | structures lying close together | |
| 6 | the resolving power | |
| 7 | to be limited by sth. | |
| 8 | a beam of light | |
| 9 | the transmission electron microscope | |
| 10 | to focus an image | |
| 11 | to produce clear images | |
| 12 | complicated and time-consuming | |
| 13 | dead specimens | |
| 14 | pass readily through the lightly stained parts | |
| 15 | to be impregnated with sth. | |

## VII. Find synonyms among the pool of words:

| Pool of words | Synonyms |
|---|---|
| **1)**1. multiply /2. sample /3.increase /4. specimen | |
| **2)**1. image / 2. visible / 3. apparent / 4. picture | |
| **3)**1.beam/2.refract/3.examine/4.bend/5.explore/6. ray | |
| **4)**1.organism/2.compound/3.living thing/4. complex | |

## VIII. Answer the following questions. Use all information given before:

1. What are microscopes used for?
2. What types of microscopes are most commonly used today?
3. What is a compound light microscope?
4. What does the magnification of an instrument depend on?
5. How do electron microscopes differ from compound light microscopes?
6. What are the main types of electron microscopes?
7. What is the difference between the transmission electron microscope and the scanning electron microscope?

## IX. Match the sentence halves. Make complete centences:

| | | | |
|---|---|---|---|
| **1.** | A microscope is used | **A.** | a light microscope or optical microscope. |
| **2.** | Since the 18th century many new types have been invented, of which the most commonly used today are | **B.** | they have not completely replaced light microscopes. |
| **3.** | The compound light microscope is also called | **C.** | in the apparent size of the object. |
| **4.** | The compound light microscope is also called | **D.** | the transmission electron microscope and the scanning electron microscope. |
| **5.** | The magnification of an instrument is the increase | **E.** | the compound light microscope and the electron microscope. |
| **6.** | Light microscopes can magnify objects up to | **F.** | a beam of light. |
| **7.** | Electron microscopes use a beam of electrons instead of | **G.** | to produce a magnified image of an object or specimen. |
| **8.** | There are two main types of electron microscopes: | **H.** | a light microscope or optical microscope. |
| **9.** | Although electron microscopes have revolutionized cell biology, | **I.** | about 1500 times without losing clarity. |

## X. Read and translate the short text without any dictionary:

**Fact of life:**

A new microscope, called a scanning tunneling microscope, was invented in 1980. It measures surface features by moving a sharp probe over the object's surface. It can achieve magnifications of 100 million, allowing scientists to view atoms on the surface of a solid. This type of microscope is likely to have a major impact on biology. Recently, it has been used to view DNA directly.

## XI. Food for thought:

Suggest which unit should be used when calculating the diameter of the DNA molecule. Why might there be a discrepancy between the actual diameter and that estimated from the scanning tunneling micrograph?

## ■ Have Some Fun! Biologist Jokes!

A young college student stayed up all night studying for his zoology test the next day. As he entered the classroom, he saw ten stands with ten birds on them with a sack over each bird and only legs showing. He sat right on the front row because he wanted to do the best job possible. The professor announced that the test would be to look at each set of bird legs and give the common name, habitat, genus, species, etc.

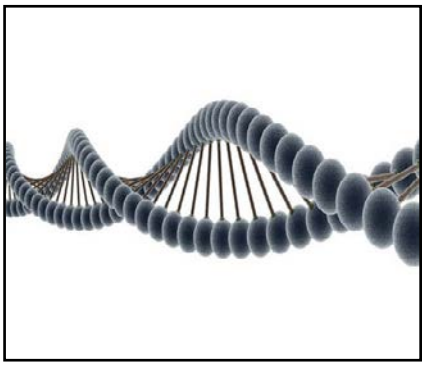
The student looked at each set of bird legs. They all looked the same to him. He began to get upset. He had stayed up all night studying, and now had to identify birds by their legs. The more he thought about it, the madder he got. Finally, he could stand it no longer. He went up to the professor`s desk and said: "What a stupid test! How could anyone tell the difference between birds by looking at their legs?" With that the student threw his test on the professor`s desk and walked out the door.

The professor was surprised. The class was so big that he didn`t know every student`s name, so as the student reached the door the professor called:

"Mister, what`s your name?" The enraged student pulled up his pant legs and said: "You guess, buddy! You guess!"

# UNIT III. MOLECULAR BIOLOGY OF THE GENE

## Text 3.1. DNA Structure



**■ Essential targets:**

By the end of this text you should be able to:

- distinguish between a nucleoside, a nucleotide, and a polynucleotide;
- explain how a phosphodiester bond forms;
- discuss the significance of complementary base pairing in DNA.

*Pre-reading*

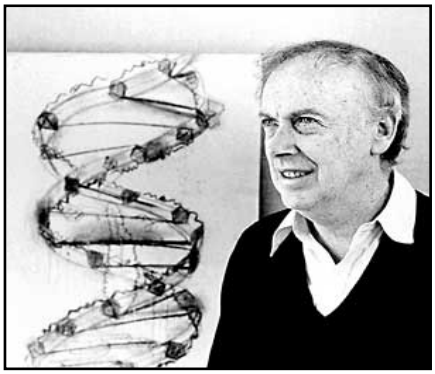
**■ Working in pairs, try and answer the following questions before you read the text. Don`t be afraid of guessing the answers! When you have finished, check your answers by reading the text.**

1. Who discovered the structure of DNA?
2. What do you know about a nucleoside and a nucleotide?
3. What shape does a molecule of DNA have?
4. What kind of information does a molecule of DNA contain?

**Exercise A. Match the words with their definitions:**

| | | | |
|---|---|---|---|
| **1** | to join | **A** | only one or considered to its own |
| **2** | base | **B** | serious study of a subject that is intended to discover new facts or test new ideas |
| **3** | ring | **C** | to connect or fasten things together |
| **4** | support | **D** | the most important part of something from which new ideas develop |
| **5** | bond | **E** | a circular line or mark |
| **6** | single | **F** | sympathetic encouragement and help that you give to someone |
| **7** | research | **G** | the chemical force that holds atoms together |
| **8** | to discover | **H** | a single thin piece of thread, wire, hair etc. |
| **9** | double | **I** | something that is twice the size, quantity, value, or strength of something else |
| **10** | strand | **J** | to find something that was hidden or that people did not know about before |

## ■ Read the given text and make your essential assignments:



The description of the double helical structure of DNA (deoxyribonucleic acid) by Watson and Crick in 1953 (see Fact of life) was a landmark in science history. Their discovery sparked off a new era in scientific research which has had, and will continue to have, far-reaching consequences.

**A polymer of nucleotides**

Each DNA strand is a polymer made up of nucleotide subunits. The nucleotides join together to form long unbranched polynucleotide chains.

Each nucleotide consists of deoxyribose (a five-carbon or pentose sugar), an organic nitrogen-containing base (of which there are four different types), and phosphoric acid.

The sugar and the organic base join together by a condensation reaction to form a nucleoside. (A condensation reaction results in the removal of a water molecule.)

Another condensation reaction joins the nucleoside with phosphoric acid to form the nucleotide. This bond forms between carbon 5 of the sugar and the phosphate, and is called a phosphoester bond.

The organic bases present in DNA are either purines (guanine, G and adenine, A) or pyrimidines (cytosine, C and thymine, T). Purines have a double ring structure; pyrimidines have a single ring structure.

Two nucleotides can join together by a condensation reaction between the phosphate group of one nucleotide and the hydroxyl group on carbon 3 of the sugar of the other nucleotide. The bonds linking the nucleotides together are strong, covalent phosphodiester bonds.

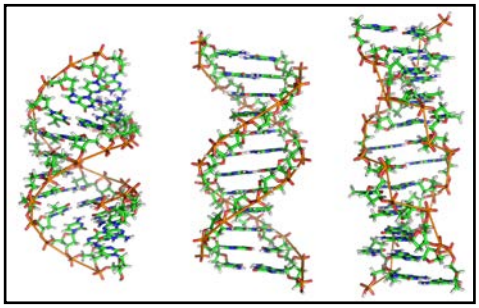
The process can be repeated so that a polynucleotide chain builds up. The chain has a sugar-phosphate backbone with the organic bases projecting outwards.

Each chain has two distinct ends: a 3' ('three prime') end and a 5'('five prime') end. At the 3' end, the carbon 3 of the deoxyribose is closest to the end; at the 5' end, the carbon 5 of the deoxyribose is closest to the end.

**The double helix**

DNA consists of two polynudeotide chains coiled around each other to form a double helix. The double helix is held together by hydrogen bonds between pairs of bases in the two chains. The pairings depend on the shapes of the bases (a purine can only bond with a pyrimidine) and on their ability to form hydrogen bonds:

Adenine (a purine) pairs with thymine (a pyrimidine), forming two hydrogen bonds (A=T).



Guanine (a purine) pairs with cytosine (a pyrimidine), forming three hydrogen bonds (G = C).

**Complementary base pairing**

These complementary base pairs are the only ways the bases can bond and join the two nucleotide chains. Thus, the sequence of bases along one polynudeotide chain determines the sequence along the other: an adenine on one chain means there must be a thymine on the other chain at that point, and so on. Complementary base pairing forms the basis of DNA replication and its ability to form messenger RNA during protein synthesis.

Complementary base pairing can happen only if the two polynudeotide chains are antiparallel. Antiparallel chains run in opposite directions; one chain runs from 3' to 5', and the other from 5' to 3'.

Watson and Crick's model of DNA showed that the base pairs are 0.34 nm apart, and that each complete turn of the helix has ten base pairs.

**In summary**

DNA is a double helix made of two polynucleotide chains.

Each chain has a sugar-phosphate backbone on the outside with organic bases on the inside.

The two chains are held together by complementary base pairing.

The chains are antiparallel (the 5' end of one chain lies next to the 3' end of the other chain).

## ■Glossary of essential terms for you to know

| № | English term | Russian equivalent |
|---|---|---|
| 10. | physicist | физик |
| 11. | description | описание |
| 12. | to carry out | проводить, выполнять |
| 13. | particularly | особенно |
| 14. | to obtain | получать |
| 15. | crucial | решающий |
| 16. | helical | винтовой, спиральный |
| 17. | datum (pl. data) | данное (данные) |
| 18. | strand | нить (днк, белка) |
| 19. | to receive | получать |
| 20. | discovery | открытие |
| 21. | cancer | рак |
| 22. | posthumously | посмертно |
| 23. | landmark | веха, поворотный пункт |
| 24. | to spark off | вызвать |

| | | |
|---|---|---|
| 25. | far-reaching | далеко идущий |
| 26. | consequence | последствие |
| 27. | unbranched | без ветвей, не имеющий ветвей |
| 28. | nucleotide | нуклеотид |
| 29. | nitrogen | азот |
| 30. | removal | отщепление, перемещение |
| 31. | pyrimidine | пирамидин |
| 32. | thymine | тимин |
| 33. | cytosine | цитозин(нуклеотид) |
| 34. | hydroxyl | гидроксил |
| 35. | bond | химическая связь |
| 36. | to link | связывать, соединять |
| 37. | to build up | наращивать, создавать |
| 38. | backbone | основа, каркас |
| 39. | bases(basis) | основа, основание |
| 40. | outwards | наружу, снаружи |
| 41. | to project | выдаваться, выступать |
| 42. | distinct | отдельный, отличный, особый |
| 43. | helix | спираль |
| 44. | to coil | скручивать |
| 45. | pairing | скручивание парами, расположение парами |
| 46. | ability | способность |
| 47. | adenine | аденин (нуклеотид) |
| 48. | guanine | гуанин (нуклеотид) |
| 49. | complementary | дополнительный |
| 50. | sequence | последовательность |
| 51. | apart | раздельно, на расстоянии друг от друга |

## ■ Your Essential Assignments

## I. Quick check

I. Distinguish between a nucleoside and a nucleotide.
2. By what type of chemical reaction is a phosphodiester bond formed?
3. If one strand of DNA has the base sequence AATCCG, what will be the corresponding base sequence of bits complementary strand ?

## II. Fill in the missing words:

| Verb | Noun |
|---|---|
| discover | |
| project | |
| describe | |

| | |
|---|---|
| receive | |
| remove | |
| condensate | |
| react | |

## III. Use a monolingual English dictionary and give the definitions of the words below:

landmark; bond; chain; sequence; to coil.

## IV. Find English equivalents to the following word combinations:

| № | Russian term | English equivalent |
|---|---|---|
| 1. | опубликовать первое описание структуры ДНК | |
| 2. | ДНК имеет спиральную структуру | |
| 3. | премия не присуждается посмертно | |
| 4. | далеко идущие последствия | |
| 5. | прочные ковалентные связи | |
| 6. | образование пар зависит от | |
| 7. | носитель РНК | |
| 8. | противоположные направления | |
| 9. | полный оборот спирали | |

## V. Suggest Russian equivalents for the following word combinations

| № | English term | Russian equivalent |
|---|---|---|
| 1. | X-ray data | |
| 2. | crucial support to the idea | |
| 3. | double helical structure | |
| 4. | to receive a Nobel Prize for a discovery | |
| 5. | far-reaching consequences | |
| 6. | the nucleotides join together to form long unbranched polynucleotide chains | |
| 7. | removal of a water molecule | |
| 8. | chains coiled around each other | |
| 9. | the double helix is held together | |
| 10. | messenger RNA during protein synthesis | |
| 11 | their discovery sparked off a new era | |

## VI. Fill in the gaps with the words and expressions from the text:

I. DNA consists of two polynucleotide chains … to form a double helix.

2. The description of the double helical structure of DNA was a … in science history.

3. The two chains … by complementary base pairing.

4. Another condensation reaction … the nucleoside with phosphoric acid to form the nucleotide.

5. Purines have a … ring structure

## VII. Answer the following questions. Use all information given before.

1. Who and when published the first description of the DNA structure?
2. What information did Watson and Crick use for their model?
3. Why did not Rosalind Franklin receive a Nobel Prize?
4. What is each DNA strand made of?
5. What is a condensation reaction?
6. What does each nucleotide consist of?
7. What is the main difference between purines and pyrimidines?
8. What is the main condition for complementary base pairing to happen?
9. Distinguish between a nucleoside and a nucleotide.
10. What type of chemical reaction forms a phosphodiester bond?
11. If one strand of DNA has the base sequence AATCCG, what will be the corresponding base sequence of bits complementary strand?

## VIII. Read and translate the short text without any dictionary:

**Fact of life:**

In April 1953, the biologist James Watson and the physicist Francis Crick published the first description of the structure of DNA, in a letter to the journal Nature. They based their description on a model they had constructed, but they did little experimental work themselves. The information they used for their model came from work carried out by Erwin Chargaff on the base composition of DNA , and X-ray data obtained by Rosalind Franklin, working with Maurice Wilkins at King's College, London. One particularly good X-ray diffraction photograph obtained by Franklin in the winter of 1952-3 gave crucial support to the idea that DNA has a helical structure. Other data from Franklin showed that DNA has two strands, not three or more as some scientists had proposed. In 1962, Watson, Crick, and Wilkins received a Nobel Prize for their discoveries. Tragically, Rosalind Franklin died of cancer in 1958 at the age of 37. Nobel prizes cannot be given posthumously.

## IX. Food for thought:

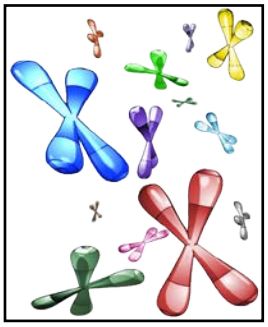
In 1948 the chemist Ervin Chargaff began using paper chromatography to analyses the base composition of DNA from a number of species. Table 1 shows the types of results may be interpreted to support Watson and Crick's double-helix hypothesis. What other interpretations could be given?

| DNA source | A | G | C | T |
|---|---|---|---|---|
| Human | 30.9 | 19.9 | 19.8 | 29.4 |
| Sheep | 29.3 | 21.4 | 21.0 | 28.3 |
| Hen | 28.8 | 20.5 | 21.5 | 29.2 |
| Turtle | 29.7 | 22.0 | 21.3 | 27.9 |
| Salmon | 29.7 | 20.8 | 20.4 | 29.1 |
| Locust | 29.3 | 20.5 | 20.7 | 29.3 |
| Wheat | 27.3 | 22.7 | 22.8 | 27.1 |
| Yeast | 31.3 | 18.7 | 17.1 | 32.9 |
| *Escherichia coli* | 24.7 | 26.0 | 25.7 | 23.6 |
| *Staphylococcus aureus* | 30.8 | 21.0 | 19.0 | 29.2 |

## X.Translate into English using all the active possible:

1. Описание структуры ДНК в виде двойной спирали было поворотным пунктом в истории науки.
2. Это открытие явило новую эру в научном исследовании, которое Кимеет и будет иметь далеко идущие последствия.
3. Реакция конденсации (уплотнения) приводит к отщеплению молекулы воды.
4. Нуклеотиды объединяются и образуют длинные неразветвленные полинуклеотидные цепи.
5. ДНК состоит из двух полинуклеотидных цепей скрученных вокруг друг друга и образующих двойную спираль.
6. Модель ДНК Уотсона и Крика показала, что базовые пары располагаются в 0.34 нм друг от друга.
7. Таким образом, последовательность баз вдоль одной полинуклеотидной цепи определяет последовательность вдоль другой: аденин в одной цепи означает, что в той же точке другой цепи должен быть тимин и так далее.
8. Органические основания, присутствующие в ДНК, являются либо пуринами, либо пиримидирами.

# Text 3.2 Chromosomes



**■ Essential targets:**

By the end of this text you should be able to
- explain how DNA is folded in a chromosome
- describe the structure and function of centromeres
- discuss the role of telomeres.

*Pre-reading*

**■ With your partner, consider the following questions before looking at the text. Then quickly scan the text to see if you were right.**

1. What do you know about chromosomes?
2. What is mitosis?
3. What is meosis?
4. What kind of molecules are called histones?

**Exercise A. Match the words with their definitions:**

| | | | |
|---|---|---|---|
| **1.** | artificial | **A.** | the act of separating something into different parts |
| **2.** | gene | **B.** | physical harm caused to something or someone |
| **3.** | visible | **C.** | not made of natural materials or substances |
| **4.** | division | **D.** | a series of related events, actions etc. which have a fixed order |
| **5.** | damage | **E.** | something that can be seen |
| **6.** | sequence | **F.** | the measurement of something from one end to the other |
| **7.** | to attach | **G.** | to be able to recognize and understand the difference between two similar things or people |
| **8.** | to distinguish | **H.** | when a battery takes in and stores electricity |
| **9.** | to fold | **I.** | to connect one thing to another |
| **10.** | to charge | **J.** | to wind or fold cloth, paper around something |
| **11.** | length | **K.** | to make something smaller, to bend a piece of paper by laying or pressing one part over another |
| **12.** | to wrap | **L.** | a small part of the material inside the nucleus of a cell, that controls the development of the qualities that have been passed on to a living thing from its parents |

**■ Read the given text and make your essential assignments:**

**What's in a chromosome?**

A chromosome consists of hundreds or thousands of genes (a gene is the basic unit of inheritance), and specialised parts that are thought to be important to the chromosomes stability and function. The deoxyribonucleic acid (DNA) that makes up the genes is packaged with the aid of proteins to form a complex structure. Chromosomes also contain small amounts of ribonucleic acid (RNA).

**DNA is packaged in chromosomes**

Each human chromosome contains one very long DNA molecule which unravelled would measure about 4.8 cm in length. The total length of DNA in the nucleus of a human cell has been estimated to be about 2.2 m. This poses a packaging problem: how does a chromosome measuring on average 6 µm long contain about 8000 times its length of DNA? The answer is that chromosomal DNA is intricately folded and is tightly bound to protein molecules called histones. Histones are small proteins that are rich in the amino acids lysine and/or arginine.

The complex formed between DNA and histones is called chromatin**.** Chromatin takes up stain and is visible in non-dividing nuclei. Individual chromosomes can be seen under the light microscope only during cell division (mitosis or meiosis).

**Nucleosomes - the basic structural unit**

Each DNA molecule is wound around histones arranged in groups of eight known as octamers.

The DNA and octamers form bead-like structures known as nucleosomes. Positively charged groups on the side-chains of the histones form strong ionic bonds with negatively charged phosphate groups in the backbone of the DNA.

In each nucleosome, a length of DNA containing about 150 base pairs is wrapped around the octamer.

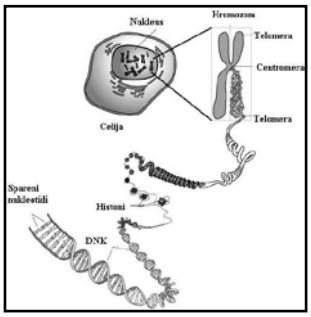
Another histone molecule attached to the outside of the nucleosome binds DNA to the octamer.

The nucleosome is regarded as the basic unit of the structure. The linker region, the stretch of DNA between the nucleosomes, varies in length from 14 to over 100 base pairs.

**Nucleosomes fold to form solenoid fibres**

More histones in the linker region help to fold the thread of DNA and nucleosomes (the nucleosome fibre) into a tightly coiled structure called a solenoid. The solenoids are thought to be further looped and coiled around non-histone proteins called scaffolding proteins. The precise details of this higher level of folding are not known.

**The centromere**




Each chromosome has a centromere which usually appears as a constriction when the chromosomes condense during mitosis and meiosis. The position of the centromere can be used to distinguish between different chromosomes.

Centromeres do not contain any genes. However they do contain large segments of highly repetitive DNA, called alpha satellite DNA. This is thought to play a significant role in centromere function. The centromere contains the kinetochore. This is a densely staining structure that attaches the chromosome to the spindle apparatus during nuclear division. Centromeres control the distribution of chromosomes during cell division. Chromosomes that do not have centromeres cannot divide.

**Telomeres**

Telomeres are located at the ends of chromosomes. They consist of DNA and protein. The telomeres appear to play a vital role in maintaining the stability of the chromosomes, 'sealing' the ends of linear DNA. They have been likened to the tips of shoelaces, and have a similar function: to stop the DNA fraying. They also seem to play an important role in regulating cell division. Under normal circumstances, telomeres become shorter and shorter with each cell division. When the telomeres have shortened to a certain critical length, the cell stops dividing.

If the telomeres are removed, the chromosome disintegrates. It is thought that the ageing process may be linked to telomere damage.

**Telomeres: a role in cancer?**

Telomeres contain repeating sequences of bases which are synthesised with the help of an RNA-containing enzyme called telomerase**.** Telomerase activity is suppressed in normal human somatic (body) cells. However, in cancerous cells, telomerase is active and maintains the telomere length so that the cells continue to divide. It is thought that this abnormal retention of the telomeres is involved in the development of some types of cancer.

## ■ Glossary of essential terms for you to know

| № | English term | Russian equivalent |
|---|---|---|
| 1. | artificial | искусственный |
| 2. | achievement | достижение |
| 3. | to treat | лечить |
| 4. | to remain | оставаться |
| 5. | host | хозяин |
| 6. | accessory | добавочный |
| 7. | inheritance | наследственность |

| | | |
|---|---|---|
| 8. | to package | упаковывать, укладывать |
| 9. | acid | кислота |
| 10. | to make up | составлять, |
| 11. | to consist of | состоять из |
| 12. | to contain | содержать |
| 13. | to unravel | распутывать, раскручивать |
| 14. | length | длина |
| 15. | nucleus (nuclei – pl) | ядро (ядра) |
| 16. | to estimate | оценивать |
| 17. | to pose | ставить (вопрос), задавать (вопрос) |
| 18. | on average | в среднем |
| 19. | intricately | запутанно, замысловато |
| 20. | to fold | складывать, сгибать, завертывать |
| 21. | tightly | тесно |
| 22. | bound | связанный |
| 23. | lysine | лизин (аминокислота) |
| 24. | arginine | аргинин (аминокислота) |
| 25. | chromatin | хроматин |
| 26. | to take up | принимать(ся), брать на себя |
| 27. | stain | краситель |
| 28. | to wind around (wound) | виться вокруг, обвивать |
| 29. | bead | пузырек, шарик, бусы, бисер |
| 30. | side – chain | боковая цепь |
| 31. | to wrap around | обертывать, упаковывать |
| 32. | to attach | прикрепляться, присоединяться |
| 33. | to regard | рассматривать |
| 34. | to vary | отличаться, изменяться |
| 35. | fibre | волокно, нить |
| 36. | to loop | перекручивать, делать петлю |
| 37. | scaffolding | костяк, строительные леса |
| 38. | constriction | ограничение |
| 39. | to condense | уплотняться, конденсировать(ся) |
| 40. | mitosis | митоз (деление клетки) |
| 41. | meiosis | мейоз |
| 42. | satellite | спутник (хромосомы) |
| 43. | densely | плотно, густо |
| 44. | to distinguish | различать |
| 45. | spindle | стержень, ось |
| 46. | apparatus | система, аппарат, орган |
| 47. | vital | жизненно важный |
| 48. | to maintain | поддерживать, сохранять |

| | | |
|---|---|---|
| 49. | to seal | запечатывать, плотно закрывать |
| 50. | to liken | находить сходство, приравнивать |
| 51. | tip | конец, наконечник |
| 52. | to fray | протираться, изнашиваться |
| 53. | to disintegrate | распадаться, расщепляться |
| 54. | circumstance | обстоятельство |
| 55. | to remove | удалять, уничтожать |
| 56. | sequence | последовательность |
| 57. | to suppress | подавлять, сдерживать |
| 58. | somatic | телесный |
| 59. | retention | удерживание, сохранение |

## ■ Your Essential Assignments:

### I. Quick check:

1. What is a nucleosome?
2. Centromeres contain no genes. What is their main function?
3. Why have telomeres been compared with the tips of shoelaces?

### II. Suggest Russian equivalents for the following word combinations:

| № | English term | Russian equivalent |
|---|---|---|
| 1. | artificial human chromosome | |
| 2. | to treat a genetic disease | |
| 3. | basic unit of inheritance | |
| 4. | this poses a packaging problem | |
| 5. | to be intricately folded | |
| 6. | to be wound around | |
| 7. | positively charged groups | |
| 8. | side-chains | |
| 9. | higher level of folding | |
| 10. | to play a vital role | |
| 11. | ageing process | |
| 12. | cancerous cells | |

### III. Fill in the gaps with the words and expressions from the text:

1. The artificial chromosome remains … and functions as ….
2. Chromosomes also contain small amounts of ….
3. Chromosomal DNA … and … to protein molecules called histones.
4. The complex formed between … is called chromatin.

5. Each DNA molecule … histones arranged in groups of eight known as octamers.
6. The DNA and octamers form … known as ….
7. Centromere appears as … when the chromosomes condense during mitosis and meiosis.
8. Centromeres do not contain any ….

## IV. Find English equivalents for the following word combinations:

| № | Russian term | English equivalent |
|---|---|---|
| 1. | хромосома состоит из сотен или тысяч ген | |
| 2. | хромосомы также содержат небольшие количества РНК | |
| 3. | хромосомальная ДНК замысловато упакована | |
| 4. | теломеры жизненно играют важную роль в поддержании стабильности хромосом | |
| 5. | положение центромера | |
| 6. | деление клетки | |
| 7. | хромосома распадается | |
| 8. | укорачиваться до определённой критической длины | |
| 9. | процесс старения | |
| 10. | хромосома распадается | |
| 11. | наконечники шнурков | |
| 12. | при нормальных обстоятельствах | |
| 13. | РНК-содержащие ферменты | |
| 14. | раковые клетки | |
| 15. | общая длина ДНК; | |
| 16. | запечатывать концы линейного ДНК | |
| 17. | строительные белки. | |

## V. Answer the following questions. Use all information given before:

1. What is a nucleosome?
2. Centromeres contain no genes. What is their main function?
3. Why have telomeres been compared with the tips of shoelaces?
4. What risks might be associated with changing the length of telomeres in body cells?
5. What is the total length of DNA in the nucleus of a human cell?
6. What are histones?
7. What happens if the telomeres are removed?

8. When and where was the first artificial human chromosome made?
9. How could synthetic chromosomes be used?
10. How is DNA packaged in chromosomes?

## VI. Read and translate the short text without a dictionary:

**Fact of life:**

In February 1997, the first artificial human chromosome was made by Dr Huntington Willard and his colleagues from the Case Western Reserve University in Cleveland, Ohio. According to their report, this achievement should: '... open the door to a whole new avenue of research in chromosome biology and gene therapy.' A synthetic chromosome containing a specific gene could be introduced into human cells to treat a genetic disease. The artificial chromosome remains independent within host cells and functions as an 'extra' or accessory chromosome.

## VII. Food for thought:

In January 1998, a paper in the journal *Science* explained how telomeres can be lengthened by introducing a gene for an enzyme called telomerase reverse transcriptase (hTRT). This enzyme causes cells to produce active telomerase, the enzyme that repairs telomeres. Suggest how techniques for manipulating telomere length might be used to treat age-related diseases and cancers. What risks might be associated with deliberately changing the length of telomeres in body cells?

## VIII. Translate into English using all the active possible:

1. Искусственная хромосома остается независимой внутри клетки хозяина и функционирует в качестве дополнительной хромосомы.
1. Ген является основным звеном наследственности.
2. ДНК упаковывается с помощью белков и образует сложную структуру.
3. Хромосомальная ДНК замысловато складывается и тесно связывается с белковыми молекулами, называемыми гистонами, которые богаты аминокислотами лизином и/или аргинином.
4. Этот комплекс, образованный между ДНК и гистонами, называется хроматином.
5. Отдельные хромосомы могут быть увидены только во время деления клетки.

6. Положительно заряженные группы на боковых цепях гистонов образуют сильные (крепкие) ионные связи с отрицательно заряженными фосфатными группами в основании ДНК.Каждая хромосома имеет центромер, который обычно появляется в качестве ограничения, когда хромосомы уплотняются во время деления клетки (митоза или мейоза).
7. Центромеры контролируют распределение хромосом во время деления клетки.
8. Теломеры поддерживают стабильность хромосом, закрывая концы линейной ДНК.
9. Процесс старения связан с повреждением теломера.

**IX. Use a monolingual English dictionary and write down what could the words given below mean:**

to treat; host; aid; complex; distribution; vital; to maintain; abnormal.

**X. Read the text and render it in English:**

Сколько лет проживем?

Скоро каждый желающий сможет узнать, сколько лет ему отпущено природой. Разработанный испанцами тест измеряет длину ДНК на концах хромосом. Эти участки, называемые теломерами, защищают ДНК от повреждений. Со временем теломеры становятся слишком короткими, в результате чего клетка перестает делиться и умирает, что ускоряет процесс старения. На основе этого был сделан вывод, что люди с короткими теломерами живут меньше.

Исследователи считают, что тест получит широкое распространение в ближайшие 5-10 лет и поможет в борьбе с раком, сердечно-сосудистыми заболеваниями и болезнью Альцгеймера.

**XI. Prepare a short presentation reflecting the following issues:**

- discuss the role of telomeres;
- describe the structure and function of centromeres;
- explain how DNA is folded in a chromosome.

**■ Have Some Fun! Biologist Joke!**

Enzymes are things invented by biologists that explain things which otherwise require harder thinking.

# INIT IV. INHERITANCE

## Text 4.1. Variation

**■ Essential targets:**

By the end of this text you should be able to:

- define the following genetic terms: allele; homozygous; heterozygous; dominant; recessive; polygenic
- distinguish between genotype and phenotype
- distinguish between continuous variation and discontinuous variation
- explain how mutations contribute to variation.

*Pre-reading*

**■ Discuss these questions with your partner. Then scan the text quickly to find the answers.**

1. What is variation?
2. What is mutation?
3. Are mutations harmful or beneficial?
4. How do X-rays influence the mutation rate?

**Exercise A. Match the words with their definitions:**

| | | | |
|---|---|---|---|
| **1.** | ultimate | **A** | being the only one of its kind |
| **2.** | unique | **B** | a process by which two or more things have an effect on each other and work together |
| **3.** | distinguish | **C** | the final and the most important one |
| **4.** | source | **D** | the air, water and land in which people, animals and plants live |
| **5.** | feature | **E** | someone`s child or children; animal`s baby or babies |
| **6.** | spontaneous | **F** | how tall someone is |
| **7.** | twin | **G** | a thing, place, activity that you get something from |
| **8.** | offspring | **H** | a part of something that you notice because it seems important, interesting, or typical |
| **9.** | identical | **I** | to be able to recognize and understand the difference between two similar things or people |
| **10.** | environment | **J** | happening or done without being planned or organized |

| | | | |
|---|---|---|---|
| **11.** | interaction | **K** | one of two children born at the same to the same mother |
| **12.** | height | **L** | exactly the same |

**■ Read and translate the given text and make your essential assignments:**

The Earth is inhabited by billions of organisms, every one of which is unique. Individuals belonging to different species are usually easy to distinguish; members of the same species may differ only in small ways; but even clones (such as identical twins) show some subtle differences. The differences between individuals of the same species are called variation. These differences may be the result of genetic differences, the influence of the environment, or a combination of genetic and environmental influences.

**Genetic variation**

Genetic differences reflect the genotype of an organism, that is, its genetic make-up. A diploid organism has two sets of chromosomes and two forms **(**alleles) of each particular gene. These alleles may be the same (the organism is homozygous for that gene) or different (the organism is heterozygous for that gene). If different, one of the alleles (the dominant allele**)** may mask the other allele (the recessive allele). The dominant allele is therefore expressed in either the heterozygous or the homozygous condition, whereas the recessive allele is expressed only in the homozygous condition. If an organism is haploid (that is, it has only one set of chromosomes), all its alleles will be expressed and will be reflected in its observable or measurable characters (the features or traits transmitted from parent to offspring).

**Phenotypic variation: continuous and discontinuous**

The measurable physical and biochemical characteristics of an organism, whether observable or not, make up its phenotype. The phenotype results from the interaction of the genotype and the environment. The genotype determines the potential of an organism, whereas the environmental factors to which it is exposed determine to what extent this potential is fulfilled. For example, in humans the potential height of a person is genetically determined, but a person cannot reach this height without an adequate diet. Phenotypic variation (commonly referred to simply as variation) is of two main types: continuous and discontinuous.

In continuous variation, differences are slight and grade into each other. Characteristics such as human height and weight show continuous variation, and are usually determined by a large number of genes (they are polygenic) and/or considerable environmental influence.

In discontinuous variation, the differences are discrete (separate) and clear cut: they do not merge into each other. Discontinuous variations are generally caused by different alleles of one, two, or only a few genes.

Continuous variations are usually quantitative (they can be measured) whereas discontinuous variations are qualitative (they tend to be defined subjectively in descriptive terms). Thus height in humans is a continuous variation given a value in metres, whereas height in sweet peas is a discontinuous variation described as 'tall' or 'dwarf.

**Mutations: more variation**

Genetic variation arises partly from sexual reproduction by a combination of independent assortment, crossing over, and random fertilisation. However, these processes merely shuffle the existing pack of genes so that new combinations are made. The ultimate source of inherited variations is mutations.

A mutation is a change in the amount or the chemical structure of DNA. If the information contained within the mutated DNA is expressed (that is, transcribed into mRNA and translated into a specific polypeptide chain) it can cause a change in the characteristics of an individual cell or an organism. Mutations in the gametes of multicellular organisms can be inherited by offspring. Mutations of the body cells of multicellular organisms (somatic mutations) are confined to the body cells derived from the mutated cell; they are not inherited.

Mutations can happen spontaneously as a result of errors in DNA replication or errors during cell division, or they can be induced by various environmental factors (such as certain chemicals, X-rays, and viral infection). Factors that induce mutations are called mutagens.

**Chromosome mutations and gene mutations**

Alterations in the number or structure of chromosomes are called chromosome mutations. Chromosome mutations can happen during mitosis and meiosis when chromosomes are being condensed and pulled apart. Homologous chromosomes may fail to separate, resulting in non-disjunction. Chromosome mutations also occur during interphase when DNA replicates, and during crossing over when sections of chromosomes are exchanged.

Gene mutations are changes in the nucleotide base sequence in a cistron (the portion of DNA that makes up a single gene). A change of a single nucleotide base pair is called a point mutation. There are a number of types of point mutation, including:

- substitution - the replacement of one nucleotide with another containing a different base
- deletion - the loss of a nucleotide
- insertion or addition - addition of an extra nucleotide.

Sickle-cell anaemia is an example of an inherited condition that results from a substitution. Gene mutations may also result from duplication (repetition of a portion of a nucleotide sequence within a cistron) and inversion (reversal of the portion of the nucleotide sequence in the cistron).

Most mutations, if expressed, are harmful. Note, however, that in diploid organisms such as ourselves, mutations usually result in recessive alleles. These are expressed only in the homozygous condition unless the mutation is on the X chromosome. Many mutations result in a change in the shape of a protein so that the protein cannot function properly (for example, the mutation that causes sickle-cell anaemia). Mutations that affect large sections of a gene, and chromosome mutations are often lethal. However, some mutations have no effect: a mutation may occur in a non-coding part of DNA; it may produce a different codon for the same amino acid; or the altered amino acid sequence may not affect the protein's shape or function. Occasionally, a mutation is beneficial, changing the phenotype so that an organism has a better chance of surviving and reproducing. Although beneficial mutations are very rare events, they are bound to happen sooner or later if there is a large number of individuals in a population. These mutations are of immense importance because they are the ultimate source of all variation: the raw material for the evolution of new species by natural selection.

**■ Glossary of essential terms for you to know**

| № | English term | Russian equivalent |
|---|---|---|
| 1. | variation | генетическая изменчивость, мутация |
| 2. | source | источник, причина |
| 3. | ultimate | конечный, предельный, основной |
| 4. | to inherit | наследовать |
| 5. | to arise | возникать |
| 6. | spontaneously | спонтанно, хаотично |
| 7. | to induce | вызывать, побуждать, причинять |
| 8. | mutagen | мутаген |
| 9. | mustard gas | иприт, горчичный газ |
| 10. | unique | уникальный |
| 11. | to distinguish | различать |
| 12. | twins | близнецы |
| 13. | subtle | незаметный |
| 14. | make-up | состав, конституция |
| 15. | to mask | маскировать, скрывать |
| 16. | feature | черта, качество |
| 17. | trait | свойство, особенность |
| 18. | offspring | потомство |

| | | |
|---|---|---|
| 19. | to fulfill | реализовывать |
| 20. | to grade into each other | постепенно переходить одному в другой |
| 21. | considerable | значительный |
| 22. | to merge | сливаться |
| 23. | quantitative | количественный |
| 24. | qualitative | качественный |
| 25. | subjective | субъективный, индивидуальный |
| 26. | descriptive | описательный |
| 27. | dwarf | карликовый |
| 28. | discontinuous | прерывистый, прерывающийся |
| 29. | assortment | набор, выбор, ассортимент |
| 30. | to cross over | переходить, перекрещиваться |
| 31. | random | случайный, произвольный, беспорядочный |
| 32. | fertilization | оплодотворение, опыление |
| 33. | shuffle | перемешивать, перетасовывать |
| 34. | to affect | негативно воздействовать, поражать |
| 35. | to transcribe | записывать, воспроизводить |
| 36. | to confine | заточить, держать взаперти, ограничивать |
| 37. | to derive | наследовать, происходить, получать |
| 38. | viral | вирусный |
| 39. | alteration | изменение |
| 40. | to condense | конденсироваться |
| 41. | to put apart | разрывать на части (куски), раздирать |
| 42. | disjunction | разъединение, отделение |
| 43. | to replicate | реплицировать, воспроизводиться путем клеточного деления |
| 44. | substitution | замещение |
| 45. | deletion | делеция (удаление или утрата части генетического материала хромосомы), стирание |
| 46. | sequence | последовательность |
| 47. | cistron | цистрон |
| 48. | inversion | инверсия (генов), (взаимная перестановка) |
| 49. | reversal | полная перестановка |
| 50. | lethal | смертельный, летальный |
| 51. | codon | кодон |
| 52. | to be bound to happen | обязательно случаться, происходить |
| 53. | immense | огромный, колоссальный |
| 54. | insertion | инсерция (встраивание генетическогоэлемента в хромосому) |

| | | |
|---|---|---|
| 55. | sickle-cell anemia | серповидноклеточная анемия (наследственная болезнь, преимущественно афро-американцев) |

## ■ Your Essential Assignments

## I.Quick check

1. What is a mutagen? Give one example.
2. Distinguish between the genotype and the phenotype of an organism.
3. If a diploid organism has two different alleles for the same gene, is it homozygous or heterozygous?
4. Is weight in humans an example of continuous variation or discontinuous variation?

## II. Using a monolingual English dictionary define the following genetic terms:

allele; homozygous; heterozygous; dominant; recessive; polygenic.

## III. Find Russian equivalents to the following word combinations:

| № | English term | Russian equivalent |
|---|---|---|
| 1. | inherited variation | |
| 2. | spontaneous mutations | |
| 3. | recessive form | |
| 4. | to be easy to distinguish | |
| 5. | subtle differences | |
| 6. | genetic make-up | |
| 7. | observable or measurable traits | |
| 8. | human height and weight | |
| 9. | differences grade into each other | |
| 10. | considerable environmental influence | |
| 11. | to arise partly | |
| 12. | multicellular organisms | |
| 13. | to induce mutations | |
| 14. | base sequence | |
| 15. | to result from | |
| 16. | to result in | |
| 17. | beneficial mutation | |
| 18. | natural selection | |
| 19. | to be of immense importance | |

## IV. Fill in the gaps with the words and expressions from the text:

1. Mutations can either … spontaneously or … by agents called mutagens.
2. Mutations are usually thought of as … and they often are.
3. Occasionally, a mutation is …, changing the phenotype so that an organism has a better chance of … and ….
4. Genetic differences reflect… of an organism, that is, its genetic ….
5. Mutations that affect large sections of a gene and chromosome mutations are often ….
6. Although beneficial mutations are …, they are found to happen sooner or later if there is a large … in a population.
7. A mutation is … in the amount or the chemical structure of DNA.
8. The genotype determines the … of an organism, whereas the environmental factors to which it is exposed determine to ….
9. In continuous variations, differences are ….
I. 10.In discontinuous variations, the differences are ….

## V. Find English equivalents to the following word combinations:

| № | Russian term | English equivalent |
|---|---|---|
| 1. | возникать спонтанно | |
| 2. | уровень спонтанных мутаций варьирует | |
| 3. | оказывать негативное воздействие | |
| 4. | доза радиации | |
| 5. | члены одного вида | |
| 6. | влияние окружающей среды | |
| 7. | видимые или измеряемые характеристики | |
| 8. | взаимодействие генотипа и окружающей среды | |
| 9. | существующий набор генов | |
| 10. | быть результатом замещения | |
| 11. | поражать большие наборы генов | |
| 12. | нуклеотидная последовательность | |
| 13. | функционировать нужным образом | |
| 14. | незначительные различия | |

## VI. Answer the following questions. Use all information given before.

1. If a diploid organism has two different alleles for the same gene, is it homozygous or heterozygous?
2. What is the difference between the genotype and the phenotype of an organism?
3. Is weight in humans an example of continuous variations or discontinuous variations?
4. What is a mutagen?
5. Are mutations harmful or beneficial?
6. What is variation and what does it result from?
7. Could you give an example of gene mutations?
8. Why are beneficial mutations of immense importance?
9. When do chromosome mutations happen?
10. What is a haploid organism?

## VII. Read and translate the short text without any dictionary:

**Fact of life:**

Mutations (changes in DNA) are the ultimate source of inherited variation. They can either arise spontaneously or be induced by agents called mutagens (such as X-rays, mustard gas, or ultraviolet radiation). The rate of spontaneous mutations varies for different genes and in different organisms. Each human gene has about a one in 100 000 chance of mutating. Mutations are usually thought of as harmful, and they often are. However, because we have so many genes, even the healthiest of us probably have at least a few spontaneously mutated genes hidden in the recessive form which do not affect us. X-rays and other mutagens increase the mutation rate, and the higher the dosage of radiation, the higher the rate of mutation.

## VIII. Food for thought:

Twins (pairs of children born at the same time) may be dizygotic or monozygotic.

Each dizygotic or non-identical twin develops from a different egg and may be of a different sex. Monozygotic twins or identical twins develop from one egg and contain identical genetic information; they are always of the same sex. Suggest how the study of twins may be used to distinguish between the effects of inheritance and environmental factors on the variations of an individual character.

## IX.Translate into English using all the active possible:

1. Мутации – это основная причина наследственных генетических изменений.
2. Каждый человеческий ген имеет шанс мутировать как 1 к 100000.
3. Рентгеновские лучи и другие мутагены увеличивают уровень мутирования и чем выше доза радиации, тем выше уровень мутирования.
4. Большинство выраженных мутаций вредны.
5. Однако, случайно мутации бывают полезными, меняя фенотип таким образом, что организм имеет больше шансов выживать и воспроизводиться.
6. Различия между особями одного вида называются генетической изменчивостью.
7. Измеряемые физические и биохимические характеристики организма, будучи видимыми или нет, составляют его фенотип.
8. Характеристики, такие как человеческий рост и вес, показывают непрерывную изменчивость, и они обычно определяются большим набором генов и ощутимым (заметным) влиянием окружающей среды.
9. Генотип определяет потенциал организма, в то время как факторы окружающей среды, в которой он существует, определяют, до какой степени этот потенциал будет реализован.
10. Мутация – это изменение в количестве или структуре ДНК.
11. Мутации могут происходить спонтанно или быть вызваны факторами окружающей среды (химические препараты, рентгеновские лучи, вирусная инфекция).
12. Многие мутации выражаются в изменении формы белка, что приводит к его неправильному функционированию.
13. Мутации, которые поражают большие секторы генов, и хромосомальные мутации часто являются смертельными.
14. Однако, полезные мутации являются сырьевым материалом для эволюции новых видов путём естественной селекции (естественного отбора).

## X. Meet essential targets reflecting the following issues:

1. Define the following genetic terms: allele; homozygous; heterozygous; dominant; recessive; polygenic
2. Distinguish between genotype and phenotype
3. Distinguish between continuous variation and discontinuous variation
4. Explain how mutations contribute to variation.

# Text 4.2. Down's Syndrome And Genetic Screening

**■ Essential targets:**

By the end of this text you should be able to

- explain how Down's syndrome arises;
- compare the main features of amniocentesis and chorionic villus sampling;
- discuss the role of a genetic counselor.

*Pre-reading*

**■ Try and answer the following questions. Then check your answers by reading the text.**

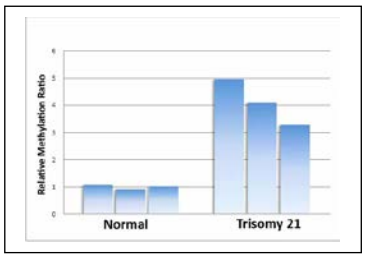
1. What do you know about Down's syndrome?
2. Who and what is the syndrome named after?
3. What do children with Down's syndrome look like?

**Exercise A. Match the words with their definitions:**

| | | | |
|---|---|---|---|
| **1.** | disability | **A.** | a fault or a lack of something that means that something is not perfect |
| **2.** | disease | **B.** | a small part or amount of something that is examined in order to find out something about the whole |
| **3.** | defect | **C.** | happening or done without being planned or organized |
| **4.** | to prevent | **D.** | to receive money, property etc. from someone after they have died |
| **5.** | to inherit | **E.** | the final result of a meeting, discussion, war etc., especially when no one knows what it will be until it actually happens |
| **6.** | to observe | **F.** | to stop something from happening or stop someone from doing something |
| **7.** | sample | **G.** | the act of ending something or the end of something |
| **8.** | spontaneous | **H.** | to and notice something; to watch something or someone carefully |
| **9.** | outcome | **I.** | a physical problem that makes someone unable to use a part of their body properly |
| **10.** | termination | **J.** | an illness or unhealthy condition in your body, especially one caused by infection |

**■ Read the given text and make your essential assignments:**

## Down's syndrome: trisomy 21




Down's syndrome is the most common single cause of learning disability in children of school age. Children with the syndrome typically have a round, flat face, and eyelids that appear to slant upwards. In addition to some learning disability, they also have an increased risk of infection (particularly respiratory and ear infections), and heart defects occur in about one-quarter of those with the syndrome.

The syndrome is named after John Langdon Down, a nineteenth century doctor who first described the condition in 1866. In 1959, the French physician Lejeune used chromosome-staining techniques to show that Down's syndrome is caused by an extra chromosome 21. Having one extra chromosome is known as **trisomy,** hence Down's syndrome is also known as **trisomy 21.** The extra chromosome usually comes from the egg cell due to non-disjunction of chromosome 21. About 70% of the non-disjunctions occur during meiosis I, when homologous chromosomes fail to separate; 30% occur during meiosis II, when sister chromatids fail to separate. Whether it occurs during meiosis I or meiosis II, non-disjunction leads to trisomy. In a few cases, the extra chromosome comes the father.

In about 3% of cases, Down's syndrome results from translocation of an extra chromosome 21. A region of the chromosome breaks off and rejoins with either the end of the other chromosome 21 or with another non-homologous chromosome (commonly chromosome 15). In these cases, a person may have the normal number of chromosomes, but one of the chromosomes will be abnormally long.

**Genetic screening: amniocentesis and chorionic villus sampling**

Because of the high risk of Down's syndrome among the babies of older mothers, in the UK mothers over the age of 35 years are usually offered free genetic screening by the National Health Service. **Genetic screening** refers to procedures used to examine an individual for the presence of a genetic disease or disorder. The most widely available genetic screening procedure for Down's syndrome is amniocentesis.

**Amniocentesis** is usually carried out at 15-16 weeks of pregnancy. It involves passing a very fine needle into the uterus, observed with an ultrasound image, and withdrawing a sample of amniotic fluid containing fetal cells. The karyotype of the fetal cells is then analysed to test for Down's syndrome. The fetal cells can also be cultured in a suitable medium in a laboratory so that further tests, such as DNA analysis, can be carried out.

Amniocentesis is performed under local anaesthetic and most women do not find it too uncomfortable. However, there is a 0.5-1 per cent risk of spontaneous miscarriage after the procedure. Therefore, amniocentesis is usually recommended only for those at high risk of carrying a Down's baby-In the 1970s, chorionic villus sampling (CVS) was developed in China. In CVS, a sample of cells is taken from the chorionic villus (small finger-like processes which grow from the embryo into the mothers uterus). The sample is obtained either by inserting a needle through the abdomen, or inserting a catheter. The fetal cells in the sample can then be analysed in the same way as for amniocentesis.

CVS can be carried out between week 8 and week 12 of pregnancy. If the test shows the fetus has Down's syndrome, a decision about abortion can be made earlier than with amniocentesis. Early abortions are usually less difficult, both physically and mentally, than later abortions. However, a higher risk of miscarriage is associated with CVS than with amniocentesis.

Until recently, a mother's age was the only factor available to assess the risk for Down's syndrome. Now biochemical markers are being discovered for the condition. For example, women with a high risk of Down's syndrome pregnancies tend to have about twice as much chorionic gonadotrophin (a sex hormone produced in placenta cells) in their blood serum as women with normal pregnancies. Tests for these biochemical markers cannot show the presence of a Down's baby, but they can be used in conjunction with the mother's age to predict the probable risk of having a baby with Down's syndrome. If the risk is high, the mother can then decide whether to have an amniocentesis or CVS.

**Genetic counselling**

Genetic screening should be followed by genetic counselling, the giving of advice and information about the risks of a genetic disease and its outcome. Counselling is a very challenging task. Counsellors must have a good understanding of medical genetics and need to be well trained in sympathetic counselling techniques. They must give information which helps clients come to their own decision rather than imposing their own views on the clients. Clients should be made aware that the features of Down's syndrome vary widely. The condition often results in individuals with severe mental disability who require a great deal of support, but many people with Down's syndrome lead independent, long, and fulfilling lives, and they are often very loving individuals. It should not be assumed that mothers carrying a fetus with Down's syndrome would automatically opt for termination of pregnancy.

## ■ Glossary of essential terms for you to know

| № | English term | Russian equivalent |
|---|---|---|
| 1. | overall | общий |
| 2. | frequency | частотность, повторяемость |
| 3. | advance | достижение |
| 4. | preventative | профилактический |
| 5. | eyelid | веко |
| 6. | to slant | отклоняться |
| 7. | upwards | вверх, выше |
| 8. | condition | состояние (здоровья) |
| 9. | staining | окрашивающий |
| 10. | hence | следовательно, отсюда |
| 11. | disjunction | разъединение, расчленение |
| 12. | to break off | отрываться, прерываться |
| 143. | to rejoin | присоединить(ся) вновь |
| 14. | screening | отбор, проверка, обследование |
| 15. | villus | ворсинка |
| 16. | sampling | отбор, взятие проб |
| 17. | disorder | расстройство |
| 18. | to involve | включать |
| 19. | uterus | матка |
| 20. | to withdraw | забирать |
| 21. | amniotic fluid | околоплодные воды, амниотическая жидкость |
| 22. | karyotype | кариотип (хромосомный комплекс) |
| 23. | to culture | высевать, культивировать |
| 24. | miscarriage | выкидыш |
| 25. | process | отросток, придаток |
| 26. | to assess | оценивать, давать оценку |
| 27. | marker | индикатор |
| 28. | gonadotrophin | гонадотропный гормон |
| 29. | serum | сыворотка |
| 30. | in conjunction with | в сочетании с, совместно |
| 31. | to counsel | советовать, консультировать |
| 32. | outcome | результат, последствия |
| 33. | challenging | требующий напряжения, испытывающий |
| 34. | sympathetic | полный сочувствия, благожелательный |
| 35. | to impose on | навязывать |
| 36. | aware | сознающий, подготовленный |
| 37. | severe | тяжёлый, суровый, сильный, серьёзный |

| | | |
|---|---|---|
| 38. | to require | требовать |
| 39. | fulfilling | соответствующий |
| 40. | to assume | допускать, предполагать |
| 41. | fetus | плод |
| 42. | to opt | делать выбор, выбирать |
| 43. | termination | прекращение |
| 44. | trisomy | трисомия |
| 465. | chorionic | хорионный |
| 46. | fetal | эмбриональный |

## ■ Your Essential Assignments

### I. Quick check

1. What is non-disjunction?
2. Compare amniocentesis and chorionic villus sampling with respect to:
   A) When they can be carried out.
   B) The risk of inducing a miscarriage.
3. Name one biochemical marker which can help genetic counselor assess the risk of Down's syndrome for a client.

### II. Find the missing words:

| Verb | Noun | Adjective |
|---|---|---|
| increase | | |
| | prevention | |
| | | risky |
| inherit | | |
| | performance | |
| | | decisive |
| | analysis | |

### III.Use a monolingual English dictionary and give the definitions of the following words:

frequency; range; common; disorder; sympathetic; support.

### IV. Suggest Russian equivalents for the following word combinations:

| № | English term | Russian equivalent |
|---|---|---|
| 1. | throughout the world | |
| 2. | overall frequency | |

| | | |
|---|---|---|
| 3. | preventative medicine | |
| 4. | inherited diseases; | |
| 5. | learning disability | |
| 6. | genetic screening | |
| 7. | challenging task | |
| 8. | sympathetic counselling techniques | |
| 9. | imposing their own views on the clients | |
| 10. | great deal of support | |

## V. Fill in the gaps with the words and expressions from the text:

1. Advances in DNA technology have brought …in preventive medicine.
2. We can now … a large range of inherited diseases before birth.
3. In addition to some learning disability they also have ….
4. The syndrome is named after John Langdon Down, …who first described the condition in 1866.
5. Down's syndrome is caused by ….
6. Because of the high risk of Down's syndrome among the babies of older mothers, in the UK mothers over the age of 35 years are usually offered ….
7. Genetic screening should be followed by genetic counseling? The giving of advice and information about ….
8. Counselling is ….
9. They must give information which helps clients … rather than ….
10. It should not be assumed that mothers carrying a fetus with Down's syndrome would ….

## VI. Find English equivalents for the following word combinations:

| № | Russian term | English equivalent |
|---|---|---|
| 1. | достижения в технологии ДНК | |
| 2. | большой спектр наследственных заболеваний | |
| 3. | повышенный риск | |
| 4. | ушные заболевания | |
| 5. | бесплатное генетическое обследование | |
| 6. | подходящая среда | |
| 7. | и физически, и морально | |
| 8. | технология (методика) дружелюбной консультации | |
| 9. | серьёзная умственная отсталость | |

| | | |
|---|---|---|
| 10. | прерывание беременности | |

## VII. Answer the following questions. Use all information given before.

1. What is non-disjunction?
2. How do you think society should treat parents who choose to bring into the world a child with a genetic disorder?
3. Who or what is the syndrome named after?
4. What do children with Down's syndrome look like?
5. When can amniocentesis and chorionic villus sampling be carried out?
6. Could you compare amniocentesis and CVS with respect to the risk of inducing a miscarriage?
7. What is Down's syndrome caused by?
8. What is a biochemical marker which can help a genetic counselor assess the risk of Down's syndrome for a client?
9. What is genetic counseling like?

## VIII. Read and translate the short text without any dictionary:

**Fact of life:**

Throughout the world, the overall frequency of Down's syndrome is about three per 2000 births. The risk increases with the age of the mother. For mothers aged 20 years, one in 2000 babies has Down's syndrome; one in 900 for those aged 30 years; one in 100 for those aged 40 years; and one in 40 for those aged 45 years.
Advances in DNA technology have brought a new era in preventative medicine. We can now detect a large range of inherited diseases before birth, one of the most common of which is Down's syndrome.

## IX. Food for thought:

Modern genetics is making it much easier to detect genetic disorders and to screen potential parents, fetuses, and babies. Suggest what benefits and problems might be associated with large-scale genetic screening. How do you think society should deal with parents who choose to proceed with a pregnancy likely to bring into the world a child who has a genetic disorder?

## X. Translate into English using all the active possible:

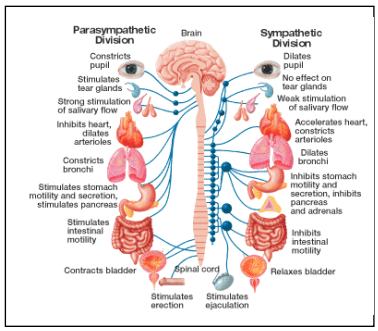
1. По всему миру вероятность синдрома Дауна равна 3 из 2000 рожденных.
2. Риск возрастает с возрастом матери.
3. Дети с синдромом Дауна обычно имеют круглое плоское лицо с широко посаженными глазами.
4. В дополнение к неспособности к обучению они также подвержены повышенному риску инфицирования (особенно респираторные и ушные инфекции), и кроме того сердечные заболевания случаются у каждого четвертого с синдромом Дауна.
5. Из-за высокого риска синдрома Дауна у новорожденных в Соединенном королевстве матерям старше 35 лет обычно предлагается бесплатное генетическое обследование, проводимое государственной медицинской службой.
6. После генетического обследования проводится генетическая консультация, которая дает советы и предоставляет информацию о риске генетического заболевания и его последствиях.
7. Консультирование является очень непростой задачей.
8. 8.Консультанты должны иметь хорошее понимание медицинской генетики и должны владеть методикой благожелательного консультирования.
9. Они должны давать информацию, которая может помочь клиентам принять собственное решение, вместо навязывания клиентам своей точки зрения.
10. Следует довести до клиентов, что признаки синдрома Дауна варьируют широко.
11. Заболевание часто приводит к сильной умственной отсталости, которая требует большой заботы. Но наряду с этим, многие люди с синдромом Дауна проживают долгую, независимую и полноценную жизнь, и часто эти люди бывают очень любящими.

## XI. Meet essential targets reflecting the following issues:

1. Explain how Down`s syndrome arises
2. Compare the main features of amniocentesis and chorionic villus sampling
3. Discuss the role of a genetic counselor.

# UNIT V. NERVOUS AND HORMONAL COORDINATION

## Text 5.1. Nerves And Hormones




**■ Essential targets:**

By the end of this spread you should be able to:

- explain how information is transferred in a multicellular animal
- compare nervous systems with endocrine systems.

*Pre-reading*

**■Talk about the following two questions with your partner. Then scan the text to compare your ideas with the author`s.**

1. What do you know about nerves` functions in human body?
2. In your opinion why is hormonal balance so important for humans?

**■ Read the given text and make your essential assignments:**

**Sensitivity: responding to stimuli**

All living organisms must be able to detect changes in their environment and respond appropriately. Changes in the environment are called **stimuli** (singular: stimulus). A stimulus may be in either the external environment (outside the organism) or the internal environment (inside the organism). Sensitivity, the ability to respond appropriately to stimuli, is one of the characteristic features of life. Each organism has its own specific type of sensitivity that improves its chances of survival. A single-celled amoeba, for example, can move away from a harmful stimulus such as very bright light, and move towards a favourable stimulus such as food molecules, but it can only distinguish between a limited number of different stimuli.

In an amoeba, the detection of the stimulus and the response to the stimulus must both take place in a single cell. However, in large multicellular animals such as mammals, stimuli are detected in sense organs, and organs that respond are called effectors. The sense organs and effectors may be in quite different parts of the body. In addition, responses usually involve the coordinated actions of many different parts of the body. To achieve this coordination, one part of the body must be able to pass information to another

part. In mammals, there are two major systems that convey information: the nervous system and the endocrine (hormonal) system.

**The nervous system**

Nervous systems range from the simple nerve nets of jellyfish and sea anemones, which have no brain and relatively few interconnections, to the nervous system of humans, with brains of staggering complexity. The human brain contains many millions of cells, each of which may communicate with thousands of other nerve cells. Their interconnections form circuits which enable us to control our muscles, think, remember, and even study our own brains.

All the various animal nervous systems are fast-acting communication systems containing nerve cells, neurones, which convey information in the form of nerve impulses (electrochemical changes). Neurones take various forms but each has a cell body, containing a nucleus, and nerve fibres, long extensions that transmit nerve impulses rapidly from one part of the body to another. Fibres carrying impulses away from the cell body are called axons; those carrying impulses towards the cell body are called dendrons. Apart from the main nerve fibre, there may be small dendrons (dendrites) extending from the cell body.

In mammals, sensory neurones carry messages from peripheral sense organs to a central nervous system (CNS) consisting of the brain and spinal cord. The CNS acts as an integration centre and processes information from many sources. Motor neurones convey instructions from the CNS to effector organs (mainly muscles and glands).

A mammalian motor neurone can convey information rapidly over considerable distances; for example, a single nerve impulse may be transmitted from the spinal cord to the feet in a few milliseconds. These fast-conducting neurones are enclosed along most of their length by a thick insulating material called the myelin sheath. The myelin sheath is produced by special supporting cells called Schwann cells. The sheath is essentially a series of cell membranes, each produced by a Schwann cell and wrapped many times around the axon. Gaps between the membranes of each Schwann cell, called the nodes of Ranvier**,** are the key to the fast transmission of nerve impulses.

Fast transmission enables mammals to respond almost instantaneously to stimuli. Nerve impulses can be directed along the nerve fibres to specific points in the body so that responses can be very localised.

**The endocrine system**

Typically, the nervous system is adapted to convey messages rapidly between specific locations so that quick responses can be made. In contrast, the endocrine system is adapted to carry information from one source to many destinations to bring about long-lasting responses.

The endocrine system consists of a number of glands that secrete hormones (organic chemicals, usually proteins or steroids). The glands of the endocrine system are called endocrine glands or ductless glands because they secrete their hormones directly into the bloodstream. Once inside a blood vessel, a hormone is carried in the bloodstream so that it can reach almost any cell in the body. However, each hormone has its own target cells on which it acts. Therefore, although all the hormones are transported together in the bloodstream, each has its own specific effect on the body. In some cases, a target cell has specific receptor molecules on its cell surface membrane which bind the hormone molecule. Once bound onto the membrane, the hormone brings about its response.

Endocrine glands occur at strategic points around the body. Their hormones regulate a wide range of activities, including blood glucose concentration, gastric secretion, heart rate, metabolism, growth rate, reproduction, and water balance.

**■ Glossary of essential terms for you to know**

| N | English term | Russian equivalent |
|---|---|---|
| 1. | stimulus | *зд.* раздражитель |
| 2. | single-celled | одноклеточный |
| 3. | multicellular | многоклеточный |
| 4. | effector | нервное окончание; эффектор |
| 5. | mammals | млекопитающие |
| 6. | favourable | благоприятный |
| 7. | sense organs | органы чувств |
| 8. | relatively | относительно; довольно |
| 9. | spinal cord | спинной мозг |
| 10. | characteristic features | отличительные признаки; характерные черты |
| 11. | to transmit nerve impulses | передавать нервные импульсы |
| 12. | the myelin sheath | миелиновая оболочка |
| 13. | ductless glands | железы внутренней секреции |
| 14. | bloodstream | кровоток |

| | | |
|---|---|---|
| 15. | blood vessel | кровеносный сосуд |
| 16. | heart rate | пульс (частота сердцебиений) |
| 17. | to respond to stimuli | реагировать на раздражители |
| 18. | cranial nerve | черепно-мозговой нерв |
| 19. | to process information | обрабатывать информацию |
| 20. | to enclose | окружать; окаймлять |
| 21. | insulating material | изолирующий материал |
| 22. | gastric secretion | желудочная секреция |

## ■ Your Essential Assignments

### I. Quick check

1. What is an axon?
2. In what form is information conveyed in:

a) the nervous system

b) the endocrine system?

### II. Using monolingual English dictionary write down what the words below mean:

The nodes of Ranvier, proteins, muscle, reproduction.

### III. Match the words with their definitions:

| Words | Definitions |
|---|---|
| 1. neurones | a) the ability to respond appropriately to stimuli |
| 2. stimuli | b) fibres carrying impulses away from the cell body |
| 3. axons | c) nerve cells which convey information in the form of nerve impulses |
| 4. schwann cells | d) fibres carrying impulses towards the cell body |
| 5. dendrons | f) a thing that produces a reaction in living things |
| 6. sensitivity | g) special supporting cells which produce the myelin sheath |

### IV. Match words in A with words in B to form word combinations. Make up sentences with them.

| A | B |
|---|---|
| 1. favourable | appropriately |
| 2. nervous | information |
| 3. to process | stimulus |
| 4. motor | material |
| 5. target | balance |

| | |
|---|---|
| 6. water | system |
| 7. to respond | neurones |
| 8. considerable | environment |
| 9. insulating | cell |
| 10. external | distances |

## V. Translate into English using all the active possible:

1. Железы внутренней секреции выделяют гормоны непосредственно в кровоток.
2. Эндокринная система состоит из некоторого количества желез, которые выделяют гормоны.
3. Реакции на раздражители обычно предполагают согласованные действия различных частей тела.
4. Центральная нервная система играет роль интеграционного центра и обрабатывает информацию из многих источников.
5. Каждый живой организм имеет свой тип чувствительности.
6. Гормоны регулируют такие процессы как частота сердцебиений, метаболизм, желудочная секреция и др.
7. Органы чувств и эффекторы находятся в разных частях тела.
8. Нервная система млекопитающих сложнее, чем нервная система одноклеточных организмов.
9. Нейроны передают информацию в форме нервных импульсов.
10. Концентрация глюкозы в крови регулируется эндокринной системой.

## VI. Fill in the gaps with the words and expressions from the text:

1. Nervous systems ____ ____ the simple nerve nets to the nerve system of humans.
2. The endocrine system _____ ____ a number of glands.
3. Endocrine glands ____ ____ strategic points ____ the body.
4. The CNS ____ ____ an integration centre and processes information from many sources.
5. In large multicellular animals ____ ____ mammals, stimuli are detected in sense organs.
6. In mammals, there are two ____ systems that convey information: the nervous system and the endocrine system.

7. ____ ____ the main nerve fibre, there may be small dendrons (dendrites) extending from the cell body.
8. Sensitivity, the ability to respond appropriately to stimuli, is one of the ____ ____ of life.
9. All living organisms must be able to ____ changes in their environment and respond ____.
10. Responses usually ____ the coordinated actions of many different parts of the body.

**VII. Answer the following questions. Use all information given before.**

1. What is sensitivity?
2. What do all animal nervous systems consist of?
3. Why are ductless glands called so?
4. What is the difference between sense organs and effectors?
5. What is CNS? What does it consist of?
6. What are two major systems that convey information in mammals?

**VIII. Find English equivalents to the following word combinations and make up sentences with them:**

| N | Russian term | English equivalent |
|---|---|---|
| 1. | главным образом, в основном | |
| 2. | передача нервных импульсов | |
| 3. | состоять из чего-либо | |
| 4. | находиться где-либо | |
| 5. | железы внутренней секреции | |
| 6. | выделять гормоны | |
| 7. | нервные волокна | |
| 8. | передавать информацию | |
| 9. | мозг человека | |
| 10. | содержать, заключать (в себе) | |
| 11. | реагировать соответственно, должным образом | |
| 12. | одноклеточный | |
| 13. | благоприятный | |
| 14. | ограниченное число / небольшое количество чего-либо | |

**IX. Read and translate the short text without any dictionary**

**Fact of life:**

Most nerve fibres are very thin (less than 10 um in diameter), but the giant nerve fibre of a squid may be more than 1 mm across.

**X. Food for thought.**

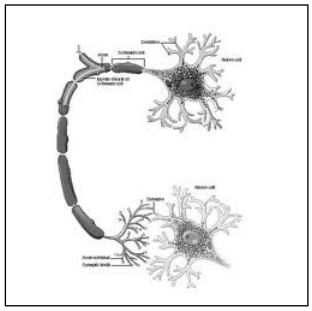
Squids can escape from danger because they have giant nerve fibres. These fibres can conduct nerve impulses very rapidly, since speed of conduction is directly related to the diameter of the fibre. Squids have nerve fibres of normal diameter to control their slow cruising movements, but giant nerve fibres control their rapid escape response. When danger threatens, giant nerve fibres carry information from the brain down the body, causing circular muscles to contract and force a jet of water out of the body, enabling the squid to make a quick backward escape.

***Suggest why squids have giant nerve fibres only for rapid escape responses. Why do mammals not require giant nerve fibres?***

**XI. Prepare a short presentation on 2 or 3 glands reflecting the following issues:**

- Type of gland, its position
- Type of hormone, its function
- Role of the hormone in human health

## Text 5.2. Setting up a nerve impulse



■ **Essential targets:**

By the end of this text you should be able to:

- explain how a resting potential is maintained
- explain how an action potential is generated.

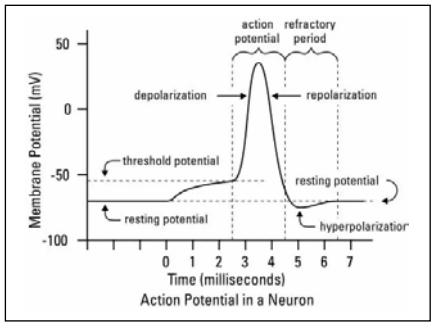
*Pre-reading*

■ **Discuss these questions with your partner. Then compare your ideas with the information given in the text.**

1. What do you know about the nature of nerve impulses?
2. Why are nerve impulses important for humans?

■ **Read the following text and make your essential assignments:**

**Investigating nerve impulses**



Action Potential in a Neuron

Nerves convey information rapidly from one part of the body to another, enabling animals to respond quickly to changes in their external and internal environments. The information is carried in the form of electrical signals called nerve impulses. Most of our understanding of the nature of nerve impulses comes from work done on giant axons of squids. These are the nerve fibres responsible for the rapid escape movements of squids. Their large diameter (up to 1 mm) makes it possible to measure the electrical activity in a giant axon when it is at rest and when it is conveying a nerve impulse.

A fine glass microelectrode is inserted inside an axon, and the voltage (potential difference; p.d.) between it and a reference electrode on the surface of the axon can be displayed on a cathode ray oscilloscope. By convention, the potential difference of the inside of the cell is always measured relative to that on the outside, so that the outside potential is taken as zero.

**Resting potential**

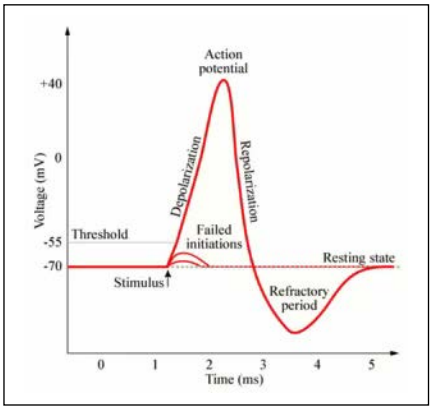
A resting neurone is so called because it does not convey a nerve impulse, not because it is inactive. On the contrary, a resting neurone expends much energy in maintaining a potential difference across its membrane. This is called the resting potential and measures about -70 millivolts.

During the resting potential, the inside of the neurone is negative relative to the outside because of an unequal distribution of charged ions. On the outside, sodium ions ($Na^+$), chloride ions ($Cl^-$), and calcium ions $Ca^{2+}$) are present in higher concentrations than inside the cell. By contrast, the inside of the cell has a higher concentration of potassium ions ($K^+$) and organic anions (negative ions).

This unequal distribution of ions results from a combination of active transport and diffusion of sodium and potassium ions across the cell membrane, and the inability of large organic anions to pass out of the cell. A sodium-potassium pump actively transports sodium ions out of the neurone and potassium ions in. For every three sodium ions pumped out, only two potassium ions are pumped inwards. On its own, this would result in only a slight potential difference across the membrane. However, this difference is amplified by the membrane being about 50 times more permeable to potassium

ions than to sodium ions. Potassium ions are able to diffuse freely back out of the cell down their concentration gradient, but the sodium ions diffuse back into the cell only very slowly. This creates a negative electrical charge inside compared with outside. Without active transport, an equilibrium would eventually be reached and there would be no potential difference across the membrane.

**Action potential**




A nerve impulse occurs when the resting potential across the membrane of a neurone has a sufficiently high stimulus. A stimulus is any disturbance in the external or internal environment which changes the potential difference across a membrane. The stimulus may be chemical, mechanical, thermal, or electrical, or it may be a change in light intensity.

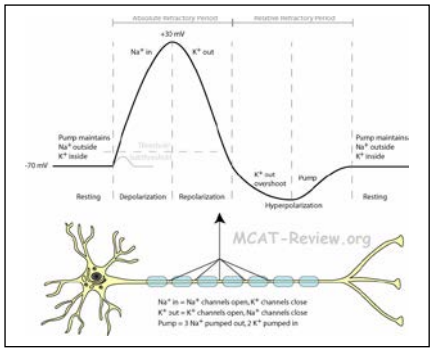
The recording on the cathode ray oscilloscope shows the effects of a stimulus on a giant axon. When the stimulus is applied, the axon becomes depolarised; that is, the inside becomes temporarily less negative. If the stimulus is strong enough (if it exceeds the threshold level), an action potential occurs. There is a complete reversal of the charge across the nerve cell: the interior becomes positively charged relative to the outside. Typically, the action potential reaches a peak of about +35 millivolts. The potential difference then drops back down, undershoots the resting potential and finally returns to it. The return of the potential difference towards the resting potential is called repolarisation. The entire action potential takes about 7 milliseconds. Although this example refers specifically to a giant axon, its general features apply to all animal neurones.

**Ion channels and action potentials**

The action potential results from the changes in the permeability of cell membranes to ions. At rest, the membrane permeability of a nerve fibre is thought to depend on ion channels through which specific ions can move. An ion channel consists of a protein molecule spanning the membrane, with a pore through the centre. Sodium ions move through one type of channel and potassium ions through another. There are many more of these ion channels for potassium than for sodium, therefore at rest the membrane permeability to potassium ions is much greater than that to sodium ions.

During an action potential, special ion channels control ion movements across the membrane. These channels are believed to have voltage-sensitive

gates that open and close in response to voltage changes, and are therefore called voltage-gated ion channels.




During the resting potential, the voltage-gated sodium and potassium ion channels are closed. When a stimulus is applied, sodium ion channels open rapidly, sodium ions move in, and the inside becomes more positive. If the stimulus reaches the threshold level, an action potential occurs. When the action potential reaches its peak, the sodium ion channels close slowly and potassium ion channels open slowly. Sodium ions stop moving into the cell but potassium ions diffuse more rapidly out. These changes cause the potential difference to drop. When the membrane returns to its resting potential, potassium ion channels close, but because they do this slowly, the potential dips below the resting level. Finally, when the potassium ion channels are closed, the membrane returns to its resting condition.

So far, we have examined how an action potential is generated at the point of stimulation. However, this is only the first step in the propagation of a nerve impulse along a neurone. These localised action potentials are converted into nerve impulses which transmit information from one part of a neurone to another neurone or to an effector such as a muscle or a gland.

Action potentials obey the all-or-none law. This means that no matter how strong the stimulus, the size of an action potential is always the same. Therefore, information about the strength of a stimulus is carried along a nerve fibre not as variations in the size of nerve impulses, but by changes in their frequency. The next spread discusses these points more fully.

**■ Glossary of essential terms for you to know**

| N | English term | Russian equivalent |
|---|---|---|
| 1. | voltage | электрическое напряжение |
| 2. | potential difference | *зд.* разница потенциалов |
| 3. | reference electrode | контрольный электрод |
| 4. | cathode ray oscilloscope | электролучевой / катодный / электронный осциллоскоп |
| 5. | by convention | условно считается, что; обычно, по определению; |
| 6. | relative to smth. | относительно чего-л. |
| 7. | resting potential | потенциал покоя; остаточный |

| | | |
|---|---|---|
| | | потенциал |
| 8. | on the contrary | напротив; на самом деле |
| 9. | to result from sth. | быть следствием, происходить в результате чего-л. |
| 10. | sodium-potassium pump | калиево-натриевый насос |
| 11. | to pump out | выкачивать, высасывать |
| 12. | on its own | сам по себе |
| 13. | permeable | проницаемый |
| 14. | concentration gradient | градиент концентрации; перепад концентраций |
| 15. | equilibrium | равновесие, баланс |
| 16. | action potential | потенциал действия |
| 17. | reversal of charge | перезарядка; перемена знака заряда |
| 18. | to reach a peak | достигнуть высшей точки |
| 19. | at rest | в состоянии покоя; в неподвижном состоянии |
| 20. | voltage-sensitive | потенциалочувствительный |
| 21. | voltage change | скачкообразное изменение напряжения |
| 22. | voltage-gated | потенциалозависимый |
| 23. | all-or-none law | закон «всё или ничего» |

## ■ Your Essential Assignments.

### I. Quick check

What are the main factors that determine the resting potential of a neurone?

### II. Using monolingual English dictionary write down what the words below mean:

To insert, surface, to expend, charged, to amplify, to exceed.

### III. Match the words in the left column with the definitions in the right:

| | | |
|---|---|---|
| 1. | ion channels | a) electrical signals conveyed by neurones |
| 2. | repolarisation | b) channels which have voltage-sensitive gates that open and close in response to voltage changes |
| 3. | resting neurone | c) channels through which specific ions can move |
| 4. | all-or-none law | d) neurone which doesn`t convey a nerve impulse |

| | | |
|---|---|---|
| 5. | nerve impulse | e) no matter how strong the stimulus, the size of an action is always the same |
| 6. | voltage-gated ion channels | f) the return of the potential difference towards the resting potential |

**IV. Match words in A with words in B to form word combinations. Make up sentences with them.**

| A | B |
|---|---|
| resting; escape; external; sodium; light; potential; electrical; to respond; nerve; to reach | charge; fibres; potential; a peak; intensity; movements; quickly; difference; environment; ions. |

**V. Answer the following questions. Use all information given before:**

1. Why are voltage-gated ion channels called so?
2. What the function of a sodium-potassium pump is?
3. What does the membrane permeability of a nerve fibre depend on?
4. What does an ion channel consist of?
5. What does the all-or-none law mean?

**VI. Translate into English using all the active possible:**

1. Внутреннее пространство нейрона заряжено отрицательно относительно внешнего в связи с неравномерным распределением заряженных ионов.
2. Величина потенциала действия не зависит от раздражителя.
3. Животные могут быстро реагировать на изменения в окружающей среде в связи со способностью нервных волокон быстро передавать информацию.
4. Нервный импульс – это информация, которая передаётся в форме электрических сигналов.
5. Возникновение нервного импульса связано с достаточно сильным раздражителем.

**VII. Find English equivalents to the following word combinations and make up sentences with them:**

| N | Russian Term | English equivalent |
|---|---|---|
| 1. | Внутреннее пространство (нейрона) | |
| 2. | Величина потенциала | |
| 3. | Реагировать быстро | |
| 4. | Состояние покоя | |
| 5. | Разница потенциалов | |
| 6. | Достигнуть порогового уровня | |
| 7. | Подчиняться закону | |
| 8. | Неравномерное распределение | |
| 9. | Мерить, измерять | |
| 10. | Полная перезарядка (перемена знака заряда) | |

**VIII. Read and translate the short text without any dictionary**

**Fact of life:**

Puffer fish produce a highly potent neurotoxin called tetrodotoxin. This selectively blocks the entry of sodium ions into nerve and muscle cells during an action potential, preventing the generation of nerve impulses and muscle contractions.

**IX. State whether the voltage-gated potassium ion channels and the voltage-gated sodium ion channels in a neurone membrane are open or closed:**

a) during the resting phase
b) during the depolarisation phase of the action potential
c) in the repolarisation phase
d) during the undershoot.

**X. Suggest why depolarisation is not a good word for describing what happens during the transmission of an action potential.**

**XI. Explain how resting potential and action potential are connected with each other.**

# UNIT VI. EVOLUTION

## Text 6.1. Theories Of Evolution

■ **Essential targets:**

By the end of this text you should be able to:

- explain the biological meaning of evolution;
- distinguish between neo-Darvinism and Darvinism.

*Pre-reading*

■ **Working in pairs, try to answer the following questions before you read the text. When you have finished, check your answers by reading the text.**

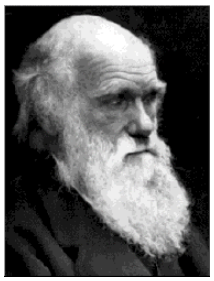
1. What is evolution? How does it happen?
2. What is a species?
3. What is natural selection?
4. What theory did Darwin develop?

■ **Read the given text and make your essential assignments:**

One of the most fundamental questions in biology is: where do all living things come from? According to most biologists, the millions of species living on Earth today (including humans) are descended from other species that inhabited the world in the past. This change has come about by a process called evolution. Evolution happens when the genetic composition (allele frequency) of a population changes over successive generations. When the changes are sufficiently great, a new species may be formed. (A species is a group of closely related organisms potentially capable of interbreeding to produce fertile offspring.)

**The mechanism of evolution.**

Evolution is not a modern concept. Since ancient times, a number of philosophers and naturalists (including Confucius and Aristotle in Greece) have suggested that complex species evolve from simpler pre-existing ones by a process of continuous and gradual change. However, it was not until the 19$^{th}$ century that scientists came up with plausible mechanisms for evolution. The mechanism that is widely accepted among biologists today is called neo-Darwinism. It is modern theory based on the work of the nineteenth- century naturalist Charles Darwin.



Between 1831 and 1836, Darwin was the naturalist on board HMS Beagle, a research vessel engaged in mapping different parts of the world. After spending over three years surveying the coast of South America, the Beagle landed on the Galapagos Islands in the Pacific Ocean. Darwin compared the organisms on these islands with those on the South American mainland, and this led him to develop his theory of evolution. He came to the conclusion that, over successive generation, a new species comes into being by slow and gradual changes from a pre-existing one. He believed that these changes are brought about by a process which he called natural selection.

Darwin's theory was based on three main observations:

1. Within a population are organisms with varying characteristics, and these variations are inherited (at least in part) by their offspring.

2. Organisms produce more offspring than are required to replace their parents.

3. On average, population numbers remain relatively constant and no population gets bigger indefinitely.

From these observations, Darwin came to the conclusion that within a population many individuals do not survive, or fail to reproduce. There is a "struggle for existence". For example, members of the same population compete to obtain limited resources, and there is a struggle to avoid predation and disease, or to tolerate changes in environmental conditions such as temperature. In this struggle for existence those individuals that are best adapted to their environment will have a selective advantage: they will be more likely to survive and produce offspring than less well-adapted organisms.

**The origin of species**

For more than 20 years, Darwin collected evidence to support his theory and refined his ideas. He delayed publishing his ideas until 1858, when Alfred Russel Wallace sent him a letter describing a theory of evolution identical to Darwin's own. Wallace was a British naturalist who had worked in the Malay Archipelago for eight years. He concluded from his research that some organisms live while others die because of differences in their characteristics, such as their ability to resist disease or escape predation. Darwin and Wallace published a paper jointly describing their theory of evolution by natural selection. However, Darwin's name has become more strongly linked with the theory because of a book he published on 24 November 1859. The book, entitled "The Origin of Species by Means of Natural Selection or the Preservations of Favoured Races in the Struggle for Life", has been called the most important biology book ever written. It not only gives a full description of the theory of evolution by natural selection, but also contains a huge mass of evidence to support the theory.

**The reaction to Darwin.**

Many people found it difficult to accept Darwin's ideas, especially the idea that modern humans and apes are probably descended from a common ancestor. However, his theory is supported by so much evidence that the majority of biologists accept it. Evolution by natural selection has become a central theme which underpins much of modern biology. The modern theory of evolution is called neo-Darwinism because it incorporates new scientific evidence, particularly from genetics and molecular biology. For example, we know that the variations that are so important in natural selection come about by random and spontaneous changes in genes, particularly from mutations in reproductive cells. Despite modifications to Darwin's theory in neo-Darwinism, natural selection is still the driving force behind evolution, or the theory of evolution by the natural selection of inherited characteristics.

**■ Glossary of essential terms for you to know**

| № | English term | Russian equivalent |
|---|---|---|
| 1 | to accept | принимать |
| 2 | to inhabit | населять |
| 3 | to descend | происходить |
| 4 | to interbreed | скрещивать |
| 5 | offspring | потомство |
| 6 | to suggest | предполагать |
| 7 | to bring about | осуществлять; вызывать |
| 8 | capable of | способный |
| 9 | species | вид |
| 10 | to evolve | развивать |
| 11 | gradual | постепенный |
| 12 | to compete | соревноваться |
| 13 | coast | побережье |
| 14 | to obtain | получать |
| 15 | to refine | совершенствовать |
| 16 | pre-existing | ранее существовавший |
| 17 | to develop | развивать |
| 18 | to replace | заменять |
| 19 | mainland | материк |
| 20 | to reproduce | размножаться |
| 21 | successive | последующий |
| 22 | selection | отбор |
| 23 | to vary | меняться |
| 24 | on average | в среднем |
| 25 | relatively | относительно |

| | | |
|---|---|---|
| 26 | observation | наблюдение |
| 27 | to fail | не суметь, провалить |
| 28 | struggle | борьба |
| 29 | existence | существование |
| 30 | to exist | существовать |
| 31 | disease | болезнь |
| 32 | generation | поколение |
| 33 | environment | окружающая среда |
| 34 | advantage | преимущество |
| 35 | well-adapted | хорошо приспособленный |
| 36 | evidence | свидетельство |
| 37 | to describe | описывать |
| 38 | to produce | производить |
| 39 | to conclude | сделать вывод, заключить |
| 40 | to resist | сопротивляться |
| 41 | research | исследование |
| 42 | by means | посредством |
| 43 | to support | поддержать |
| 44 | apes | приматы |
| 45 | genetics | генетика |
| 46 | cell | клетка |
| 47 | to survive | выжить; пережить |

## ■ Your Essential Assignments

### I. Quick check:

1. Give the biological meaning of evolution.
2. How does neo-Darwinism differ from Darwin's original theory of evolution?

### II. Fill in the missing words:

| Term (verb) | Noun | Adjective |
|---|---|---|
| exist | ..... | ..... |
| suggest | ..... | ..... |
| reproduce | ..... | ..... |
| develop | ..... | ..... |
| inherit | ..... | ..... |
| inhabit | ..... | ..... |
| evolve | ..... | ..... |
| select | ….. | …… |

**III. Use monolingual English dictionary and write down what could the words given below mean:**

change, naturalist, complex, to escape, to collect, humans.

**IV. Match these words with their definitions:**

| | | | |
|---|---|---|---|
| **1** | generation | **A.** | an illness or unhealthy condition in your body |
| **2** | evolution | **B.** | the air, water and land in which people, animals and plants live |
| **3** | evidence | **C.** | a member of your family who lived a long time ago |
| **4** | reproduce | **D.** | the careful choice of a particular person or thing from among a group of similar people or things |
| **5** | species | **E.** | to continue to live or exist |
| **6** | survive | **F.** | to change into a larger, stronger, or more advanced state |
| **7.** | ancestor | **G.** | to produce young animals from parents of different breeds or groups |
| **8.** | develop | **H.** | all the members of a group of things which have been developed from a previous group |
| **9.** | naturalist | **I.** | an animal's baby or babies |
| **10** | environment | **J.** | the state of existing |
| **11** | selection | **K.** | the gradual change and development |
| **12.** | disease | **L.** | to produce young animals or plants |
| **13.** | interbreed | **M.** | someone who studies plants or animals, especially outdoors |
| **14.** | offspring | **N.** | facts that make you believe that something exist or is true |
| **15.** | existence | **O.** | a group of closely related organisms |

**V. Find English equivalents to the following word combinations:**

| № | Russian term | English equivalent |
|---|---|---|
| 1. | произошедший от | |
| 2. | тесно связанный | |
| 3. | последующие поколения | |
| 4. | живущие на земле | |
| 5. | производить оплодотворенное потомство | |
| 6. | генетический состав | |
| 7. | придти к выводу | |
| 8. | относительно постоянный | |
| 9. | собирать свидетельства | |
| 10. | сопротивляться болезни | |

| | | |
|---|---|---|
| 11. | генетика и молекулярная биология | |
| 12. | случайные и спонтанные изменения | |
| 13. | мутации в репродуктивных клетках | |
| 14. | большинство биологов | |
| 15. | естественный отбор | |

## VI. Give Russian equivalents to the following English terms:

| № | English term | Russian equivalent |
|---|---|---|
| 1 | according to | |
| 2 | inhabited the world in the past | |
| 3 | sufficiently great | |
| 4 | continuous and gradual change | |
| 5 | widely accepted among biologists | |
| 6 | to develop the theory | |
| 7 | natural selection | |
| 8 | with varying characteristics | |
| 9 | struggle for existence | |
| 10 | to obtain limited resources | |
| 11 | best adapted to their environment | |
| 12 | to escape predation | |
| 13 | a full description of the theory of evolution | |
| 14 | a common ancestor | |

## VII. Find synonyms among the pool of words:

| Pool of words | Synonyms |
|---|---|
| **1)**1.develop/2.accept/3.change/4.alter/5.evolve/6.obtain | |
| **2)**1.support /2.happen/3.exist/4.occur/5.underpin /6.live | |
| **3)**1. investigation /2.selection /3.research /4. choice | |
| **4**)1.escape/2.disease/3.individual/4.get away/5.illness/ 6.human being | |

## VIII. Answer the following questions. Use all information given before:

1. How does the evolution usually take place?
2. What led Charles Darwin to develop his theory of evolution?
3. What did Darwin mean by “natural selection”?
4. What are three main observations of Darwin’s theory?
5. What does “struggle for existence” mean?
6. What book has been called the most important biology book ever written?
7. Do the majority of biologists accept Darwin’s theory?
8. What is called neo-Darwinism?

## IX. Match the sentence halves. Make complete sentences:

| | | | |
|---|---|---|---|
| **1.** | According to most biologists, the millions of species living on Earth today | **A.** | is called neo-Darwinism. |
| **2.** | Evolution happens | **B.** | than are required to replace their parents. |
| **3.** | The mechanism that is widely accepted among biologists today | **C.** | to support his theory and refined his ideas. |
| **4.** | Organisms produce more offspring | **D.** | which underpins much of modern biology. |
| **5.** | Members of the same population compete | **E.** | are descended from other species that inhabited the world in the past. |
| **6.** | For more than 20 years, Darwin collected evidence | **F.** | come about by random and spontaneous changes in genes. |
| **7.** | Evolution by natural selection has become a central theme | **G.** | to obtain limited resources. |
| **8.** | The variations that are so important in natural selection | **H.** | when the genetic composition of a population changes over successive generations. |

## X. Read and translate the short text without any dictionary:

**Fact of life:** Highly sensitive dating techniques tell us that the Earth is between 4.5 and 5.0 thousand million years old. It is generally agreed by scientists that the Earth was originally devoid of life, and that the first living organisms arose by biochemical evolution from complex organic chemicals formed in the atmosphere and seas of early Earth. These first forms of life gave rise to countless millions of species. Most have become extinct, but some have evolved into organisms found today. According to the latest estimates, 20-30 million species share our planet.

## XI. Food for thought:

In 1809 Jean-Baptiste de Lamark suggested that the driving force behind evolution was the need for organisms to adapt to changing environmental conditions. His theory became known as the theory of evolution by the inheritance of acquired characteristics. He believed that adaptations developed

by an organism during its lifetime could be passed on to its offspring. According to Lamark, modern giraffes might have evolved from a short-necked ancestors in the following way. Giraffes feed on leaves ripped off the branches of trees. When leaves on the lower branches were removed, or when the trees became taller, the ancestral giraffe needed to stretch to reach leaves on higher branches. By continually stretching, their necks lengthened and the ability to grow a slightly longer neck was inherited by the next generation which carried on stretching, and so on.

We know that this explanation of the evolution of the giraffe's neck is untrue because activities such as stretching to feed do not affect the gametes. Therefore, this type of characteristic acquired during the life of an organism is not inherited by its offspring. Expressed in modern terms, Lamarckism would mean that changes in phenotype could determine the genotype of future generations. This does not agree with modern genetics, and there are no generally accepted examples of acquired characteristics being inherited. Suggest a neo-Darwinian explanation for the evolution of the modern long-necked giraffe from a short-necked ancestor.

## Text 6.2. Natural Selection

■ **Essential targets:**

By the end of this text you should be able to:

- explain what is meant by " survival of the fittest";
- distinguish between directional selection, stabilising selection, disruptive selection.

*Pre-reading*

■ **With a partner consider the following questions and try to answer them. Then scan the text to check your answers.**

1. What is natural selection?
2. What environmental factors effect on surviving and producing offspring?

■ **Read the given text and make your essential assignments:**

**Survival of the fittest**

Darwin had the idea that natural selection is the mechanism that drives evolution after reading *An Essay on the Principal of Population* by Thomas Malthus, a clergyman and political economist. Malthus argued that, in time, the growth of human populations will outstrip the food supply, and that this will lead to "famine, pestilence, and war". Darwin applied this idea to populations

of other animals and of plants. In his book on the origin of species, Darwin wrote: “There is no exception to the rule that every organic being naturally increases at so high a rate that if not destroyed, the Earth would soon be covered by the progeny of a single pair”. In spite of reproducing quickly, no single species has completely over-run the planet, although the populations of some species may be increasing at any one particular time. Darwin concluded that populations are kept in check by a “struggle for existence” as they compete for limited resources and are exposed to disease. Environmental factors that keep populations in check are called selection pressures or environmental resistances. These include:

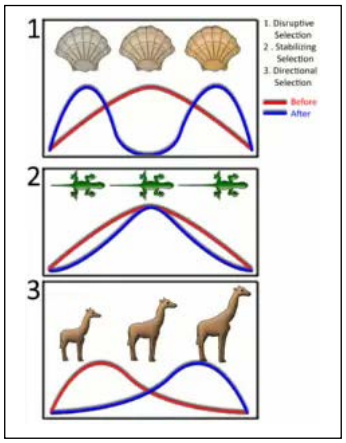
- disease
- competition for resources such as food and a place in which to live
- predation
- lack of light, water, or oxygen
- changes in temperature.

Those organisms best suited to the environmental conditions, with characteristics that give them an advantage in the “struggle for existence”, will have the best chance of surviving and producing offspring. Their high natality (birth rate) gives them a selective advantage. On the other hand, those will unfavourable characteristics are more likely to die. Their high mortality (death rate) gives them a selective disadvantage. Darwin argued that this difference in natality and mortality results in natural selection. As environmental conditions change certain characteristics within a randomly varying population are favoured, and natural selection occurs. This has become known as the “survival of the fittest”.

In evolution, fitness is defined as the ability of an organism to pass on its alleles to subsequent generations, compared with other individuals of the same species. The “fittest” individual in a population is the one that produces the largest number of offspring that survive to reproduce themselves. Natural selection by “survival of the fittest” means that the genetic characteristics of a population gradually change from generation to generation in response to changes in the environment. As we shall see in the following spreads, natural selection affects a gene pool by increasing the frequency of alleles that give an advantage, and reducing the frequency of alleles that give a disadvantage. (A gene pool is all the genes and their different alleles present in an interbreeding population.)

**Three types of natural selection**

Natural selection is not always a mechanism for change. There three different types: stabilising selection, directional selection, and disruptive selection. These are three different ways in which natural selection acts on the phenotypes in a population (the observable characteristics such as colour or




height). Typically, the frequency in the population of each phenotype has a normal distribution, described by a bell-shaped curve.

**Stabilising selection** happens in an unchanging environment. Extremes of the phenotype range are selected against, leading to a reduction in variation (more individuals tend to conform to the mean). Stabilising selection occurs in the natural selection of birth mass in humans.

**Directional selection** favours one extreme of the phenotype range and results in a shift of the mean either to the right or to the left. This type of selection usually follows some kind of environmental change. The long neck of the giraffe is thought to have evolved in this way. Probably, when food was in short supply, only the tallest individuals could reach enough food to survive. They passed on their genes to the next generation.

**Disruptive selection** selects against intermediate phenotypes and favours those at the extremes. This leads to a bimodal distribution (the distribution curve has two peaks or modes) and two overlapping groups of phenotypes. If the two groups become unable to interbreed, then each population may give rise to a new species. Disruptive selection may have contributed to the evolution of Darwin's finches. Because there were few other birds to compete, finches with short strong beaks had exclusive use of nuts as a food source, while those with long slender beaks had almost exclusive use of insects. Those finches with an average, unspecialised beak were more likely to have been in completion with other species of bird and would have reproduced less successfully.

**■ Glossary of essential terms for you to know**

| № | English term | Russian equivalent |
|---|---|---|
| 1 | natural | естественный |
| 2 | selection | отбор |
| 3 | growth | Рост |
| 4 | famine | голод |
| 5 | pestilence | Чума |
| 6 | progeny | потомство |
| 7 | origin | происхождение |
| 8 | to increase | увеличиваться |
| 9 | disease | болезнь |
| 10 | lack of sth | недостаток ч.-л. |
| 11 | condition | условие |
| 12 | to suit | подходить |
| 13 | natality | рождаемость |

| | | |
|---|---|---|
| 14 | mortality | смертность |
| 15 | favourable | благоприятный |
| 16 | fitness | приспособленность |
| 17 | frequency | частота |
| 18 | disruptive | разрушительный |
| 19 | curve | изгиб |
| 20 | either….or | Или…..или, либо……либо |
| 21 | in response to | в ответ на …… |
| 22 | to occur | происходить |
| 23 | to give rise to | давать начало чему-либо |
| 24 | finch | зяблик |
| 25 | beak | Клюв |
| 26 | insect | насекомое |

## ■ Your Essential Assignments

### I. Quick check

1. What is meant by fitness in evolutionary terms?
2. Some individuals of the European swallowtail butterfly (Papilio machaon) pupate on brown stems or leaves; others pupate on green stems or leaves. Two distinct colour forms of the pupae are found, namely brown and green, with very few intermediates.
    a. What type of natural selection does this example show?
    b. Explain why the intermediate colour forms would be at a selective disadvantage?

### II. Fill in the missing words:

| Term (verb) | Noun | Adjective |
|---|---|---|
| argue | ..... | ..... |
| occur | ..... | ..... |
| increase | ..... | ..... |
| compete | ..... | ..... |
| expose | ..... | ..... |
| survive | ..... | ..... |
| distribute | ..... | ..... |
| describe | ….. | …… |

### III. Use monolingual English dictionary and write down what could the words given below mean:

species, existence, selection, environment, to occur, gene.

## IV. Match these words with their definitions:

| | | | |
|---|---|---|---|
| **1** | outstrip | **A.** | a group of closely related organisms |
| **2** | origin | **B.** | a living creature such as a dog or cat |
| **3** | disease | **C.** | becoming firm, steady or unchanging |
| **4** | selection | **D.** | the situation, place, or physical matter from which something begins |
| **5** | species | **E.** | birth rate |
| **6** | plant | **F.** | prevents something from continuing in its usual way and causes trouble |
| **7.** | animal | **G.** | an illness or unhealthy condition in your body |
| **8.** | favourable | **H.** | to be greater in quantity than something else |
| **9.** | natality | **I.** | an animal's baby or babies |
| **10** | directional | **J.** | a small part of the material inside the nucleus of a cell |
| **11** | stabilising | **K.** | a living thing that has leaves and roots and grows in earth |
| **12.** | disruptive | **L.** | to do something that produces an effect or change in someone or something |
| **13.** | gene | **M.** | the careful choice of a particular person or thing from among a group of similar people or things |
| **14.** | offspring | **N.** | suitable and likely to make something happen or succeed |
| **15.** | affect | **O.** | pointing in a particular direction |

## V. Find English equivalents to the following word combinations:

| № | Russian term | English equivalent |
|---|---|---|
| 1 | запасы еды | |
| 2 | применить к ….. | |
| 3 | происхождение видов | |
| 4 | несмотря на | |
| 5 | ограниченные ресурсы | |
| 6 | факторы окружающей среды | |
| 7 | недостаток света, воды, кислорода | |
| 8 | высокая рождаемость | |
| 9 | высокая смертность | |
| 10 | приводит к естественному отбору | |
| 11 | способность организма | |
| 12 | генетические характеристики | |
| 13 | в ответ на изменения в окружающей среде | |
| 14 | давать начало новому виду | |
| 15 | короткие сильные клювы | |

## VI. Give Russian equivalents to the following English terms:

| № | English term | Russian equivalent |
|---|---|---|
| 1 | to over-run the planet | |
| 2 | struggle for existence | |
| 3 | selection pressures | |
| 4 | environmental resistances | |
| 5 | to expose to disease | |
| 6 | changes in temperature | |
| 7 | best suited to the environmental conditions | |
| 8 | to give an advantage in … | |
| 9 | the best chance of surviving and producing offspring | |
| 10 | selective disadvantage | |
| 11 | survival of the fittest | |
| 12 | compared with other individuals | |
| 13 | gradually change from generation to generation | |
| 14 | to act on the phenotypes in a population | |
| 15 | to become unable to interbreed | |

## VII. Find synonyms among the pool of words:

| Pool of words | Synonyms |
|---|---|
| **1)**1.offspring /2.struggle /3.change /4.progeny /5.battle / 6. alteration | |
| **2)** 1.gradually /2.surroundings /3. steadily /4.environment | |
| **3)** 1.population/ 2.resource/ 3.reduction/ 4.inhabitants/ 5.supply/ 6.decrease | |
| **4)** 1.quickly/ 2.survive/ 3.superiority/ 4.fast/ 5.advantage/ 6.remain alive | |

## VIII. Answer the following questions. Use all information given before:

1. What might lead to famine, pestilence and war?
2. What is called selection pressures?
3. What environmental factors do selection pressures include?
4. What organisms will have the best chance of surviving and producing their offspring?
5. Why does the difference in natality and mortality result in natural selection?
6. What is meant by “survival of the fittest”?
7. How is fitness defined in evolution?

8. What are three types of natural selection?
9. What is the difference between them?

## IX. Match the sentence halves. Make complete sentences:

| | | | |
|---|---|---|---|
| **1.** | Those organisms best suited to the environmental conditions, with characteristics that give them an advantage in the "struggle for existence", | **A.** | although the populations of some species may be increasing at any one particular time. |
| **2.** | Environmental factors that keep populations in check | **B.** | results in natural selection. |
| **3.** | Darwin argued that this difference in natality and mortality | **C.** | from generation to generation in response to changes in the environment. |
| **4.** | In spite of reproducing quickly, no single species has completely over-run the planet, | **D.** | will have the best chance of surviving and producing offspring. |
| **5.** | The "fittest" individual in a population is the one that produces | **E.** | in an unchanging environment. |
| **6.** | Stabilising selection occurs | **F.** | are called selection pressures. |
| **7.** | Natural selection by "survival of the fittest" means that the genetic characteristics of a population gradually change | **G.** | the largest number of offspring that survive to reproduce themselves. |
| **8.** | Stabilising selection happens | **H.** | in the natural selection of birth mass in humans. |

## X. Read and translate the short text without any dictionary:

**Fact of life:**

You may think that natural selection results in change and diversification. This is not always the case. For example, natural selection helps to keep the average birth mass for human babies around 3.3 kg. Not surprisingly, extremely small or large babies have low rates of survival under natural conditions.

## XI. Food for thought:

The extinction of animal and plants species is of great concern today because it is accelerated by direct and indirect results of human activities. However, extinction is a natural process that has occurred since the dawn of life. The 20-30 million species that inhabit the Earth today represent only a minute proportion of all species that have ever existed. Suggest why more than 99.9 per cent of all species that ever evolved have become extinct by natural processes. Explain why the highest rates of extinction in recent times have occurred among species that live only on small oceanic islands.

## Text 6.3. Artificial Selection

■ **Essential targets:**

By the end of this text you should be able to:

- describe one example of artificial selection;
- distinguish between inbreeding and outbreeding;
- explain the meaning of hybrid vigour.

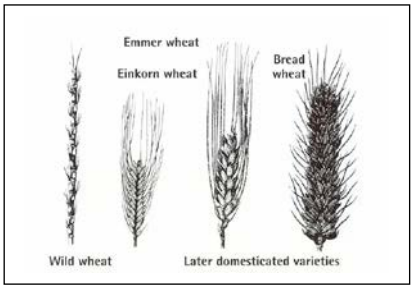
*Pre-reading*

**■ In a small group discuss the current problems associated with the artificial selection and then try and answer the following questions:**

1. How do you understand artificial selection?
2. Do you have any ideas about how wheat cultivation began?
3. Can you explain the difference between inbreeding and outbreeding?

■ **Read the given text and make your essential assignments:**

**The cultivation of wheat**




Ever since farming began in the Middle East about 10 000 years ago, humans have been breeding animals and plants selectively to produce specific desirable qualities. Wheat was probably among the first crop to be cultivated. By selective breeding over thousands of generations, wild wheat has been converted into the modern types which produce much higher yields. In selective breeding, particular individuals are chosen and allowed to breed, whereas others are prevented from breeding. This means that alleles that give characteristics favoured by humans are retained, while those that give

undesirable characteristics are eliminated. Artificial selection is therefore similar to directional selection, in that selection pressure brings about a gradual change in the genotype of a group of organisms. However, in artificial selection it is humans, not environmental factors, that act as the selection pressure, gradually bringing about changes in allele frequencies.

We can only speculate as to how wheat cultivation began. Perhaps people who gathered wild seeds for food observed that seeds spilled accidentally sprouted new plants from which more seeds could be harvested. This might have encouraged them to save some seeds to sow for the following season's crop.

Wild wheat sheds its grains as soon as they are ripe. This makes harvesting difficult. Therefore, grains were most likely to be gathered from plants that by chance retained their grains a little longer. By using this grain for the next crop, farmers would inadvertently have started the process of selective breeding.

The next stage in the cultivation of wheat would have been the deliberate selection of varieties with desirable qualities. Early farmers appear to have selected grains from plants which gave the greatest yield, and produced grain which was easy to separate from its husk. Eventually, over many generations, the variety of cultivated wheat changed. This led to the ancestor of our modern wheat, in which the grains are held so firmly that they must be removed by a separate operation after harvest. Selective breeding of wheat continues today by a combination of inbreeding and outbreeding.

**Inbreeding** involves breeding between closely related individuals which by chance, possess some desirable character. In wheat, desirable characters include:

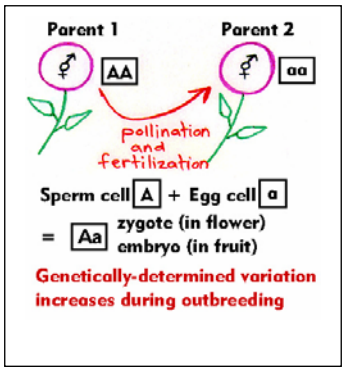
- high yield
- short stem length (allowing the plant to devote more energy to the production of seeds, which have a much higher value than straw from stems)
- pest resistance (for example, to fungal moulds and rusts)
- high protein content of the grain.

Inbreeding is carried out to try and retain the desirable characters in future generations. Wheat plants are particularly suitable for selective breeding because they self pollinate naturally. They are unlikely to cross fertilise without the intervention of the plant breeder.

Inbreeding allows a farmer to produce a uniform crop which is easy to harvest and has, given certain conditions, predictable characters. However, this uniformity of characters is at the expense of genetic diversity may be reduced to such an extent that every individual has identical alleles (a condition known as complete homozygosity). Such a wheat strain cannot be changed because

there are no other alleles present that could produce genetically different plants. Another problem is that if genetically identical plants are exposed to new diseases to which the plants have no resistance, all the plants may be killed.

Similar techniques of selective breeding have been used to develop domestic and farm animals. Although complete homozygosity has not been reached in any animals, inbreeding increases the risk of a harmful recessive allele occurring in the homozygous condition and being expressed. Because of these disadvantages, inbreeding is not carried out indefinitely. New alleles are introduced by outbreeding with other stock.




**Outbreeding** involves crossing individuals from genetically distinct strains. The offspring from such a cross are called hybrids. If the parental stocks are pure breeding, the offspring are called F1 hybrids. F1 hybrids often have characters, such as grain yield in wheat, which are superior to the characters in either parent. This phenomenon is called hybrid vigour or heterosis. Hybrid vigour probably results from an increased heterozygosity arising from the mixing of alleles. Harmful recessive alleles are less likely to be present in the homozygous condition. Hybrid vigour is also thought to result from some form of interaction between particular combinations of alleles in the hybrid. Whatever the explanation of hybrid vigour, if the descendants of F1 hybrids are continually inbred, the vigour decreases as the plant become more homozygous again.

Outbreeding depends on the availability of genetically distinct animals and plants. It is therefore important to maintain sources of genetic diversity. This may be done by maintaining seed banks of old or wild varieties of plants (the genetic diversity of wheat, rice, cabbages, and carrots is maintained in this way). Also, adults of old varieties of animals and plants with little or no commercial value may be maintained as a source of new alleles for future breeding programmes.

## ■ Glossary of essential terms for you to know:

| № | English term | Russian equivalent |
|---|---|---|
| 1 | to breed | разводить |
| 2 | to produce | производить |
| 3 | desirable | желаемый |
| 4 | inbreeding | родственное спаривание |
| 5 | outbreeding | неродственное спаривание |
| 6 | crop (syn. yield, harvest) | урожай |
| 7 | to bring about | осуществлять; вызывать |

| | | |
|---|---|---|
| 8 | to retain | сохранять |
| 9 | artificial | искусственный |
| 10 | wheat | пшеница |
| 11 | wild | дикий |
| 12 | to gather | собирать |
| 13 | cultivation | обработка, возделывание |
| 14 | grain (syn. seed) | зерно |
| 15 | ripe | спелый |
| 16 | to sprout | дать ростки |
| 17 | to sow | сеять |
| 18 | stem | стебель |
| 19 | predictable | предсказуемый |
| 20 | to reduce (syn. decrease) | уменьшать |
| 21 | to allow | позволять |
| 22 | to carry out | выполнять |
| 23 | to fertilise | оплодотворять |
| 24 | suitable | подходящий |
| 25 | resistance | сопротивление |
| 26 | domestic animals | домашние животные |
| 27 | to involve | вовлекать |
| 28 | distinct | различный |
| 29 | strain (syn. stock) | род, происхождение |
| 30 | harmful | вредный |
| 31 | disease | болезнь |
| 32 | vigour | сила |
| 33 | interaction | взаимодействие |
| 34 | descendant | потомок |
| 35 | to maintain | поддерживать, сохранять |
| 36 | diversity (syn. variety) | различие, разнообразие |
| 37 | to depend on | зависить от |
| 38 | therefore | поэтому, следовательно |
| 39 | adult | взрослый |
| 40 | to pollinate | опылять |

## ■ Your Essential Assignments

### I. Quick check:

1. Which type of natural selection does artificial selection resemble?
2. What effect does: a) inbreeding; b) outbreeding have on the genetic diversity of a population?

3. Give two possible explanations of hybrid vigour in plants produced by a cross between two different strains of pure-breeding plants.

## II. Fill in the missing words:

| Term (verb) | Noun | Adjective |
|---|---|---|
| suit | ..... | ..... |
| resist | ..... | ..... |
| interact | ..... | ..... |
| value | ..... | ..... |
| cultivate | ..... | ..... |
| desire | ..... | ..... |

## III. Use monolingual English dictionary and write down what could the words given below mean:

breeding, desirable, seed, cultivation, stem, crop.

## IV. Match these words with their definitions:

| | | | |
|---|---|---|---|
| **1** | decrease | **A.** | the seeds of crops |
| **2** | modern | **B.** | living in natural state, not changed or controlled by humans |
| **3** | famine | **C.** | the preparation and use of land for growing crops |
| **4** | yield | **D.** | to go down to a lower level |
| **5** | grain | **E.** | happening because someone has made it happen and not as a part of a natural process |
| **6** | hybrid | **F.** | physical and mental energy |
| **7.** | domestic animal | **G.** | breeding between closely related individuals |
| **8.** | wild | **H.** | time belonging to the present time |
| **9.** | cultivation | **I.** | to plant seeds on a piece of ground |
| **10** | artificial | **J.** | to produce crops, profits |
| **11** | vigour | **K.** | a thing, place activity, etc. that you get something from |
| **12.** | pollinate | **L.** | an animal or plant produced from parents of different breeds or types |
| **13.** | inbreeding | **M.** | an animal lives on a farm or in someone's home |
| **14.** | sow | **N.** | no food for a long time and many people or animals die |
| **15.** | source | **O.** | to make a flower or plant produce seeds by giving it pollen |

## V. Find English equivalents to the following word combinations:

| № | Russian term | English equivalent |
|---|---|---|
| 1. | разводить животных и растения | |
| 2. | постепенное изменение в генотипе | |
| 3. | возделывание пшеницы | |
| 4. | процесс отборного размножения | |
| 5. | тесно связанные между собой особи | |
| 6. | сохранить желаемые характеристики | |
| 7. | опыляться естественным путем | |
| 8. | происходящий в гомозиготных условиях | |
| 9. | гибридная сила | |
| 10. | зависит от | |
| 11. | особые комбинации | |
| 12. | присутствуют в гомозиготных условиях | |
| 13. | дикие разновидности растений | |

## VI. Give Russian equivalents to the following English terms:

| № | English term | Russian equivalent |
|---|---|---|
| 1 | to produce specific desirable qualities | |
| 2 | selective breeding | |
| 3 | artificial selection | |
| 4 | to sow seeds | |
| 5 | pest resistance | |
| 6 | genetically different plants | |
| 7 | to be exposed to new diseases | |
| 8 | have no resistance | |
| 9 | to develop domestic and farm animals | |
| 10 | genetically distinct strains | |
| 11 | the mixing of alleles | |
| 12 | the descendants of hybrids | |
| 13 | to maintain sources of genetic diversity | |
| 14 | future breeding programmes | |

## VII. Find synonyms among the pool of words:

| Pool of words | Synonyms |
|---|---|
| **1)**1.harvest /2.stock /3.crop /4.yield /5.strain /6.breed | |
| **2)** 1.seed /2.vigour /3.strength /4.grain | |
| **3)**1.retain /2.sow /3.decrease /4.keep /5.plant /6. reduce | |
| **4)** 1.distinct /2.diversity /3.different /4.variety | |

## VIII. Answer the following questions. Use all information given before:

1. How long have humans been breeding animals and plants selectively to produce specific desirable qualities?
2. What does selective breeding mean?
3. What type of natural selection is artificial selection similar to?
4. Describe how wheat cultivation began.
5. What does inbreeding involve?
6. Why is inbreeding carried out?
7. What does outbreeding involve?
8. How is the offspring from outbreeding called?
9. What is called hybrid vigour?

## IX. Match the sentence halves. Make complete sentences:

| | | | |
|---|---|---|---|
| **1.** | Artificial selection is therefore similar to directional selection, in that selection pressure brings about | **A.** | to try and retain the desirable characters in future generations. |
| **2.** | In selective breeding, particular individuals are chosen and allowed | **B.** | closely related individuals which by chance, possess some desirable character. |
| **3.** | Inbreeding involves breeding between | **C.** | crossing individuals from genetically distinct strains. |
| **4.** | Inbreeding is carried out | **D.** | to breed, whereas others are prevented from breeding. |
| **5.** | Outbreeding involves | **E.** | a gradual change in the genotype of a group of organisms. |
| **6.** | If the parental stocks are pure breeding, | **F.** | the vigour decreases as the plant become more homozygous again. |
| **7.** | If the descendants of F1 hybrids are continually inbred, | **G.** | on the availability of genetically distinct animals and plants. |
| **8.** | Outbreeding depends | **H.** | the offspring are called F1 hybrids. |

## X. Read and translate the short text without any dictionary:

**Fact of life:**

With the advent of genetic engineering. Artificial selection has entered a new phase. It is now possible to breed clones of cattle and sheep which have genes for producing specific human proteins. What is more, nuclei of two different species can be combined to form a completely new type of animal. In

this way, a hybrid that combines the characters of a sheep and a goat has been formed: this new species has been dubbed a “geep” by the popular press. Plants can also genetically engineered to incorporate characters of a number of different species, for example, potatoes with a high starch content and high productivity can be genetically engineered to produce the beta-carotene of green vegetables and the vitamins of citrus fruits. One day it might be possible to design foods on a computer by choosing characteristics from a palette of tastes, colours, textures, and nutrients.

**XI. Food for thought:**

The dog is thought to have been the first domesticated animal. For at least 12 000 years, it has been subjected to artificial selection. Dogs have been bred to do specific types of work (for example, Labrador retrievers for retrieving fishing gear, Old English sheepdogs for rounding up sheep, and poodles for retrieving ducks) or for show. Suggest why pedigree dogs bred for show tend to have more genetic disorders than mongrels and cross-breeds (for example, highly inbred pedigree Labradors often have hip problems, St Bernards suffer eye problems, and Pekineses pften have respiratory problems).

## Text 6.4. Human Evolution: Primate Ancestors

■ **Essential targets:**

By the end of this text you should be able to:

● explain the significance of the adaptations of primates to an arboreal mode of life.

*Pre-reading*

**■ With your partner try and answer these two questions. Then see if you were right by quickly scanning the text.**

1. Do you agree with the statement that all humans are descendent from a common ancestor?
2. How do modern primates differ from their ancestral primates?

■ **Read the given text and make your essential assignments:**

The theory of evolution applies just as much to humans as to other organisms. All humans are in the same way related and, in the words of Darwin, are “descended with modification” from a common ancestor.

Although our social and technological developments have freed us from many of the effects of natural selection, our present-day physical and behavioural characteristics are rooted in the adaptations of our ancestors. So, by finding out more about our ancestors, we can learn more about ourselves.

**Adaptation of primates**

The classification of humans reflects our evolutionary relationships. About 150-170 million years ago, all mammals were small insectivores rather like the shrews of today. About 75 million years ago some of these insectivores adopted an arboreal (tree-dwelling) mode of life and evolved into lemur-like primates. The adaptations of these ancestral primates to their new tree-living mode of life are thought to have included a short nose, large eyes and prominent ears, long flexible fingers with nail-like claws, and teeth well adapted for eating insects. These features are found in tarsiers (lemur-like primates) living today in Indonesia. Many other features that evolved in ancestral primates as adaptations to an arboreal life have been retained by modern primates.

These features include:

- A prehensile (grasping) limb: the hands (and often the feet) of primates have long and highly mobile digits so that they can grasp the branches of trees. The first digit can oppose the remaining four digits, giving primates a powerful grip. Primates have flattened nails that support pads of sensitive skin on the fingers or toes.

- A mobile forearm: the clavicle (collar bone) and scapula (shoulder blade) are adapted to allow a wide range of movements. Mobile forearms are essential for moving from tree to tree, and for manipulating objects in the hand; for example, to transfer food to the mouth or to bring an object to the eyes for closer examination.

- **Well developed stereoscopic vision:** the ability to judge distances is essential for leaping from branch to branch. Primates have large, well developed, forward-looking eyes with overlapping fields of view. The development of stereoscopic vision has been associated with a flattening of the face.

- **A reduce sense of smell:** it is not easy to locate scents through the canopies of trees and primates have a reduced sense of smell and a relatively small nose. Combined with the flattering of the face, a shorter nose is associated with the development of stereoscopic vision, and has allowed the development of facial muscles which play an important part in non-verbal communication.

- **An inspecialised digestive system:** primates have relatively unspecialised teeth and guts and they can exploit a wide range of food sources.

Although some primates have a specialized herbivorous diet, all primate families have some omnivorous members that have a mixed diet.

**- A skull modified for upright posture:** primates have an upright posture associated with having a forward-looking face. The skull rests on top of the vertebra and has a large opening, the foramen magnum, though which the medulla of the brain emerges and extends downwards as the spinal cord.

**- Reduced number of offspring:** life in the trees is difficult and dangerous, especially for young animals. Some arboreal animals, such as birds and squirrels, build nests in which the young can be protected until they are old enough to fend for themselves. Primates have adopted another strategy: from birth, the young cling to the mother's body and only slowly gain independence. Primates produce few young but look after them for a long time: they have a long gestation period a prolonged period of dependency after birth.

**- A large brain:** an active life in the trees requires precise movements and therefore good muscular coordination, vision, tactile senses, memory, thought, and learning. These processes depend on a large and highly developed brain.

**- A social groupings:** all primates live to some degree in social groups in which members cooperate with each other. Complex social behaviour probably stems from the strong pair bond which enables a mother and her young to remain closely together for a long time. Lengthy rearing of a small number of young is most successful when he mother has support from other adults. The continued success of a group of animals depends on the recruitment of young helpers, and so evolves a social interdependency which is the basis of our own human society.

**The groups of modern primates**

At about the same time as the dinosaurs became extinct, about 65 million years ago, the primitive primates diverged quickly to give rise to two main suborders; the prosimians (meaning "before apes") and anthropoids (meaning "ape fom"). The prosimians are represented today by lemurs, lorises, and tarsiers, and the anthropoids by monkeys, apes, and humans.

Monkeys are distinguished from apes in having long tails, and the forelimbs are not usually longer than the hindlimbs. They are believed to have evolved from two different groups of lemur-like animals which became isolated when continental drift separated Eurasia from North America. The North American group evolved into New World monkeys which died out in North America but somehow colonised South America. The Eurasia group gave rise to Old World monkeys, from which apes and humans evolved. There are several differences between Old World monkey and New World monkeys which show their separate evolution. For example, the nostrils of monkeys from South America are wide open and far apart, and New World monkeys have a long tail that is prehensile (adapted for grasping branches); the nostrils

of monkeys from Africa and Asia are narrow and close together and no old World monkey has a prehensile tail.

## ■ Glossary of essential terms for you to know

| № | English term | Russian equivalent |
|---|---|---|
| 1 | to descend | происходить |
| 2 | common | общий |
| 3 | behaviour | поведение |
| 4 | to be rooted in | корнями уходит в… |
| 5 | adaptation | адаптация, приспособление |
| 6 | ancestor | предок |
| 7 | to find out | выяснить, обнаружить |
| 8 | to retain | сохранять |
| 9 | relationship | взаимосвязь, родство |
| 10 | mammal | млекопитающее животное |
| 11 | insectivores | насекомоядное животное |
| 12 | shrew | землеройка |
| 13 | arboreal | древесный |
| 14 | mode | способ |
| 15 | prominent | заметный |
| 16 | finger | палец руки |
| 17 | toe | палец ноги |
| 18 | claw | коготь |
| 19 | nail | ноготь |
| 20 | flexible | гибкий |
| 21 | to reduce | уменьшать |
| 22 | well adapted | хорошо приспособленный |
| 23 | insects | насекомые |
| 24 | feature | черта, особенность |
| 25 | prehensile (syn. grasping) | хватательный |
| 26 | limb | конечность |
| 27 | digit | палец (руки или ноги) |
| 28 | branch | ветка |
| 29 | grip | схватывание |
| 30 | to flatten | выравнивать |
| 31 | to support | поддерживать |
| 32 | sensitive | чувствительный |
| 33 | skin | кожа |
| 34 | forearm | предплечье |
| 35 | clavicle | ключица |

| | | |
|---|---|---|
| 36 | scapula | лопатка |
| 37 | essential | необходимый |
| 38 | to transfer | перемещать |
| 39 | vision | зрение |
| 40 | to leap | прыгать |
| 41 | scent | запах |
| 41 | guts | кишки |
| 42 | omnivorous | всеядный |
| 43 | skull | череп |
| 44 | upright | вертикальный |
| 45 | posture | положение |
| 46 | vertebra | позвонок |
| 47 | spinal cord | спинной мозг |
| 48 | to reduce | уменьшать |
| 49 | nest | гнездо |
| 50 | to fend | давать отпор |
| 51 | brain | мозг |
| 52 | tactile senses | чувства осязания |
| 53 | bond | связь |
| 54 | forelimb | передняя конечность |
| 55 | hindlimb | задняя конечность |
| 56 | nostril | ноздря |
| 57 | tail | хвост |

## ■ Your Essential Assignments

### I. Quick check:

1. Primates evolved as a group adapted to an arboreal mode of life. Briefly explain the importance of the following adaptions:

a. reduced sense of smell
b. opposable thumb
c. small, single uterus
d. flexible pectoral girdle.

### II. Fill in the missing words:

| Term (verb) | Noun | Adjective |
|---|---|---|
| reflect | ..... | ..... |
| adapt | ..... | ..... |
| grasp | ..... | ..... |
| depend | ..... | ..... |
| support | ..... | ..... |

| | | |
|---|---|---|
| extinguish | ..... | ..... |
| separate | ……. | …… |

**III. Use monolingual English dictionary and write down what could the words given below mean:**

vision, limb, adaptation, modern, independence.

**IV. Match these words with their definitions:**

| | | | |
|---|---|---|---|
| **1** | primate | **A.** | an animal that eats both meat plants |
| **2** | modern | **B.** | the smell of a particular animal or person that some other animals, for example dogs, can follow |
| **3** | insectivore | **C.** | able to move easily |
| **4** | mammal | **D.** | an animal is very like a human |
| **5** | omnivore | **E.** | the bones of person's or animal's head |
| **6** | brain | **F.** | a creature that eats insects for food |
| **7.** | scent | **G.** | connected with trees or living in trees |
| **8.** | mode | **H.** | time belonging to the present time |
| **9.** | ape | **I.** | the organ inside your head that controls how you think, feel and move |
| **10** | mobile | **J.** | one of the class of animals that drinks milk from its mother's body when it is young |
| **11** | digestion | **K.** | a member of the group of mammals that includes humans and monkeys |
| **12.** | arboreal | **L.** | a large monkey without a tail, or with a very short tail |
| **13.** | skull | **M.** | concerning human society and its organization, or the quality of people's lives |
| **14.** | social | **N.** | a particular way or style of behaving, living or doing something |
| **15.** | anthropoid | **O.** | the process of digesting food |

**V. Find English equivalents to the following word combinations:**

| № | Russian term | English equivalent |
|---|---|---|
| 1. | в некоторой степени | |
| 2. | физические и поведенческие характеристики | |
| 3. | хватать ветки деревьев | |
| 4. | нежная кожа на пальцах руки или ноги | |

| | | |
|---|---|---|
| 5. | подвижное предплечье | |
| 6. | подносить предмет к глазам для внимательного изучения | |
| 7. | хорошо развитое зрение | |
| 8. | пищеварительная система | |
| 9. | смешанная диета | |
| 10. | большой и высоко развитый мозг | |
| 11. | передние и задние конечности | |
| 12. | несколько различий | |
| 13. | хватательный хвост | |

## VI. Give Russian equivalents to the following English terms:

| № | English term | Russian equivalent |
|---|---|---|
| 1 | descended with modifications from a common ancestor | |
| 2 | arboreal mode of life | |
| 3 | ancestral primates | |
| 4 | well adapted for eating insects | |
| 5 | a prehensile limb | |
| 6 | to allow a wide range of movements | |
| 7 | to transfer food to the mouth | |
| 8 | to locate scents | |
| 9 | upright posture | |
| 10 | spinal cord | |
| 11 | a prolonged period of dependency after birth | |
| 12 | precise movements | |
| 13 | social grouping | |
| 14 | complex social behaviour | |

## VII. Find synonyms among the pool of words:

| Pool of words | Synonyms |
|---|---|
| **1)**1.descend /2.grip /3.grasp /4.originate | |
| **2)**1.digit/2.bond/3.scent/4.finger/5.link/6.smell /7.toe | |
| **3)**1.feature /2. limb /3.characteristic /4. arm /5. leg | |
| **4)**1.primitive /2.independence /3. freedom /4. ancient | |

## VIII. Answer the following questions. Use all information given before:

1. What has freed us from many of the effects of natural selection?
2. What does “arboreal mode of life” mean?
3. What features did ancestral primates have?
4. What features have been retained by modern primates?
5. What are the two main groups of modern primates?
6. How are monkeys distinguished from apes?

## IX. Match the sentence halves. Make complete sentences:

| | | | |
|---|---|---|---|
| **1.** | Although our social and technological developments have freed us from many of the effects of natural selection, | **A.** | can be protected until they are old enough to fend for themselves. |
| **2.** | About 75 million years ago some of these insectivores adopted an arboreal | **B.** | and for manipulating objects in the hand. |
| **3.** | Primates have flattened nails that support pads | **C.** | (tree-dwelling) mode of life and evolved into lemur-like primates. |
| **4.** | Mobile forearms are essential for moving from tree to tree, | **D.** | and they can exploit a wide range of food sources. |
| **5.** | The development of stereoscopic vision has been associated | **E.** | our present-day physical and behavioural characteristics are rooted in the adaptations of our ancestors. |
| **6.** | Primates have relatively unspecialized teeth and guts | **F.** | of sensitive skin on the fingers or toes. |
| **7.** | Some arboreal animals, such as birds and squirrels, build nests in which the young | **G.** | the **prosimians** (meaning “before apes”) and **anthropoids** (meaning “ape fom”). |
| **8.** | The primitive primates diverged quickly to give rise to two main suborders; | **H.** | with a flattening of the face. |

## X. Read and translate the short text without any dictionary:

**Fact of life:**

Lemurs are cat-like primates that live exclusively in the tropical rainforests of Madagascar. It is thought that ancestral lemurs became isolated on the island about 50 million years ago and gradually diversified into 40 species. Lemurs have retained numerous primitive characteristics while at the same time developing many features in parallel with monkeys and apes that

evolved on the mainland. During this evolution, body mass gradually increased (the ancestral species was very small) which corresponds with a shift away from mainly nocturnal (night-time) activity to diurnal (day-time) activity. This evolutionary trend is also seen among the monkeys and apes. Primitive lemur species are small nocturnal animals that spend nearly all their time climbing and leaping in trees, living mainly on insects. Several other species of lemur (including Lemur catta) live on the ground. These more advanced lemurs evolved to live in social groups, associated with their becoming diurnal.The young grow up within a troop and much time is spent learning the skills of life, individuals cooperate within the group to gather (fruit and leaves as well as insects) and avoid predators. However, none of the lemurs have the manual dexterity or intelligence of apes and monkeys.

## XI. Food for thought:

Suggest how stereoscopic vision evolved by natural selection in arboreal primates.

### Biology Jokes

Biology and humor, as most students know, don`t usually go hand in hand. It`s always nice, however, to step back and take a humorous look at biology. Below is a listing of biology terms and their possible meanings. Remember this is just for fun!

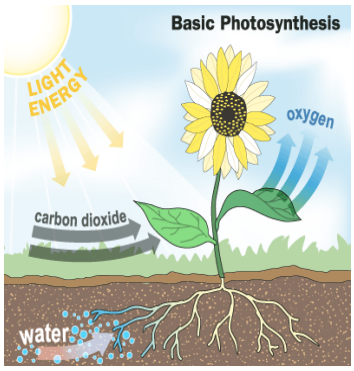
### *Humorous Biology Definitions*

Antibody _____not in favor of anybody.
Amphibian _____someone who tells lies.
Aphotic _____doesn`t like to take pictures.
Axon _____the name of a gas station.
B cell _____prison cell block.
Biogeography _____where I live.
Blood pressure _____persistent relatives.
Fauna _____likes (as in I am fauna you)
Fertilize _____very big lies.
Homeostasis _____stays at home.
Interferon _____to get in the way.
Microbodies _____short people.
Node _____past tense of know.
Organelle _____a small musical instrument.
Seed _____past tense of see.

Remember this is just for fun!

# UNIT VII. PHOTOSYNTHESIS

## Text 7.1. Photosynthesis: An Overview




■ **Essential targets:**

By the end of this text you should be able to:

•describe the overall process of photosynthesis and its importance to life on Earth;

•describe the structure and function of a chloroplast.

*Pre-reading*

■ **Discuss these questions with your partner. Then quickly scan the text to see if you were right.**

1. What is photosynthesis?
2. Why is photosynthesis considered as the basis of life?

■ **Read the given text and make your essential assignments:**

Most plants have no structures for ingesting and digesting food. They have no mouth and no alimentary canal, yet plant material is rich in carbohydrates, proteins and fats. Instead of obtaining their food from other organisms, plants make it for themselves using simple ingredients. They are autotrophs (self-feeders).

**What is photosynthesis?**

A typical plant takes in carbon dioxide (from the air) and water (from the soil) and builds these up into sugars and other complex substances. Oxygen is released as a waste product. The energy in the chemical bonds of the raw materials carbon dioxide and water is less than the energy in the chemical bonds of the products. Therefore the reaction is endergonic and requires an external source of free energy. This energy is supplied by sunlight that falls on the plant. A green substance, chlorophyll, enables the plant to trap light energy and use it to make sugars. The process of using sunlight to build up complex substances from simpler ones is called photosynthesis.

Photosynthesis is a complex process which takes place in a series of small steps. There are two main stages in photosynthesis: a light-dependent stage in which water is broken down into hydrogen and oxygen using light energy; and light-independent stage in which the hydrogen reacts with carbon dioxide to

form a carbohydrate. Water is re-formed in this reaction. The light-dependent stage happens only in the light; the light-independent stage happens both when it is light and when it is dark.

**Covering glucose to other substances**

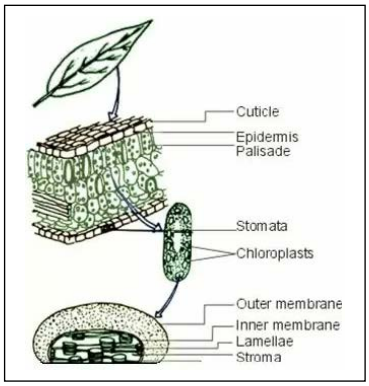
The glucose formed by photosynthesis is used as the raw material for other chemical reactions. It is the main substrate used in respiration. Some of the glucose is covered to other carbohydrates: cellulose to form cell walls; sucrose to be transported to other parts of the plant; and starch for storage. Some of the glucose is combined with minerals from the soil to make proteins and other complex organic substances. Although light is needed for making glucose, it is not needed for turning the glucose into these other substances.

**Photosynthesis: the basis of life**

Green life has been steadily pumping out oxygen as a waste product of photosynthesis for millions of years. Some of the oxygen is used as a raw material for respiration, but most of it has accumulated in the atmosphere. So the very existence of our oxygen-rich atmosphere depends on the photosynthesising activities of green life.

Animals cannot make their own food. The only way they can obtain complex organic substances is by eating other organisms. These organisms ultimately depend on the ability of plants to harvest energy from sunlight to make food from carbon dioxide and water. Life on Earth is almost entirely solar powered.

**The site of photosynthesis**




Although, leaves are the main sites of photosynthesis in most plants, it can take place in any part that is green. These green parts have chloroplasts, which contain all the biochemical machinery necessary for the light-dependent and light-independent stages of photosynthesis.

Chloroplasts act as compartments, isolating the photosynthetic reactions from other cellular activities. Each chloroplast consists of two membranes enclosing a gelatinous matrix called the stroma. The stroma contains ribosomes, circular DNA, and enzymes used in photosynthesis. Suspended in the stroma are thylakoids. These are disk-like membrane sacs, several of which are stacked in a group to form a granum (plural *grana*). The space inside each thylakoid in a stack is connected with the other thylakoids in the stack, forming a continuous fluid-filled compartment called the thylakoid space. The thylakoid membranes contain photosynthetic pigments, including chlorophyll.

## ■ Glossary of essential terms for you to know

| № | English term | Russian equivalent |
|---|---|---|
| 1 | ingestion | прием пищи |
| 2 | digestion | переваривание пищи |
| 3 | alimentary canal | пищеварительный тракт |
| 4 | raw | сырой |
| 5 | to enable | давать возможность |
| 6 | to take place | происходить |
| 7 | to convert | превращать |
| 8 | substrate | питательная среда |
| 9 | starch | крахмал |
| 10 | storage | накопление, хранение |
| 11 | complex | сложный |
| 12 | a waste product | продукт отхода |
| 13 | entirely | полностью |
| 14 | site | место |
| 15 | to enclose | окружать |

## ■ Your Essential Assignments

### I. Quick check:

**1.** During photosynthesis, what gas is:
- **a.** raw material
- **b.** product?

**2.** Give the precise location in a typical terrestrial plant of:
- **a.** the light-dependent stage
- **b.** the light-independent stage of photosynthesis.

### II. Fill in the missing words:

| Term (verb) | Noun | Adjective |
|---|---|---|
| react | ..... | ..... |
| accumulate | ..... | ..... |
| produce | ..... | ..... |
| require | ..... | ..... |
| connect | ..... | ..... |

### III. Use monolingual English dictionary and write down what could the words given below mean:

plant, leave, ingredient, substance, raw, energy.

## IV. Match these words with their definitions:

| | | | |
|---|---|---|---|
| **1** | Photosynthesis | **A.** | a type of solid or liquid that has particular characteristics |
| **2** | Chlorophyll | **B.** | natural light that comes from the sun |
| **3** | Substance | **C.** | one of several good substances such as sugar which consist of oxygen, hydrogen, and carbon and which provide your body with heat and energy |
| **4** | Soil | **D.** | the green substance in leaves |
| **5** | Respiration | **E.** | one of the many substances that exist in food such as meat, eggs, and beans, which help your body to grow and keep it strong and healthy |
| **6** | Waste | **F.** | a chemical substance produced by living cells in plants and animals, that causes changes in other chemical substances without being changed itself |
| **7.** | Sunlight | **G.** | the production by a green plant of special substances like sugar that it uses as food, caused by the action of sunlight on chlorophyll |
| **8.** | Glucose | **H.** | the smallest part of a living thing that can exist independently |
| **9.** | Protein | **I.** | the process of breathing |
| **10** | Fat | **J.** | things that people and animal eat |
| **11** | Carbohydrate | **K.** | a very thin piece of skin that covers or connects parts of the body |
| **12.** | food | **L.** | a natural form of sugar that exists in fruit |
| **13.** | enzyme | **M.** | the top layer of the earth in which plants grow |
| **14.** | cell | **N.** | Unwanted materials or substances that are left after you have used something |
| **15.** | membrane | **O.** | an oily substance contained in certain foods |

## V. Find English equivalents to the following word combinations:

| № | Russian term | English equivalent |
|---|---|---|
| 1. | прием и переваривание пищи | |
| 2. | пищеварительный тракт | |
| 3. | вместо… | |
| 4. | сложные вещества | |
| 5. | происходит только при свете | |
| 6. | химические реакции | |
| 7. | главная пищеварительная среда | |

| | | |
|---|---|---|
| 8. | производить свою собственную еду | |
| 9. | способность растений получать энергию от солнца | |
| 10. | клеточная активность | |
| 11. | состоит из двух мембран | |

## VI. Give Russian equivalents to the following English terms:

| № | English term | Russian equivalent |
|---|---|---|
| 1 | to be rich in carbohydrates, proteins and fats | |
| 2 | simple ingredients | |
| 3 | a waste product | |
| 4 | raw materials | |
| 5 | external source of free energy | |
| 6 | to be supplied by sunlight | |
| 7 | light-dependent stage | |
| 8 | light-independent stage | |
| 9 | to form cell walls | |
| 10 | complex organic substances | |
| 11 | the main site of photosynthesis | |
| 12 | a fluid-filled compartment | |

## VII. Find synonyms among the pool of words:

| Pool of words | Synonyms |
|---|---|
| **1)**1.plant /2.substance /3. material /4.herb | |
| **2)**1.digestion /2.energy /3.assimilation /4. power | |
| **3)**1.obtain /2.act /3.connect /4.join /5.react /6.get | |
| **4)**1.gather/2.enclose /3.surround /4.accumulate | |

## VIII. Answer the following questions. Use all information given before:

1. What is plant material rich in?
2. Do plants make their food for themselves?
3. What is chlorophyll?
4. What is the role of chlorophyll?
5. What process is called photosynthesis?
6. What are two main stages in photosynthesis?
7. What is the difference between light-dependent and light-independent stage?
8. What is the main site of photosynthesis in most plants?

## IX. Match the sentence halves. Make complete sentences:

| | | | |
|---|---|---|---|
| **1.** | Most plants have no structures | **A.** | plants make it for themselves using simple ingredients. |
| **2.** | Instead of obtaining their food from other organisms, | **B.** | to trap light energy and use it to make sugars. |
| **3.** | A typical plant takes in carbon dioxide (from the air) and water (from the soil) | **C.** | which contain all the biochemical machinery necessary for the light-dependent and light-independent stages of photosynthesis. |
| **4.** | A green substance, chlorophyll, enables the plant | **D.** | as the raw material for other chemical reactions. |
| **5.** | The process of using sunlight to build up complex substances from simpler ones is | **E.** | and builds these up into sugars and other complex substances. |
| **6.** | There are two main stages in photosynthesis: a light-dependent stage in which water is broken down into hydrogen and oxygen using light energy; | **F.** | for ingesting and digesting food. |
| **7.** | The glucose formed by photosynthesis is used | **G.** | And light-independent stage in which the hydrogen reacts with carbon dioxide to form a carbohydrate. |
| **8.** | These green parts have chloroplasts, | **H**. | called photosynthesis. |

## X. Read and translate the short text without any dictionary:

**Fact of life:**

It has been estimated that if all the land surface of the Earth could support plants, enough food could be produced to feed 1000 billion people. Of course, this is unrealistic because not all land is suitable for growing plants, and some land is needed for urban and recreational uses. However, even if only 7 per cent of the land surface were made agriculturally productive, plants could produce enough food to support 79 billion people. According to United Nations estimates, in 1994 the world population was 5.6 billion and is likely to be about 8.2 billion by 2025.

## XI. Food for thought:

Less than one per cent of the solar energy that falls on the Earth is used by plants for photosynthesis. Suggest what happens to the other 99 per cent of solar energy.

# Text 7.2 Factors Affecting The Rate Of Photosynthesis

■ **Essential targets:**

By the end of this text you should be able to:
- describe the main factors affecting the rate of photosynthesis;
- explain the meaning of the compensation point;
- define the law of limited factors.

*Pre-reading*

■ **Talk about the following two questions with your partner.**

1. Is photosynthesis affected by many factors?
2. How does photosynthesis depend on light intensity, temperature, wind velocity, carbon dioxide level?

**Then scan the text to compare your ideas with the author`s.**

■ **Read the given text and make your essential assignments:**

The rate of photosynthesis can be measured as the volume of carbon dioxide taken in by a part per init time, or as the amount of carbohydrate produced per unit time. In laboratory investigations, the rate is commonly estimated as the volume of oxygen released per unit time, which is more easily measured. However, this method does not give an accurate measure of photosynthesis. Some of the oxygen generated by photosynthesis is used by the plant for respiration. Respiration goes on all the time, even when photosynthesis is at its height. So using oxygen liberation as a measure of photosynthesis gives an underestimate of the true rate. We are actually measuring the rate of photosynthesis above a point called the compensation point, defined as: *the point at which the rate of photosynthesis in a plant is in exact balance with the rate of respiration, so there is no net exchange of carbon dioxide or oxygen.* The compensation point is usually related to a particular light intensity or carbon dioxide level.

**Factors that affect the rate of photosynthesis**

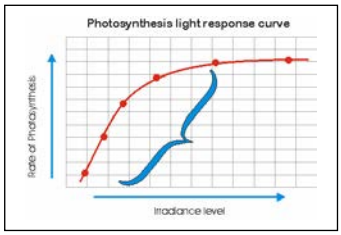
Photosynthesis is affected by many factors, both external (in the environmental) and internal (inside the plant). External factors include light

intensity, the wavelength of light, carbon dioxide levels, temperature, wind velocity, and water and mineral supplies. Internal factors include type and concentration of photosynthetic pigments, enzyme and water content, and leaf structure, and position.

The effect of many of these factors is difficult to determine quantitatively because they interact, they also affect other processes in the plant. For example, the importance of water to photosynthesis cannot be demonstrated easily. Simply depriving a plant of water kills it, but the cause of death may not be connected with photosynthesis. The importance of water can be demonstrated using water labeled with a heavy isotope of oxygen, $^{18}O$, and tracing the isotope using an instrument called a mass spectrometer which can measure the masses of atoms. One batch of *Chlorella* (green algae) is placed in water in which the oxygen atoms have been replaced by the heavy isotope. Then a second batch of *Chlorella* in unlabelled water is given a supply of carbon dioxide labeled with $^{18}O$. Only the first batch of *Chlorella* gives off oxygen labeled with $^{18}O$, confirming that the oxygen formed in photosynthesis comes only from water, not from carbon dioxide.

Light intensity, carbon dioxide concentration, and temperature are three external factors that are relatively easy to manipulate. Consequently they have been the focus of many investigations on photosynthesis.

**Light intensity**




The rate of photosynthesis is directly proportional to light intensity. A typical plant responds to changes in light intensity. Very high light intensities may actually damage some plants, reducing their ability to photosynthesise.

The **light compensation point** (the light intensity at which the rate of photosynthesis is exactly balanced by the rate of respiration) varies for different plants. Two major groups have been identified: **sun plants** and **shade plants.** Sun plants include most temperate trees, such as oak. They photosynthesise best at high light intensities. Shade plants include those of the shrub layer, such as ferns. Their light compensation point is relatively low, but they cannot photosynthesise very efficiently at high light intensities. Consequently sun plants outcompete shade plants at high light intensities.

**Carbon dioxide levels**

The average carbon dioxide content of the atmosphere is about 0.04 per cent. As long as there is no other factor limiting photosynthesis, an increase in carbon dioxide concentration up to 0.5 per cent usually results in an increase in the rate of photosynthesis. However, concentrations above 0.1 per cent can damage leaves. Therefore the optimum concentration of carbon dioxide is probably just under 0.1 per cent. In dense, warm, and well-lit vegetation, low levels of carbon dioxide often limit the rate of photosynthesis. Growers of

greenhouse tomatoes recognise this and provide a carbon dioxide enriched atmosphere for their plants.

**Temperature**

Changes in temperature have little effect on the reactions of the light-dependent stage because these are driven by light, not heat. However, the reactions of the Calvin cycle are catalysed by enzymes which, like all enzymes, are sensitive to temperature. The effect of temperature on these reactions is similar to its effects on other enzymes. The optimum temperature varies foe each species, but many temperate plants have an optimum temperature between 25° C and 30° C.

**Law of limiting factors**

So far we have looked at the effects of isolated factors. However, under natural conditions plants are subjected to many factors simultaneously. The law of limiting factors state that: *when a physiological process depends on more than one essential factor being favourable, its rate at any given moment is limited by the factor at its least favourable value and by that factor alone.* When other factors are kept constant, an improvement in the value of the limiting factor leads to an increase in the rate of the process. Conversely, when the rate of the process does not increase in response to an improvement in an important factor, some other factor is limiting to process. For a process to go at its maximum rate, all factors must be at their optimum level.

## ■ Glossary of essential terms for you to know

| № | English term | Russian equivalent |
|---|---|---|
| 1 | rate | размер |
| 2 | to measure | измерять |
| 3 | volume | объем |
| 4 | amount | количество |
| 5 | to release | выпускать |
| 6 | pondweed | рдест |
| 7 | accurate | точный |
| 8 | respiration | дыхание |
| 9 | point | точка |
| 10 | exact | точный |
| 11 | to be related to | относиться к |
| 13 | external | внешний |
| 14 | internal | внутренний |
| 15 | wavelength | длина волны |
| 16 | velocity | скорость |
| 17 | supply | снабжение |

| | | |
|---|---|---|
| 18 | leaf (pl. leaves) | листок |
| 19 | to determine | определять |
| 20 | to interact | взаимодействовать |
| 22 | to damage | повреждать |
| 23 | to reduce | уменьшать |
| 24 | oak | дуб |
| 25 | shrub | куст |
| 26 | fern | папоротник |
| 27 | content | содержание |
| 29 | sensitive | чувствительный |
| 30 | to vary | изменять |
| 31 | to subject | подвергать |
| 32 | constant | постоянный |

## ■ Your Essential Assignments

### I. Quick check:

**1.** Why is difficult to demonstrate the importance of water to photosynthesis?

**2.** How does the light compensation point of a shade plant differ from that of a sun plant?

### II. Fill in the missing words:

| Term | Noun | Adjective |
|---|---|---|
| measure | ..... | ..... |
| subject | ..... | ..... |
| interact | ..... | ..... |
| recognise | ..... | ..... |
| concentrate | ..... | ..... |

### III. Use monolingual English dictionary and write down what could the words given below mean:

concentration, factor, intensity, light, wavelength, vegetation.

### IV. Match these words with their definitions:

| | | | |
|---|---|---|---|
| **1** | photosynthesis | **A.** | connected with the outside of a surface |
| **2** | investigation | **B.** | the amount of space that a substance or object contains or fills |
| **3** | light | **C.** | the production by a green plant of special substances like sugar that it uses as food, caused by the action of sunlight on chlorophyll |
| **4** | factor | **D.** | the process of making chemical reaction |

| | | | |
|---|---|---|---|
| | | | quicker by adding a catalyst |
| **5** | external | **E.** | a small bush with several woody stems |
| **6** | internal | **F.** | one of the possible different forms of an atom of a particular element |
| **7.** | supply | **G.** | an official attempt to find out the reasons for something such as a crime, accident or scientific problem |
| **8.** | catalysis | **H.** | the energy from the sun, a lamp, a flame etc. that allows you to see things |
| **9.** | limiting | **I.** | inside something |
| **10** | shrub | **J.** | a chemical substance produced by living cells in plants and animals, that causes changes in other chemical substances without being changed itself |
| **11** | to measure | **K.** | preventing any improvement or increase in something |
| **12.** | volume | **L.** | one of several things that influence or cause a situation |
| **13.** | enzyme | **M.** | an amount of something that is available to be used |
| **14.** | velocity | **N.** | to find the size, length, or amount of something using standard units |
| **15.** | isotope | **O.** | the speed at which something moves in a particular direction |

## V. Find English equivalents to the following word combinations:

| № | Russian term | English equivalent |
|---|---|---|
| 1. | точное измерение | |
| 2. | используется растениями для дыхания | |
| 3. | внешние и внутренние факторы | |
| 4. | может быть продемонстрировано | |
| 5. | прямо пропорционально чему-либо | |
| 6. | изменения в температуре | |
| 7. | ограничивающий фактор | |
| 8. | наименее благоприятный | |
| 9. | приводит к увеличению | |
| 10. | в ответ на | |
| 11. | оптимальный уровень | |

## VI. Give Russian equivalents to the following English terms:

| № | English term | Russian equivalent |
|---|---|---|
| 1 | the rate of photosynthesis | |

| | | |
|---|---|---|
| 2 | produced per unit time | |
| 3 | compensation point | |
| 4 | light intensity | |
| 5 | concentration of photosynthetic pigments | |
| 6 | a heavy isotope of oxygen | |
| 7 | sun plants and shade plants | |
| 8 | to be sensitive to temperature | |
| 9 | to be driven by light | |
| 10 | to be similar to | |
| 11 | have little effect on the reactions | |
| 12 | under natural conditions | |

## VII. Find synonyms among the pool of words:

| Pool of words | Synonyms |
|---|---|
| **1)**1.external/2.limit/3.outer/4.internal/5.inner/6.end-point | |
| **2)**1.rate/2.measure/3.degree/4.level/5.proportion/6.position | |
| **3)**1.factor /2.strength /3.component /4.intensity | |
| **4)**1.improvement /2.isolated /3.separated /4.development | |

## VIII. Answer the following questions. Use all information given before:

1. How can the rate of photosynthesis be measured?
2. What is the compensation point?
3. What is the compensation point related to?
4. Is photosynthesis affected by external and internal factors?
5. What do external factors include?
6. What do internal factors include?
7. What is the effect of light intensity, carbon dioxide level, temperature on the rate of photosynthesis?
8. What does the law of limiting factors state?

## IX. Match the sentence halves. Make complete sentences:

| | | | |
|---|---|---|---|
| **1.** | The rate of photosynthesis can be measured as | **A.** | lght intensity, the wavelength of light, carbon dioxide levels, temperature, wind velocity, and water and mineral supplies. |
| **2.** | The compensation point is usually related to | **B.** | to light intensity. |
| **3.** | Photosynthesis is affected by many factors, | **C.** | tpe and concentration of photosynthetic pigments, enzyme and water content, and leaf structure, and position. |

| | | | |
|---|---|---|---|
| **4.** | External factors include | **D.** | its rate at any given moment is limited by the factor at its least favourable value and by that factor alone. |
| **5.** | Internal factors include | **E.** | both external (in the environmental) and internal (inside the plant). |
| **6.** | The rate of photosynthesis is directly proportional | **F.** | because these are driven by light, not heat. |
| **7.** | Changes in temperature have little effect on the reactions of the light-dependent stage | **G.** | the volume of carbon dioxide taken in by a part per init time, or as the amount of carbohydrate produced per unit time. |
| **8.** | When a physiological process depends on more than one essential factor being favourable, | **H.** | a particular light intensity or carbon dioxide level. |

## X. Read and translate the short text without any dictionary:

**Fact of life:** The atmosphere contains less than 0.04 per cent carbon dioxide, yet each year plants make more than 200 billon tones of carbon compounds from this meagre supply of carbon dioxide.

## XI. Food for thought:

Seaweeds grow on rocky shores, in zones with different species growing at different heights above the low-tide mark. Suggest how the light compensation point of seaweeds at the low-tide mark differs from that of seaweeds close to the high-water mark.

# Text 7.3. Photosynthesis In Different Climates

■ **Essential targets:**

By the end of this text you should be able to:

- distinguish between $C_3$ and $C_4$ plants;
- explain the advantages and disadvantages of crassulacean acid metabolism (CAM);
- give examples of $C_3$, $C_4$, and CAM plants.

*Pre-reading*

■ **With a partner, consider the following questions and try to answer them. Then quickly scan the text to check your answers.**

1. What is necessary for plants to survive in different climates?
2. Do you know the ways of fixing carbon dioxide?

■ **Read the given text and make your essential assignments:**

Green plants thrive in environments ranging from hot and dry equatorial regions to freezing-cold polar regions. Their success depends on their adaptability. To survive and breed, each plant has had to evolve specific adaptations to cope with the demands of its particular environment. These adaptations include ways of fixing carbon dioxide.

**$C_3$ plants: fixing directly into the Calvin cycle**

$C_3$ plants fix carbon dioxide directly into the Calvin cycle as the three-carbon compound glycerate 3-phosphate (GP). Common and widely distributed, they include some of our most important crop plants such as wheat, soya beans, and rice. $C_3$ plants function efficiently in temperature conditions. However, they suffer two major disadvantages in hot, dry environments.

First, to obtain sufficient carbon dioxide, $C_3$ plants must open their stomata (small pores in their leaves). Unfortunately, when stomata are open, they not only allow carbon dioxide to enter the plant, but also allow water to escape. So in hot dry conditions $C_3$ plants have to either cease photosynthesising or run the risk of wilting and dying.

The second disadvantage relates to the ability of ribulose biphosphate carboxylase (ribosco) to combine with oxygen. Ribosco is the enzyme that catalyses carbon dioxide fixation. On a hot, sunny day carbon dioxide concentrations around photosynthesising cells decrease, because a large proportion of the carbon dioxide is being used up on photosynthesis. In these conditions, ribosco combines with oxygen rather than carbon dioxide in a process called photorespiration. The process results in the loss of fixed carbon dioxide from the plant, reducing photosynthetic efficiently and plant growth. Unlike photosynthesis, photorespiration does not produce sugar molecules; and unlike respiration, it yields no ATP. As much as half of the carbon dioxide fixed in the Calvin cycle may be released by photorespiration. Therefore, in hot, arid conditions, or in conditions where carbon dioxide levels are low, $C_3$ plants do not grow well.

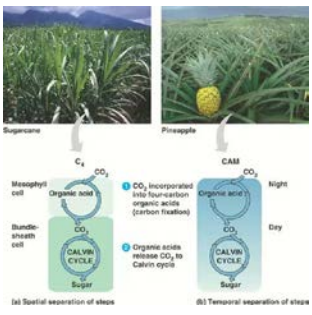
**$C_4$ plants: the Hatch-Slack pathway**

$C_4$ plants have evolved a special metabolic adaptation which reduces photorespiration. They do not use ribulose biphosphate (RuBP) to fix carbon dioxide directly into the Calvin cycle. Instead, they use phosphoenolpyruvate

(PEP) to fix carbon dioxide as a four-carbon compound, oxaloacetate. The reaction is catalysed by phosphoenolpyruvate carboxylase (PEP, carboxylase). This enzyme cannot combine with oxygen. Consequently $C_4$ plants can continue to fix carbon dioxide even when its concentration is very low.

The leaves of $C_4$ plants are specially adapted to carry out this initial fixation. A ring of large closely packed cells called the bundle sheath surrounds the leaf veins. Surrounding the bundle sheath is a smaller ring of mesophyll cells. The distinctive arrangement is called Kranz anatomy and can be used to identify $C_4$ plants ("Kranz" means crown or halo and refers to the two distinctive rings). The initial fixation of carbon dioxide into oxaloacetate takes place in the small ring of mesophyll cells. Then the oxaloacetate is converted to malate, another four-carbon compound. Malate is transported into the bundle sheath cells where it releases carbon dioxide. Once released, the carbon dioxide is reassimilated by RuBP and enters the Calvin cycle in the same way as described for $C_3$ plants. The metabolic pathway that transports carbon dioxide into the bundle sheath cells is called the Hatch-Slack pathway. As a result of this pathway, the concentration of carbon dioxide in the bundle sheath cells is 20 to 120 times higher than normal.

$C_4$ plants have two main advantages in hot, dry environments. First, because PEP carboxylase has a high affinity for carbon dioxide and does not combine with oxygen, $C_4$ plants can continue to photosynthesise even when their stomata are closed for long periods. This reduces water loss and photorespiration. $C_4$ plants need only about half as much water as $C_3$ plants for photosynthesis. Secondly, because high carbon dioxide concentrations can be maintained in the bundle sheath cells, $C_4$ plants can increase their photosynthetic efficiency.




These adaptations enable $C_4$ plants to outcome $C_3$ plants in hot and very sunny conditions, but not in temperate conditions. Fewer than 0.5 per cent of plant species are $C_4$ plants, yet they include economically important crops such as maize, sugar cane, and millet.

**CAM plants: photosynthesizing in the desert**

Although $C_4$ plants are well adapted to occasional periods of drought, they cannot cope well with desert conditions. A group of plants including cacti and pineapples have evolved a third type of carbon dioxide fixation which enables them to survive in very dry climates. These plants are called CAM plants. CAM is an abbreviation for crassulacean acid metabolism, a type of metabolism first observed in the family of plants called Crassulaceae (which includes the stonecrops, fleshy-leaved plants that will grow on rocks and walls).

CAM plants conserve water by only opening their stomata at night. During the night, they fix carbon dioxide into oxaloacetate which is converted

into malate. This acts as a carbon dioxide storage compound. During the day, malate releases carbon dioxide into the Calvin cycle. This allows photosynthesis to take place on hot, dry, sunny days, even though the stomata are closed.

CAM plants conserve water very well and are able to survive in extremely dry conditions, but CAM plants do not photosynthesise very efficiently. Most are very slow growing. Where there is plenty of water, CAM plants cannot compete well with $C_3$ and $C_4$ plants.

CAM plants and $C_4$ plants have a similar metabolism: carbon dioxide is first fixed into a four-carbon intermediate before it enters the Calvin cycle. However, in CAM plants the initial fixation and the Calvin cycle occur at separate times, whereas in $C_4$ plants the initial fixation and the Calvin cycle are separated structurally but both occur during the day. $C_4$ plants live in hot, very sunny, and periodically dry environments but where lack of water is rarely a limiting factor (partly because the plants can reduce water losses due to their $C_4$ metabolism) and annual rainfall is high (typically, tropical rainforest-type climates); CAM plants are desert plants that live in areas of very low annual rainfall. Note that $C_3$, $C_4$, and CAM plants all eventually use the Calvin cycle to make glucose from carbon dioxide.

**■ Glossary of essential terms for you to know**

| № | English term | Russian equivalent |
|---|---|---|
| 1 | to thrive | разрастаться |
| 2 | to depend on | зависит от |
| 3 | to adapt | приспособиться |
| 4 | to survive | выживать |
| 5 | to release | выпускать |
| 6 | to breed | размножаться |
| 7 | to cope with | справиться с |
| 8 | photorespiration | световое дыхание |
| 9 | to fix | закрепить, фиксировать |
| 10 | compound | смесь |
| 11 | to relate to | относиться к |
| 12 | efficiently | продуктивно, эффективно |
| 13 | temperate | умеренный |
| 14 | to suffer | страдать |
| 15 | sufficient | достаточный, подходящий |
| 16 | to escape | убежать |
| 17 | to cease | прекращать |
| 18 | leaf | листок |
| 19 | to wilt | ослабевать |

| | | |
|---|---|---|
| 20 | to decrease | уменьшаться |
| 21 | to combine | объединять |
| 22 | loss | потеря |
| 23 | to reduce | уменьшать |
| 24 | to evolve | развивать |
| 25 | to carry out | выполнять |
| 26 | bundle sheath | обкладка сосудистых пучков |
| 27 | vein | вена, жилка |
| 28 | to surround | окружать |
| 29 | cell | клетка |
| 30 | initial | первоначальный |
| 31 | pathway | тропа, путь |
| 32 | carboxylase | карбоксилаза |
| 35 | to increase | увеличивать |
| 36 | to enable | позволять |
| 37 | to compete | конкурировать, соперничать |
| 38 | maize | кукуруза |
| 39 | sugar cane | сахарный тростник |
| 40 | millet | просо |
| 41 | drought | засуха |
| 42 | desert | пустыня |
| 43 | rock | горная порода, скала |
| 44 | to conserve | сохранять |
| 45 | to enter | входить |
| 46 | to occur | происходить |
| 47 | lack of | недостаток |
| 48 | annual | ежегодный |
| 49 | rainfall | осадки |
| 50 | rainforest | тропический лес |

## ■ Your Essential Assignments

## I. Quick check

1. Name two $C_3$ plants.
2. Why is sugar cane called a $C_4$ plant?
3. When do CAM plants fix carbon dioxide?
4. Suggest which type of carbon dioxide fixation ($C_3$, $C_4$, or CAM) is most efficient:

a. If it is not hot and sunny and the carbon dioxide level is low, but water is freely available

b. In hot, dry and sunny climates where stomata are closed
c. In bright light and temperate regions where there is an ample water supply.

## II. Fill in the missing words:

| Term (verb) | Noun | Adjective |
|---|---|---|
| adapt | ..... | ..... |
| fix | ..... | ..... |
| conserve | ..... | ..... |
| separate | ..... | ..... |
| dry | ..... | ..... |

## III. Use monolingual English dictionary and write down what could the words given below mean:

adapt, hot, dry, condition, growth, compound.

## IV. Match these words with their definitions:

| | | | |
|---|---|---|---|
| **1** | adaptation | **A.** | happening at the beginning, first |
| **2** | metabolism | **B.** | a large amount of something in one place or area |
| **3** | cycle | **C.** | the gas produced when animals breathe out, when carbon is burned in air or when anima or vegetable substances decay |
| **4** | initial | **D.** | a plant such as wheat, rice or fruit that is grown by farmers, especially in order to be eaten |
| **5** | sufficient | **E.** | the state of not having something, or not having enough of it |
| **6** | wilt | **F.** | chemical activity in your body that uses food to produce the energy you need to work and grow |
| **7.** | concentration | **G.** | To continue to exist in spite of many difficulties and dangers |
| **8.** | desert | **H.** | To succeed in dealing with a difficult problem or situation |
| **9.** | carbon dioxide | **I.** | the smallest part of a living thing that can exist independently |
| **10** | survive | **J.** | As much as is needed for a particular purpose; |

| | | | |
|---|---|---|---|
| | | | enough |
| **11** | crop plant | **K.** | To stop doing something or happening |
| **12.** | cope with | **L.** | a number of events happening in a regularly repeated order |
| **13.** | cell | **M.** | if a plant wilt, it bends over because it is too dry or old |
| **14.** | cease | **N.** | the process by which something changes or is changed so that it can be used in a different way or in different conditions |
| **15.** | lack of | **O.** | a large area of sand where it is always very hot and dry |

## V. Find English equivalents to the following word combinations:

| № | Russian term | English equivalent |
|---|---|---|
| 1. | жаркий и сухой экваториальный регион | |
| 2. | замерзающий полярный регион | |
| 3. | пшеница, соевые бобы и рис | |
| 4. | умеренные условия | |
| 5. | маленькие поры в листьях | |
| 6. | уменьшает световое дыхание | |
| 7. | приспособлены, чтобы выполнять | |
| 8. | уменьшает потери воды | |
| 9. | высокая концентрация углекислого газа | |
| 10. | справляться с условиями пустыни | |
| 11. | выжить в очень сухом климате | |

## VI. Give Russian equivalents to the following English terms:

| № | English term | Russian equivalent |
|---|---|---|
| 1 | thrive in environments | |
| 2 | cope with the demands | |
| 3 | ways of fixing carbon dioxide | |
| 4 | common and widely distributed | |
| 5 | hot, dry environments | |
| 6 | obtain sufficient carbon dioxide | |
| 7 | allow water to escape | |
| 8 | cease photosynthesising | |
| 9 | plant growth | |
| 10 | the loss of | |

| | | |
|---|---|---|
| 11 | a special metabolic adaptation | |
| 12 | leaf veins | |
| 13 | the metabolic pathway | |
| 14 | the bundle sheath | |
| 15 | photosynthetic efficiency | |
| 16 | survive in extremely dry conditions | |
| 17 | occur at separate times | |

## VII. Find synonyms among the pool of words:

| Pool of words | Synonyms |
|---|---|
| **1)**1.thrive/2.lack/3.grow/4.absence/5.cycle/6.rotation | |
| **2)**1.damage/2.harm/3.cease/4.condition/5.situation/6.finish | |
| **3)**1.efficient /2.sufficient /3.ample /4.productive | |
| **4)**1.annual /2.drought /3.lack of rain /4.once a year | |

## VIII. Answer the following questions. Use all information given before:

1. Where do green plants thrive?
2. How do $C_3$ plants fix carbon dioxide?
3. What are two major disadvantages of $C_3$ plants in hot, dry environments?
4. How do $C_4$ plants fix carbon dioxide?
5. What are the bundle sheath cells?
6. What is the Hatch-Slack pathway?
7. What are two main advantages of $C_4$ plants in hot, dry environments?
8. What are CAM plants?
9. Why can CAM plants survive in very dry climates?

## IX.Match the sentence halves. Make complete sentences:

| | | | |
|---|---|---|---|
| **1.** | Green plants thrive in environments ranging from | **A.** | open their stomata (small pores in their leaves). |
| **2.** | $C_3$ plants fix carbon dioxide directly | **B.** | the Hatch-Slack pathway. |
| **3.** | To obtain sufficient carbon dioxide, $C_3$ plants must | **C.** | carbon dioxide is first fixed into a four-carbon intermediate before it enters the Calvin cycle. |
| **4.** | $C_4$ plants have evolved a special metabolic adaptation | **D.** | into the Calvin cycle as the three-carbon compound glycerate 3-phosphate (GP). |

| | | | |
|---|---|---|---|
| **5.** | A ring of large closely packed cells called | **E.** | hot and dry equatorial regions to freezing-cold polar regions. |
| **6.** | The metabolic pathway that transports carbon dioxide into the bundle sheath cells is called t | **F.** | which reduces photorespiration. |
| **7.** | CAM is an abbreviation for crassulacean acid metabolism, a type of metabolism first observed in the family of plants called | **G.** | crassulaceae (which includes the stonecrops, fleshy-leaved plants that will grow on rocks and walls). |
| **8.** | CAM plants and $C_4$ plants have a similar metabolism: | **H.** | the bundle sheath surrounds the leaf veins. |

## X. Read and translate the short text without any dictionary:

**Fact of life:**

Plants are not very efficient at harnessing energy from the sunlight they receive. Under the most carefully controlled laboratory conditions plants can reach 25% efficiency but on cloudy days the natural photosynthetic efficiency of most individual plants is about 0.1%. The annual winter evening primrose, Oenothera claviformis, has the highest natural photosynthetic efficiency at 8%, closely followed by sugar cane at 7%.

## XI. Food for thought:

If $C_4$ plants have a greater photosynthetic efficiency than $C_3$ plants, suggest why all plants do not have $C_4$ metabolism.

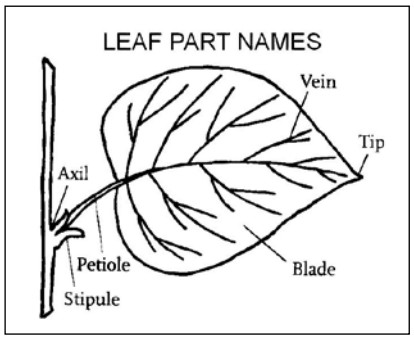
### Biology Jokes

*Enjoy funny biology jokes while taking a break from serious science.*

- What do you call the leader of a biology gang? - The nucleus
- Blood flows down one leg and up the other.
- The pistol of a flower is its last line of defense against insects.
- Mushrooms look like umbrellas because they grow in damp places.
- A couple of biologists had twins. One they called John and the other Control.
- Genetics explain why you look like your father and if you don`t why you should.
- When you breathe, you inspire. When you do not breathe, you expire.
- Three kinds of blood vessels are: arteries, vanes, and caterpillars.

# UNIT VIII. STRUCTURE AND TRANSPORT IN PLANTS

## Text 8.1 The Leaf




**■ Essential targets:**

By the end of this text you should be able to:

- describe the structure of a dicotyledonous leaf;
- distinguish between parenchyma, collenchyma, clerenchyma and sclerenchyma.

*Pre-reading*

**■ Working in pairs, discuss the following questions with your partner:**

1. What does leaf shape provide?
2. How are leafs arranged on many plants?

**■ Read the given text and make your essential assignments:**

The leaf is the main site of photosynthesis, the process by which green plants manufacture their own food. The lamina or blade of a leaf is flat and thin. Its shape provides a large surface area for absorption of light and carbon dioxide. The leaf is attached to a stem or branch by a leaf stalk or petiole. The stalk holds the leaf in a position such that its surface is exposed to the maximum amount of light. From the stalk, the main vein leads down the leaf with side veins branching out on either side. These veins connect the leaf to the rest of the plant, bringing the leaf some of the raw materials required for photosynthesis, and carrying products of photosynthesis away from it. This veins also provide mechanical support, maintaining the shape of the leaf. The stem and branches raise the leaves above the ground so they are exposed to the light. On many plants the leaves are arranged on branches in such a way that they do not shade one another.

**The tissues of a leaf**

In common with stems and roots, leaves are made up of three main types of tissue: epidermal tissue, vascular

tissue, and ground tissue. Each tissue forms a continuous system throughout the plant.

The epidermis covers and protects the leaves. It is the first line of defence against physical damage, infection, and being eaten. The upper epidermis consists of one or more layers of rectangular cells. In terrestrial plants, these epidermal cells secrete a waxy coating called the cuticle. The waxy cuticle is waterproof, minimising water loss from the surface of the leaf. It is often thicker on the upper surface, making this surface appear more shiny than the lower surface.

The epidermis is perforated by microscopic pores called stomata. Stomata allow carbon dioxide and oxygen to gain easy access into the plant, but also allow water to escape. Each stomata is flanked by a pair of guard cells that regulate the size of the pore, closing it in times of water stress. Water is more likely to be lost from the upper surface of a leaf because it is more exposed to sunlight. The upper surface usually has fewer stomata than the lower surface; this minimises water loss.

The vascular tissue consists of veins adapted to transpsort liquid substances around the plant, and it is made up of vascular bundles, groups of vessels running from the root up the stem and to the leaves. Xylem forms the upper part of a vascular bundle in the leaf, bringing water and mineral salts to the leaf. Phloem forms the lower part of a bundle, transporting sucrose and other products of photosynthesis away from the leaf.

Ground tissue is all the tissue in a plant other than the epidermis, reproductive tissue, and vascular tissue. It makes the bulk of a leaf and consists mainly of parenchyma cells reinforced by collenchyma and sclerenchyma.

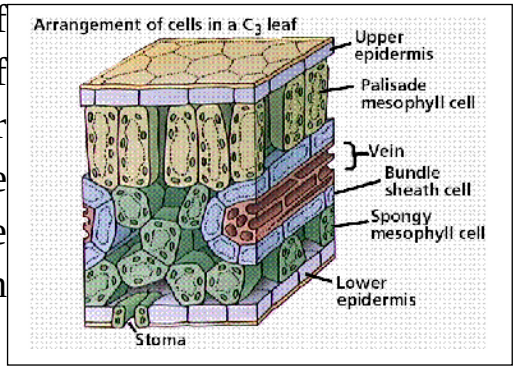
**The cells of the ground tissue**

**Parenchyma cells** are the least specialised of plant cells; they are characterised by having intercellular air spaces which vary in size. Parenchyma cells are regarded as the basic cells from which other cells have evolved. Parenchyma cells form the packing tissue of plants, and include the palisade cells and spongy mesophyll cells which make up the main photosynthesising tissue in the leaf.

**Palisade cells** are a dense green colour due to the numerous chloroplasts they contain. These cells are packed tightly together in a regular arrangement near the upper surface of the leaf so they obtain the maximum exposure to light. The chloroplasts can move round inside the cells according to the amount of light available. If it is a dull day, they are often clustered at the tops of the

cells, in the best position to trap light; in very sunny conditions, they may be grouped towards the bottoms of the cells to avoid being overexposed to light.

**The spongy mesophyll** is the chief site of gaseous exchange in the leaf. It consists of rounded or sausage-shaped cells with fewer chloroplasts than palisade cells. The cells are closely arranged and between each of them are air spaces connecting the mesophyll with stomata.




**Collenchyma** and **sclerenchyma** make up tissues that have a supportive, structural role in plants. In leaves, these cells are common around the vascular bundles (especially in midrib) and at the leaf tips. Collenchyma cells are elongated and have unevenly thickened cell walls with extra cellulose in the corners of the cells. There are two main types of sclerenchyma: fibres are very elongated and have very thick cell walls impregnated with lignin;sclereids (or stone cells) are more spherical in shape. Both types of sclerenchyma cells are specialised for support. Fibres in particular have great tensile strength and do not break easily when stretched. Mature sclerenchyma cells are dead because they are enclosed in a complete layer of lignin which is impermeable to water.

## ■ Glossary of essential terms for you to know

| N | English term | Russian equivalent |
|---|---|---|
| 12. | lamina | местовая пластинка |
| 13. | stalk | стебель, ножка, черенок |
| 14. | petiole | черешок листа |
| 15. | vein | жилка листа |
| 16. | tissue | ткань |
| 17. | vascular tissue | сосудистая ткань, проводящая ткань |
| 18. | ground tissue | покровная ткань |
| 19. | rectangular | прямоугольный |
| 20. | to gain | получать, достигать |
| 21. | to escape | улетучиваться, ускользать |
| 22. | stomata | устьице |
| 23. | to flank | защищать, прикрывать |
| 24. | guard | сторожевой, |
| 25. | to expose | выставлять, подвергать действию (солнца, света) |
| 26. | to raise | поднимать |

| | | |
|---|---|---|
| 27. | to arrange | располагать |
| 28. | vascular bundle | сосудистый пучок |
| 29. | xylem | ксилема |
| 30. | phloem | флоэма |
| 31. | palisade | столбчатый, палисадный |
| 32. | spongy | губчатый, пористый |
| 33. | mesophyll | мезофилл |
| 34. | bulk | основная масса |
| 35. | to reinforce | укреплять, усиливать |
| 36. | to evolve | развиваться |
| 37. | cluster | пучок, гроздь |
| 38. | to trap | ловить, задерживать |
| 39. | midrib | средняя жилка листа |
| 40. | tip | кончик |
| 41. | uneven | неровный, шероховатый |
| 42. | to impregnate | оплодотворять |
| 43. | tensile | растяжимый |
| 44. | lignin | лигнин |
| 45. | collenchyma | колленхима |
| 46. | sclerenchyma | склеренхима |
| 47. | sclereid | склеренда |
| 48. | impermeable | непроницаемый |

## ■ Your Essential Assignments

### I. Quick check

1. a) Which structure forms a waterproof layer on the surface of the leaf?
   b) Why is this structure thicker than the upper surface of the leaf than on the lower surface?
2. What is the main function of palisade cells?
3. How does collenchyma differ from sclerenchyma?

### II. Use monolingual English dictionary and write down what could the words given below mean:

waterproof, shade, pore, infection, waxy coating, guard cells, root.

## III. Fill in the missing words:

| Term | Noun | Adjective |
|---|---|---|
| connect | ……. | ……. |
| require | ……. | ……. |
| support | ……. | ……. |
| protect | ……. | ……. |
| adapt | ……. | ……. |
| expose | ……. | ……. |
| reproduce | ……. | ……. |

## IV. Find synonyms among the pool of words:

| Pool of words | Synonyms |
|---|---|
| **1)**1.amount /2.flat /3.trap /4.quantity /5.even /6.catch | |
| **2)**1.volume /2.fabric /3.reach /4.bulk /5.gain /6.tissue | |
| **3)**1.escape /2.produce /3.disappear /4.manufacture | |
| **4)**1.evolution /2.waterproof /3.impermiable /4.development | |

## V. Give English equivalents to the following word combinations:

| N | Russian term | English equivalent |
|---|---|---|
| 1. | группа цветущих растений | |
| 2. | поглощение света и углекислого газа | |
| 3. | главная жилка листа | |
| 4. | плоская форма листа | |
| 5. | физические повреждения листа | |
| 6. | пара охранительных (сторожевых) клеток | |
| 7. | верхняя поверхность листа | |
| 8. | потеря воды | |
| 9. | наименее специализированные растительные клетки | |
| 10. | плотные зеленые клетки листа | |
| 11. | согласно количеству света | |
| 12. | наилучшая позиция улавливания света | |
| 13. | главный участок газообмена | |
| 14. | кончик листа | |
| 15. | неровно утолщенные клеточные стенки | |

## VI. Match these words with definitions:

| N | Word | | Definition |
|---|---|---|---|
| **1.** | absorption | **A** | any of the very thin tubes that form the frame of a leaf |
| **2.** | stalk | **B** | the act of protecting s/b or s/th from attack, criticism etc. |
| **3.** | terrestrial | **C** | not allowing a liquid or gas to pass through |
| **4.** | cluster | **D** | the process of a liquid, gas or other substance being taken in |
| **5.** | defence | **E** | living on the land or on the ground rather than in water or in the air |
| **6.** | vein | **F** | a group of things of the same type that grow close together |
| **7.** | impermeable | **G** | thin stem that supports a leaf, flower or fruit and joins it to another part of the plant |

## VII. Give Russian equivalents to the following English terms:

| N | English term | Russian equivalent |
|---|---|---|
| 1. | absorption of light and carbon dioxide | |
| 2. | maintain the flat shape of the leaf | |
| 3. | secrete a waxy coating | |
| 4. | to gain easy access into the leaf | |
| 5. | bulk of a leaf | |
| 6. | intercellular air spaces | |
| 7. | cells are packed tightly together | |
| 8. | regular arrangements | |
| 9. | according to the amount of light available | |
| 10. | best position to trap light | |

## VIII. Match the sentence halves. Make complete sentences.

| | | | |
|---|---|---|---|
| **1.** | Collenchyma and sclerenchyma make up tissues that | **A** | maintaining the shape of the leaf |
| **2.** | The cells are closely arranged and between each of them are | **B** | have a supportive structural role in plants |
| **3.** | Palisade cells are green colour | **C** | bringing water and mineral salts |

| | | | |
|---|---|---|---|
| | due to | | to the leaf |
| **4.** | Xylem forms the upper part of a vascular bundle in the leaf | **D** | minimizing water loss from the surface of the leaf |
| **5.** | Parenchyma cells are regarded as basic cells | **E** | from which other cells have evolved |
| **6.** | Each stomata is flanked by a pair of guard cells | **F** | air spaces connecting the mesophyll with the stomata |
| **7.** | The waxy cuticle is waterproof | **G** | the numerous chloroplasts they contain |
| **8.** | Leaves are made up of three main types of tissue | **H** | that regulate the size of the pore |
| **9.** | The veins provide mechanical support | **I** | epidermal tissue, vascular tissue and ground tissue |
| **10.** | The stalk holds the leaf in a position such that | **J** | its surface is exposed to the maximum amount of light |

## IX. Answer the following questions. Use all information given before.

1. What does the leaf shape provide?
2. How are the leaves arranged on many plants?
3. What is the role of the waxy cuticle?
4. Is the ground tissue the same as the epidermis, reproductive tissue and vascular tissue?
5. How are palisade cells packed?
6. What makes chloroplasts move around inside the cells?
7. Why are mature sclerenchyma cells not alive?

## X. Read and translate the short text without any dictionary.

**Fact of life:**

The longest leaves belong to palm trees. Those of the palm *Raphia ruffia* (from which raffia fibres are obtained) may reach over 22 m long.

## XI. Food for thought

Leaves from different species have an enormous variety of size, shape, and structure. In addition to being adapted to absorbing light for photosynthesis, to what other factors might leaves be adapted?

**XII. Translate into English using all the active possible.**

1. Фотосинтез – это процесс, посредством которого, растения производят свою пищу.

2. Черешок удерживает лист в таком положении, чтобы поверхность листа получала максимальное количество света.

3. У многих растений листья на ветвях расположены таким образом, что они не затеняют друг друга.

4. Эпидермис представляет собой первую линию защиты листа от повреждений, инфекции и поедания животными.

5. Потеря воды с верхней поверхности листа более вероятна, т.к. она подвергается большему излучению солнца.

6. Сосудистая ткань состоит из жилок адаптированных к переносу жидких веществ ко всем частям растения.

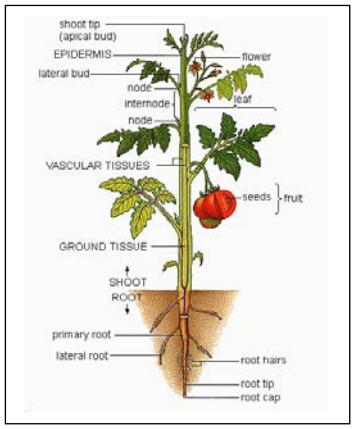
7. Хлоропласты могут перемещаться внутри клеток в соответствии с количеством поступления света.

8. Пористый мезофилл – основное место газообмена в листьях.

9. Клетки располагаются свободно, и между каждой из них имеется воздушное пространство, соединяющее мезофилл с устьицем.

10. Колленхимные клетки являются удлиненными и стенки клеток имеют шероховатое утолщение и целлюлозу в уголках клеток.

## Text 8.2. The Stem




**■ Essential targets:**

By the end of this text you should be able to:

- describe the structure of dicotyledonous stem;
- state the major functions of stems;
- explain how different tissues contribute to the mechanical support of stems.

*Pre-reading*

**■ With a partner consider the following questions and try to answer them.**

1. How do you think, what are the functions of stems?
2. What are distinguishable marks of all stems?

■ **Read the given text and make your essential assignments:**

**Functions of a stem**.

The stems of most plants are first and foremost organs of support. They lift terrestrial plants above the ground, raising their leaves towards the Sun and holding them in the best position to gain optimum exposure to light and carbon dioxide. They also hold flowers and fruit in positions that allow efficient pollination and seed dispersal.

As well as support, stems have three other major functions:

they transport materials from one part of the plant to another;

they produce new living tissue to replace cells that die and to make new growth;

they store food and water.

**The stem as plant organ**

The attachment site of a leaf or bud on a stem is called a node, and the po rtion between nodes is called an internode. Most stems point upwards from the ground and are easily distinguished from other plant organs. Some stems, however, have an unusual shape or location which makes them more difficult to identify. Potato tubers, for example, appear root-like, but they are actually swollen underground stems specialised for food storage. All stems, of whatever size, shape, or location, are distinguishable as such by the presence of nodes and internodes.

**The tissues and cells of a stem**

In a dicotyledonous, non-woody (herbaceous) stem the epidermis is like that of a leaf: a single layer of cells perforated by stomata. The epidermis helps maintain the shape of the stem. It is covered with a waxy cuticle to reduce water loss. In woody stems of trees and bushes, the epidermis is replaced by bark consisting of many layers of dead cells. Bark is penetrated by small pores called lenticels, through which gaseous exchange takes place. The lenticels usually appear as raised spots surrounded by a powdery and impermeable material.

Just inside the epidermis, a layer of collenchyma gives both support and flexibikity to the stem. Some collenchyma cells contain chloroplasts which make the stem appear green.

The inner parts of the stems of most non-woody plants consist of vascular bundles embedded in undifferentiated parenchyma cells. When fully inflated with water (turgid), the parenchyma cells press against the epidermis and collenchyma, strengthening the stem. The stems of trees and bushes are supported not by parenchyma but by rigid woody tissue which makes up the bulk of these stems. The woody tissue consists of xylem and associated cell such as fibres formed by a process called secondary growth. New wood is added outside the old wood each growing season to form annual growth rings, visible in transverse sections of the stems of trees and shrubs.

Vascular tissue in the stem takes the form of bundles containing phloem and xylem and reinforced with strong fibres. The xylem is located towards the inside of the stem and the phloem towards the outside. The tough rigid vascular bundles embedded in softer turgid parenchyma tissue have been likened to reinforced concrete, in which rigid steel girders are imbedded in softer concrete. This arrangement gives the stem strength and flexibility, making it well suited to resisting sideways bending in strong winds. The vascular bundles of dicotyledonous plants are arranged in a ring pattern around the outside of the stem, while in monocotyledons such as cacti the vascular bundles are scattered throughout the stem.

The stem centre is called the pith. It may consist of parenchyma cells for storage, or it may be devoid of cells, in which case it is called a pith cavity.

**■ Glossary of essential terms for you to know:**

| N | English term | Russian equivalent |
|---|---|---|
| 1 | foremost | самый главный |
| 2 | allow | предоставлять, позволять |
| 3 | pollination | опыление |
| 4 | dispersal | рассеяние, разброс |
| 5 | replace | заменить, замещать |
| 6 | attachment | прикрепление |
| 7 | node | узел, нарост, утолщение |
| 8 | internode | междоузлие |
| 9 | point | быть направленным, направляться |
| 10 | swollen | разбухать, пухнуть |
| 11 | herbaceous | травянистый |
| 12 | dicotyledonous | двудольный |
| 13 | monocotyledonous | однодольный |
| 14 | bark | кора |
| 15 | stomata | устьица |
| 16 | penetrate | пронизываться, проникать |
| 17 | lenticel | чечевичка |
| 18 | impermeable | непронизаемый |
| 19 | embed | вставлять, внедрять |
| 20 | inflate | наполнять, надувать |
| 21 | turgid | тургесцентный, набухший |
| 22 | rigid | жесткий |
| 23 | transverse | поперечный |
| 24 | tough | несгибаемый, жесткий |
| 25 | liken | уподоблять |
| 26 | girder | брус, перекладина |

| | | |
|---|---|---|
| 27 | scatter | разбрасывать, рассеивать |
| 28 | phloem | флоэма, луб |
| 29 | parenchyma | паренхима |
| 30 | resist | сопротивляться |
| 31 | pitch | сердцевина |
| 32 | devoid | лишенный (чего-л.), свободный (от чего-л.) |
| 33 | reinforce | усиливать, подкреплять |
| 34 | slit | продольный разрез, щель |

## ■ Your Essential Assignments

### I. Quick check

1. What distinguishes stems from other plant?
2. List the four functions structures?
3. How do parenchyma cells support herbaceous stems?

### II. Fill in the missing words:

| Term (verb) | Noun | Adjective |
|---|---|---|
| disperse | ..... | ……. |
| attach | ..... | ……. |
| …..... | location | ……. |
| identify | ..... | ……. |
| store | ..... | ……. |
| maintain | ..... | ……. |
| penetrate | ….. | ……. |
| ..... | strength | ……. |
| grow | ..... | ……. |
| add | ..... | ……. |

### III. Use monolingual English dictionary and write down what could the words given below mean:

ground, growth, woody stem, non-woody stem, exchange, flexibility, growing season, resist, bundle.

### IV. Find English equivalents to the following word combinations:

| N | Russian term | English equivalent |
|---|---|---|
| 1. 1 | наземные растения | |
| 2. | получать оптимальную экспозицию к свету | |
| 3. | удерживать цветы и плоды | |
| 4. | эффективное опыление | |
| 5. | рассеивание семян | |

| | | |
|---|---|---|
| 6. | заменять умершие клетки | |
| 7. | хранить (запасать) воду, питательные вещества | |
| 8. | трудно опознать (идентифицировать) | |
| 9. | эпидермис заменяется корой | |
| 10. | внутренние части стебля | |
| 11. | принимать форму пучков (узлов) | |
| 12. | придавать стеблю прочность и гибкость | |

## V. Give Russian equivalents to the following English terms:

| N | English term | Russian equivalent |
|---|---|---|
| 1 | foremost organs of support | |
| 2 | attachment site of a leaf | |
| 3 | most stems point upward | |
| 4 | easily distinguished from | |
| 5 | unusual shape of location | |
| 6 | swollen underground stems | |
| 7 | maintain the shape of the stem | |
| 8 | reduce water loss | |
| 9 | rigid woody tissue | |
| 10 | in softer turgid tissues | |

## VI. Find synonyms among the pool of words:

| Pool of words | Synonyms |
|---|---|
| **1)**1.keep/2.replace/3.gain/4.store/5.substitude/6.obtain/ | |
| **2)**1.ground / 2. appear / 3. soil / 4. emerge | |
| **3)**1.reinforce/2.like/3.situation/4.similar/5.position/6.strengthen | |
| **4)**1.support / 2. seem / 3. maintain/ 4. appear | |
| **5)**1.tough/2. strength/3.rigid/4.force/5.locate/6.situate | |

## VII. Answer the following questions. Use all information given before:

1. How is the stem centre called?
2. What kind of form does the vascular tissue take?
3. Where is the tough rigid vascular bundles embedded in?
4. How are vascular bundles arranged in the:
   a) dicotyledonous plants
   b) monocotyledonous plants?
5. Are the stems of trees supported by parenchyma?
6. What does the epidermis help?
7. What does the inner part of the stems consist of?
8. What is epidermis covered with?
9. Where do most stems point?

## VIII. Match the sentence halves. Make complete sentences:

| | | | |
|---|---|---|---|
| **1.** | The stems of most plants are foremost organs of support because | **A.** | upwards from the ground. |
| **2.** | Most stems point | **B.** | parenchyma cells for storage or it may be devoid of cells. |
| **3.** | Some stems have an unusual shape of location which | **C.** | vascular bundles embedded in undifferentiated cells. |
| **4.** | All stems of whatever size, shape or location are distinguishable as such by | **D.** | gaseous exchange takes place. |
| **5.** | The epidermis is covered with | **E.** | they lift terrestrial plants above the ground rising their leaves towards the sun. |
| **6.** | Bark is penetrated by small pores called lenticels through which | **F.** | waxy cuticle to reduce water loss. |
| **7.** | The inner parts of the stems of most non-woody plants consist of | **G.** | makes them more difficult to identify. |
| **8.** | Vascular tissue in the stem take the form of | **H.** | the presence of nods and internodes. |
| **9.** | The stem centre is called pitch. It may consist of | **I.** | bundles containing phloem and xylem and reinforces with strong fibres. |

## IX. Read and translate the short text without any dictionary:

**Fact of life:**

The stems of woody plants have a layer of protective tissue called cork, just below the epidermis. Cork is made of dead cells coated with a waxy substance (suberin) which makes them waterproof. The exceptionally thick cork layer of the oak (quercus suber) is removed for commercial use. If cork formed a complete layer, stem cells would die because they wouldn't be able to exchange respiration gases with the environment. However, slit-like openings called lenticels develop in the cork. The lenticels contain loosely packed thin-walled dead cells which lack suberin, and they have large intercellular spaces to allow gaseous exchange.

## X. Food for thought:

Cacti live in hot dry American deserts. To conserve water and deter herbivores, their leaves lose their photosynthesising function and are modified into spines. Nevertheless, cacti may lose as much as 20 per cent of their tissue fluids in a severe drought. Suggest how the stem is adapted to:

a) carry out photosynthesis

b) minimise water losses and minimise the effect on the plant of water-losses.

**XI. Translate into English using all the active possible.**

1. Стебель удерживает плоды и цветы в таком положении, чтобы происходило эффективное опыление и рассеяние семян.
2. Клубни картофеля кажутся похожими на корень, но на самом деле они представляют собой разбухшие подземные стебли.
3. Эпидермис помогает поддерживать форму стебля.
4. Внутри эпидермиса находится слой колленхимных клеток, который придает стеблю как поддержку, так и гибкость.
5. При полном наполнении водой (тургесцентный) парехимные клетки давят на эпидермис и колленхим, укрепляя (усиливая) стебель.
6. Древесная ткань состоит из ксилемных и ассоциированных клеток, таких как волокна, сформированных посредством процесса, называемого вторичным ростом.
7. Такое расположение придает стеблю силу и гибкость, делая его хорошо приспособленным к сопротивлению наклонам из стороны в сторону при сильном ветре.

## SUPPLEMENTARY READING

### Texts for Reading, Retelling and Discussing

### ■ Text 1. Louis Pasteur

Pasteur (1822-1895) began his scientific career as a chemist, but it is because of his applications of germ theory to the prevention of disease that he became known as ‘The Father of Microbiology’.

Pasteur did not create germ theory, but he proved it to be correct. Once he had achieved this, he set about finding ways to prevent germs, the microorganisms present in the air, from infecting food and people.

He completed his famous experiment proving that microorganisms were present in the air while working for a wine company. He was trying to discover why wine sometimes went bad as it was being made. Once he had found the cause – microorganisms – he began to develop the process which carries his

name – pasteurization. It was perfectly possible to kill all the microorganisms in food by boiling it, a process known as sterilization, but this damaged the taste and the quality of the food. Pasteur`s process killed not all, but most, of the microorganisms, with the result that the food needed to be kept cool and eaten or drunk within a limited time. Most importantly, the quality of the food was not harmed by the process. Much of the food we eat today is pasteurized.

His next achievement was to build on the discovery of the British scientist Edward Jenner. Many years earlier, Jenner had discovered a way of giving people resistance to the deadly disease smallpox, by injecting them with a similar disease that was found among cows. The process became known as vaccination. Pasteur applied germ theory to his work and looked at samples of blood taken from healthy and infected animals. He grew bacteria in his laboratory and used it to infect animals. By chance, some of these germs failed to grow well in his laboratory; these weak germs were then used to infect some chickens. Although the chickens suffered at first, they made a complete recovery and could not be infected again. In this way he discovered a way of increasing resistance to disease. Pasteur developed vaccines for many serious diseases including cholera and anthrax. At that time, these illnesses were certain death for anyone who caught them.

Pasteur`s discoveries revolutionized work on infectious diseases. Pasteur`s vaccines were different from Jenner`s in one important way. Jenner found a weak form of smallpox and transferred it to humans. Pasteur weakened the disease in a laboratory and immunized people with that weakened form. His success allowed a colleague to develop the first vaccine for rabies, which Pasteur used to save the life of a nine-year-old boy. By this act, Pasteur`s position as a hero was assured.

Thanks to the work of Pasteur, we now live longer, our food stays fresh longer and we are less likely to die of disease. Indeed, smallpox is no longer found anywhere in the world, due to a huge vaccination programme carried out in the 20$^{th}$ century. This could never have happened without the scientific achievements of The Father of Microbiology.

## Extract from a lecture about immunisation

Historically, being immunized against diseases is a relatively new thing but that doesn`t mean the idea hadn`t been thought before. If we go as far back as 429 BC, the historian Thucydides noted that after a smallpox plague in Athens survivors did not become infected again. This was a time before there was even recognition of such things as bacteria and viruses.

Nowadays we take it for granted that we will be vaccinated and avoid diseases like polio, but how many of us actually stop to ask ourselves what is behind the injection we have? How does vaccination work?

Basically, it is the process by which a person is exposed to an agent so that his or her immune system develops against that agent. The immune system makes antibodies which fight against infection. Once the human immune system is exposed, that is, made open to a disease, it is able to act against any future infection. Vaccination exposes a person to an immunogen – something which helps develop immunity – in a controlled way by using a weak dose so he or she doesn`t become ill while being immunized.

The good thing about a vaccination programme is that it can limit the spread of a disease among a population, reducing the risk for people who have not been vaccinated, so we have something which is known as herd immunity. That means when the number of non-immune people has dropped to a certain level, the disease will disappear from the whole population. This is how we have achieved the elimination of many diseases.

**Quick check:**

1. What does pasteurization mean?
2. What is the difference between pasteurization and sterilization?
3. What does the word vaccination mean?
4. Do we need vaccination?
5. What vaccinations have you had?
6. Are there any negative aspects to vaccination?
7. Do you know of any diseases for which we cannot be immunized?
8. What vaccines would you like to see developed?
9. In what way do Pasteur`s vaccines differ from those of Jenner?

## ■ Text 2. Gregor Mendel

Gregor Mendel was born on 20th July, 1822, and died on 6th January, 1884. He was a biologist and botanist whose scientific research showed that inheritance proceeds according to certain scientific laws.

Mendel was a brilliant student and his family encouraged him to study, but they were very poor so Mendel entered a monastery in 1843. There he taught Mathematics, Physics and Greek to his school students. Eight years later, in 1851, the monastery sent him to the University of Vienna where he was able to continue his education. In 1853, he returned to the monastery and began teaching and researching again.

Mendel`s theories of heredity based on his work with pea plants are well known to students of Biology. But his findings were so different from the accepted views on heredity at the time that his work was ignored until long after his death. His paper, ‘Experiments in Plant Hybridisation”, in which he

described how traits were inherited, has become one of the most influential publications in the history of science.

Mendel was the first person to trace the characteristics of successive generations of an organism. In Mendel`s day, a number of hypotheses had been suggested to explain heredity. The most popular one was the so-called *blending theory*. According to this theory, inherited traits blended from generation to generation. For instance, a red rose crossed with a white rose would, over time, produce a pink rose. Another theory put forward by Charles Darwin was called *pangenesis*. This stated that there were hereditary particles in our bodies, and that these particles were affected by our actions. The altered particles could be inherited by the next generation. These theories were disproved by Mendel.

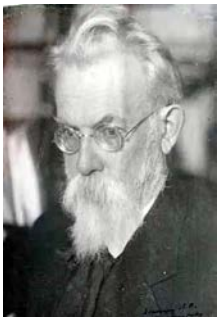
The first thing he noticed when he began his experiments was that traits were inherited in certain numerical ratios. This observation led him to come up with the idea of the dominance of genes and he tested it in peas. For seven years he crossed thousands of plants to prove the Laws of Inheritance. From his experiments, Mendel developed the basic laws of heredity. Those laws are the following: that traits do not combine, but are passed whole from generation to generation (which disproved the blending theory and Darwin`s theory); each member of the parental generation passes on only half of its hereditary information to each offspring (with certain traits dominant over others); and different offspring of the same parents receive different sets of hereditary information.

Mendel`s research formed the beginning of the modern science of genetics. Genetic theory has had a huge impact on our lives. Many diseases, for example haemophilia, are known to be inherited, and family histories can be traced to determine the probability of passing on a hereditary disease. Scientists can now design plants that are easier to grow, or which can produce more food. This practical side of the results of Mendel`s research is being used to improve the way we live.

**Quick check:**

1. How are characteristics passed on from generation to generation?
2. How does modern science change this? Why?

## ■ Text 3. Vladimir Vernadsky



Vladimir Ivanovich Vernadsky was a Russian scientist who was born on 12th March, 1863 in St. Petersburg. His most important contributions to science were the development of the ideas of the biosphere (from the Greek word *bios* meaning *life*) and the noosphere (from the Greek word *noos* meaning mind).

He graduated from the Physics and Mathematics Department of St Petersburg University in 1885. From 1890 to 1911 he taught mineralogy and crystallogaphy at the University of Moscow. In 1912 he was made a full member of the Russian Academy of Sciences where he was actively involved for 33 years, until his death in Moscow on 6th January, 1945.

Through his work in mineralogy, Vernadsky became interested in the distribution of chemical elements in the Earth`s crust, hydrosphere and atmosphere – the field known as geo chemistry. Vernadsky published many papers on the geochemistry of various elements, including the geochemistry of radioactive compounds.

Vernadsky was one of the first scientists to suggest the possibility of using radioactive elements as sources of energy, and he organized a special commissions to look for uranium ores in Russia. In 1916, the first uranium deposits were discovered. But Vernadsky was aware of the danger of putting atomic energy into the hands of man. He said that scientists carried the huge responsibility of making sure their discoveries did not lead to destruction.

However, Vernadsky is probably best known for his development of the idea of the biosphere of the Earth and his ideas on the evolution of the biosphere into the noosphere.

The biosphere is the layer of the Earth in which all life exists. The term biosphere was coined in 1875 by the geologist, Eduard Suess, but it was Vladimir Vernadsky who recognized its ecological importance in 1929. He believed that all living organisms together with their environments make up the biosphere. These environments include the air (the atmosphere), land (the geosphere), rocks (the lithospere) and water (the hydrosphere). The exact thickness of the biosphere on Earth is difficult to calculate, but most scientists would agree that it is from about 5000 metres above sea level to around 9000 metres below sea level. Thus, there is a 14-kilometre zone within which life exists.

Vernadsky defined the boundaries of the biosphere by showing that the biosphere includes all the hydrosphere, part of the troposphere – the lowest layer of the atmosphere where most weather changes take place – and the upper part of the Earth`s crust down to a depth of two or three kilometers, in short, everywhere that life exists. For Vernadsky, the biosphere had existed

since the very beginning of the Earth`s history and it was constantly evolving. Our present living world is the product of a long and complex evolution of the biosphere.

Vernadsky believed that the technological activities of mankind were a stage in this evolution. He believed that human reason and combined scientific efforts could overcome the negative results of technology and could lead to a safe future for everyone. This positive evolutionary stage of the biosphere of the Earth is for him the *noosphere*, the sphere of reason.

In his paper, *Several Words on the Noosphere* (1944, the last paper he published before his death), Vernadsky outlined the conditions that were required for the creation of the noosphere: equality for all people and an end to wars, poverty and hunger. Today, Vernadsky`s vision of the world is more important than ever before.

**Quick check**

1. What do you understand by the term *biosphere*?
2. Why is it so important?
3. What layers does it consist of?
4. In what sorts of different environments can life exist?
5. Think about humanity. How do we affect our environment?

## ■ Text 4. Ivan Pavlov

Ivan Petrovich Pavlov was born on September 14, 1849 at Ryazan, where his father, Peter Dmitrievich Pavlov, was a village priest. He was educated first at the church school in Ryazan and then at the theological seminary there.

Inspired by the progressive ideas which D. I. Pisarev, the most eminent of the Russian literary critics of the 1860's and I. M. Sechenov, the father of Russian physiology, were spreading, Pavlov abandoned his religious career and decided to devote his life to science. In 1870 he enrolled in the physics and mathematics faculty to take the course in natural science.

Pavlov became passionately absorbed with physiology, which in fact was to remain of such fundamental importance to him throughout his life. It was during this first course that he produced, in collaboration with another student, Afanasyev, his first learned treatise, a work on the physiology of the pancreatic nerves. This work was widely acclaimed and he was awarded a gold medal for it.

In 1875 Pavlov completed his course with an outstanding record and received the degree of Candidate of Natural Sciences. However, impelled by his overwhelming interest in physiology, he decided to continue his studies and

proceeded to the Academy of Medical Surgery to take the third course there. He completed this in 1879 and was again awarded a gold medal. After a competitive examination, Pavlov won a fellowship at the Academy, and this together with his position as Director of the Physiological Laboratory at the clinic of the famous Russian clinician, S. P. Botkin, enabled him to continue his research work. In 1883 he presented his doctor's thesis on the subject of «The centrifugal nerves of the heart». In this work he developed his idea of nervism, using as example the intensifying nerve of the heart which he had discovered, and furthermore laid down the basic principles on the trophic function of the nervous system. In this as well as in other works, resulting mainly from his research in the laboratory at the Botkin clinic, Pavlov showed that there existed a basic pattern in the reflex regulation of the activity of the circulatory organs.

In 1890 Pavlov was invited to organize and direct the Department of Physiology at the Institute of Experimental Medicine. Under his direction, which continued over a period of 45 years to the end of his life, this Institute became one of the most important centres of physiological research.

It was at the Institute of Experimental Medicine in the years 1891-1900 that Pavlov did the bulk of his research on the physiology of digestion. It was here that he developed the surgical method of the «chronic» experiment with extensive use of fistulas, which enabled the functions of various organs to be observed continuously under relatively normal conditions. This discovery opened a new era in the development of physiology, for until then the principal method used had been that of «acute» vivisection, and the function of an organism had only been arrived at by a process of analysis. This meant that research into the functioning of any organ necessitated disruption of the normal interrelation between the organ and its environment. Such a method was inadequate as a means of determining how the functions of an organ were regulated or of discovering the laws governing the organism as a whole under normal conditions - problems which had hampered the development of all medical science. With his method of research, Pavlov opened the way for new advances in theoretical and practical medicine. With extreme clarity he showed that the nervous system played the dominant part in regulating the digestive process, and this discovery is in fact the basis of modern physiology of digestion.

Pavlov's research into the physiology of digestion led him logically to create a science of conditioned reflexes. In his study of the reflex regulation of the activity of the digestive glands, Pavlov paid special attention to the phenomenon of «psychic secretion», which is caused by food stimuli at a distance from the animal. By employing the method - developed by his colleague D. D. Glinskii in 1895 - of establishing fistulas in the ducts of the salivary glands, Pavlov was able to carry out experiments on the nature of

these glands. A series of these experiments caused Pavlov to reject the subjective interpretation of «psychic» salivary secretion and, on the basis of Sechenov's hypothesis that psychic activity was of a reflex nature, to conclude that even here a reflex - though not a permanent but a temporary or conditioned one - was involved.

This discovery of the function of conditioned reflexes made it possible to study all psychic activity objectively; it was now possible to investigate by experimental means the most complex interrelations between an organism and its external environment.

Subsequently, in a systematic programme of research, Pavlov transformed Sechenov's theoretical attempt to discover the reflex mechanisms of psychic activity into an experimentally proven theory of conditioned reflexes.

As guiding principles of materialistic teaching on the laws governing the activity of living organisms, Pavlov deduced three principles for the theory of reflexes: the principle of determinism, the principle of analysis and synthesis, and the principle of structure.

The development of these principles by Pavlov and his school helped greatly towards the building-up of a scientific theory of medicine and towards the discovery of laws governing the functioning of the organism as a whole.

Experiments carried out by Pavlov and his pupils showed that conditioned reflexes originate in the cerebral cortex, which acts as the «prime distributor and organizer of all activity of the organism» and which is responsible for the very delicate equilibrium of an animal with its environment. In 1905 it was established that any external agent could, by coinciding in time with an ordinary reflex, become the conditioned signal for the formation of a new conditioned reflex. In connection with the discovery of this general postulate Pavlov proceeded to investigate «artificial conditioned reflexes». Research in Pavlov's laboratories over a number of years revealed for the first time the basic laws governing the functioning of the cortex of the great hemispheres. Many physiologists were drawn to the problem of developing Pavlov's basic laws governing the activity of the cerebrum. As a result of all this research there emerged an integrated Pavlovian theory on higher nervous activity.

Even in the early stages of his research Pavlov received world acclaim and recognition. In 1901 he was elected a corresponding member of the Russian Academy of Sciences, in 1904 he was awarded a Nobel Prize, and in 1907 he was elected Academician of the Russian Academy of Sciences; in 1912 he was given an honorary doctorate at Cambridge University and in the following years honorary membership of various scientific societies abroad. Finally, upon the recommendation of the Medical Academy of Paris, he was awarded the Order of the Legion of Honour (1915).

Pavlov directed all his indefatigable energy towards scientific reforms. He devoted much effort to transforming the physiological institutions headed by

him into world centres of scientific knowledge, and it is generally acknowledged that he succeeded in this endeavour.

Pavlov created a great school of physiologists, which produced many distinguished pupils. He left the richest scientific legacy - a brilliant group of pupils, who would continue developing the ideas of their master, and a host of followers all over the world.

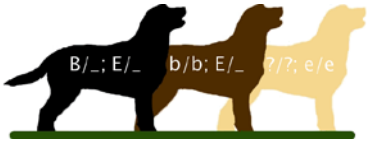
Dr. Pavlov died in Leningrad on February 27, 1936.

From Nobel Lectures, Physiology or Medicine 1901-1921, Elsevier Publishing Company, Amsterdam, 1967.

**Quick check**

1. What made Pavlov devote his life to physiology?
2. What does the term “chronic” experiment mean?
3. Does the merit of inventing the method of establishing fistulas in the ducts of salivary glands belong to Pavlov?
4. What did the discovery of the function of conditioned reflexes help to study?
5. Name three principles of the theory of reflexes.
6. What did the development of these principles lead to?
7. Where do conditioned reflexes start?
8. What is the main postulate of the theory of “artificial conditioned reflexes”?
9. What was the outcome of all Pavlov`s investigations?
10. What highest award did I.P. Pavlov receive and when?

## ■ Text 4. Dihybrid Inheritance




Mendel would have had a problem interpreting the genetics of coat colour in Labrador retrievers because this is controlled by two genes, not one. Labrador retrievers have three possible coat colours (black, yellow, and chocolate or liver) controlled by two sets of genes. One set determines whether the retriever will be dark (either black or chocolate) or light (yellow). Dark is dominant to light. The second set comes into play only if the dog is dark. This set determines whether the dog is black (the dominant trait) or chocolate (the recessive trait). Labrador retrievers were bred originally as water dogs, trained to haul cod nets ashore and retrieve items lost overboard.

**The inheritance of two characteristics**

**Dihybrid inheritance** is the inheritance of two characteristics, each controlled by a different gene at a different locus. In one experiment Mendel studied dihybrid inheritance by crossing plants from two pure-breeding strains: one tall with purple flowers, the other dwarf with white flowers. All the

offspring in the F1 generation were tall with purple flowers, these being the dominant characteristics. The F1 generation were self-crossed, producing the following phenotypes and ratios in the $F_2$ generation:

- 9 tall purple-flowered
- 3 tall white-flowered
- 3 dwarf purple-flowered
- 1 dwarf white-flowered.

Mendel observed that two phenotypes resembled one or other of the parents, and two phenotypes had combined the characteristics of both parents. He also observed that the ratio of tall plants to dwarf plants was 3:1, and that the ratio of purple-flowered plants to white-flowered plants was 3:1. This was the same ratio that occurred in the monohybrid crosses. He concluded from these results that the two pairs of characteristics behave quite independently of each other. This led him to formulate his law of independent assortment, which states that any one of a pair of characteristics may combine with any one of another pair.

**Interpreting the results of a dihybrid cross**

Mendel's results can be explained in terms of alleles and the behaviour of chromosomes during meiosis. Notice that the two alleles for one gene are always written together (for example, **TtPp,** *not* **TPtp).** This makes it easier to interpret the crosses. The pure-breeding adult plants, being diploid, have two alleles for each gene. The genes for height and flower colour are carried on separate chromosomes. During gamete formation, meiosis occurs, producing gametes containing one allele for each gene. In the F1 generation, the only possible genotype is TtPp. When these plants are self-crossed, there are four possible combinations of alleles in both the female and male gametes: TP, Tp, tP, and tp. Assuming fertilisation is random, any male gamete can fuse with any female gamete, so there are 16 possible combinations for the offspring, as shown in the Punnett square. These combinations can produce four different phenotypes from nine genotypes.

The only genotype that can be worked out simply by looking at the plants is that of the dwarf white-flowered plants. Genotypes of the other plants can be established by test crosses.

**Recombination**

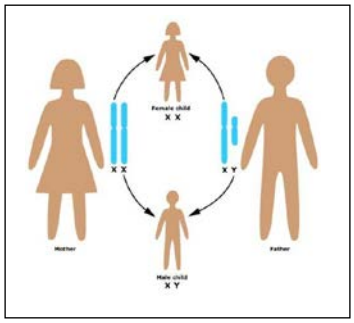
As already stated, two of the phenotypes in the $F_2$ resemble the original parents (tall purple-flowered and short white-flowered), and two show new combinations of characteristics (tall white-flowered and dwarf purple-

flowered). This process that results in new combinations of characteristics is called recombination, and the individuals that have the new combinations are known as recombinants. Recombination is an important source of genetic variation, contributing to the differences between individuals in a natural population.

**Quick check:**

1. What are recombinants?
2. Give a genetic explanation of Mendelian dihybrid inheritance.
3. Explain the significance of recombination.
4. Explain the use of test crosses to determine unknown genotypes in studies of dihybrid inheritance
5. Divide the text into an introduction, principal part and conclusion.
6. Express the main idea of each part.
7. Give a title to each paragraph of the text.
8. Summarize the text in brief.

## ■ Text 5. Sex Determination



One of the most fascinating marine animals is the slipper limpet, a mollusc with the intriguing scientific name of *Crepidula fornicate*. It was given this name because it has the surprising ability to change its sex. The limpets are immobile for most of their lives, growing in chains. The sex of each limpet depends on its size and its position in the chain. The young, small individuals are males, with long tapering penises which fertilise females lower in the chain. In due course, when a male has grown and has been settled on by another smaller limpet, the male loses its penis and grows into a female. Thus large females occur at the base of the chain, with animals changing sex above them, and males at the apex. In this way, the limpets have been able to combine immobility with internal fertilisation.

**Sex chromosomes**

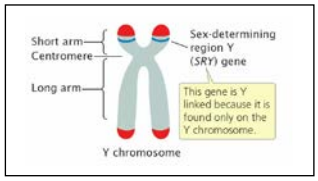
There have been many weird and wonderful ideas about sex determination in humans. Some Ancient Greeks thought that the sex of a baby was determined by which testicle the sperm came from. Apparently, this belief was adopted by some European kings who tied off or removed their left testicle to ensure a male heir to the throne. Other people believed that the sex of a baby could be controlled by conceiving when the Moon was in a particular phase, when the wind was blowing in a certain direction, or whilst speaking certain words. We now know that human sex is determined by a pair of sex chromosomes called X and Y. Because these chromosomes do not look alike,

they are sometimes called heterosomes. All other chromosomes are called autosomes. Females have two X chromosomes (XX). Males have one X and one Y chromosome (XY). Although the sex chromosomes determine the sex of an individual, it is important to realise that they do not carry all the genes responsible for the development of sexual characteristics.

During meiosis, the sex chromosomes pair up and segregate into the daughter cells. Males are called the heterogametic sex because they produce different sperm: approximately 50% contain an X chromosome and 50% have a Y chromosome. Females are called the homogametic sex because (usually) all of their eggs contain an X chromosome. This arrangement applies to all mammals and some insects (including *Drosophila*, the fruit fly commonly used in genetic experiments). However, in birds, moths, and butterflies, females are the heterogametic sex with the XY genotype (or XO, meaning the second sex chromosome may be absent). In some species, sex determination depends on a complex interaction between sex chromosomes and autosomes, or between inherited factors and environmental ones. The sex of some turtles, for example, depends on the temperature of the sand in which eggs are laid: those laid in sand warmed by the Sun develop into females; those laid in cool sand in the shade develop into males.

In humans, the father's sperm determines the sex of the baby: if a baby inherits a Y chromosome from its father it will be a boy; if it inherits an X chromosome from its father it will be a girl. So the sex of a baby depends on which sperm fertilises the egg cell: a sperm with an X chromosome or one with a Y chromosome. However, there are cases where having a Y chromosome does not necessarily mean that an embryo will become a boy.

**The SRY gene**




In the early stages of development, human embryos have no external genitalia. Whether they develop testes or ovaries depends on the presence and activity of a particular gene on the Y chromosome. This gene, called the sex related Y gene (SRY gene), was discovered in 1990 when geneticists were studying some interesting people: men who had two X chromosomes and women who had one X and one Y chromosome. Microscopical examination of the sex chromosomes of these people revealed that the XX males had a very small piece of Y chromosome in their X chromosomes, whereas this piece was missing from the Y chromosome of the XY females. The geneticists found the SRY gene within this small piece of Y chromosome.

The SRY gene codes for a protein called testis determining factor. This switches on other genes, causing the embryo to develop male structures. The

testes develop and androgens (hormones which promote the development of male sexual organs and secondary sexual characteristics) are secreted. At about 16 weeks, an embryo with the SRY gene begins to produce immature sperm. In addition to stimulating male structures to grow, SRY suppresses the development of female structures by activating a gene on chromosome 19. This activation leads to the production of a protein called Mullerian- inhibiting substance, which destroys female structures early in their development. Lack of testis determining factor results in the development of female genital organs. Therefore, all embryos are female unless active testis determining factor makes them male.

**Sex testing**

The governing bodies of all-female sports sometimes use sex tests to make sure participants in their sports are female. The first attempts at gender verification were by the International Amateur Athletic Federation, whose sex test included parading naked female athletes before a panel of male doctors. In 1968 this rather dubious procedure was dropped, and the International Olympic Committee adopted the Barr test. This test uses the presence of stainable particles called Barr bodies as sex indicators. Barr bodies occur in epithelial cells in the mouth (buccal epithelial cells), and are thought to be derived from inactive X chromosomes. Females therefore usually have one Barr body in their buccal epithelial cells and males usually have none. At the 1992 Barcelona Olympics, the Barr test was replaced by the polymerase reaction test. In this test, the polymerase chain reaction. Sex testing is complicated by the fact that, on rare occasions, sex chromosomes fail to segregate at meiosis. This phenomenon, known as non-disjunction, can result in a sperm cell either having both an X and a Y chromosome or having no sex chromosome, and an egg cell either having two X chromosomes or having no sex chromosome. Non-disjunction can lead to unusual genotypes. Sex testing is confused even further by the occurrence of chimaeras. A chimaera is any animal or plant consisting of some cells with one genetic constitution and some with another. Very rarely, chimaera formation can occur during the early stages of embryonic development when chromosomes in mitotically dividing cells fail to segregate properly (for example, some cells can have the genotype XXX, others XO, while the majority are XX!).

**Quick check:**

1. Why are males called the heterogametic sex?

2. Explain why an embryo with an XY genotyper may develop female sexual organs.

3. Explain why a person may have buccal epithelial cells with two Barr bodies.

Discuss the role of the sex related Y gene in determining sex.

4. Describe how non-disjunction can affect the distribution of sex chromosomes in gametes and offspring.

5. Explain how sex is determined in humans.

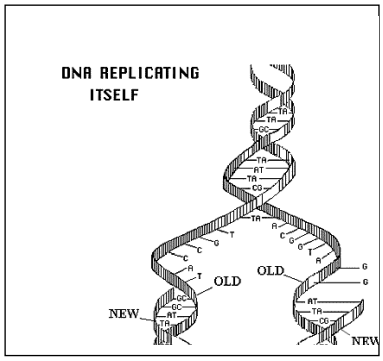
6. Divide the text into an introduction, principal part and conclusion.

7. Express the main idea of each part.

8. Give a title to each paragraph of the text.

9. Summarize the text in brief.

## ■ Text 6. DNA Replication




DNA replication is a very complex process during which mistakes happen. Uncorrected mistakes may lead to harmful mutations. In the living cell, errors are kept to a very low frequency (about one in $10^9$) by a number of repair mechanisms. One such mechanism is mismatch repair. This is carried out by the enzyme DNA polymerase which 'proofreads' newly formed DNA against its template as soon as it is added to the strand. If it finds an incorrectly paired nucleotide, the polymerase reverses its direction of movement, removes the incorrect nucleotide, and replaces it before replication continues. The process is similar to correcting a typing error by going back a space, deleting the error, and typing in the correct letter before continuing.

**A possible mechanism for replication**

A chemical that carries inherited information must be able to copy itself exactly. Complementary base pairing between adenine and thymine and between cytosine and guanine makes this possible.

Watson and Cricks description of DNA suggested that, during replication, the hydrogen bonds connecting base pairs are disrupted allowing the two polynucleotide chains to unwind from one another. Each chain then acts as a template for the synthesis of a new complementary polynucleotide chain. It was suggested that the DNA molecule 'unzips' from one end and new nucleotides already present in the nucleus bind with their complementary bases in each exposed chain. This therefore forms two identical molecules of DNA from the single parent molecule.

**Experimental evidence**

Arthur Korrnberg and his colleagues were the first to successfully replicate DNA in a test tube. They used the following ingredients:

- intact DNA (to act as a template)
- a mixture containing all four nucleotides
- DNA polymerase (an enzyme which catalyses the synthesis of DNA)
- ATP (as a source of energy).

New DNA molecules were formed, which contained the same proportions of the four bases as the original parent DNA. This was a strong indication that DNA can copy itself by complementary base pairing.

**Semiconservative replication**

The idea that DNA unzips before replication is an attractively simple one. This mechanism is called semiconservative replication, because each new molecule of DNA (daughter DNA) contains one intact strand from the original DNA (parental DNA) and one newly synthesised strand. However, semiconservative replication is not the only means by which DNA might replicate by complementary base pairing (figure 1).

**Meselsohn and Stahl**

In 1958, two American biochemists, Matthew Meselsohn and Franklin Stahl, conducted a neat experiment which gave strong support for the theory of semiconservative replication.

- First, they grew *Escherichia coli* bacteria for many generations in a medium containing $^{15}N$, a heavy isotope of nitrogen. The bacteria incorporated the $^{15}N$ into their DNA. This made the DNA denser than normal ('heavy' DNA).
- A control culture of bacteria was grown in a medium with $^{14}N$, the normal, lighter isotope of nitrogen. These bacteria had normal 'light' DNA.
- The bacteria grown in $^{15}N$ were then transferred to a $^{14}N$ medium and left for periods of time that corresponded to the generation time of E.. *coli* (about 50 minutes at 36° C).
- Samples of bacteria were taken at intervals to analyse the parental, first-generation, and second-generation DNA.
- The composition of the DNA was analysed using density gradient centrifugation. The mixture of the three DNA types was suspended in a solution of caesium chloride and spun at high speed in a centrifuge. The DNA separated according to its density: heavy DNA (which contained $^{15}N$) formed a band lower down the tube than the light DNA (which contained $^{14}N$). The bands became visible when the tubes were exposed to ultraviolet light.
- The results gave overwhelming support to the semiconservative hypothesis. In the first generation, all the DNA had a density midway between that of heavy DNA and light DNA. Thus it contained equal amounts of each.

- In the second generation, two sorts of DNA were detected: one was light DNA; the other containing equal amounts of $^{14}N$ and $^{15}N$ (i.e. it was like the DNA in the first-generation bacteria).
- Throughout the investigation, DNA from the control culture produced only light bands, indicating that it contained only $^{14}N$.
- **The enzymes involved in replication**

DNA replication is a complex process involving several different enzymes:

- **Helicases** separate the two DNA strands. Their action uses energy from ATP.
- **DNA binding proteins** keep the strands separate during replication.
- **DNA polymerases** catalyse the polymerisation of nucleotides to form a polynucleotide chain in the 5' to *Y* direction. This allows one strand to be replicated continuously.
- The other strand is not replicated continuously but in small sections. The pieces of polynucleotide chain are joined together by an enzyme called DNA ligase.

DNA is a long molecule. DNA replication would take a long time if it started at one end and proceeded nucleotide by nucleotide along the entire length of the molecule. In fact, the double helix opens up and replicates simultaneously at a number of different sites, known as replication forks. DNA ligases then join the segments of DNA together, completing the synthesis of new DNA strands.

**Quick check:**

1. List the ingredients Kornberg used to make DNA in the test tube.
2. During DNA replication, what is the function of:

a) helicases

b) DNA binding proteins

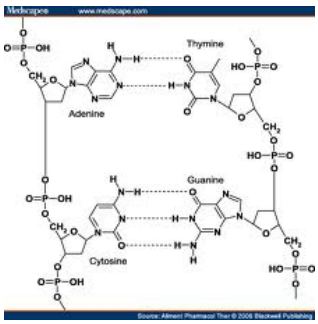
c) DNA polymerase

d) DNA ligase?

3. Suppose DNA replication were conservative. What results would Meselsohn and Stahl have obtained in the first generation?
4. Describe how DNA can be made in the laboratory.
5. Interpret Meselsohn and Stahl's experiment on semiconservative replication.
6. Describe how semiconservative replication takes place.

7. Divide the text into an introduction, principal part and conclusion.
8. Express the main idea of each part.
9. Give a title to each paragraph of the text.
10. Summarize the text in brief.

## ■ Text 7. The Chemical Nature Of Genes




A capsule is an outer coat covering a bacterial cell. Unlike a slime layer, it is not easily washed off. Although capsules are not essential for bacterial growth and reproduction in laboratory conditions, they can make the difference between life and death in natural situations. For example, Streptococcus pneumoniae (a member of the pneumococci, the group of pneumonia-causing bacteria used in Griffith's experiment; see text) has non-capsulated and capsulated strains. Those lacking a capsule are easily destroyed by the host and do not cause disease. However, the capsulated strain kills mice quickly. The capsule helps the bacterium resist phagocytosis by host cells. It contains a great deal of water, protecting the bacterium from desiccation; it keeps out detergents which could destroy the cell surface membrane; and it helps bacteria attach to host cells.

We know today that DNA is the chemical in which information is from parent to offspring. This spread looks at how researchers established this link between DNA and inheritance. In the 1860s, nearly 100 years before Watson and Crick's work on the structure of DNA, Gregor Mendel established that inheritance depends on factors that are transmitted from parents to offspring. In 1909 it was found that patterns of inheritance were reflected in the behaviour of chromosomes. Wilhelm Johannsen referred to these factors as genes. Genes were assumed to be located on the chromosomes because genes that are inherited together (linked genes) were found to be carried on the same chromosome. However, the chemical composition of genes was not known.

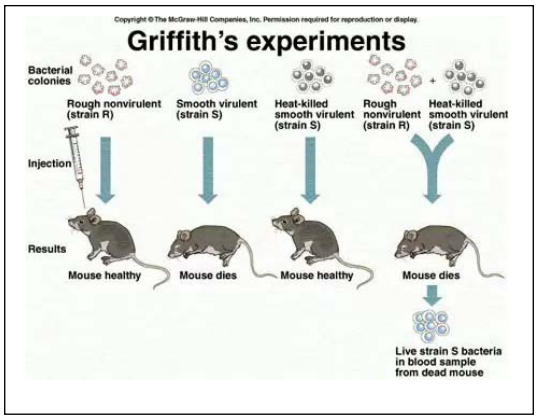
**Protein or DNA: which is the genetic material?**

Chromosomes were known to contain both protein and DNA. Most biologists assumed that proteins, with their highly complex and infinitely variable structure, were the inherited material. The nucleic acids were thought to be too simple to carry complex genetic information. This view was reinforced by the work of Phoebus Aaron Levene. Levene made major

contributions to the chemistry of nucleic acids but believed, mistakenly, that DNA was a very small molecule, probably only four nucleotides long.

In 1928 Fred Griffith, an English medical bacteriologist, published a paper describing experiments on pneumococci. His results set the stage for the research that finally showed that DNA is the genetic material.

**Griffith's experiment: transformation of pneumococci.**

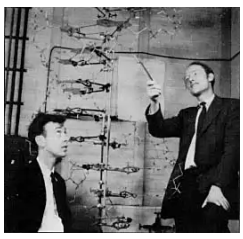



**Pneumococci** are bacteria that cause pneumonia. They occur in two strains: a disease-causing smooth strain (strain S), and a harmless rough strain (strain R). Strain S has a capsule on its cell surface; this capsule is absent from the harmless strain R (see Fact of life).

Griffith found that mice injected with live strain S soon died, but those injected with live strain R survived. Mice injected with dead strain S bacteria (killed by heat) all survived. The results of this series of experiments were as expected. However, the results of Griffith's next series of experiments were thoroughly baffling: mice injected with a mixture of heat-killed strain S and live strain R died. Moreover, Griffith recovered live strain-S bacteria from the dead mice.

After many careful experiments, Griffith concluded that hereditary material had passed from the dead bacteria to the live bacteria. This changed harmless strain R bacteria into virulent strain S pathogens. This process is called transformation.

**Avery's experiment: DNA was the transforming agent.**



In the 1940s, Oswald T. Avery, Colin MacLeod, and Maclyn McCarty showed that DNA was responsible for transformation.

- They used enzymes that hydrolysed polysaccharide, DNA, RNA, and protein on samples of the disease-causing strain-S pneumococci.
- Different samples had different parts of their cells destroyed by these enzymes.
- The researchers then exposed strain-R pneumococci to the treated samples of strain S.
- The transformation of strain R to strain S was blocked only when the DNA in the sample was destroyed.

These results provided strong evidence that DNA carried genetic information for transformation. However, many scientists remained unconvinced.

**Hershey and Chase: the role of DNA on the T2 phage life cycle**


Martha Chase and Alfred Hershey in 1953 when the blender experiment had just been completed.

In 1952, Alfred D. Hershey and Martha Chase performed several experiments with T2 bacteriophage, a virus that infects bacteria. Their results convinced even the sceptics that DNA, and not protein, was the genetic material.

Electron micrographs indicate that T2 bacteriophage infects Escherichia coli by injecting its DNA into the bacterium while leaving its protein coat on the outside. The phage takes over the genetic machinery of the host cell to make new phages. Eventually, the bacterial cell bursts (a process called lysis), releasing new phages to infect other bacteria (figure 1).

Hershey and Chase wanted to test the hypothesis that only the viral DNA entered the bacterium. They made use of the fact that DNA contains phosphorus but not sulphur, whereas protein contains sulphur but not phosphorus.

- With some T2 phages, they labelled the viral DNA with a radioactive isotope of phosphorus ($^{32}P$). With other T2 phages, they labelled the viral protein coat with a radioactive isotope of sulphur ($^{35}S$).
- They added the viruses to a culture of E. coli and gave them enough time to infect their host cells (but not enough time to reproduce).
- The viral coats were then separated from the infected bacteria by shaking the mixture vigorously in a blender.
- When E. coli was infected with a T2 phage containing $^{35}S$ (labelled Protein), little radioactivity occurred within the bacterial cells.
- With a T2 phage containing $^{32}P$ (labelled DNA), the bacterial cells were radioactive. Moreover, when the bacterial cells burst open, the new viruses that emerged were radioactively labelled with $^{32}P$. When the protein was labelled, new viruses were only slightly radioactive.

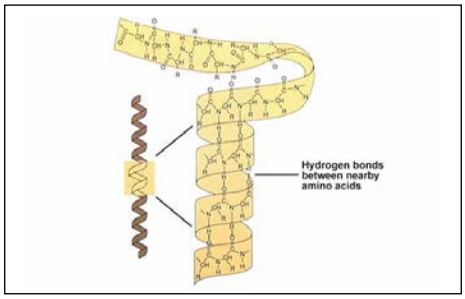
## Quick check:

1. How can the harmless rough strain of pneumococcus be transformed into the pathogenic smooth strain?
2. How can the DNA in the disease-causing smooth strain of bacteria bt extracted from RNA and proteins?

3. Describe the distribution of protein and DNA in T2 bacteriophage.
4. Explain how they can each be labelled.
5. Explain the significance of Griffith's work on Pneumococcus.
6. Describe how Avery and other workers analysed the transforming factor.
7. Describe Hershey and Chase's experiment.
8. Express the main idea of each paragraph in a single sentence in English.
9. Suggest a suitable title for each paragraph of the text.
10. Divide the text into an introduction, principal part and conclusion.

## ■ Text 8. The One Gene One Polypeptide Hypothesis

Phenylketonuria (PKU) occurs in about one in 10 000 live births among white Europeans. If untreated, a patient may have an IQ (intelligence quotient) of less than 20 (the average IQ is 100).




The disorder is treated by reducing the intake of phenylalanine in the diet to an absolute minimum. A child with PKU must avoid products that are rich in phenylalanine such as drinks and confectionery that are sweetened with aspartame. (Aspartame contains a mixture of two amino acids: aspartic acid and phenylalanine.)

High blood levels of phenylalanine are not damaging in adulthood (presumably because brain growth is complete), so except while pregnant or breast feeding, adults with PKU can eat a normal diet.

In the 1940s and early 1950s, researchers established that genes are made of DNA. At the same time, other researchers wanted, to know how genes determine inherited characteristics. Clues came from research carried out in the early 1900s by Sir Archibald Garrod. He observed that two human inherited diseases - **alkaptonuria** and **phenylketonuria (PKU)** - were each caused by absence of a specific enzyme. (He called these diseases 'inborn errors of metabolism'.)

**Alkaptonuria**

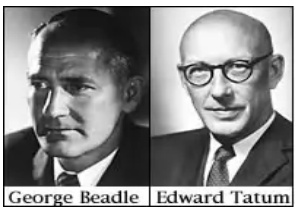
People suffering from alkaptonuria lack an enzyme called homogenistic acid oxidase. This enzyme breaks down the amino acids tyrosine and phenylalanine. When the enzyme is absent, an intermediate product known as homogenistic acid accumulates. This causes a dark brown discoloration of the skin and eyes, and progressive damage to the joints, especially the spine.

**Phenylketonuria**

Normally, phenylalanine is converted into another amino acid by a transferase (an enzyme which helps transfer a chemical group from one organic molecule to another). This enzyme is absent from people with PKU. This means that phenylalanine accumulates in the blood. High concentrations of phenylalanine damage the nervous system, leading to severe mental retardation. Nowadays, routine postnatal screening detects the condition early enough that the diet can be modified to prevent brain damage (see Fact of life).

Garrod's observations indicated that genes probably exert their effects through enzymes, but the evidence was only circumstantial. Scientists wanted more direct proof that genes brought about their effects by determining which enzymes were made in cells. This proof came with the work of George Beadle and Edward Tatum on *Neurospora crassa*.

**Beadle and Tatum: the one gene - one enzyme hypothesis**




*Neurospora crassa* is a common pink mould (a fungus) which is a particularly damaging pest in bakeries because it can turn bread mouldy. It reproduces by spores and grows in the bread as a mycelium (a mass of threads). It has several features which make it suitable for genetic research . One of the most important is its ability to produce haploid spores asexually. These spores are identical, and have only one set of chromosomes. They therefore have only one allele for each characteristic (spread 19.3). This means that a recessive mutation is not masked by a dominant allele; it is always expressed in the haploid organism.

*Neurospora* can grow on a culture medium called minimal medium. This contains sugar, a source of nitrogen, mineral ions, and the vitamin biotin. The fungus can synthesise all the other carbohydrates, fats, proteins, and nucleic acids it needs using enzymes produced by its cells.

- Beadle and Tatum grew *Neurospora* on minimal medium and exposed the culture to a dosage of X-rays that caused the formation of mutations.
- Occasionally a mutant spore was produced that was unable to grow on minimal medium. However, it would grow and reproduce if provided with all 20 amino acids.
- After isolating a mutant *Neurospora,* Beadle and Tatum attempted to grow it on 20 different minimal media, each of which was supplemented with a different single amino acid.

▪ They discovered that the mutant that could not grow on the minimal medium needed only one particular amino acid in order to grow and reproduce normally.

▪ They concluded that the mutant lacked the enzyme required to synthesise that particular amino acid.

Further experiments indicated that other mutants lacked different enzymes, each of which was dictated by a particular gene. In each case, Beadle and Tatum found that the inability to synthesise a specific enzyme was inherited in a normal Mendelian manner. They concluded that each gene in an organism coded for the production of one enzyme. This became known as the one gene-one enzyme hypothesis. The hypothesis was soon extended to a one gene-one protein hypothesis when it was shown that proteins other than enzymes could also be determined by specific genes.

**Refining the theory**

The hypothesis was modified into the one gene-one polypeptide hypothesis when it was realised that proteins could consist of more than one polypeptide chain, each determind by the action of a different gene.

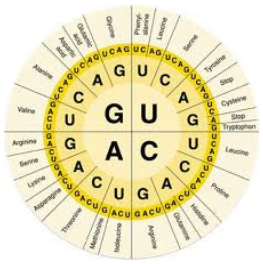
For example, haemoglobin has four polypeptide chains, two identical alpha and two identical beta chains. These two different types of polypeptide are determined by two separate genes. Sickle-cell anaemia is caused by a mutation in a single gene which results in just one amino acid being changed in the beta chain of haemoglobin.

**Quick check:**

1. How does phenylketonuria indicate that genes exert their effects through the production of specific enzymes?
2. How does Beadle and Tatum`s experiment on neurospora support the one gene-one protein hypothesis?
3. Explain why the one gene-one protein hypothesis needed to be modified in the light of conditions such as sickle-cell anaemia.
4. Describe Beadle and Tatum’s experiment on *Neurospora* which led to the one gene-one enzyme hypothesis.
5. Explain how certain inherited metabolic disorders indicate that genes exert their effects through enzymes.
6. Discuss why the one gene-one enzyme hypothesis had to be modified.
7. Divide the text into an introduction, principal part and conclusion.
8. Express the main idea of each part.

9. Give a title to each part of the text and summarize the text in brief.

## ■Text 9. The Gene Code



Prokaryotes and eukaryotes share the same 'language of life'. Comparisons of DNA sequences with the corresponding protein sequences reveal that (with a few exceptions) an identical genetic code is used in both prokaryotes and eukaryotes. This means that bacteria can be genetically engineered to make human proteins. The universal nature of the code suggests that all living things are descended from a single pool of primitive cells which first evolved this code.

One of the most remarkable facts of life is that each cell in an organism contains all the information required to determine all the characteristics of that whole organism. This information is stored in DNA, and is known as the **genetic code.** Deciphering that code has been one of the major scientific breakthroughs of the twentieth century. It has given us an understanding of how genes function, and it has opened the way for most of the recent developments in genetic engineering and biotechnology.

**Transcribing the genetic code from DNA to mRNA**

The genetic code is held in the order of bases along the DNA molecule. Sections of DNA called **cistrons** (commonly referred to as **genes)** contain the information needed to make a particular polypeptide. However, DNA does not carry out polypeptide synthesis directly. When the DNA in a cistron is activated, the information is transferred to a molecule of ribonucleic acid (RNA) called **messenger RNA (mRNA),** which acts as a template for the synthesis of the polypeptide.

**The central dogma of biology**

The relationship between DNA, mRNA, and polypeptides in a eukaryotic I cell is often called the **central dogma** of biology.

- mRNA is made on a DNA template in the nucleus, in a process called 1 **transcription**.
- The mRNA then moves into the cytoplasm, where it combines with ribosomes to direct protein synthesis by a process called **translation**.
- When the information in a cistron is used to make a functional polypeptide chain by transcription and translation, **gene expression** is said to have taken place.

**mRNA is made from the DNA template**

mRNA is a large polynucleotide polymer, chemically similar to DNA but differing in that:

- mRNA consists of only one chain of nucleotides, not two
- mRNA contains the sugar ribose instead of deoxyribose
- mRNA contains the base uracil instead of thymine.

During transcription, DNA acts as a template for making mRNA by complementary base pairing. Thus a particular short sequence of DNA may be transcribed as follows:

DNA base sequence: TAGGCTTGATCG
mRNA base sequence: AUCCGAACUAGC

**The triplet code: frame-shift experiments**

Twenty amino acids make all the proteins in living organisms.

- If a code consisted of one base for one amino acid, only four combinations would be provided (there are four bases).
- If two bases coded for one amino acid there would be 16 ($4^2$) possible combinations.
- A three-base **(triplet)** code provides 64 ($4^3$) possible combinations, more than enough for all 20 amino acids.

Francis Crick and his co-workers confirmed that the genetic code is a **triplet code.** Using enzymes, they added or deleted nucleotide bases in the DNA of a virus that infects bacteria. They found that when one or two bases were added or deleted, the viruses were unable to infect the bacteria. But when three bases were added or deleted, the virus was able to infect the bacteria. They concluded that adding or removing one or two bases caused a **frame shift** which inactivated the gene. However, adding or removing three bases only partially affected the gene. Thus the sequence of bases shown above would contain the following sequences of DNA base triplets and mRNA **codons:**

DNA base triplet sequence: TAG GCT TGA TCG
mRNA codon sequence: AUC CGA ACU AGC

If one base (for example, guanine) is added to the DNA the frame shifts and the sequence of triplets and codons is changed:

DNA base triplet sequence: **G**TA GGT TTG ATC G
mRNA codon sequence: **C**AU CCG AAC UAG C

The results of the frame-shift experiments also showed that the code is non-overlapping:

- Each triplet in DNA specifies one amino acid.
- Each base is part of only one triplet, and is therefore involved in specifying only one amino acid.

A non-overlapping code requires a longer sequence of bases than an overlapping code (see box): however, replacing one base for another has a small or no effect.

**Cracking the genetic code**

To crack the genetic code, scientists had to work out which of the 64 codons determined each amino acid. To do this, they made mRNA molecules with a known sequence of bases. This mRNA was added to a cell-free system that contained isolated ribosomes, radioactively labelled amino acids, and all the enzymes needed for polypeptide synthesis. The polypeptides that were synthesised were then analysed to determine their amino acid sequence.

The first synthetic mRNA molecule made was a chain of uracil bases and was called poly-U. The polypeptide chain synthesised from it contained only phenylalanine. It was therefore concluded that the codon UUU codes for phenylalanine.

The complete genetic code was confusion finally deciphered in 1966.

## Quick check:

1. What is the “central dogma” of biology?
2. What is the name given to the result of adding one or two nucleotide bases to a DNA sequence?
3. Describe the relationship between DNA, messenger RNA, and proteins.
4. Explain how frame-shift experiments support the triplet code hypothesis.
5. Discuss the main features of the genetic code.
6. Divide the text into an introduction, principal part and conclusion.
7. Express the main idea of each part.
8. Give a title to each part of the text and summarize the text in brief.

# Suggested Answers and Solutions

## Unit I. Text 1.1

**p. 4. Ex. A:** 1H; 2A; 3F; 4G; 5D; 6C; 7E; 8B.

**p. 10. Ex. II:** respond-response; transform-transformation;
move-movement; develop-development;
respire-respiration; create-creation; define-definition.

**p. 11. Ex. VI: 1)** 1-5; 2-6; 3-4; **2)** 1-4; 2-6; 3-5;
**3)** 1-3; 2-4; **4)** 1-4; 2-5; 3-6.

**p. 12. Ex. VIII:** 1H; 2F; 3G; 4A; 5B; 6C; 7D; 8E.

## Text 1.2

**p. 19. Ex. II:** 1) 1-4; 2-6: 3-5; 2) 1-2; 3-5; 4-6; 3) 1-4; 2-3;
4) 1-3; 2-4; 5) 1-3; 2-4.

**pp.19. Ex. III:** 1. employment; 2. inheritance; 3. modification;
4. observation; 5. measurement; 6. prediction; 7. understanding;
8. discovery; 9. knowledge; 10. contradiction.

**p. 20. Ex. V:** 1E; 2G; 3A; 4F; 5B; 6D; 7H; 8C.

**p. 23. Ex. XII: Model answer**

*Dear Mrs Jones,*

*I am writing this letter to let you know about the areas of biology I am mostly interested in specializing in. These are molecular biology and genetics. I have chosen these areas because I have always been interested in the cell, this tiny living organisms, and the ways it works. I would like to know everything how its different systems interact. Also, DNA is another great mystery to me. I would like to learn how all this genetic information is stored and passed on from one generation to the next.*

*I realize that there are no hard lines between these two areas of study, that is, molecular biology and genetics, so I would like to know how my choice now will affect my career prospects later. What I hope to do when I graduate is work with doctors and chemists and do research in order to find cures for different diseases.*

*I would very much appreciate it if you could meet me during your office hours in order to discuss my options. Would Monday 17$^{th}$ October at 10 am be suitable for you?*

*Thank you very much for your time. I am looking forward to hearing from you.*

*Yours sincerely,*

*Carly Browny.*

**Unit II. Text 2.1**

**p. 26. Quick check**

1. Living things are made of cells and these cells have certain things in common.

2. a) glycogen granules; b) chloroplast, cell wall, vacuole membrane (tonoplast), vacuole; c) cell surface membrane, mitochondria, cytoplasm, and nucleus.

**pp. 26. Ex. II:** exist– existence – existent; store – store – store;
form – form – formal; divide – division – divisible;
act – act – active; suit – suitability – suitable;
differ – difference – different.

**p. 27. Ex. IV:** 1L; 2 F; 3A; 4I; 5J; 6B; 7E; 8C; 9D; 10G; 11H; 12K.

**p. 28. Ex.VII: 1)** 1-3;2-4; **2)** 1-5; 2-3; 4-6;
**3)** 1-3;2-5; 4-6; **4)** 1-2; 3-5; 4-6.

**p. 29. Ex. IX:** 1D; 2H; 3B; 4F; 5C; 6I; 7E; 8K, 9G, 10A, 11J, 12L.

**Text 2.2**

**p. 33. Quick check**

1. a) interphase, prophase, metaphase, anaphase, and telophase.
b) interphase.

2. mitosis involves one division and the formation of two daughter cells from each parent cell whereas meiosis involves two divisions and the formation of four daughter cells from each parent cell.

**p. 33. Ex. II:** replace – replacement – replaceable
continue – continuity - continuous
condition – condition - conditional
fuse – fuse - fusible
mutate – mutation - mutable
double – double – double

**pp. 34. Ex. IV:** 1L; 2K; 3H; 4J; 5B; 6I; 7E; 8A; 9C; 10F; 11G; 12D.

**p. 35. Ex. VII: 1)** 1-4; 2-3; **2)** 1-2; 3-4-5; **3)** 1-3; 2-4-5; **4)** 1-3-5;2-4.

**pp. 36. Ex. IX:** 1F; 2I; 3D; 4A; 5B; 6G; 7E; 8C, 9H.

**Text 2.3**

**pp. 39. Quick check**

1. a) a magnification in a light microscope is varied by changing the power of the glass lenses.

b) magnification of an electron microscope is varied by changing the strength of the electromagnets.

2. Electron microscopes use beams of electrons which have a shorter wavelength than light, giving electron microscopes a higher resolving power than light microscopes.

3. 0.2 micrometres.

**p. 40. Ex. II:** magnify – magnification - magnified
multiply – multiplication – multiple
reflect – reflection – reflective
absorb – absorbability – absorbable
prevent – prevention – preventative

**p. 40. Ex. IV:** 1E; 2H; 3K; 4A; 5B; 6C; 7J; 8D; 9F; 10G;11I.

**p. 41. Ex.VII: 1)** 1-3; 2-4; **2)** 1-4; 2-3; **3)** 1-6; 2-4; 3-5;
**4)** 1-3; 2-4;

**p. 42. Ex. IX:** 1G; 2E; 3A; 4H; 5C; 6I; 7F; 8D, 9B.

**Unit III. Text 3.1**

**p. 44. Ex.A.:** 1C; 2D; 3E; 4F; 5G; 6A; 7B; 8I;9J; 10H

**p. 47. Quick check**

1. a nucleoside contains a base and pentose sugar whereas a nucleotide consists of a base, sugar, and phosphate;
2. condensation
3. TTAGGC.

**pp. 47-48. Ex.II.:** discover – discovery; project – project;
describe – description; receive – receiver;
remove – remove/remover;
condensate – condensation; react – reaction.

**Text 3.2**

**p. 51. Ex. A.** 1C; 2L; 3E; 4A; 5B; 6D; 7I; 8G; 9K; 10H; 11F; 12J.

**p. 64. Quick check**

1. a bead-like structure consisting of DNA and histones on chromosomes;
2. control the distribution of chromosomes during cell division;
3. telomeres seal the ends of chromosomes; shoelace tips seal the ends of shoelaces.

**Unit IV. Text 4.1**

**p. 59. Ex. A:** 1C; 2A; 3I; 4G; 5H; 6J; 7K; 8E; 9L; 10D; 11B; 12F.

**p. 65. Quick check**

1. an agent that causes a mutation (e.g. X-rays)
2. the genotype refers to the genetic make-up of an organism (i.e.the alleles it has) whereas the phenotype refers to the visible or otherwise measurable characteristics of an organism resulting from an interaction between the genotype and environment;
3. heterozygous
4. continuous variation

**Text 4.2**

**p. 67. Ex. A**: 1I; 2J; 3A; 4F; 5D; 6H; 7B; 8C; 9E; 10G.

**p. 72. Quick check**

1. non-separation of one or more homologous chromosomes during meiosis;

2. a) amniocentesis can be carried out at about 15-16 weeks of pregnancy whereas chorionic villus sampling can be carried out between weeks 8 and 12;

b) amniocentesis carries a lower risk than chorionic villus sampling;

3. chorionic gonadotrophin.

**p. 72. Ex. II.** increase – increase – increased;
prevent – prevention – preventative/preventive;
risk – risk – risky;
inherit – inheritance – inheritable/inherited;
perform – performance – performing/performable;
decide – decision – decisive;
analyse – analysis – analytic.

**Unit V. Text 5.1**

**p. 79. Quick check**

1. nerve fibre carrying nerve impulses away from the cell body

2. a) nerve impulses; b) hormones.

**p. 79. Ex. III.** 1c; 2f; 3b; 4g; 5d; 6a;

**pp. 79-80. Ex. IV.** 1. Favourable stimulus; 2.nervous system;

3. to process information; 4. motor neurones; 5. target cell; 6. water balance; 7. to respond appropriately; 8. considerable distances; 9. insulating material; 10. external environment.

**p. 80. Ex. V.**

1. Ductless (endocrine) glands secrete their hormones directly into the bloodstream.
2. The endocrine system consists of a number of glands that secrete hormones.
3. Responses to stimuli usually involve the coordinated actions of different parts of the body.
4. The CNS acts as an integration centre and processes information from many sources.
5. Each living organism has its own specific type of sensitivity.
6. Hormones regulate such processes as heart rate, metabolism, gastric secretion etc.
7. Sense organs and effectors occur in different parts of the body.
8. The nervous system of mammals is more complicated than one of single-celled organisms.
9. Neurones convey information in the form of nerve impulses.
10. Blood glucose concentration is regulated by the endocrine system.

**p. 80-81. Ex. VI.** 1. range from; 2. consists of; 3. occur at; around; 4. acts as; 5. such as; 6. major; 7. apart from; 8. characteristic features; 9. detect; appropriately; 10. involve.

**Text 5.2**

**p. 86. Quick check**

The resting potential is determined by an unequal distribution of charged ions inside and outside a neurone, making the inside negative relative to the outside.

**p. 86-87. Ex. III.** 1C; 2F; 3D; 4E; 5A; 6B.

**p. 87. Ex. IV.**

1. resting potential; 2. escape movements; 3. external environment;

4. sodium ions; 5. potential difference; 6. electrical charge;

7. light intensity; 8. to respond quickly; 9. nerve fibres; 10. to reach a peak.

**p. 88. Ex. VII.** The inside / interior (of the neurone); the size of the potential; to respond quickly; resting condition; potential difference; to reach the threshold level; to obey the law; unequal distribution; to measure; complete reversal of charge.

**p. 88. Ex. IX**. During the resting potential, the voltage-gated sodium and potassium ion channels are closed. When a stimulus is applied, sodium ion channels open rapidly, sodium ions move in, and the inside becomes more positive. If the stimulus reaches the threshold level, an action potential occurs. When the action potential reaches its peak, the sodium ion channels close slowly and potassium ion channels open slowly. Sodium ions stop moving into the cell but potassium ions diffuse more rapidly out. These changes cause the potential difference to drop. When the membrane returns to its resting potential, potassium ion channels close, but because they do this slowly, the potential dips below the resting level. Finally, when the potassium ion channels are closed, the membrane returns to its resting condition.

**Unit VI. Text 6.1**

**p. 92. Quick check**

1. The change over successive generations of the genetic composition (allele frequency of a population) that may result in the formation of new species from pre-existing species.

2. Neo-Darwinism incorporates new scientific evidence, particularly from genetics and molecular biology.

**pp. 92. Ex. II:** exist – existence – existent;
suggest- suggestion – suggestible;
reproduce – reproduction – reproductive;
develop – development – developmental;

inherit – inheritance – inheritable;
inhabit- inhabitant – inhabitable
evolve – evolution – evolutionary;
select – selection – selective.

**p. 93. Ex. IV:** 1H; 2K; 3N; 4L; 5O; 6E; 7C; 8F; 9M; 10B; 11D; 12A; 13G; 14I; 15J.

**p. 94. Ex.VII: 1)** 1-5;2-6;3-4; **2)** 1-5; 2-4; 3-6; **3)** 1-3; 2-4; **4)** 1-4; 2-5; 3-6.

**p. 95. Ex. IX:** 1E; 2H; 3A; 4B; 5G; 6C; 7D; 8F.

**Text 6.2**

**p. 99. Quick check**

1. Ability to pass on alleles to subsequent generations; the fittest individual in a population is the one that produces the largest number of offspring.

2. a. Disruptive selection; b. intermediates would be at a selective disadvantage because they would be easily seen against either a green or brown background.

**p. 99. Ex. II:** argue – argument – argumentative
occur – occurrence – occurring
increase – increase – increasing
compete – completion – competitive
expose – exposition - expository
distribute – distribution – distributive
describe – description - descriptive

**pp. 101. Ex. IV:** 1H; 2D; 3G; 4M; 5A; 6K; 7B; 8N; 9E; 10O; 11C; 12F; 13J; 4I; 15L.

**p. 101. Ex.VII: 1)** 1-4; 2-5; 3-6; **2)** 1-3; 2-4; **3)** 1-4; 2-5; 3-6; **4)** 1-4; 2-6; 3-5.

**pp. 102. Ex. IX:** 1D; 2F; 3B; 4A; 5G; 6H; 7C; 8E.

**Text 6.3**

**p. 106. Quick check**

1. Directional selection.
2. a. Inbreeding reduces genetic diversity;
   b. outbreeding increases genetic diversity.
3. Harmful recessive alleles may be less likely to be present in the homozygous condition and some allele combinations may interact positively.p

**p. 107. Ex. II:** suit – suitability - suitable
resist – resistance - resistant
interact – interaction - interactive
value – valuation , value - valuable
cultivate – cultivation – cultivable
desire – desire – desirable

**p. 107. Ex. IV:** 1D; 2H; 3N; 4J; 5A; 6L; 7M; 8B; 9C;
10E; 11F; 12O; 13G; 14I;15K.

**p. 108-109. Ex.VII: 1)** 1-3-4; 2-5-6; **2)** 1-4; 2-3; **3)** 1-4; 2-5; 3-6;
**4)** 1-3; 2-4.

**p. 109. Ex. IX:** 1E; 2D; 3B; 4A; 5C; 6H; 7F; 8G.

**Text 6.4**

**p. 114. Quick check**

1. a. Associated with a shorter and flatter nose which has allowed the evolution of stereoscopic vision;

b. gives a powerful grip;

c. results in reduced number of offspring associated with increased parental care;

d. allows increased mobility of forearm.

**p. 115. Ex. II:** reflect – reflection – reflective
adapt – adaptation – adaptive
grasp – grasp - grasping
depend – dependence – dependent
support - - support – supportive
extinguish – extinction – extinct
separate – separation – separate

**p. 115. Ex. IV:** 1K; 2H; 3F; 4J; 5A; 6I; 7B; 8N; 9L;
10C; 11O; 12G; 13E; 14M;15D.

**p. 117. Ex.VII: 1)** 1-4; 2-3; **2)** 1-4-7; 2-5; 3-6;
**3)** 1-3; 2-4-5; **4)** 1-4; 2-3.

**p. 117. Ex. IX:** 1E; 2C; 3F; 4B; 5H; 6D; 7A; 8G.

**Unit 7. Text 7.1**

**p. 121. Quick check**

1. a. Carbon dioxide; b. oxygen
2. a. Light-dependent stage occurs in the grana of chloroplasts;

b. the light-independent stage occurs in the stomata of chloroplasts.

**p. 121. Ex. II:** react – reaction – reactive
accumulate – accumulation – accumulative
produce – product productive
require – requirement – requisite
connect – connection – connective

**pp. 122. Ex. IV:** 1G; 2D; 3A; 4M; 5I; 6N; 7B; 8L; 9E;
10O; 11C; 12J; 13F; 14H;15K.

**pp. 123. Ex.VII: 1)** 1-4; 2-3; **2)** 1-3; 2-4; **3)** 1-6; 2-5; 3-4; **4)** 1-4; 2-3.

**p. 124. Ex. IX:** 1F; 2A; 3E; 4B; 5H; 6G; 7D; 8C.

**Text 7.2**

**p. 128. Quick check**

1. Water availability affects many activities in addition to photosynthesis. Water deprivation may kill a plant, but the cause of death may not be connected to photosynthesis.

2. The compensation point for a shade plant is at a lower light intensity than that of a sun plant.

3. Light intensity.

**p. 128. Ex. II:** measure – measure - measurable
subject – subject - subjective
interact – interaction – interactive
recognise – recognition – recognizable
concentrate – concentration – concentric

**pp. 128-129. Ex. IV:** 1C; 2G; 3H; 4L; 5A; 6I; 7M; 8D;
9K; 10E; 11N; 12B; 13J; 14O;15F.

**p. 130. Ex.VII: 1)** 1-3; 2-6; 4-5; **2)** 1-5; 2-3; 4-6; **3)** 1-3; 2-4; **4)** 1-4; 2-3

**p. 130-131. Ex. IX:** 1G; 2H; 3E; 4A; 5C; 6B; 7F; 8D.

**Text 7.3**

**pp. 135-136. Quick check**

1. Two from wheat, soya beans, and rice.

2. Sugar cane is called a C 4 plant because it fixes carbon dioxide as a four-carbon compound.

3. At night.

4. **a** C4; b CAM; c C3

**p. 136. Ex. II:** adapt – adaptation – adaptable
fix – fixation – fixed
conserve – conservation - conservative
separate – separation – separate
dry – drought - dry

**pp. 136-137. Ex. IV:** 1N; 2F; 3L; 4A; 5J; 6M; 7B; 8O; 9C;
10G; 11D; 12H; 13I; 14K;15E.

**p. 138. Ex.VII: 1)** 1-3; 2-4; 5-6; **2)** 1-2; 3-6; 4-5;
**3)** 1-4; 2-3; **4)** 1-4; 2-3.

**pp. 138-139. Ex. IX:** 1E; 2D; 3A; 4F; 5H; 6B; 7G; 8B.

**Unit VIII. Text 8.1**

**p. 143. Quick check**

1. a) cuticle; b) the upper surface is more exposed to sunlight, making it hotter than the lower surface.

2. Photosynthesis.

3. Collenchyma consists of living cells with the corners of each cell reinforced by extra cellulose whereas mature sclerenchyma consists of dead cells impregnated with a thick layer of lignin.

**p. 144. Ex. III:** connect – connection – connective
require – requirement - required
support – support – supportive
protect – protection – protective
adapt – adaptation/adaptability – adaptable
expose – exposition – exposed
reproduce – reproduction – reproductive

**p. 144. Ex. IV:** **1)** 1-4; 2-5; 4-6; **2)** 1-4; 2-6; 3-5; **3)** 1-3; 2-4; **4)** 1-4; 2-3.

**p. 145. Ex. VI:** 1D; 3G; 3E; 4F; 5B; 6A; 7C.

**pp. 145-146. Ex. VIII:** 1B; 2F; 3G; 4C; 5E; 6H; 7D; 8I; 9A; 10J.

**Text 8.2**

**p.150. Quick check**

1. All stems have nodes and internodes.

2. Support, transport, tissue production, storage of food and water.

3. Parenchyma cells help support stems by becoming fully turgid and pressing against other cells.

**p. 150. Ex. II**: diperse – dispersal - dispersed
attach – attachment – attached
locate – location – located
identify – identification - identified
store – storage - stored
maintain – maintenance - maintained
penetrate – penetration - penetrated
strengthen – strength - strong
grow – growth - grown
add – addition – additional

**p. 151. Ex. VI:** **1)**1-4; 2-5; 3-6; **2)**1-3; 2-4; **3)**1-6; 2-4; 3-5;
**4)**1-3; 2-4; **5)**1-3; 2-4; 5-6.

**p. 152. Ex. VIII:** 1E; 2A; 3G; 4H; 5F; 6D; 7C; 8I; 9B.

# Glossary of Biological Terms

**aerobe** An organism which needs molecular oxygen for its metabolism.

**agar** A jelly-like substance obtained from seaweed (red algae) used to help solidify nutrient media for growing microorganisms.

**anaerobe** An organism which cannot grow if molecular oxygen is present; strict anaerobes are killed by oxygen, facultative anaerobes will grow if oxygen is present but can also grow if oxygen is absent.

**antibiotic** A chemical produced by microorganisms, such as bacteria and moulds that, in dilute solution, can kill or inhibit the growth of other microorganisms.

**antibody** A protein produced by B lymphocytes of the immune system. Antibodies are very specific and help defend the body against pathogens and foreign molecules by binding to antigens and bringing about their destruction.

**antigen** A molecule that is recognised and bound by a specific antibody.

**apoptosis** A kind of cellular self-destruction that demands energy and protein synthesis for its occurrence.

**artificial selection** The purposeful breeding of certain traits over others.

**autotroph** An organism that is able to synthesise the organic materials it requires from inorganic substances in its environment.

**biotechnology** The application of living organisms, or substances made from them, to make products of value to humans.

**capsid** The protein coat of a virus.

**cell** A very small unit of living matter.

**cell culture** Growing cells or tissues in a laboratory, or on an appropriate nutrient medium.

**chemoautotroph** An organism which uses carbon dioxide as its sole source of carbon and inorganic chemicals as its source of energy.

**chitin** A tough resistant polysaccharide which is a component of some fungal cell walls.

**class** The second highest group into which animals and plants are divided, below a Phylum and including several orders.

**clone** A group of genetically identical organisms or cells which are all descended asexually from the same individual.

**coccus** (*plural* **cocci**) A sphere-shaped bacterium.

**dry** Without moisture.

**environment** The natural conditions, eg land, air and water, in which people, animals and plants live.

**eukaryotic** Cells containing a true nucleus, with a nuclear membrane and membrane-bound organelles.

**evolution** The scientific theory according to which types of animals and plants change gradually over long periods of time through a process known as natural selection to become better adapted to their environment.

**family** A group of related animals, plants, etc.

**fermentation** The extraction of energy from organic products without the involvement of oxygen. Or The use of microorganisms or enzymes extracted from microorganisms to carry out a wide variety of chemical reactions, which may or may not be anaerobic.

**flagellum** (*plural* **flagella**) A fine, long, whip-like organelle which protrudes from the cell surface. Used in locomotion and feeding they are common in some protoctista where they have a 9+2 arrangement of microtubules in cross section. They are also found as thread-like organelles in some bacteria, also used in locomotion, they have a much simpler structure in prokaryotes, being a rigid hollow cylinder of protein with a rotating base which propels the cell along.

**fungi** A kingdom of eukaryotic, mainly multicellular organisms which lack chlorophyll.

**gene** A length of DNA which **codes** for the production of a particular protein.

**genetic engineering** The application of methods using recombinant DNA to give new genetic traits to an organism by introducing new genes into its cells.

**genome** The complete set of genes present in an organism.

**genus** (*plural* **genera**) A group of animals or plants within a family, often itself divided into several species.

**grow 1** to increase in size or quantity; to become greater; **2** to develop into a mature or an adult form.

**growth** The process of growing; development.

**heterotroph** An organism which requires organic compounds as its carbon and energy source.

**host** An animal or a plant on which another animal or plant lives.

**hypothesis** (*plural* **hypotheses**) An idea or a suggestion that is based on known facts and is used as a basis for reasoning or further investigation.

**immunization** A process rendering a host immunity to a disease.

***in vitro*** Latin for 'in glass'. This term refers to biological processes carried out outside a living organism, for example, in a test tube.

**inoculation** The transfer of microorganisms from one source to another, e.g. transferring bacteria from a broth culture on to a sterile agar plate, or from a starter culture into a fermenter containing sterile medium.

**interferons** A group of proteins which are active in the immune system. They fight viral infections and stimulate the cell-killing abilities of some immune cells. They are being tested for use in cancer therapy and in the treatment of AIDS and other viral diseases.

**limb** **1** A leg, an arm or a wing; **2** a large branch of a tree.

**lymphocyte** A type of white blood cell (granulocyte) for example B and T cells.

**magnify** To make something appear larger, especially by using a lens or microscope.

**meristem culture** Plant cells cultured from the undifferentiated meristematic tissue from which new cells arise.

**mesophile** An organism which has an optimum growth between 20*C and 40*C, including most human pathogens.

**microscope** An instrument for making very small objects appear larger, especially for scientific study.

**muscle** A piece of elastic body tissue that can be tightened or relaxed to produce movement.

**mycelium** Composed of a mass of fungal hyphae tangled together.

**natural selection** The process by which heritable advantageous traits become more common in successive generations, and unfavourable traitsbecome less common.

**nutrient** A substance that helps a living thing to grow.

**order** A group of related animals or plants below a class and above a family.

**pathogen** A microorganism or virus that causes disease.

**phylum** (*plural* **phyla**) A major group to which animals or plants belong.

**plant** A living thing that grows in the earth and usually has a stem, leaves and roots.

**plasmid** A small, usually circular molecule of DNA that occurs in bacteria but is not part of the bacterial chromosome. Plasmids have been used as cloning vectors to transfer genes between species.

**Prokaryotae** A kingdom of microscopic, mainly unicellular microorganisms, including bacteria. Their DNA is circular, naked, and not situated inside a nuclear membrane. Prokaryotic cells also lack membrane-bound organelles, such as mitochondria.

**Protoctista** A kingdom of microscopic, eukaryotic organisms. They may be unicellular or multicellular, and mainly show sexual reproduction. It is a diverse group including heterotrophic and photosynthetic organisms.

**protoplasts** Plant cells that have had their rigid cellulose cell walls removed. They are fused to produce cell hybrids and used as targets for gene transfer in plant genetic engineering.

**recombinant DNA** A DNA molecule that has been formed by joining together segments of DNA from two or more sources.

**root** The part of a plant that grows under the ground, absorbing water and minerals.

**sample** One of a number of things, one part of a whole, that can be examined in order to see what the rest is like; a specimen.

**sap** The liquid in a plant that carries food to all parts of it.

**seed** The part of a plant from which a new plant of the same kind can grow.

**species** A group of animals or plants within a Genus. Members of a species are able to breed with each other but usually not with other species.

**stem** The main long thin part of a plant above the ground, or any of the smaller parts growing from this, from which the leaves or flowers grow.

**substrate** A compound acted on by an enzyme and converted to a product.

**vector** In biotechnology, a vector is a DNA molecule which is used to transfer genes into cells; usually this is plasmid or viral DNA.

**vegetation** Plants in general; plants found in a particular environment.

**viable** Live; capable of reproducing.

**virology** The study of viruses and some other virus-like agents.

**virus** A particle containing a nucleic acid core, either DNA or RNA, surrounded by a protein coat called a capsid. Viruses are obligate parasites that reproduce by entering cells and taking over the cell`s own protein synthesizing mechanisms.

**vital** Connected with or essential to life.

# A p p e n d i c e s

## Appendix 1

## Words That Are Commonly Misused

| English word | Russian equivalent |
|---|---|
| accept | принимать, признавать |
| except | кроме |
| access | доступ |
| excess | избыток, избыточный |
| adapt | приспосабливать(ся) |
| adopt | принимать, внедрять |
| affect | влиять на |
| effect | результат |
| cite | цитировать |
| site | место, местоположение |
| considerable | значительный, большой |
| considerate | внимательный, вежливый |
| decent *adj* | приличный, порядочный |
| descent *n* | спуск, происхождение |
| desert *n* | пустыня |
| desert *v* | покидать, дезертировать |
| dessert *n* | десерт |
| detract | умалять, уменьшать |
| distract | отвлекать |
| expand | расширять(ся) |
| expend | тратить, расходовать |
| expanse | пространство, протяжение |
| expense | трата, расход |
| expansive | обширный |
| expensive | дорогой, дорогостоящий |
| hard | много, упорно; трудный, тяжелый |
| hardly | едва, едва ли |
| industrial | промышленный |
| industrious | прилежный, усердный, трудолюбивый |
| intellectual | интеллектуал; умный |

| | |
|---|---|
| intelligent | умный, разумный |
| intelligible | понятный, вразумительный |
| intense | сильный |
| intensive | интенсивный, напряженный |
| later | позже, более поздний |
| latter | последний *(из двух выше упомянутых*) |
| lately | недавно, за последнее время |
| lay (laid, laid) | класть, положить |
| lie (lay, lain) | лежать |
| lie (lied, lied) | лгать |
| lend | дать взаймы, одолжить |
| borrow | брать в долг, занять |
| lonely | одинокий |
| alone | один, без других |
| loose | свободный |
| lose | терять |
| loss | потеря |
| near | близкий, близко |
| nearby | близкий, соседний |
| nearly | почти |
| precede | предшествовать |
| proceed | возобновлять *(после перерыва)* |
| quantity | множество чего-л. *(о неисчисляемых предметах)* |
| number | много *(об исчисляемых предметах)* |
| a number of | ряд |
| room | место, пространство *(вообще)* |
| place | место *(конкретное)* |
| position | положение, расположение, размещение |
| location | размещение, место |
| locus (*pl* loci) | точное место расположения чего-л. |
| sensible | благоразумный |
| sensitive | чувствительный, восприимчивый |
| sufficient | достаточный |
| deficient | недостаточный |
| technique | методика, способ |

**Appendix 2**

## Book Presentation
(Useful Language)

| English Phrase | Russian Equivalent |
|---|---|
| The present article (book, text, paper) is about (deals with, is devoted to )… | Настоящая статья (книга, текст, работа) посвящена… |
| The book embraces a wide range of problems. | Книга охватывает широкий круг проблем. |
| The main emphasis in this book is on… | Основное внимание в этой книге сосредоточено на… |
| The paper presents (a comparative analysis of…) | В работе дан (сравнительный анализ…) |
| The problem is … | Проблема заключается в том, что.. |
| The problem raised (studied, considered,) here is… | Проблема, поднятая (изучаемая, рассматриваемая) заключается в… |
| There is a vast literature on the subject. | Существует обширная литература по данному предметую |
| It is necessary to point out that … | Необходимо отметить, что … |
| There is another proof that … | Имеется еще одно доказательство |
| It is true that … | Верно, что |
| It is clear (evident, obvious) that … | Ясно, что … |
| This is proved by the fact that … | Это подтверждается фактом, что |
| It must be admitted that … | Следует допустить, что … |
| It seems essential to emphasize that... | Представляется важным отметить, что … |
| It should be noted that … | Необходимо отметить, что … |
| It should be added that … | Следует добавить, что … |
| As we have said … | Как было сказано … |
| As has been mentioned earlier … | Как было упомянуто ранее … |
| It is generally accepted that … | Общепринято, что … |
| It is known that … | Известно, что … |
| It a well-known fact that … | Это хорошо известный факт, что... |
| It is usually regarded as … | Это обычно рассматривается как... |
| According to this view … | Согласно данной точке зрения … |
| On the basis of the view it is possible to … | Исходя из данной точки зрения, возможно … |
| This is a scientifically valid theory… | Это научно-обоснованная теория... |
| This conception is current. | Эта концепция общепризнанна. |

**Appendix 3**

## Phrases to Be Used in Discussion

1. Could you explain what you mean by …
2. I`m not quite sure I follow you.
3. Well, the point is …
4. It is obvious that …
5. In my opinion …
6. As I see it …
7. Won`t (Would) you agree that …?
8. There is no doubt about that.
9. I couldn`t agree more.
10. I completely agree with you.
11. That`s just what I was thinking.
12. You haven`t convinced me that …
13. I agree with you on the whole but …
14. Perhaps, but …
15. Possibly, but …
16. Oh, but don`t you think that …
17. Look at it in another way …
18. On the contrary.
19. On the one hand …
20. On the other hand …
21. It seems to me that …
22. I am not sure about that.
23. As far as I know …
24. Could you be a little more specific?
25. I am afraid, I don`t agree with you here.
26. It`s too time-consuming.
27. It`s a good point.
28. You did a great job.
29. I see your point.
30. Basically I understand what you mean, but I think your conclusions are wrong.
31. I don`t think it will work.
32. I`m sorry to interrupt you, but …
33. Excuse me for interrupting you, but (I don`t think this information is relevant to the subject of our discussion).
34. You misunderstood. Let me explain.

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## Web – Resources and Support

### Web links to some useful and helpful resources:

1. http://www.bbc.com.english.news/science/i-Biology.net
2. http://www.nature.com/nature/focus/index_biologyscience.html
3. http://www.scientificamerican.com/biology
4. http://www.bbc.co.uk/schools/gcsebitesize/science/aqa/ evolutiontheories
5. http://www.biologycorner.com
6. http://www.e-journals.org/botany
7. http://www.en.academic.ru/dic.nsf/enwiki/4821078
8. http://www.humanfactor.mit.edu/overview/fellowships/science-bioligy/
9. http://www.science.discovery.com/convergence/100discoveries/ big100/biology.html
10. http://www.encyclopedia2.thefreedictionary.com/biological+science
11. http://www.biology.about.com/od/biologysciencefair/a/aao10807a.htm
12. http://www.wired.com/wiredscience/2008/01/biology-moving
13. http://www.newworldencyclopedia.org/entry/Biology
14. http://www.rspb.royalsocietypublishing.org
15. http://www.theregister.co.uk/science/biology
16. http://www.topix.net/science/biology
17. http://www.reference.com/browse/biology
18. http://www.ru.wikipedia.org/wiki/PLoS_Computational_Biology
19. http://www.open-site.org/Science/Biology/Molecular_Biology
20. http://www.bio-microscope.blogspot.com
21. http://www.blog.scientificfictionbiology.com
22. http://www.sciencedirect/com
23. http://www.history.nasa.gov/SP-4225/science/science.htm
24. http://www.wolfram.com/solutions/industry/biological-sciences/
25. http://www.ng.ru/science/2004-03-10/14_biology.htm
26. http://www.dictionary.reference.com/tools/toolbar-adite/install
27. http://www.biosci.org