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English for Biology Students

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Ushbu uslubiy qo'llanma biologiya yo'nalishida ta'lim oluvchi talabalarning ingliz tilida biologiya sohasiga oid maxsus tushunchalar va terminlar bilan tanishish hamda ularni chuqur o'rganishga imkon yaratadi. Qo'llanma biologik terminlarni o'qish, gapirish, yozish ko'nikmalari orqali rivojlantirish, shuningdek, turli metodlar va mashqlarni qo'llash barobarida maxsus sohani o'zlashtirirhsni taqozo etadi.

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Content

PREFACE

In the days grammar of the target language was the major center of attention in language classes. At the same time vocabulary was also the focus of drills, exercises and memorization efforts. Vocabulary can be defined, roughly, as the words we teach in the foreign language. However, a new item of vocabulary may be more than one word. For example, post office and mother-in-law which are made up of two or three words but express a single idea. There are also multi-word idioms where the meaning of the phrase can not be deduced from an analysis of the component words. A useful convention is to cover all such cases by talking about vocabulary "items" rather than "words".

Teaching vocabulary demands that exact time should be pointed for vocabulary teaching in interactive classroom. Because the interactive classroom is the place where vocabulary of target language is learned effectively through interaction. Grammar is under focus of teachers in foreign language teaching. And it is not difficult to find language teachers who think that vocabulary can be left to take care itself.

There are very strong reasons for a systematic and principled approach to vocabulary by both teacher and the learners. Let us look at these reasons. First because of the considerable research about what to do about vocabulary and about what vocabulary to focus on. This means that our vocabulary work can be directed toward useful words and can give learners practice in useful skills. We feel confident that learners will get a good return for the effort that they put in. Second, aim is to show that there is a wide variety of ways for dealing with vocabulary in foreign or second language learning. Some teachers do not use some of these ways. For example, getting learners to study words out of context. Another way is interruption of learners' reading to get them to guess an unknown word in context. Dissatisfaction with one approach to vocabulary should not result in ignoring all the other ways of encouraging learners develop their vocabulary. It is important that a teacher chooses

or rejects a way to deal with vocabulary. This choice or rejection should be based on a good understanding of the way of dealing with vocabulary, the principles behind it, and its theoretical and experimental justification. For example, many teachers too quickly dismiss the approach of getting learners to study lists of words out of context. For a teacher confronted with learners with a small vocabulary who want to go on to academic study in a few months' time. The approach which deals with teaching vocabulary is very effective. Moreover, there is a very large amount of experimental research showing the effectiveness of such an approach and providing useful guidelines on how to go about it.

The third reason for having a systematic and principled approach to vocabulary is that both learners and investigators see vocabulary as being a very important element in language learning. Learners feel that many of their difficulties in both receptive and productive language use result from an inadequate vocabulary.

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 17th 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 18th 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 as 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.

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. 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	

V. 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	

VI. 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?

VII. 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.

VIII. 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.

IX. 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?

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)*

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	
4) 1.carry out /2.experimentally /3.fulfill /4.tentatively **3)** 1.work /2.be involved /3.take part /4.be employed	

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
	individual	**A.**	very strict and difficult to change
	horticulture	**B.**	the protection of natural environment
	rigid	**C.**	the natural world in which people, animals and plants live
	predict	**D.**	to say that sth a person has said or written is wrong or untruthful
	conservation	**E.**	a single person or thing, considered separately from the class or group to which he, she, or it belongs
	contradict	**F.**	to say that sth will happen in the future

	variable	**G.**	the art, practice or science of growing fruit, flowers and vegetables
	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.	Особый 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
	Such observations may be obtained directly or indirectly.	
	To carry out a controlled experiment aimed at producing data.	
	Culturing cells outside organisms.	
	To refute a hypothesis.	
	Dysfunctional organs.	
	In addition.	
	An essential aspect of a scientific experiment.	
	Factors that can vary or may be varied.	
	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. 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 ..... .

X. 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**)

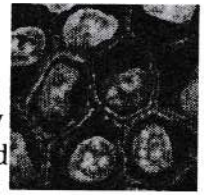
Reasons for choosing: interested in (**plants / animals / latest ideas /**
laboratory work / your own ideas)
Possible career choices: what I hope to do when I graduate
(**medicine / ecology / agriculture / your own idea**)
Offer to meet and discuss choices: I would like your advice and hope
we can .....
Yours sincerely,
(**your full name: first name + surname**)
Write 100 – 140 words.

XI. 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.

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.

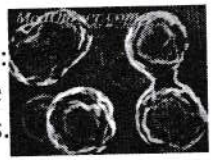
X. Read and translate the short text without any dictionary:

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:

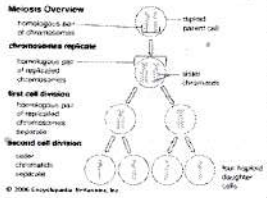
One of the most important concepts in biology is that cells arise only by the division of existing cells. Cell division is essential to all life. It enables a multicellular organism to grow and to replace worn out or damaged cells. It is also the basis of reproduction in every organism. Cell division 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:

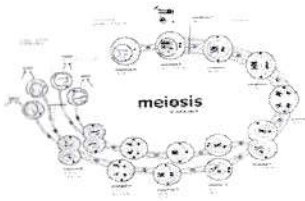
1. During interphase, the cell grows, carries out its functions, and replicates its DNA. After the DNA is replicated, new protein becomes attached to it. The chromosome now consists of two strands called sister chromatids which contain identical genetic information. Sister chromatids are joined at some 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.

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.

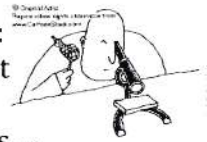
X. Read and translate the short text without any dictionary:

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?

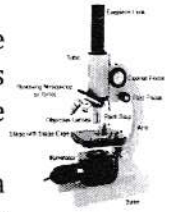
Read the given text and make your essential assignments:

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



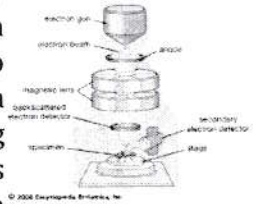
The magnification of an instrument is the increase in the apparent size of the object. The total magnification of a compound microscope is worked out by multiplying the magnification of the objective lens by that of the ocular lens.

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



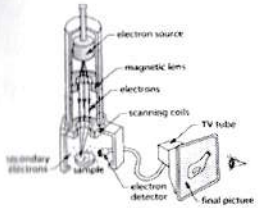
The TEM is used to study the details of the internal structure of cells. Extremely thin samples of the specimen are needed. To make these the specimen is supported in a resin block to prevent in collapsing during cutting, and is sliced with a diamond or glass knife. The section is then impregnated with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

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.

Who discovered the structure of DNA?

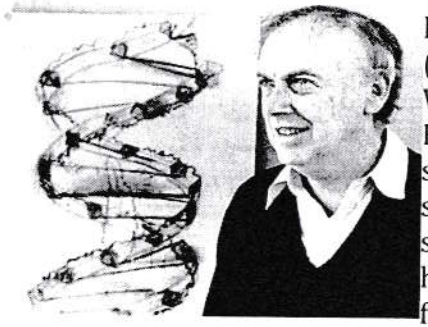
1. What do you know about a nucleoside and a nucleotide?
2. What shape does a molecule of DNA have?
3. What kind of information does a molecule of DNA contain?

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

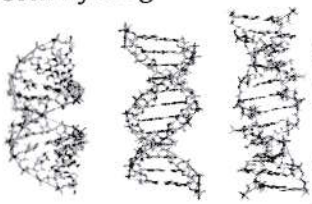
reaction between the phosphate group of one nucleotide and the hydroxyl group on carbon 3 of the sugar of the other nucleotide. The bonds linking the nucleotides together are strong, covalent phosphodiester bonds.

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).

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. 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	

V. 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

VI. 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?

VII. 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,

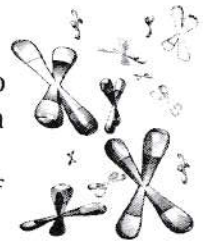
not three or more as some scientists had proposed. In 1962, Watson, Crick, and Wilkins received a Nobel Prize for their discoveries. Tragically, Rosalind Franklin died of cancer in 1958 at the age of 37. Nobel prizes cannot be given posthumously.

VIII. 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
20.520.729.3 Salmon	29.7	20.8	20.4	29.1
Wheat29.3 Locust	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

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.

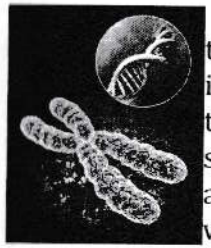
1. What do you know about chromosomes?
2. What is mitosis?
3. What is meosis?
4. What kind of molecules are called histones?

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.

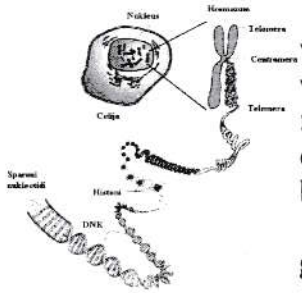
Another histone molecule attached to the outside of the nucleosome binds DNA to the octamer.

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.

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. 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?

V. 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.

VI. 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?

VII. Prepare a short presentation reflecting the following issues:

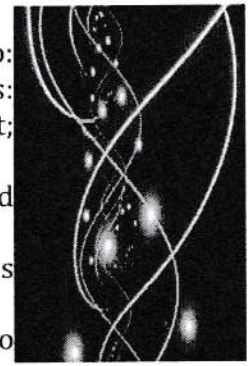
- discuss the role of telomeres;
- describe the structure and function of centromeres;
- explain how DNA is folded in a chromosome.

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:

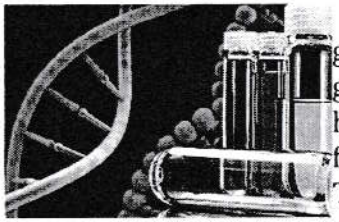
1.	ultimate	**A**	being the only one of its kind
2.	unique	**B**	a process by which two or more things have an effect on each other and work together
3.	distinguish	**C**	the final and the most important one
4.	source	**D**	the air, water and land in which people, animals and plants live
5.	feature	**E**	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.

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 ....
10. In discontinuous variations, the differences are ....

V. 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?

VI. 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.

VII. 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.

VIII. 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?

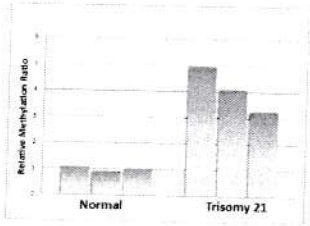
Exercise A. Match the words with their definitions:

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.

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. 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?

VII. 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.

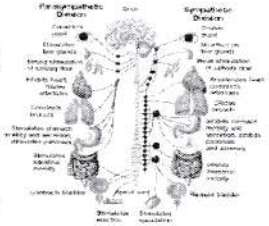
Advances in DNA technology have brought a new era in preventative medicine. We can now detect a large range of inherited diseases before birth, one of the most common of which is Down's syndrome.

VII. 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?

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.

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	distances
10. external cell	

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?

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.

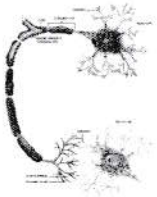
Squids can escape from danger because they have giant nerve fibres. These fibres can conduct nerve impulses very rapidly, since speed of conduction is directly related to the diameter of the fibre. Squids have nerve fibres of normal diameter to control their slow cruising movements, but giant nerve fibres 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.

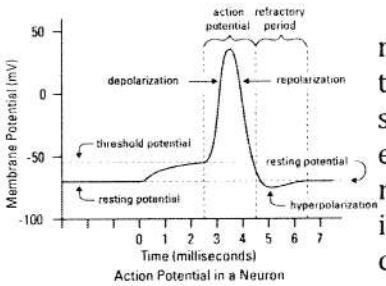
Pre-reading

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.

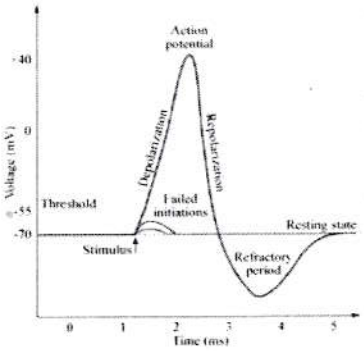
Resting potential

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.

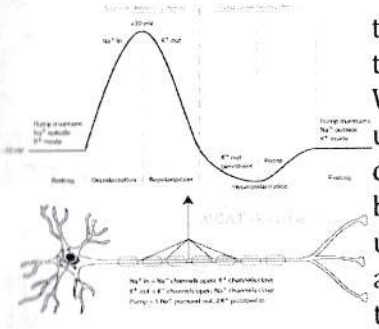
The recording on the cathode ray oscilloscope shows the effects of a stimulus on a giant axon. When the stimulus is applied, the axon becomes depolarised; that is, the inside becomes temporarily less negative. If the stimulus is strong enough (if it exceeds the threshold level), an action potential occurs. 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.

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:

	ion channels	a) electrical signals conveyed by neurones
	repolarisation	b) channels which have voltage-sensitive gates that open and close in response to voltage changes
	resting neurone	c) channels through which specific ions can move
	all-or-none law	d) neurone which doesn`t convey a nerve impulse
	nerve impulse	e) no matter how strong the stimulus, the size of an action is always the same
	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. 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.

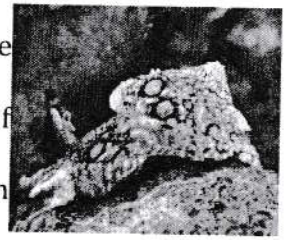
VII. State whether the voltage-gated potassium ion channels and the voltage-gated sodium ion channels in a neurone membrane are open or closed:

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

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?

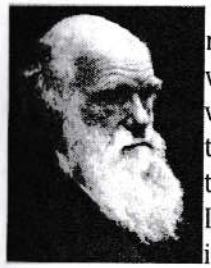
Read the given text and make your essential assignments:

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 19th 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.

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. 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	

VI. 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	

VII. 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?

VII. 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

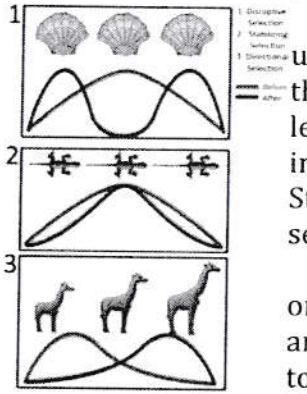
characteristics that give them an advantage in the "struggle for existence", will have the best chance of surviving and producing offspring. Their high natality (birth rate) gives them a selective advantage. On the other hand, those will unfavourable characteristics are more likely to die. Their high 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.

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. 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	

VI. 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	

VII. 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?

VII. 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.

IX. 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.

X. 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.

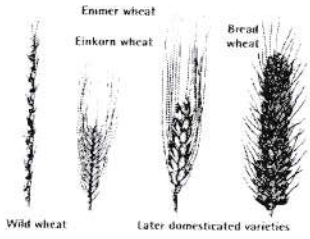
Pre-reading

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:

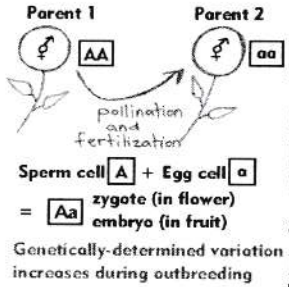
- high yield
- short stem length (allowing the plant to devote more energy to the production of seeds, which have a much higher value than straw from stems)
- pest resistance (for example, to fungal moulds and rusts)
- high protein content of the grain.

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.

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. Give Uzbek 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	

VI. 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	

VII. 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?

VII. 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.

VIII. 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.

IX. 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.

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. Give Uzbek 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	

VI. 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	

VII. 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?

VIII. 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.

IX. 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.

X. 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

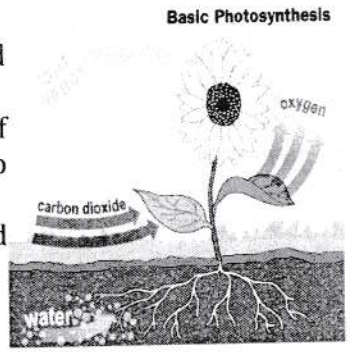
Text 7.1. Photosynthesis: An Overview

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

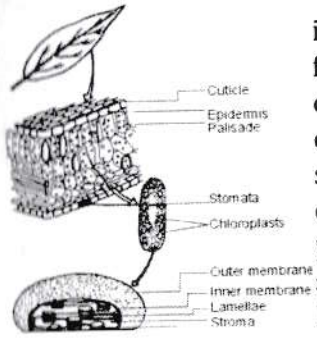
Green life has been steadily pumping out oxygen as a waste product of photosynthesis for millions of years. Some of the oxygen is used as a raw material for respiration, but most of it has accumulated in the atmosphere. So the very existence of our oxygen-rich atmosphere depends on the photosynthesising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

<u>Your Essential Assignments</u>

<u>I. Quick check:</u>

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. Give Uzbek 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	

VI. 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	

VII. 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?

VIII. 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.

IX. 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.

X. 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.

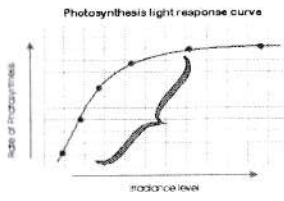
Factors that affect the rate of photosynthesis

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.

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. Give Uzbek 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	

VI. 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	

<u>VII. Answer the following questions. Use all information given before:</u>

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?

VIII. 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.

IX. 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.

X. 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.

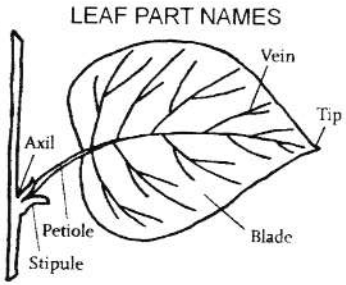
UNIT VIII. STRUCTURE AND TRANSPORT IN PLANTS

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.

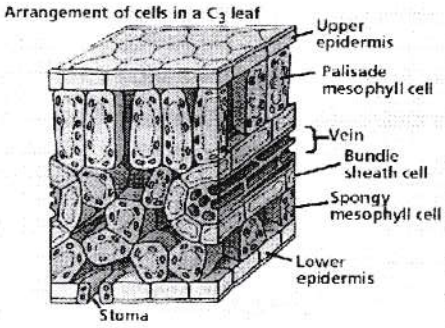
Ground tissue is all the tissue in a plant other than the epidermis, reproductive tissue, and vascular tissue. It makes the bulk of a leaf and consists mainly of parenchyma cells reinforced by collenchyma and sclerenchyma.

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.

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. 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

VI. Give Uzbek 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	

VII. 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 due to	**C**	bringing water and mineral salts 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

VIII. 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?

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

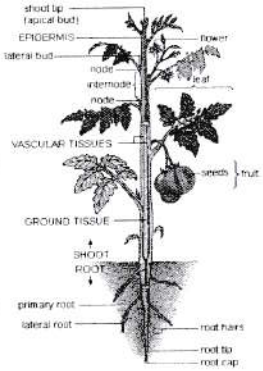
Fact of life:

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.

X. 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?

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.

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. Give Uzbek equivalents to the following English terms:

N	English term	
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	

V. 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	

VI. 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?

VII. 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.

VII. 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.

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.

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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

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