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BIOLOGY

Grade 9

1ST EDITION

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N. Karimova

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PREFACE

Natural science is an exciting and very useful subject. This textbook will show you all the beauty of it and will help you become true explorers. The main aim of this book is to answer the fundamental question: “What is science and what is its importance in our life?”

Starting from the first pages, you will realize that this textbook is completely different from any other usual textbook full of theoretical passages. Every chapter contains useful information, interesting facts, tasks for individual and group work. You will also learn how to conduct researches and experiments yourselves, search for information, make your own discoveries.

One more valuable feature of this textbook is the language. Every sentence has been carefully chosen so that it is not difficult for you to understand science in English language. Each page contains the translation of all the important terms, both in Kazakh and Russian. This textbook will not only help you improve your English, but it will also make you a part of a big international science community.

Please pay attention to the structure of this textbook. Remember: a textbook is no longer the only source of information in a modern world. With the help of carefully selected tasks, you are going to learn such important skills as critical thinking, problem solving, information analysis, creativity, imagination, teamwork, digital literacy etc.

If you have any questions, suggestions or ideas regarding the contents of this book, please feel free to contact us:

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 [@astanakitap](https://www.t.me/astanakitap)

Best regards,,
team of authors, “Astana-kitap”

HOW TO USE THIS BOOK

Lesson opener question

Chapter title

Lesson objectives

11.1

EYE STRUCTURE



You will:

- explore the features of visual perception



Human body on average has 75 trillion cells. Bacteria which live inside and outside human body are more than 75 trillions. How is this possible that we have more bacteria cells than our own cells?

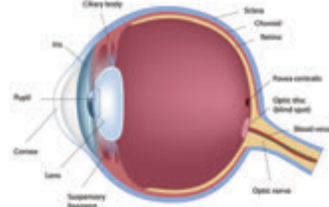
Definitions of main terms



Key terms

Sclera - white and the outermost layer of eye
Cornea - transparent part of eye that covers iris
Retina - the innermost layer of eye containing light-sensitive receptors

Vision helps human to analyze the world. We see things, colours, processes using eyes. Eye is a complicated organ. It consists of three layers: inner, outer and middle.



Human eye structure

Main text



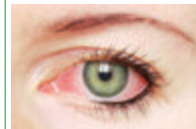
Facts

"Ішін ауырса, ауызды тый. Көзін ауырса, қолыңды тый"
This is kazakh proverb about hygiene of eyes and preventing them from diseases like conjunctivitis. Conjunctiva is transparent membrane covering eyes. When it is inflamed, blood vessels that feed membrane become larger and visible. So, this makes whites of eye to turn pink. It is highly contagious.

Outer layer consists of sclera and cornea. Sclera is a white layer. It protects eyes from damage. Cornea is a transparent layer.

Middle layer consists of three parts: iris, ciliary body and choroid. Ciliary body holds the lens of an eye. Lens focuses incoming light. Iris has eye colouring pigments. In the middle of the iris there is an opening called pupil. Light enter through this opening. Choroid has blood vessels. They bring nutrients to the eye.

Inner layer is a retina. It has cells called receptors. They receive information from outside and transfers it to our brain.



Activity

You are the mayor of the city called Cellorda (Cell Orda). Tell us about your city and citizens!
1. Who lives in Cell Orda?
2. Some bad bacteria want to attack Cell Orda. Soldiers protect the city. Who are they?
3. Now you have problems with energy supply. Who will find energy needed for Cell Orda
4. Work in groups. Show your city's life in action with your group.

Interesting facts



4

Activities to do during the lesson by students

Questions to review the chapter

Experiment of the chapter

Research related to the lesson

Interdisciplinary links

Profession introduction

Questions to review the chapter

Experiment of the chapter

Research related to the lesson

Interdisciplinary links

Profession introduction

11.1 EYE STRUCTURE

Lab works

Eyesight

Pre-lab questions:

1. What is the importance of eye and why we should take care of it?
2. Which eye structure determines a person's eye colour?
3. What are similarities of eyes and camera?

Methods and materials: Sivtsev table, tape-measure.

Procedures:

Print Sivtsev table on three A4 papers on landscape orientation.

Put it on the wall. 10th line of the table should be on the level of your eyes.

Illuminate the table with the lamp.

Stand 5 meters away from the table.

Close one eye and read which letters, aren't there more rows on the table. If you do not see the letter come closer for 0.5 meters. Repeat until you see the letter.

Measure your eyesight using formula:

$$V=d/D$$

where,

V - eyesight

d - distance, when you see the letter

D - distance, where you started the measurement

Literacy

1. Active cells or cells which need lots of energy have more mitochondria in them. Write 3 human cells with big amounts of mitochondria in them.
2. Plant cells have special plastids called chloroplasts, they do photosynthesis. Plant root cells do not have chloroplasts. Explain why.

Terminology

pupil - карашык / зрачок
lens - көз буршағы / линза
iris - нурлы кабық / радужная оболочка
complicated - күрделі / сложный

transparent - мөлдір / прозрачный
blink - жыпылықтау / моргать
well-lit - жақсы жарықтандырылған / хорошо освещенный

retina - торлы қабық / сетчатка
sclera - ақ қабықша / склера, белковая оболочка
outermost - ең сыртқы / самый внешний

Research time

How monomers link together or how polymers break down?
Take an interview from your chemistry teacher. Ask questions about building up and breaking down reactions. Write a short conclusion.



Maths in Biology

Artificial polymer
In daily life we use plastic bags: polyethylene. Which is also a polymer of ethylene. Polyethylene is used for the packaging of many products: all sorts of drinks, household chemical goods and cosmetic products. Polyethylene usage needs recycling. Because decomposition of plastics takes minimum 700 years and it pollutes environment.

Career

Ophthalmologist
Ophthalmologist is a medically trained doctor who is an expert in diagnosing, treating and preventing eye diseases.

New terms of the chapter

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CHAPTER 1.0

Cell Biology

1. Cell structure
2. Linear calculation of cell magnification



Slide containing cells under the microscope

**You will:**

- explain the basic functions of organelles in animal and plant cells.

**Key terms**

Cell - the smallest unit of organization that can perform all activities required for life;

Organelle - cellular structures with specialized functions;

Cytoplasm - the contents of the cell bounded by the plasma membrane;

Plasma membrane - the boundary of every cell that acts as a selective barrier, regulating the cell's chemical composition.

Nucleus - the organelle of a eukaryotic cell that contains the genetic material in the form of chromosomes.



Plasma membrane consists of a lipid bilayer with proteins and carbohydrates.

**What makes cell alive?**

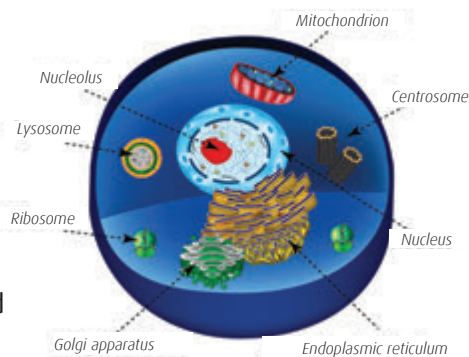
Most cells contain three main parts: cell membrane, cytoplasm, and nucleus.

The plasma membrane is a boundary between the cell and its surroundings. It is composed of two lipid layers and proteins. Membrane allows certain molecules in and out of the cell. This property of the cell membrane is called selective permeability.

Inside, the cell is filled with cytoplasm. It consists of three parts:

1. Cytosol is the liquid part of the cytoplasm that contains salts, ions, proteins, enzymes, and complex compounds.
2. Cytoplasmic inclusions are non-living materials like nutrients and pigments, which are not constantly in the cell.
3. Organelles are cellular structures with specialized forms and functions.

The cell nucleus is a part of all eukaryotic cells. It contains genetic information and regulates the activity of the cell. The nucleus is surrounded by a double membrane with pores.



Cell structure

Cell organelles

Organelle	Structure	Function
Ribosome	consists of two subunits: large subunit and small subunit	synthesizes proteins
Rough endoplasmic reticulum	a network of membranous tubules and sacs covered with ribosomes	synthesizes and transports proteins
Smooth endoplasmic reticulum	a network of membranous tubules and sacs without ribosomes	synthesizes and transports lipids and detoxifies drugs
Golgi body	a stack of flattened sacs called cisternae	modifies and packages materials
Lysosome	single membranous sac which contains digestive enzymes	breaks down substances

Mitochondria	double membranous organelles; inner membrane has inward projections called cristae; contains fluid called matrix	produces energy in the form of ATP
Plastids (chloroplasts, chromoplasts, leucoplasts)	double membranous organelles; chloroplast is filled with liquid called stroma; stroma contains small cylindrical structures called grana; each granum has many disc-shaped membranous sacs called thylakoid	chloroplast conducts photosynthesis and gives green color to plants chromoplast gives different colors to plant parts (yellow, orange, red) leucoplast is colorless, used to store food
Centrosome	includes two centrioles that are made of rings of microtubules arranged in nine triplets	play a major role in the division of the cell
Cilia	short projections	movement
Flagella	long projection	movement



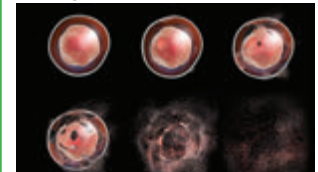
Research time

You know that cell's genetic material is found inside the nucleus. But have you ever wondered if other cell parts contain genetic material? Find out organelles that have their own DNA. Draw their structures. Research why do they need their own genetic material.



Facts

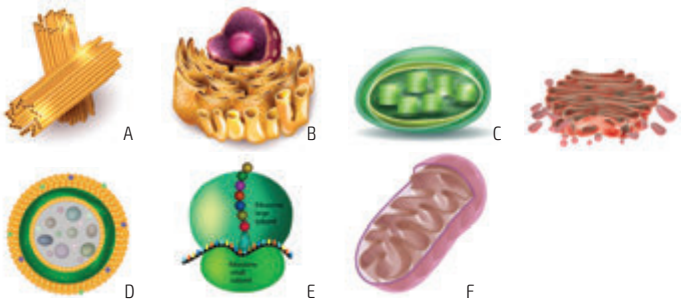
Cells can sacrifice their own life for other cells. When one cell is damaged or infected, it destroys itself. It bursts own lysosomes, so that enzymes inside the lysosome digest the cell. Consequently, cell sacrifices itself to save other cells from infection or damage.



Activity

Think-Pair-Share

Look at the pictures and fill the gaps with suitable letters. Then compare with your friend. After comparison, share your answers with the whole class and discuss it.



1. ___ has ___ on the surface.
2. ___, ___ are double membranous organelles.
3. ___ modifies proteins received from ___.
4. ___ made of materials produced by ___.
5. ___ digests old cell parts.
6. Write your own sentences with gaps.



Literacy

1. Which organelles are only in plants?
2. Which organic compounds compose cell membranes?
3. Which organelle is responsible for the cellular digestion?



Terminology

inclusion - кірiстiру, қосу / включение;
permeability - өткізгіштік / проницаемость;
sacs - қаптар / мешочки;
to burst - жарылу / взрыватьcя;

to damage - жарақаттау / повреждать;
to destroy - жою / уничтожать;
to sacrifice - қию / жертвовать.



LINEAR CALCULATION OF CELL MAGNIFICATION



You will:

- calculate a linear magnification in cells using micrographs.



Key terms

Linear magnification - the ratio of image length to object length measured in planes;

Micrograph - a photograph of an image under the microscope.



Facts

The *m* (meter) is the basic unit of distance or of "length" in the International System of Units.

1m = 100 cm (centimeter)

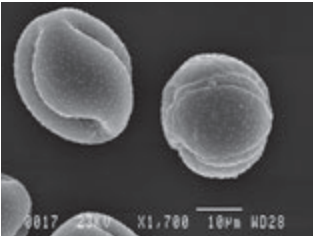
1m = 1000 mm (millimeter)

1m = 1000 000 μm

(micrometer)

1m = 1000 000 000 nm

(nanometer)



Micrograph of two pollen particles from Lesser Celandine flower.



Facts

Modern light microscopes can magnify images about 1500 times, while electron microscopes can magnify images about two million times.



What is the real size of our body cells?

There are many microscopic structures that we can't see with naked eye. Studying these structures lead to discoveries in science. Scientists often need to do calculations involving the magnification and sizes of images and specimens. Magnification is how much larger the image is than the actual size. This formula is used to calculate magnification:

$$\text{magnification} = \text{size of actual image} : \text{size of specimen}$$

Linear magnification is the ratio of image length, you see in the microscope, to the actual specimen length. The International System of Units (SI) is used to measure the size of structures. SI is the modern metric system of measurement. It is important to use the same units for measuring the sizes of the image and the specimen.

For example, let's assume that the length of an image is 30 mm. It represents a specimen that has an actual size of 3 μm . To determine the magnification of the image we first convert 30mm to μm . Then, determine the magnification by using the formula:

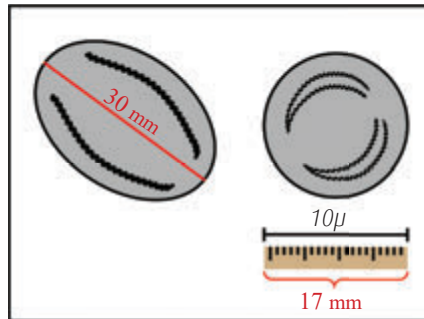
magnification = 30000 μm : 3 μm = 10000, so the specimen is magnified 10000x (times).

Scale bars are sometimes given instead of magnification on micrographs. The scale consists of a line with the actual size that the line represents. This is useful in publishing because any change in size during printing will automatically change both the micrograph and the scale bar equally.

To calculate the linear magnification of micrograph using the scale bar follow the steps below.

1. Measure the length of the scale by a ruler in mm: **17 mm**
2. Convert your measurement into μm : **17000 μm**
3. Calculate the magnification:

$$\text{magnification} = (17000) : 10 = 1700x$$



So the micrograph of pollen magnified 1700 times.

Also, the actual size of structures is calculated using a scale bar:

1. Measure the length of the pollen in mm and convert into μm :

$$30 \text{ mm} = 30000 \mu\text{m}$$

2. Measure the length of the scale bar in mm and convert into μm :

$17 \text{ mm} = 17000 \mu\text{m}$

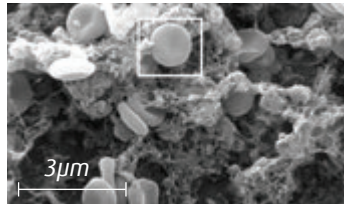
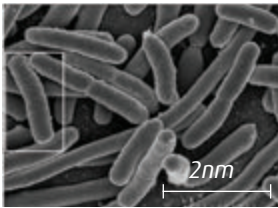
3. By using magnification formula make a proportion as they have same magnifications: $17000 : 10 = 30000 : (\text{actual size})$
And the actual size of pollen is approximately $18 \mu\text{m}$.



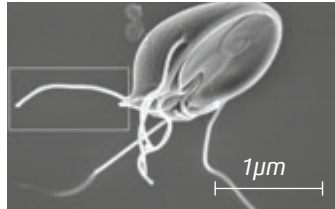
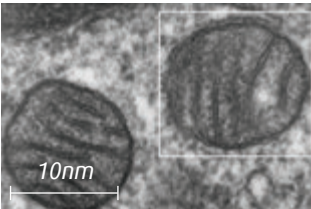
Activity

Calculate linear magnification of images and answer to following questions.

1. What is the actual size of bacteria?



2. What is the original diameter of erythrocyte?



3. What is the original length of mitochondria?
4. What is the actual size of giardia's flagella?
5. A student draws a cell diagram 22 mm long. She writes 600x below the diagram. How large is the actual cell?
6. You are looking at a specimen that measures $5 \mu\text{m}$, and the image you see is 10 mm long. Your friend is looking at a specimen 0.1 mm long using the same magnification. What size of the image does your friend see?



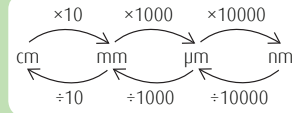
Terminology

convert - айналдыру / конвертировать;
giardia - лямблия;
magnification - ұлғайту / увеличение;
measurement - өлшеу / измерение;

micrographs - микросурет / микроснимок;
scale bar - масштабты сызғыш / масштабная линейка;
specimen - үлгі / образец;
to represent - көрсету / представлять.



Maths in Biology



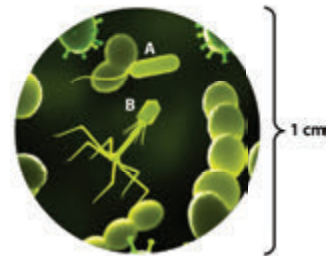
Convert the following measurements.

- 9.2 mm = $____ \mu\text{m}$
- 5800 μm = $____ \text{cm}$
- 0.077 mm = $____ \mu\text{m}$
- 0.0061 mm = $____ \text{nm}$



Research time

Draw each organism A and B separately to your notebook. Write short information about these organisms. By using scale bar calculate your drawings magnification.



Literacy

1. Why linear magnification is necessary?
2. How many meters is one nanometer equal to?



Problems

Cell Biology

Test questions with one right answer

1. Which of the following organelles contains digestive enzymes?

- A) ribosome
- B) nucleus
- C) lysosome
- D) mitochondria
- E) golgi body

2. If the length of an image is 65 mm and an actual size is 13 μm . Determine the magnification of the image.

- A) 500x
- B) 5000x
- C) 10000x
- D) 13000x
- E) 65000x

3. Which organelle gives different colors to plant parts?

- A) mitochondria
- B) vacuole
- C) endoplasmic reticulum
- D) vacuole
- E) plastid

4. Which organelle contains the genetic material?

- A) vacuole
- B) lysosome
- C) nucleus
- D) endoplasmic reticulum
- E) cell membrane

Test questions with several (max 3) correct answers

1. In which organelles proteins can be synthesized?

- A) golgi body
- B) cytoplasm
- C) ribosome
- D) smooth endoplasmic reticulum
- E) vacuole
- F) mitochondria
- G) plastids
- H) rough endoplasmic reticulum

2. Which of the following organelles consist of a double membrane?

- A) ribosome
- B) lysosome
- C) chloroplast
- D) vacuole
- E) golgi body
- F) endoplasmic reticulum
- G) mitochondria
- H) centrosome

3. What are the main parts of the cell?

- A) cell membrane
- B) ribosome
- C) cytoplasm
- D) lysosome
- E) golgi body
- F) mitochondria
- G) nucleus
- H) vacuole

Matching questions (3 correct answers)

1. Match the following organelles with their functions.

- | | |
|-----------------|---------------------------|
| 1. Mitochondria | A) packages materials |
| 2. Golgi body | B) transport materials |
| 3. Lysosome | C) protection |
| | D) produce energy |
| | E) breaks down substances |
| | F) protein synthesis |

2. Match the following organelles with their structure.

- | | |
|--------------------------|------------------------------------|
| 1. Centrosome | A) consists of two subunits |
| 2. Endoplasmic reticulum | B) a stack of flattened sacs |
| 3. Ribosome | C) a network of membranous tubules |
| | D) contains digestive enzymes |
| | E) sacs covered with ribosomes |
| | F) includes two centrioles. |