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**BASICS OF PHYSICS II**  
**ОСНОВЫ ФИЗИКИ II**

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Учебное пособие составлено в целях совершенствования навыков чтения научной литературы на английском языке; написания аннотаций и научных статей; умения вести беседу на научные темы. Пособие состоит из двух модулей, каждый из которых подразделяется на четыре темы и посвящен одному из разделов физики: оптика и биофизика, включает практикум для самостоятельной работы студента, краткий грамматический справочник и библиографию.

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## UNIT ONE: OPTICS

### PART 1

#### The Nature of Light

*“When you light a candle, you also cast a shadow.”*  
Ursula K. Le Guin

#### LEAD-IN

##### 1. Answer the next questions:

- 1) What is light?
- 2) Can you name all constituents of the light spectrum?
- 3) How much of the whole spectrum does the visible light amount?

#### PRE-READING

##### 2. Match terms with their definitions:

- |                    |   |
|--------------------|---|
| 1) wavelength      | a) throwing back by a body or surface of light, heat, or sound without absorbing it   |
| 2) frequency       | b) a glow or soft light which is produced in the dark without using heat  |
| 3) reflection      | c) the number of times that a periodic function or vibration repeats itself in a particular time  |
| 4) transparency    | d) the distance between successive peaks of a wave, especially points in a sound wave or electromagnetic wave                                       |
| 5) diffraction     | e) the process by which a beam of light or another system of waves is spread out as a result of passing through a narrow aperture or across an edge |
| 6) phosphorescence | f) the quality of an object or substance when you can see through it  |

#### READING

##### 3. Read the text called **The Properties of Light**. While reading, insert the following sentences into spaces inside the text (there is one extra sentence):

- a) with the degree of change dependent on the angle of the incoming light;
- b) for example, a magnification of 10× means that the image appears 10 times the size of the object as viewed with the naked eye;
- c) for example, a red piece of cloth may reflect red light to our eyes while absorbing other colors of light;

- d) for example, light moves much more slowly through water than through air, so light entering water from air can change direction greatly;
- e) dropping two pebbles into a puddle causes;
- f) when the retina receives visible light of many different frequencies;
- g) thus, a dye such as Texas red may be excited by blue light, but emit red light;
- h) in a simplified definition, represents the rate of oscillation.

## The Properties of Light

Visible light consists of electromagnetic waves that behave like other waves. Hence, many of the properties of light that are relevant to microscopy can be understood in terms of light's behavior as a wave. An important property of light waves is the wavelength, or the distance between one peak of a wave and the next peak. The height of each peak (or depth of each trough) is called the **amplitude**. In contrast, the frequency of the wave is the rate of vibration of the wave, or the number of wavelengths within a specified time period.

### Interactions of Light

Light waves interact with materials by being reflected, absorbed, or transmitted. Reflection occurs when a wave bounces off of a material. (1) \_\_\_\_\_ Absorbance occurs when a material captures the energy of a light wave. In the case of glow-in-the-dark plastics, the energy from light can be absorbed and then later re-emitted as another form of phosphorescence. Transmission occurs when a wave travels through a material, like light through glass (the process of transmission is called **transmittance**). When a material allows a large proportion of light to be transmitted, it may do so because it is thinner, or more transparent (having more transparency and less **opacity**).

Light waves can also interact with each other by interference, creating complex patterns of motion. (2) \_\_\_\_\_ the waves on the puddle's surface to interact, creating complex interference patterns. Light waves can interact in the same way.

In addition to interfering with each other, light waves can also interact with small objects or openings by bending or scattering. This is called diffraction. Diffraction is larger when the object is smaller relative to the wavelength of the light (the distance between two consecutive peaks of a light wave). Often, when waves diffract in different directions around an obstacle or **opening**, they will interfere with each other.

### Refraction

In the context of microscopy, refraction is perhaps the most important behavior exhibited by light waves. Refraction occurs when light waves change direction as they enter a new medium. Different transparent materials transmit light at different speeds; thus, light can change speed when passing from one material to another. This change in speed usually also causes a change in direction (refraction), (3) \_\_\_\_\_.

The **extent** to which a material slows transmission speed relative to empty space is called the refractive index of that material. Large differences between the refractive indices of two materials

will result in a large amount of refraction when light passes from one material to the other. (4) \_\_\_\_\_ . We say that the water has a higher refractive index than air.

## Electromagnetic Spectrum and Color

Visible light is just one form of electromagnetic radiation (EMR), a type of energy that is all around us. Other forms of EMR include **microwaves**, **X-rays**, and **radio waves**, among others. The different types of EMR fall on the electromagnetic spectrum, which is defined in terms of wavelength and frequency. The spectrum of visible light occupies a relatively small range of frequencies between infrared and ultraviolet light.

Whereas wavelength represents the distance between adjacent peaks of a light wave, frequency, (5) \_\_\_\_\_ . Waves with higher frequencies have shorter wavelengths and, therefore, have more oscillations per unit time than lower-frequency waves. Higher-frequency waves also contain more energy than lower-frequency waves. This energy is **delivered** as elementary particles called photons. Higher-frequency waves deliver more energetic photons than lower-frequency waves.

Photons with different energies interact differently with the **retina**. In the spectrum of visible light, each color **corresponds** to a particular frequency and wavelength. The lowest frequency of visible light appears as the color red, whereas the highest appears as the color violet. (6) \_\_\_\_\_ , we **perceive** this as white light.

However, white light can be separated into its component colors using refraction. If we pass white light through a prism, different colors will be refracted in different directions, creating a rainbow-like spectrum on a screen behind the prism. This separation of colors is called **dispersion**, and it occurs because, for a given material, the refractive index is different for different frequencies of light.

Certain materials can refract nonvisible forms of EMR and, in effect, transform them into visible light. Certain fluorescent dyes, for instance, absorb **ultraviolet** or blue light and then use the energy to emit photons of a different color, **giving off** light rather than simply vibrating. This occurs because the energy absorption causes electrons to jump to higher energy states, after which they then almost immediately fall back down to their ground states, emitting specific amounts of energy as photons. Not all of the energy is emitted in a given photon, so the emitted photons will be of lower energy and, thus, of lower frequency than the absorbed ones. (7) \_\_\_\_\_ ; or a dye such as fluorescein isothiocyanate (FITC) may absorb (invisible) high-energy ultraviolet light and emit green light. In some materials, the photons may be emitted following a **delay** after absorption; in this case, the process is called phosphorescence. Glow-in-the-dark plastic works by using phosphorescent material.

## VOCABULARY

### 4. Find words in the text (in bold) that mean the following (there are extra words):

- 1) the quality of being large in size or quantity;
- 2) a hole or empty space through which things or people can pass;
- 3) the quality of being difficult to see through;
- 4) range or limits of anything;
- 5) the area at the back of your eye;

- 6) to be similar or analogous in character or function;
- 7) a measure of the ability of a substance to separate by refraction;
- 8) to make smth late or to slow them down;
- 9) the part of the electromagnetic spectrum with wavelengths shorter than visible light but longer than X-rays;
- 10) to emit or discharge;
- 11) electromagnetic radiation emitted when matter is bombarded with fast electrons.

**5. Define the following words in English in pairs or small groups:**

microscopy, bounce off, interference, pattern, EMR, fluorescent, ground state, visible light, dye, glow, capture, exhibit, oscillation

**6. Fill in the gaps with the words from the box:**

**Part 1**

opacity   transparency   extent   absorbance   retina   interference   opening   oscillation
--

- 1) The quality of the product was increased to a certain \_\_\_\_\_ but it's still not good enough.
- 2) It will be clear from the experiment that the presence of two slits is essential to give a(n) \_\_\_\_\_ pattern.
- 3) Emission standards come in a variety of forms, such as the maximum concentration of a substance in a given volume of gaseous effluent or the maximum \_\_\_\_\_ of a smoke plume.
- 4) \_\_\_\_\_ is also called optical density.
- 5) For some of the later applications of paint, white was used in the mixtures, making them more contrasting with the areas of maximum \_\_\_\_\_ through which the white of the paper is visible.
- 6) Uneven increase and decrease caused a(n) \_\_\_\_\_ of the graph.
- 7) Medical treatment of the \_\_\_\_\_ turned out to be successful; now he can see clearly.
- 8) The walls of the cave seemed solid but there must have been hidden \_\_\_\_\_ because I could feel the flow of cold air.

**Part 2**

fluorescent   correspond   simplify   bounce off   capture   exhibit   adjacent   delay
---

- 1) Black material \_\_\_\_\_ light much easier than that of any other colour.
- 2) Finally the measurements \_\_\_\_\_ fairly well with the differences in plant size due to temperature stress.
- 3) He surely \_\_\_\_\_ his persistence and determination in completing this long-term project.
- 4) To \_\_\_\_\_ computation, we used a specifically created programme.

- 5) If he had \_\_\_\_\_ publication any longer, his competitors would have outrun him.
- 6) When particles \_\_\_\_\_ the thin gold sheet and back to the apparatus, scientists understood there was something else in its atomic structure.
- 7) The journal with all data was found in a room \_\_\_\_\_ to the main lab.
- 8) The room was about twelve foot square and lit by a(n) \_\_\_\_\_ tube running almost the full length of the ceiling.

**7. Change words in brackets so that they are grammatically correct for the sentence:**

- 1) Various substances are said to have different \_\_\_\_\_ indices, for example, it is 1.47 for olive oil. (refraction)
- 2) Orbital telescopes give much better resolution of images because in their case atmospherics don't \_\_\_\_\_ with the reception of data. (interference)
- 3) Phosphorescence is a type of \_\_\_\_\_ of the energy from absorbed light, typical of certain kinds of glow-in-the-dark substances. (emit)
- 4) The level of acoustic \_\_\_\_\_ is highly important in choosing the location of laboratories with sensitive equipment. (transmit)
- 5) One of the most desirable property of military transport is radar \_\_\_\_\_, hence its research and invention are highly demanded by government. (visible)
- 6) The client asked to make the design of his company's site more \_\_\_\_\_. I don't know what he's thinking, it would just make images blurred and text illegible. (transparency)
- 7) The small statuette appeared to be phosphorous; it's such a pity that I didn't notice it before going to bed, since now its steady \_\_\_\_\_ in the darkness was bothering me. (glow)
- 8) The area under research was not so wide \_\_\_\_\_, still it required painstaking analysis of each and every component. (space)
- 9) Vitamin C increases the \_\_\_\_\_ of iron from food. (absorb)
- 10) Physical changes in the body also cause \_\_\_\_\_ in sleep patterns. (alter)

**8. Write a sentence using a set of words:**

- a) amplitude, wave, alter;
- b) extent, delay, measure;
- c) ground state, correspond, photon.

**9. Think what word can be used in the gaps in all three sentences:**



A) 1 Having a regular \_\_\_\_\_ of sleeping is a key to a healthy lifestyle.

2 Detected particles created a rather clear \_\_\_\_\_ on the graph.

3 I don't suppose Jane would ever agree to wear a dress with flowery \_\_\_\_\_, it would be absolutely unlike her.

B) 1 In normal conditions quicksilver keeps a liquid \_\_\_\_\_.

2 The police report \_\_\_\_\_ that he had been arrested the day before.

3 Supplies in these warehouses are considered \_\_\_\_\_ property. No one can freely take anything from them.

C) 1 The United States \_\_\_\_\_ Puerto Rico from the Spaniards in 1898.

2 You need very sensitive apparatus and unique conditions in order to \_\_\_\_\_ neutrino.

3 Busy parents often use cartoons to \_\_\_\_\_ their children's attention but the minus is that eventually it can cause a bad habit.

## POST-READING

### 10. Using the information from the article, complete the key concepts below:

- Light waves interacting with materials may be \_\_\_\_\_, \_\_\_\_\_, or \_\_\_\_\_, depending on the properties of the material.
- Light waves can interact with each other (\_\_\_\_\_) or be distorted by interactions with small objects or openings (\_\_\_\_\_).
- \_\_\_\_\_ occurs when light waves change speed and direction as they pass from one medium to another. Differences in the \_\_\_\_\_ of two materials determine the magnitude of directional changes when light passes from one to the other.
- A \_\_\_\_\_ is a medium with a curved surface that refracts and focuses light to produce an image.
- Visible light is part of the \_\_\_\_\_; light waves of different frequencies and wavelengths are distinguished as colors by the human eye.
- A prism can separate the colors of white light (\_\_\_\_\_) because different frequencies of light have different refractive indices for a given material.
- \_\_\_\_\_ dyes and \_\_\_\_\_ materials can effectively transform nonvisible electromagnetic radiation into visible light.

### 11. Answer the questions:

- 1) What are the main properties of light?
- 2) What is the difference between amplitude and frequency?
- 3) How do light waves interact with each other? Illustrate your answer with an example.
- 4) What types of EMR are mentioned? How do they differ from each other?

- 5) How do people perceive light? What makes it possible?
- 6) How can invisible forms of EMR be transformed for us to see them?

**12. There are other aspects connected with properties of light which were not mentioned in the article. They are magnification and resolution. Find information about them yourself (you may use the Internet) and write the last paragraph for this article (150-200 words.) Make sure you have credible data and correct terms!**

**13. Read the text and fill in the gaps with the words from the box:**

temperature	light	function	filament	shininess	example	fusion	absorption
environment	surface	concept	reemission	equilibrium	space	cavity	

### Blackbody Radiation

Hot objects glow. In 1860, Kirchhoff proposed that the radiation emitted by hot objects as a 1)\_\_\_\_\_ of frequency is approximately the same for all materials. The notion that all materials behave similarly led to the 2)\_\_\_\_\_ of an ideal blackbody radiator. Most materials have a certain 3)\_\_\_\_\_ that causes light to reflect or scatter in addition to being absorbed and reemitted. However, light that falls upon an ideal blackbody is absorbed perfectly before the possibility of 4)\_\_\_\_\_, hence the name blackbody.

The distribution of frequencies emitted by a blackbody radiator is related to its 5)\_\_\_\_\_. We often consider a blackbody radiator that is in thermal 6)\_\_\_\_\_ with the surrounding light that is absorbed and reemitted. If it is not in thermal equilibrium, for example, if more light is emitted than absorbed, then the object inevitably cools as light escapes to the 7)\_\_\_\_\_, moving the system toward thermal equilibrium.

The Sun is a good 8)\_\_\_\_\_ of a blackbody radiator. The light emitted from the Sun is associated with its 9)\_\_\_\_\_ temperature. Any light that arrives to the Sun from outer 10)\_\_\_\_\_ is virtually 100% absorbed, however little light that might be, so the name blackbody aptly describes it. Mostly, light escapes to the much colder surrounding space (i.e. it is not in thermal equilibrium), and the temperature of the Sun's surface is maintained by the 11)\_\_\_\_\_ process within. As another example, a glowing tungsten 12)\_\_\_\_\_ in an ordinary light bulb may be reasonably described as a blackbody radiator. However, surface reflections make it less than ideal both for 13)\_\_\_\_\_ and emission.

Experimentally, a near perfect blackbody radiator can be constructed from a hollow object. As the interior of the object is heated, the light present inside the internal 14)\_\_\_\_\_ is in equilibrium with the glowing walls. A small hole can be drilled through the wall to observe the radiation inside without significantly disturbing the system. The observation hole can be thought of as a perfect blackbody since any 15)\_\_\_\_\_ entering the hole from the outside is eventually absorbed (before being potentially reemitted), if not on the first bounce then on subsequent bounces inside the cavity.

### SPEAKING

#### **14. Extended discussion questions:**

- 1) Why has light been such an interesting phenomenon of the research for many decades and centuries?
- 2) What is the red shift? What theories were based on the features of it?
- 3) What is luminiferous aether? Does it exist?

**15. In pairs, role-play the conversation between: a) an optics professor and his student; b) two groupmates one of whom missed the last lecture. Explain to your partner the properties of light. The asking student must prepare 2-3 questions before you start.**

#### **16. Challenge questions — test yourself!**

- a) What is the relationship between the speed of light, wavelength, and frequency of electromagnetic radiation?
- b) What are the properties of electromagnetic waves?
- c) What properties of light allow shadows to form?
- d) Why is visible light useful in photosynthesis, while other forms of electromagnetic radiation are not?
- e) How was the speed of light calculated?
- f) If a light wave has a long wavelength, is it likely to have a low or high frequency?
- g) What is Doppler's effect?
- h) Which has a higher frequency: red light or green light?
- i) Why do fluorescent dyes emit a different color of light than they absorb?
- j) Why can't ultraviolet light pass through glass?
- k) What is the speed of a photon in water?

#### **LISTENING**

**17. You are going to watch a video named *What is light?* Before you start, read the next words from this video and make sure you understand their meanings:**

in a nutshell, quantity, to put smth into perspective, from one's standpoint, coincidence, to alter

**18. Watch the video and answer the questions below:**

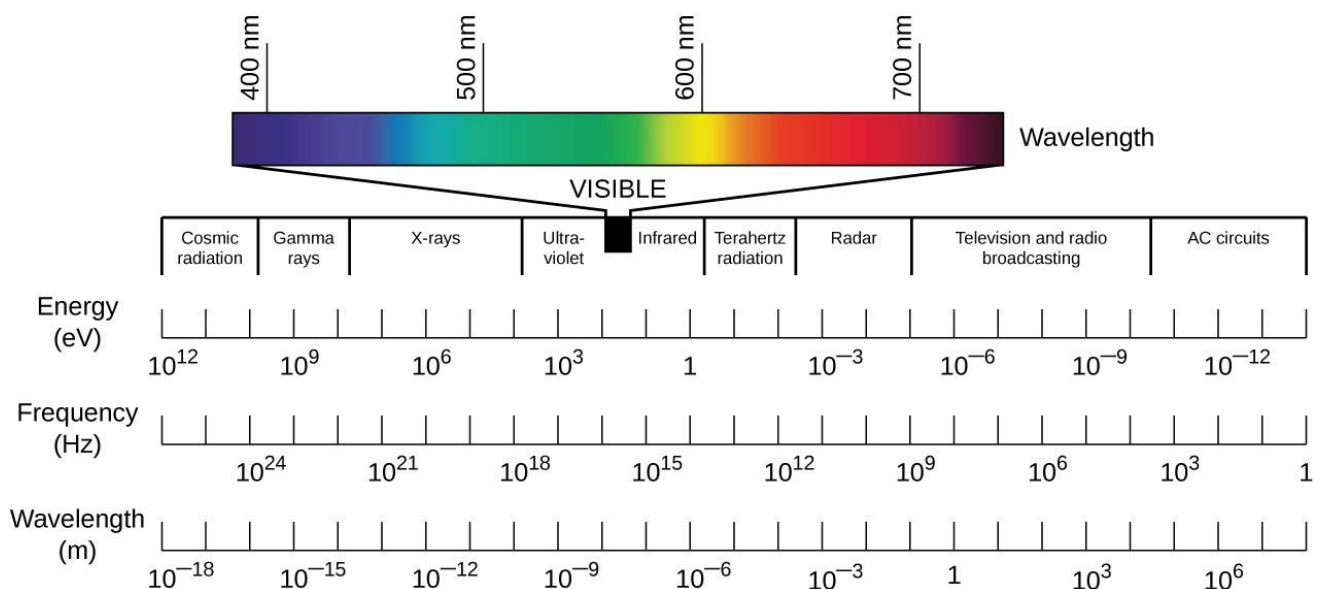
- 1) What is light?
- 2) What are properties of a photon?

- 3) What is called electromagnetic spectrum?
- 4) What information is given about gamma rays and radio waves?
- 5) What makes visible light special?
- 6) Why is light said to be helpful for survival?
- 7) How does light appear?
- 8) What is the speed of light (in vacuum)?

**19. What physical theories and questions were mentioned at the end of the video? Do you know anything about them? What other theories and problems are connected with light?**

## GRAPH DESCRIPTION

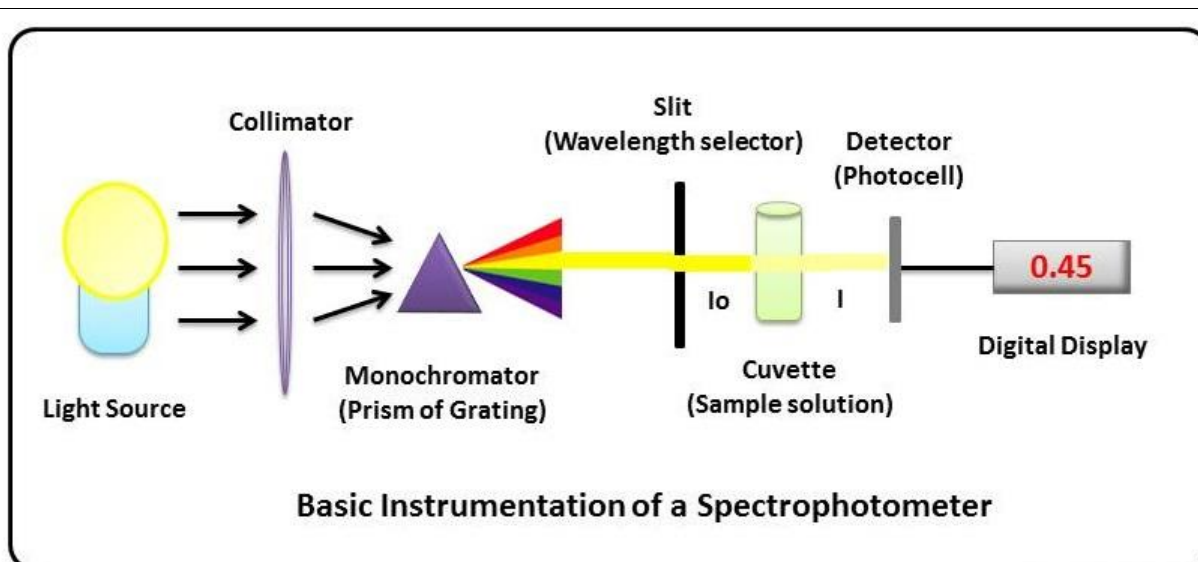
**20. Describe the graph showing the light spectrum**



## DEVICE EXPLANATION

**21. Using the facts below and the scheme of the device, explain the work of the spectrometer:**

- ✓ its structure;
- ✓ its purpose;
- ✓ how do you use it.



Namrata Heda

About the device	A spectrophotometer is a device used to measure light at a specific wavelength. It consists of two parts: a spectrometer and a photometer. The spectrometer provides light at a specific wavelength. The photometer measures how intense the light is. By calculating the amount of light that a solution is able to absorb and applying Beer's Law, the spectrophotometer can determine the concentration of a colored solution.
Working mechanism	A ray of light enters a spectrometer, through a collimator slit (which converts the incoming light into a parallel beam) and falls on the diffraction grating. These gratings are surfaces with several thousand lines etched into them, which cause the light to get diffracted. The readable side of a DVD or a compact disc, for example, acts as a diffraction grating, splitting incident visible light, into its fundamental wavelength components.
Tips	<ul style="list-style-type: none"> <li>• Special light filters may be required on some spectrophotometers if working at certain wavelengths.</li> <li>• The machine must be zeroed out after each sample or if changing the wavelength.</li> </ul>
Warning	<ul style="list-style-type: none"> <li>• Failure to allow the spectrophotometer enough time to warm can result in erroneous results.</li> <li>• Make sure cuvettes are free of any particles, smudges or fingerprints, as these can throw the machine's calculations off.</li> <li>• Spectrophotometers are expensive machines. Take care to not inadvertently damage the machine while using it.</li> </ul>

## TRANSLATION

### 22. Translate from English into Russian:

The electromagnetic spectrum describes light as a wave which has a particular wavelength. The description of light as a wave first gained acceptance in the early 1800's when experiments by Thomas

Young, François Arago, and Augustin Jean Fresnel showed interference effects in light beams, indicating that light is made of waves. By the late 1860's light was viewed as part of the electromagnetic spectrum. However, in the late 1800's a problem with the wave-based view of light became apparent when experiments measuring the spectrum of wavelengths from heated objects could not be explained using the wave-based equations of light. This discrepancy was resolved by the works of 1 in 1900, and 2 in 1905. Planck proposed that the total energy of light is made up of indistinguishable energy elements, or a quanta of energy. Einstein, while examining the photoelectric effect (the release of electrons from certain metals and semiconductors when struck by light), correctly distinguished the values of these quantum energy elements. For their work in this area Planck and Einstein won the Nobel prize for physics in 1918 and 1921, respectively and based on this work, light may be viewed as consisting of "packets" or particles of energy, called photons.

### **23. Translate from Russian into English:**

Долгое время физики полагали, что им не удастся осуществить преломление гамма-лучей. Франко-германская группа учёных сумела экспериментально доказать, что это возможно. Для этого они использовали особую кремниевую линзу.

Чтобы понять, в чём состоит "невозможность" преломления гамма-излучения, необходимо вспомнить школьные уроки физики. Так, известно, что, проходя через различные среды, волны электромагнитного излучения (к ним, в частности, относятся свет и гамма-лучи) способны изменять траекторию распространения. Степень такого отклонения измеряется коэффициентом преломления и определяется соотношением фазовых скоростей электромагнитных волн в вакууме и в среде. Если скорости равны, то коэффициент равен единице (то есть преломление отсутствует). К примеру, видимый свет, распространяясь в воздушной среде при обычных условиях, имеет коэффициент преломления, практически равный единице.

Свойства электромагнитных волн видимого диапазона позволяют относительно свободно им управлять (отражать, фокусировать и рассеивать). Более того, недавно физики научились изгибать лучи света под любым углом без внешнего воздействия.

## PART 2

### Models of Light

*“It seems as though we must use sometimes the one theory and sometimes the other, while at times we may use either. We are faced with a new kind of difficulty. We have two contradictory pictures of reality; separately neither of them fully explains the phenomena of light, but together they do.”*

*Albert Einstein*

### LEAD-IN

#### 1. Answer the questions:

- 1) What is a particle?
- 2) What is a wave?
- 3) Is light a particle or a wave?

### PRE-READING

#### 2. Write derivatives of the following words:

*E.g. theory — theories, theoretical, theoretically, to theorize, theorist*

magnet

light

wave

locus

### READING

#### 3. Restore the order of sentences in paragraph 2 (Classical Particles).

#### 4. Read the whole text and then insert the words at the end of this text into spaces (a — m):

### The Problem Posed by Light

#### Overview

In classical physics, especially mechanics and electricity and magnetism, two (a)\_\_\_\_\_ and very useful concepts have been invented and used repeatedly, that of particles and that of waves. However, to explain phenomena on the atomic level of size, the **distinction** between waves and particles becomes (b)\_\_\_\_\_, and an important modification, involving probability, must be made. Because the separate concepts of particle and of wave are so natural and satisfying for phenomena on the human scale it is somewhat difficult to explain why and how they must be modified and combined in order to describe the behavior of very small objects. Our most complete theory of light is a

“quantum field” theory having both wavelike and particle-like properties that is, **incorporating** “wave-particle dualism.” We will (c)\_\_\_\_\_ the relationships between classical particles, classical electromagnetic waves and quantum field theory by asking what each of them predicts for a single (d)\_\_\_\_\_ experiment.

## Classical Particles

1\_\_\_ For example, in Fig. 1 we have a particle with charge  $q$  moving near a charged **plate**. 2\_\_\_ The subsequent motion of the particle in the next infinitesimal interval of time is governed by:  $\vec{a} = \vec{F}/m = (q/m)\vec{E}$ . 3\_\_\_ A particle is characterized by having infinitesimal size and a definite location in space at each **instant** of time. 4\_\_\_ At each instant of time, the particle experiences a force  $\vec{F} = q\vec{E}$  determined by the electric field at the location of the particle. 5\_\_\_ If there are no forces acting on it, the particle travels in a straight line at constant speed. 6\_\_\_ It may have mass and an electrical charge, it certainly has momentum and carries kinetic energy. 7\_\_\_ As time increases, the particle moves along a definite trajectory, which is determined entirely by local conditions at the point where the particle is.

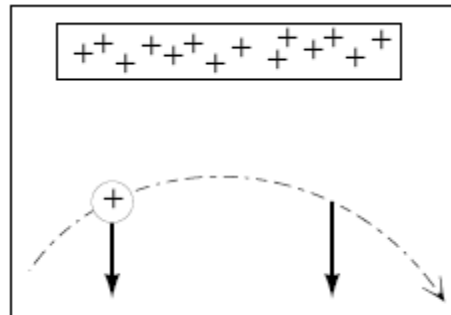


Figure 1. Local influences on the trajectory of a charged particle near a charged plate.

## Classical Waves

The “wave” concept is **abstracted** from many different phenomena that are only geometrically similar, such as waves on the surface of water, sound in gas, liquid or **solid**, electromagnetic waves, **displacement** of a (e)\_\_\_\_\_ string or a stretched membrane (drumhead, flapping sail) etc. In each case there is some “field” quantity varying **smoothly** in 1, 2 or 3 dimensions. (For water waves, vibrating strings and membranes it is the displacement of particles from their equilibrium position; for sound in air it can be density or pressure variations; for electromagnetic waves there are six varying fields, the three components of  $\vec{E}$  and the three components of  $\vec{B}$ .)

We will not need to consider the detailed electromagnetic wave picture for light that can be (f)\_\_\_\_\_ from Maxwell's differential equations of the electromagnetic field, and which correctly predicts the light's velocity, its polarization (i.e., the fact that the  $\vec{E}$  vector is perpendicular to the direction of propagation of the light wave) and the wave's behavior at surface boundaries with conducting and dielectric materials. Rather, we will consider the most characteristic property of any wave, that it undergoes diffraction at an obstacle.

The momentum and energy carried by a wave are not concentrated at a point, but are spread out smoothly over a (g)\_\_\_\_\_ volume. This is in contrast to the very small sizes of atomic particles, and this contrast is what makes it hard to imagine an entity which is (h)\_\_\_\_\_ a “wave” and a “particle.” In fact, we will see that light is composed neither of classical waves nor of classical particles, but is a new kind of entity that behaves in certain ways like a particle and in other ways like a wave. A (i)\_\_\_\_\_ description ties these aspects together.

## The Nature of Light

Is light:

— A wave?	Evidence: diffraction and interference experiments.
-----------	---



— An electromagnetic wave?	Evidence: Maxwell's equations predict such behavior as its speed in vacuum, Snell's law of refraction, polarization, generation of long waves by simple electromagnetic circuits, etc.
— A particle?	Evidence: Compton effect, photoelectric effect, photochemical reactions, etc.

The (j)\_\_\_\_\_ **contradictory** wave and particle natures of light are (k)\_\_\_\_\_ by quantum field theory. Its basic statement is: “The intensity (at a given point in space and time) of an electromagnetic wave of frequency  $\nu$  gives the probability, and only the probability, that energy in the amount  $h\nu$  may be transferred between the wave and an external object at that point in space.” The wave, particle and quantum field theory ideas can be contrasted, compared and explained by using each to **predict** the results of a Fraunhofer single slit diffraction experiment.

[...]

### Light Is Not Particles, Not Waves

Light cannot be categorized as either classical particles or classical waves. If it were (l)\_\_\_\_\_ as a classical particle it would not produce a diffraction pattern, but light diffracts. If it were a classical wave, its energy and momentum would have a continuous **distribution** in space and time, but light often acts as if it consists of localized photons having discrete energy and momenta. Thus light cannot be said to be (m)\_\_\_\_\_ one or the other.

seemingly  
simultaneously  
taut  
distinct  
reconciled

clarify  
blurred  
slit  
classifiable  
probabilistic

derived  
finite  
intrinsically

## POST-READING

### VOCABULARY

#### 5. Find words in the text (in bold) which fit the following definitions:

- 1) an extremely short period of time;
- 2) removed or separated (from smth);
- 3) very hard or firm;
- 4) unable for both to be either true or false under the same circumstances;
- 5) the state of being different;
- 6) spreading or supplying smth;
- 7) a flat piece of metal, especially on machinery or a building;
- 8) including;

- 9) in approximately equal amounts;
- 10) the removal of something from its usual place or position by something which then occupies that place or position;
- 11) make a declaration about smth in advance.

**6. In pairs or small groups define the following words (do not forget to use terms!)**

equilibrium, boundary, wave, entity, propagation, drumhead, evidence, polarization, refraction, generation, circuit

**7. Fill in the gaps:**

**Part A**

equilibrium distinction propagation boundaries distribution evidence generation circuit  
refraction string

- 1) Latest studies of cosmic background radiation showed the \_\_\_\_\_ of light wasn't smooth; there were brighter and darker spots on the map.
- 2) According to Newton, rectilinear \_\_\_\_\_ of light is possible because photons are unaffected by gravity, hence they travel in a straight line from its source at high speed.
- 3) A(n) \_\_\_\_\_ of the existence of other universes is unlikely to be found in the near future.
- 4) In a chemical reaction, chemical \_\_\_\_\_ is the state in which the concentrations of the reactants and products have not yet changed with time.
- 5) Referring to Figure 1, consider a taut \_\_\_\_\_ stretched between two fixed points at  $x = 0$  and  $x = L$ .
- 6) \_\_\_\_\_ of degree seemed to be the main factor of getting this result. In the last experiment a bigger amount of sodium was used.
- 7) Only twenty years ago the Frenchman Laussedat noted a(n) \_\_\_\_\_ of the solar disc during an eclipse.
- 8) Scientists still cannot state what exactly is located at the \_\_\_\_\_ of the Solar system, thus the interest in this research is high enough to get more funding.
- 9) My attempts to cut through the cabling will break the electrical \_\_\_\_\_.
- 10) We have greatly expanded our gas production and power \_\_\_\_\_ activities through acquisitions and investment.

**Part B**

smoothly incorporating entirely subsequent simultaneously contradictory classifiable  
predicting reconcile displaced

- 1) First results of my research are promising but only the \_\_\_\_\_ study will show the worth of the whole theory.
- 2) His line of work was to check from time to time if the engine is working \_\_\_\_\_. When it didn't, he stopped the whole mechanism and oiled its parts.
- 3) Two levers are located in opposite sides of the control room and must be pushed \_\_\_\_\_, so that no single person could initiate the mechanism and launch missiles.
- 4) According to the American Hazardous Substances Data Bank pentachlorobenzene is not \_\_\_\_\_ as to human carcinogenicity because there are no human data and no animal data available.
- 5) \_\_\_\_\_ these results as hard facts about the universe as we know it is premature.
- 6) Various cases of writers \_\_\_\_\_ new technologies decades earlier are known to history.
- 7) Due to a fault in an algorithm, the program ceased to open \_\_\_\_\_, it didn't even react to the click on it.
- 8) Scientific world had to \_\_\_\_\_ particle-wave duality of light since it had both theoretical and experimental proofs.
- 9) Despite models of light seeming \_\_\_\_\_, each of them works perfectly.
- 10) Coal is to be \_\_\_\_\_ by natural gas and nuclear power.

**8. Change words in brackets so that they are grammatically correct for the sentence:**

- 1) Survival to the age of 60 years with such complex cardiac malformations, \_\_\_\_\_ by surgical correction, is a rare occurrence. (modification)
- 2) The coordination problem is too important an issue to be kept \_\_\_\_\_ off economist's research agenda. (definite)
- 3) Deciding upon a date of a conference without preceding discussion was \_\_\_\_\_, that's why the organizers agreed to have a(n) \_\_\_\_\_ where all details will be cleared. (point)
- 4) Tornadoes and hurricanes are too \_\_\_\_\_ phenomena to be easily observed and studied. (predict)
- 5) Increasing interest in the research of alternative sources of energy makes \_\_\_\_\_ of traditional problematic ways of producing energy with new ones much more realistic. (place)
- 6) The uproar caused by his recent discovery is simply \_\_\_\_\_: by the end of the day at least three other laboratories have asked to repeat his experiments for the testimony. (description)
- 7) Federal and state costs for building and operating new laboratories \_\_\_\_\_ to \$25 billion. (amount)
- 8) Since this method of evaluating the receptive-field center sizes is significantly different from ours, these results are not straightforwardly \_\_\_\_\_ to ours. (compare)
- 9) All his teammates get irritated with constant \_\_\_\_\_ remarks of his; it was especially annoying on long conferences and plan making meetings. (time)

10) In order to turn the deserts into fertile and \_\_\_\_\_ land, engineers built an 900-mile canal.  
(produce)

**9. Translate the following word combinations into English:**

- 1) определяется локальными условиями
- 2) дифференциальное уравнение
- 3) сконцентрированный в одной точке
- 4) на атомном уровне
- 5) по прямой
- 6) двигаться по определенной траектории
- 7) в заданной точке
- 8) с постоянной скоростью
- 9) перпендикулярный (по направлению) к
- 10) на препятствии

**10. Find what word is suitable in all three sentences:**

A 1 What temperature is required for mercury to become \_\_\_\_\_?

2 Even though I had a(n) \_\_\_\_\_ meal for dinner, by 5 o'clock I was hungry again.

3 Unfortunately, there are \_\_\_\_\_ grounds to stop the work of this laboratory. It seems not to meet safety requirements.

B 1 He is in \_\_\_\_\_ of the project being carried out.

2 Rent cars are convenient for travelers, the only two things you need are an ID and to pay car hire \_\_\_\_\_.

3 The Earth's surface is known to have a negative \_\_\_\_\_.

C 1 The company's production \_\_\_\_\_ has increased in the last 1.5 years.

2 How do you know an atomic \_\_\_\_\_ of a chemical element?

3 Never mind that she's sitting silently, look at her face — it speaks \_\_\_\_\_.

**11. Write a sentence with a set of words:**

a) contradictory, entity, wave;

- b) distinct, solid, seemingly;
- c) predict, evidence, proper;

**12. Which topics are not discussed in the text:**

- a) the definition of light
- b) properties of a wave
- c) properties of a particle
- d) the reason of particle-wave dualism of light
- e) the proof of particle-wave dualism of light
- f) the distinction between a wave and a particle
- g) the double slit experiment

**13. Formulate the main idea 1) of the whole text; 2) of each paragraph.**

**14. Answer the questions:**

- 1) What problem did light pose?
- 2) What became necessary to explain the behaviour of objects on the smallest scale?
- 3) What is a particle from classical point of view?
- 4) How is the motion of a classical particle governed?
- 5) What is a wave from classical point of view?
- 6) What do Maxwell's equations predict?
- 7) What is light eventually? How is it proved?
- 8) How such contradictory properties as a wave and a particle can be reconciled?

**15. Match beginnings and endings of the sentences:**

- |   |  |
|---|--|
| 1) The details of the photoelectric effect were in direct | a) no matter what the intensity.   |
| 2) Increasing the intensity of the light increased        | b) proportional to the frequency of the illuminating light.                    |
| 3) Red light will not cause the ejection of electrons,    | c) contradiction to the expectations of very well developed classical physics. |

- |   |   |
|---|---|
| 4) A weak violet light will eject only a few electrons, but their maximum kinetic energies                | d) you will find that their DeBroglie wavelengths are ridiculously small.                           |
| 5) The electrons were emitted immediately -   | e) the circumference of an electron orbit in such a way as to experience constructive interference. |
| 6) Analysis of data from the photoelectric experiment showed that the energy of the ejected electrons was | f) no time lag.   |
| 7) So it might be implied that there must be a particle treatment of refraction of light,                 | g) the number of photoelectrons, but not their maximum kinetic energy.                              |
| 8) In the Bohr model of atomic energy levels, the electron waves can be visualized as "wrapping around"   | h) to the transmission plane is selectively absorbed.   |
| 9) If you explore the wavelength values for ordinary macroscopic objects like baseballs,                  | i) are greater than those for intense light of longer wavelengths.                                  |
| 10) In dichroic materials like polaroid, the component of the field perpendicular                         | j) but for ordinary optics the wave view of light is the practical approach.                        |

**16. Read the following text carefully and fill in the gaps (you should use only one word in each gap):**

Here are some more details on the ways each classical model fails for light:

1. Light is not a (1)\_\_\_\_\_ wave. For example, consider the photoelectric (2)\_\_\_\_\_ using a "dust cathode." When light of low intensity is shown on fine metallic dust, photo-electrons start coming off immediately, whereas wave (3)\_\_\_\_\_ predicts that a long time must elapse before a dust particle can collect (4)\_\_\_\_\_ energy over its area from a wave to emit a photo-electron.

2. Light is not a (5)\_\_\_\_\_ particle. That is, the photon cannot be thought of as having a straight-line (6)\_\_\_\_\_ of infinitesimal width. Experiments designed to establish which part of the slit opening a given (7)\_\_\_\_\_ crossed (for example by having a second, narrower slit will cause a further diffraction or other disturbance of the photon and no definite path can be established. It is most correct to (8)\_\_\_\_\_ of photons only at their instant of creation or destruction, and to consider light to (9)\_\_\_\_\_ a probability wave in between these times, although in the geometrical limit (resolution of the path is less than  $\sqrt{L\lambda}$ ) an approximate trajectory can be assigned to the light wave, as though it were a (10)\_\_\_\_\_.

**WRITING**

**17. Write a scientific definition of a photon taking into consideration its wave-particle duality.**

## SPEAKING

### 18. Search for necessary information and prepare for oral reports:

- a) the double slit experiment;
- b) light is a particle — history of discovery;
- c) light is a wave — history of discovery;
- d) the ‘measurement problem’ of quantum physics.

### 19. Extended discussion:

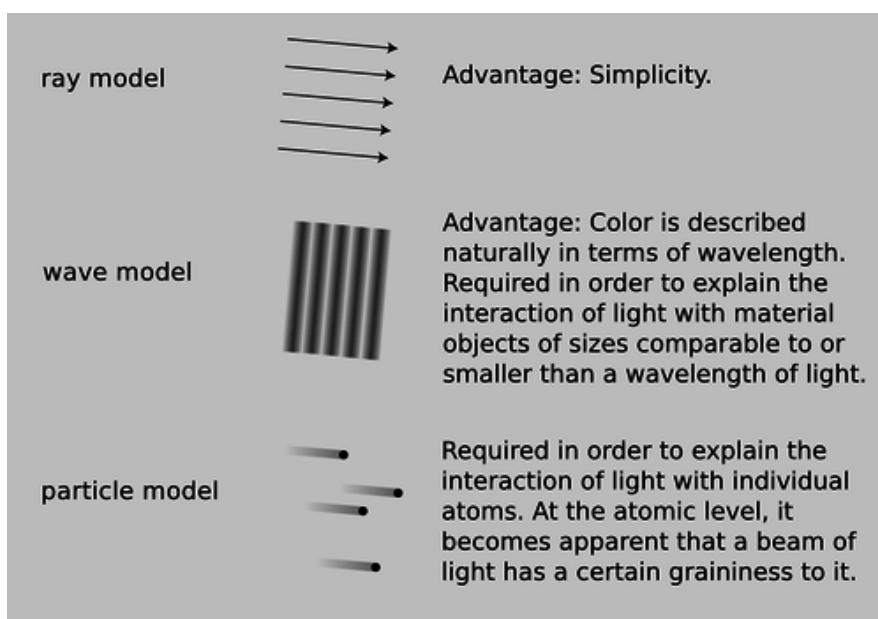
Apart from models of light described in the article some scientists also mention **a ray model of light**.

A light ray will be reflected from a smooth surface in such a manner that the angle incident ray makes normal to the reflecting surface at the point of incidence which is precisely equal to the angle that the reflected ray makes with normal. Also, the reflected ray along with the incident ray and the normal to the reflecting surface all lie on the same plane defined at the incident point.

The optical ability of humans and other animals is the consequence of the complex interaction of light, eyes and brain. People are able to see because light from an object can move through space and influence our eyes. When light reaches our eyes, signals are sent to our gray matter, and our brain deciphers the information in order to perceive the appearance, location and movement of the objects we are looking at. If a ray of light could be witnessed approaching and reflecting off of a flat mirror, then the manner of the lights reflection would follow a predictable law known as the law of reflection.

The ray model is extremely useful while studying reflection of light, refraction of light and various images created by lenses, spherical mirrors and plane mirrors.

How can all three models be used at the same time? Why do they not exclude each other? What are their applications? Discuss in small groups, then summarize your ideas and present to the whole class as a short statement.



## 20. Challenge questions — test yourself!

1) Which of the following is true about light?

- I) It is an electromagnetic wave
- II) It does not propagate in vacuum
- III) Its maximum speed is approximately  $3 \times 10^8$  m/s

- A) I only
- B) I and II only
- C) I and III only
- D) III only
- E) I, II and III

2) The speed of light in a certain material is 50% of its speed in vacuum. What is the refractive index of this material?

- A) 1.5
- B) 0.5
- C) 6.0
- D) 2.0
- E)  $1.5 \times 10^8$

3) What is the critical angle  $i_c$  at the interface glass-cladding of an optical fiber whose core has a refractive index equal to 1.5 and cladding with a refractive index 1.45?

- A)  $15^\circ$
- B)  $105^\circ$
- C)  $86^\circ$
- D)  $83^\circ$
- E)  $75^\circ$

4) Which of the following is true about light with a single wavelength?

- I) It can be refracted
- II) It cannot be dispersed
- III) It can be reflected

- A) I, II and III
- B) I and II only
- C) II and III only
- D) I and III only
- E) None

## LISTENING

**21. You are going to watch a video named *Is Light a Particle or a Wave?* Before you start, read the next words from this video and make sure you understand their meanings:**

to originate, vision, a probe, intelligence (information), a lightbulb, chalk, a ripple, a still pond



**22. Watch the video and choose if the following statements are true or false:**

- 1) Ancient Greeks gave the first scientific explanation of the phenomenon of light.
- 2) According to ancient Greeks, light originated in our eyes.
- 3) Only 100 years later this idea was disproved.
- 4) Alhazen's theory was good but couldn't explain why it gets dark.
- 5) Newton assumed light to be made of tiny atom-like particles which he called quanta.
- 6) After Newton's death scientists experimentally proved that light isn't made of small atom-like particles.
- 7) Two crossing beams of light interact with each other.
- 8) Interference patterns happen when two waves occupy the same space.
- 9) Particles never make interference patterns unlike waves.
- 10) Light is both a wave and a particle at the same time.

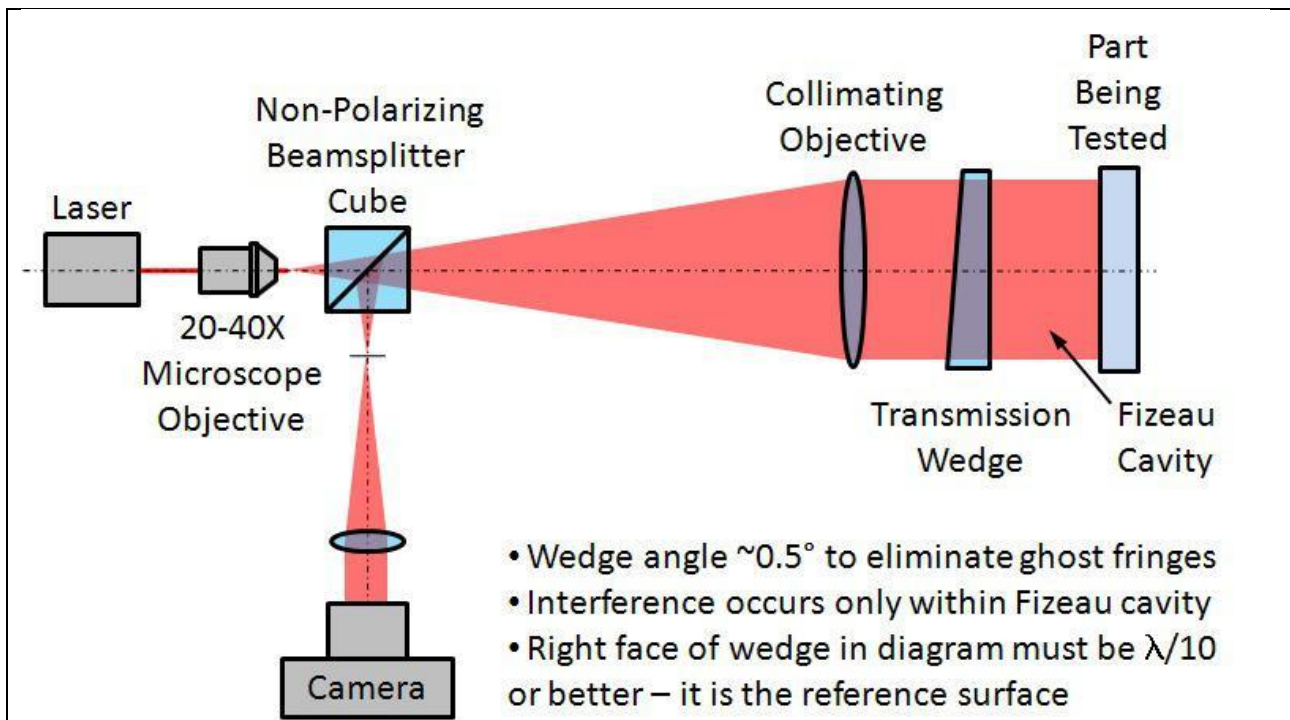
**23. Watch the video once more and complete the tasks:**

- 1) Shortly explain ancient Greeks' theory about light.
- 2) Shortly explain Alhazen's theory: what ideas different from earlier ones did he suggest?
- 3) What was Isaak Newton's theory of light? What was wrong with it?
- 4) Eventually what is light?

**24. DEVICE EXPLANATION**

**Using the facts below and the scheme of the device, explain the work of the interferometer:**

- ✓ its structure;
- ✓ its purpose;
- ✓ how do you use it.



About the device	An interferometer is a really precise scientific instrument designed to measure things with extraordinary accuracy. The basic idea of interferometry involves taking a beam of light (or another type of electromagnetic radiation) and splitting it into two equal halves using what's called a beam-splitter (also called a half-transparent mirror or half-mirror). This is simply a piece of glass whose surface is very thinly coated with silver. If you shine light at it, half the light passes straight through and half of it reflects back—so the beam-splitter is like a cross between an ordinary piece of glass and a mirror.
Working mechanism	One of the beams (known as the reference beam) shines onto a mirror and from there to a screen, camera, or other detector. The other beam shines at or through something you want to measure, onto a second mirror, back through the beam splitter, and onto the same screen. This second beam travels an extra distance (or in some other slightly different way) to the first beam, so it gets slightly out of step (out of phase). When the two light beams meet up at the screen, they overlap and interfere, and the phase difference between them creates a pattern of light and dark areas (in other words, a set of interference fringes). The light areas are places where the two beams have added together (constructively) and become brighter; the dark areas are places where the beams have subtracted from one another (destructively). The exact pattern of interference depends on the different way or the extra distance that one of the beams has traveled. By inspecting and measuring the fringes, you can calculate this with great accuracy—and that gives you an exact measurement of whatever it is you're trying to find.
Tips	<ul style="list-style-type: none"> <li>• Interferometers are widely used in all kinds of scientific and engineering applications for making precise measurements. By scanning interferometers over objects, you can also make very detailed maps of surfaces.</li> </ul>

	<ul style="list-style-type: none"> <li>• Astronomers also use interferometers to combine signals from telescopes so they work in the same way as larger and much more powerful instruments that can penetrate deeper into space.</li> <li>• Interferometry is also helping us to figure out the secrets of gravity.</li> </ul>
Warning	A state-of-the-art interferometer can measure distances to within 1 nanometer (one billionth of a meter, which is about the width of 10 hydrogen atoms), but like any other kind of measurement, it's subject to errors. The biggest source of error is likely to come from changes in the wavelength of the laser light, which depends on the refractive index of the material through which it's traveling. The temperature, pressure, humidity, and concentration of different gases in the air all change its refractive index, altering the wavelength of the laser light passing through it and potentially introducing measurement errors.

## TRANSLATION

### 25. Translate the text from English into Russian:

A misconception which most physicists acquire in their formative years is that the photoelectric effect requires the quantization of the electromagnetic field for its explanation. The following quotation taken from a widely used physics text book' illustrates the point.

"Einstein's photoelectric equation played an enormous part in the development of the modern quantum theory. But in spite of its generality and of the many successful applications that have been made of it in physical theories, the equation  $h\nu = E + \phi$  is, as we shall see presently, based on a concept of radiation - the concept of 'light quanta' - completely at variance with the most fundamental concepts of the classical electromagnetic theory of radiation".

In fact we shall see that the photoelectric effect may be completely explained without invoking the concept of "light quanta". To be sure, certain aspects of nature require quantization of the electromagnetic field for their explanation, for example:

1. Planck distribution law for black body radiation (1900);
2. Compton effect (1926);
3. Spontaneous emission (Dirac, 1927);
4. Electrodynamical level shifts (1947).

The photoelectric effect is definitely not included in the foregoing list. It is an historical accident that the photon concept should have acquired its strongest early support from Einstein's considerations on the photoelectric effect.

### 26. Translate from Russian into English:

Эффект Комптона и фотоэффект подтверждает корпускулярную природу света. Свет ведет себя как поток частиц – фотонов. Тогда как же частица может обнаруживать свойства, присущие классическим волнам? Ведь частица может пройти либо через одну, либо через

другую щель. Однако известна интерференция света от двух щелей (опыт Юнга). Таким образом, мы пришли к парадоксу – свет обладает одновременно и свойствами корпускул, и свойствами волн. Поэтому говорят, что свету свойствен корпускулярно-волновой дуализм.

Противопоставление квантовых и волновых свойств света друг другу является ошибочным. Свойства непрерывности электромагнитного поля световой волны не исключают свойств дискретности, характерных для световых квантов – фотонов. Свет одновременно обладает свойствами непрерывных электромагнитных волн и свойствами дискретных фотонов. Он представляет собой диалектическое единство этих свойств. С уменьшением длины волны все более отчетливо проявляются квантовые свойства света (с этим связано, например, существование красной границы фотоэффекта). Волновые же свойства у коротковолнового излучения проявляются весьма слабо (например, дифракция у рентгеновских лучей). У длинноволнового же излучения квантовые свойства проявляются слабо и основную роль играют волновые свойства.

## PART 3

### Images

*No lens is quick enough to track the movement of the human body.  
The molecules are always moving.  
Roger Rees*

#### LEAD-IN

##### 1. Answer the following questions:

- 1) What is an image?
- 2) How does an image form?
- 3) What is a lens used for?
- 4) How many types of lenses are there? Can you name them all?

#### PRE-READING

##### 2. Match the word with its definition:

- |                      |  |
|----------------------|--|
| 1) a convex lens     | a) the distance from the center of the lens to the point where it focuses light rays                             |
| 2) a concave lens    | b) a type of lenses which surface bulges inwards in the centre   |
| 3) a focal point     | c) an optically formed reproduction of an object   |
| 4) a focal length    | d) a crystalline body whose lateral faces meet at edges that are parallel to each other                          |
| 5) a reflexive index | e) a surface that forms the boundary between two bodies, liquids, or chemical phases                             |
| 6) a prism           | f) a type of lenses which surface bulges outwards in the centre  |
| 7) an image          | g) the place to which rays of light converge or from which they appear to diverge after refraction or reflection |
| 8) an interface      | h) the speed of light in a vacuum divided by the speed of light in the substance in question                     |

## READING

3. Look at the headings from the text *Lenses*. Can you answer any of these questions before reading the text? Try to answer them in pairs.

What are lenses?

How are lenses made?

What are lenses used for?

4. Now read the text and check if your answer is close to its information, then insert the words at the end of this text into spaces (1 - 13):

### Lenses

Microscopes let us peer inside invisible worlds our eyes could never see, telescopes take us far (1)\_\_\_\_\_ the Earth to the stars and planets of the night sky, movie projectors throw enormous images onto screens, and lighthouses cast reassuring beams of light far across the ocean. Amazing curves of glass or plastic called lenses make all these things possible.

What are lenses?

A lens is a transparent piece of glass or plastic with at least one curved surface. It gets its name from the Latin word for "(2)\_\_\_\_\_" (a type of **pulse** used in cooking), but don't let that confuse you. There's no real reason for this other than that the most common kind of lens (called a (3)\_\_\_\_\_ lens) looks very much like a lentil!

How are lenses made?

Until plastics became **common** in the 20th century, (4)\_\_\_\_\_ all lenses were made by **grinding** solid pieces of glass into different shapes. Convex lenses were made by using a (5)\_\_\_\_\_-shaped grinding tool (and vice-versa), and then the **roughly** shaped lens was polished to make its final shape. The ordinary glass we use in windows and **crockery** isn't good enough to use for lenses, (A) \_\_\_\_ it contains air bubbles and other **imperfections**. These cause (6)\_\_\_\_\_ to divert from their correct path, making a **fuzzy** image or one that makes different colors of light behave in different ways (problems that optical scientists refer to as aberrations). (B) \_\_\_\_\_, lenses are made using a more refined material known as optical glass. For eyeglasses, many people now prefer plastic lenses because they're much lighter and safer than optical glass. Plastic lenses can be (7)\_\_\_\_\_ to shape, instead of being ground, (C) \_\_\_\_\_ they can be made in huge quantities far more cheaply than glass lenses. (D) \_\_\_\_\_ ordinary plastic **scratches** easily, it can be (8)\_\_\_\_\_ with a thin layer of a protective material such as diamond-like carbon (DLC) to reduce the risk of damage. Some optical lenses are also coated with thin plastic to reduce annoying reflections.

What are lenses used for?

Lenses are everywhere in the world around us—in everything from car (9)\_\_\_\_\_ and flashlights to the LED lights used in electronic instrument panels.

Our eyes contain probably the most amazing lenses of all. Think what happens when you look at the world around you. One minute you're staring at the ground in front of your feet. Seconds later, you hear an airplane screaming past, turn your head, and watch it fly by. Do this trick with a pair of (10)\_\_\_\_\_ and you'll find it takes you quite a while to adjust the focus from near-sight (looking at the ground) to far (watching the plane). Try it with the naked eye and you won't even notice what you're doing. That's because your eyes have flexible lenses, controlled by tiny muscles, that can bulge in and out, changing shape (11)\_\_\_\_\_ to focus on anything from the prints on your finger to the surface of the Moon. How amazing is that?

We all have lenses in our eyes, but many of us balance extra ones on the end of our noses to correct long and short sight: more glass and plastic lenses are used for eyeglasses and contact lenses than for any other purpose. There are all kinds of eyeglass lenses, including light-sensitive photo-chromic ones that **darken** in sunlight and double-up as sunglasses.

You'll also find lenses in binoculars (which use two or three lenses in each of the cylinders serving your eyes) and telescopes, though not all microscopes use them. Ordinary (optical) microscopes use a (12)\_\_\_\_\_ of glass lenses to **magnify** tiny objects, while super-powerful electron microscopes use electromagnets to bend electron beams that help us see in even more detail. Movie projectors and projection televisions use lenses to convert small movie pictures into giant images that lots of people can view at once. Cameras work the opposite way, catching light rays from a distance and bringing them to focus on chemically **treated** plastic film or light-sensitive electronic chips called CCDs. You can even find lenses built into magazine and book covers to make images change as you shift your head from side to side; this cunning trick is called lenticular printing—but it really just means "printing with (13)\_\_\_\_\_ lenses."

concave  
lenticular  
light rays  
coated  
molded

headlamps  
virtually  
beyond  
convex

binoculars  
instantly  
built-in  
series

**5. Four conjunctions were taken from the paragraph 3 (A – D). Fill in each space with a suitable conjunction, you can use every word only once:**

instead      because      although      so

## POST-READING

### VOCABULARY

**6. Find synonyms for the words in the text (in bold):**

- 1) blurred
- 2) to dim
- 3) unevenly
- 4) to enlarge
- 5) a bean

- 6) plates
- 7) a flaw
- 8) to polish
- 9) to cover
- 10) usual
- 11) to damage

**7. In pairs or small groups define the following words (do not forget to use terms!)**

near-sight, to divert, an aberration, refined, eyeglasses, a flashlight, a LED light, to adjust, a naked eye, to double-up, lenticular

**8. Fill in the gaps:**

**Part A**

to darken to stare to divert to adjust to scratch to mold to magnify to treat to coat
---

- 1) Clearly this was not the cleverest move by the chemical industry to \_\_\_\_\_ attention away from pesticides.
- 2) A rectangle of light dazzles us and, as our eyes \_\_\_\_\_, we see a summer meadow.
- 3) People \_\_\_\_\_ a well-polished piece of glass with amalgam to make its surface reflecting.
- 4) The particular height of the ceiling is said to be able \_\_\_\_\_ the room, so it is advised to buy a house with a high enough ceiling for your living space to be cozy.
- 5) If you've \_\_\_\_\_ at the picture for a few minutes and then abruptly look away, you can see blurred colourful spots disturbing your vision.
- 6) Galileo's telescope was a huge success at that time because it \_\_\_\_\_ distant objects eightfold compared with the spyglass used before.
- 7) Crockery \_\_\_\_\_ by hands is still popular but no more as a mass production.
- 8) If you \_\_\_\_\_ the lens of the camera, I won't just let it go — you will have to buy me a new one.
- 9) Only natural wood, which is not \_\_\_\_\_ with any chemicals, is used in production of goods for children.

**Part B**

beyond common virtually fuzzy instantly roughly refined built-in ordinary
---



- 1) No matter how much he sympathized with their problem, he couldn't help since it was \_\_\_\_\_ his jurisdiction.
- 2) The image was \_\_\_\_\_, so I adjusted binoculars just a little.
- 3) John was a(n) \_\_\_\_\_ laboratory worker and couldn't influence their decision.
- 4) A truly talented person of any background can get access to good education, though it didn't use to be \_\_\_\_\_ just a century or so ago.
- 5) It was believed that we receive an image of something \_\_\_\_\_ until in 1676 Ole Rømer demonstrated that the speed of light was finite.
- 6) Goods baked from \_\_\_\_\_ flour provide us with more starch, stronger gluten and less nutrition.
- 7) There was a belief for a long time that the equinox - when there are \_\_\_\_\_ equal hours of day and night - affects the weather.
- 8) That hot pipe is surrounded by a cover with a(n) \_\_\_\_\_ fan.
- 9) It would have been \_\_\_\_\_ impossible to research all the information.

**9. Change words in brackets so that they are grammatically correct for the sentence:**

- 1) Frank was carrying out fuel-system tests which \_\_\_\_\_ turning the booster pumps off. (necessary)
- 2) Many of the drawbacks previously associated with the use of dry powder \_\_\_\_\_ as an industrial finish have been eliminated. (coat)
- 3) A ten-fold increase in dietary selenium causes a \_\_\_\_\_ of this enzyme in the body. (double)
- 4) The book presents the latest research findings in wastewater \_\_\_\_\_ and runoff control that are ideal for academics and senior consultants. (treat)
- 5) With the increasing awareness of food safety and quality, consumers continuously demand the \_\_\_\_\_ of origin and content of their foods. (sure)
- 6) This technology may become a long \_\_\_\_\_ solution for the problem of experimentally test the assumptions which have been purely theoretical. (due)
- 7) Mark said his new computer is actually \_\_\_\_\_ parts of old computers of his brothers. (assemble)
- 8) At the moment computer chips have to be wired together into a \_\_\_\_\_ board. (circuit)
- 9) That includes reading the instruction for novice \_\_\_\_\_ receiving on-the-job training. (optics)

**10. Choose the best explanation for the following phrases from the text (only one answer is correct):**

- 1) screaming past
  - a) moving closer b) moving quickly nearby c) moving nearby with a loud sound
- 2) with the naked eye
  - a) without equipment b) without protective goggles c) clearly
- 3) to bend electron beams
  - a) to shape electron beams b) to change electron beams c) to change tracks of electron beams
- 4) this cunning trick
  - a) this way of deception b) this clever idea c) this productive method

**11. Find what word is suitable in all three sentences:**

A 1 It's important to \_\_\_\_\_ everybody with politeness — you don't know what another's situation might be like.

2 They \_\_\_\_\_ potato with pesticides to exterminate insects.

3 The research of the methods of \_\_\_\_\_ cancer is being held.

B 1 The switch works by passing a \_\_\_\_\_ of current between the pole and the surface.

2 Vegetarians substitute lack of proteins usually received from meat by eating different kinds of \_\_\_\_\_.

3 She could feel the \_\_\_\_\_ of a headache between her brows.

C 1 Ancient Egyptians are believed to have lightened some halls using \_\_\_\_\_ of meticulously placed mirrors.

2 Infinite \_\_\_\_\_ are widely used in mathematics, physics and other sciences.

3 That new comedy \_\_\_\_\_ is rather promising.

**12. Write a sentence with a set of words:**

- a) common, treat, instead
- b) fuzzy, so, eyeglass
- c) LED light, instantly, beam

**13. Which is the main idea of the text:**

- a) A lens is a piece of glass or plastic which is made by giving a certain shape to ordinary glass and widely used in various devices.
- b) Lenses allowed people to cross the boundaries of their known world.

c) Lenses can be used in a vast variety of different types of equipment — from flashlights and book covers to binoculars and microscopes.

**14. Choose if the following statements are true or false:**

- 1) A lens can be made of glass, plastic and other materials.
- 2) Since plastic lenses are easily damaged, they are covered with a layer of a protective substance.
- 3) Lenses are used in lighthouses.
- 4) Human eyes adjust much quicker than the most of optical devices.
- 5) Lenses are used in all kinds of binoculars, microscopes and telescopes.
- 6) Our eyes can see so well because there are flexible lenses in them.
- 7) Movie projectors catch light rays from a distance and focus them on a screen.

**15. Answer the questions:**

- 1) When did plastic appear as a material for lenses? How were lenses made before that time?
- 2) Why isn't usual glass good enough for the lens production?
- 3) What is DLC? What is its purpose?
- 4) What eyeglasses are mentioned in the text?
- 5) How do movie projectors and cameras work?

**16. Fill in the spaces with suitable words. You can use only one word in one space:**

How do you measure the power of a lens?

You'll find (1) \_\_\_\_\_ lengths written either in (2) \_\_\_\_\_ units of length (such as centimeters, millimeters, or inches) or in special optical (3) \_\_\_\_\_ called diopters. The diopter measurement of a (4) \_\_\_\_\_ is the reciprocal of the focal length in meters (one divided (5) \_\_\_\_\_ the focal length), so 1 diopter = 1 m, 2 diopters = 0.5 m, 3 diopters = 0.33 meters, and (6) \_\_\_\_\_ on. Eyeglass prescriptions from opticians typically show the strength of the corrective lenses you need (7) \_\_\_\_\_ diopters.

The (8) \_\_\_\_\_ length isn't the only important (9) \_\_\_\_\_ of a lens. Bigger lenses gather more light than smaller (10) \_\_\_\_\_, so they make a brighter image. This is particularly important if you're choosing a lens for (11) \_\_\_\_\_ camera, because the (12) \_\_\_\_\_ of light the lens gathers will determine what the image looks like. Camera lenses are usually rated with a measurement called the f-number, which is the focal length divided (13) \_\_\_\_\_ the diameter. Generally speaking, lenses with a small f-number make brighter images. Lenses with a higher f-number have a bigger depth of focus: essentially, more of the object you're (14) \_\_\_\_\_ and its surroundings are in focus (15) \_\_\_\_\_ the same time.

## WRITING

17. Write an article 'The role of the image recording / transmission / generation / analyzing in modern science.' Choose only one word for the title of your article. Instead of the word "important" use its synonyms.

Do not overuse the word "important." It has an abundance of synonyms. On the right you can see only some of them:

- significant
- crucial
- relevant
- momentous
- considerable
- influential
- critical
- of (high) importance
- vital
- essential
- paramount
- major

## SPEAKING

### 18. Extended discussion questions:

- 1) Can you explain how a mirror works?
- 2) Why do glasses help people with bad eyesight?
- 3) What happens if two mirrors are set in front of each other?
- 4) Can the shape of a mirror (rectangular, round, oval, elongated, zigzag) influence the image formed inside?

### 19. Search for necessary information and prepare for short oral reports:

- a) how is a hologram formed?
- b) the lens production — in past and nowadays;
- c) the history of a mirror;
- d) the principle of work of a magnifying glass.

### 20. Challenge questions — test yourself!

- a) Why are lenses always round in shape?
- b) Why do we see virtually inverted image on concave side of a spoon?
- c) Why don't we see inverted image while wearing spectacles?
- d) How to check whether the telescope is properly collimated?
- e) Why can't we see images reflected on a piece of paper?
- f) Can we see stars in day time by making use of a blue notch-filter?
- g) How do we distinguish virtual images?
- h) If white coloured light falls on an object, colours of certain wavelengths are absorbed and colours of certain wavelengths are reflected. We see the object's colour as the reflected colour. Then what happens to the absorbed colour on an object?

- i) What are the differences between Convex Lens and Convex Mirrors?
- j) Where would interfering rays of light produce an image?
- k) What would happen if light was completely blocked from an object?
- l) Is it possible to calculate the distance to a rainbow by using the parallax method?

## LISTENING

**21. You will watch a video explaining how an image forms by lenses. Before watching the video, find and explain the meaning of two words:**

- converge
- diverge

**22. Fill in the gaps below with the information from the video:**

If you look at this image on the left, you have a \_\_\_\_\_ lens, we're looking at a pine tree. Yet in that lens the pine tree looks \_\_\_\_\_ and \_\_\_\_\_.

Reversely, if we look on the right, we have the same \_\_\_\_\_ lens as we're trying to read a book. Yet that print looks \_\_\_\_\_ and \_\_\_\_\_.

They look very similar for lenses except we just have to interpret them a little differently because light doesn't \_\_\_\_\_ by a lens, it \_\_\_\_\_ a lens.

Since light rays \_\_\_\_\_ and bend, Snell's law will tell us that these light rays, \_\_\_\_\_ to the focus and through the center, will behave \_\_\_\_\_.

Next let's put the object inside the focus. So we draw a \_\_\_\_\_ again. I move my \_\_\_\_\_ point a little further away.

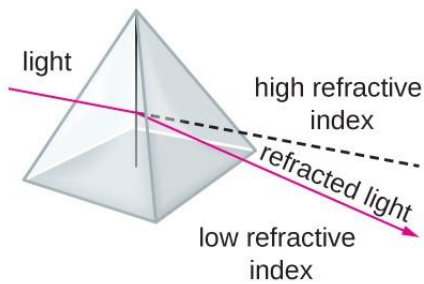
There rays don't meet. They're diverging and spreading \_\_\_\_\_. So we want to \_\_\_\_\_ those \_\_\_\_\_ rays \_\_\_\_\_ the mirror (lens).

**23. Watch the video once again and answer the questions:**

- a) What are rules for ray diagrams for lenses?
- b) How is the formation of an image by lenses different from that of mirrors?
- c) What is a real image? How does it form?
- d) What is a virtual image? How does it form?

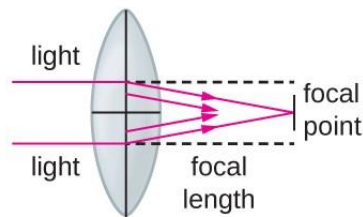
## 24. GRAPH DESCRIPTION

Describe the following graphs:



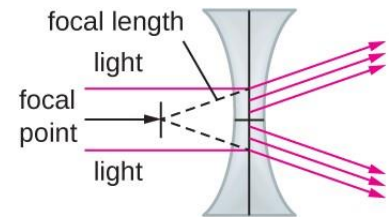
Prism

(a)



Convex lens

(b)



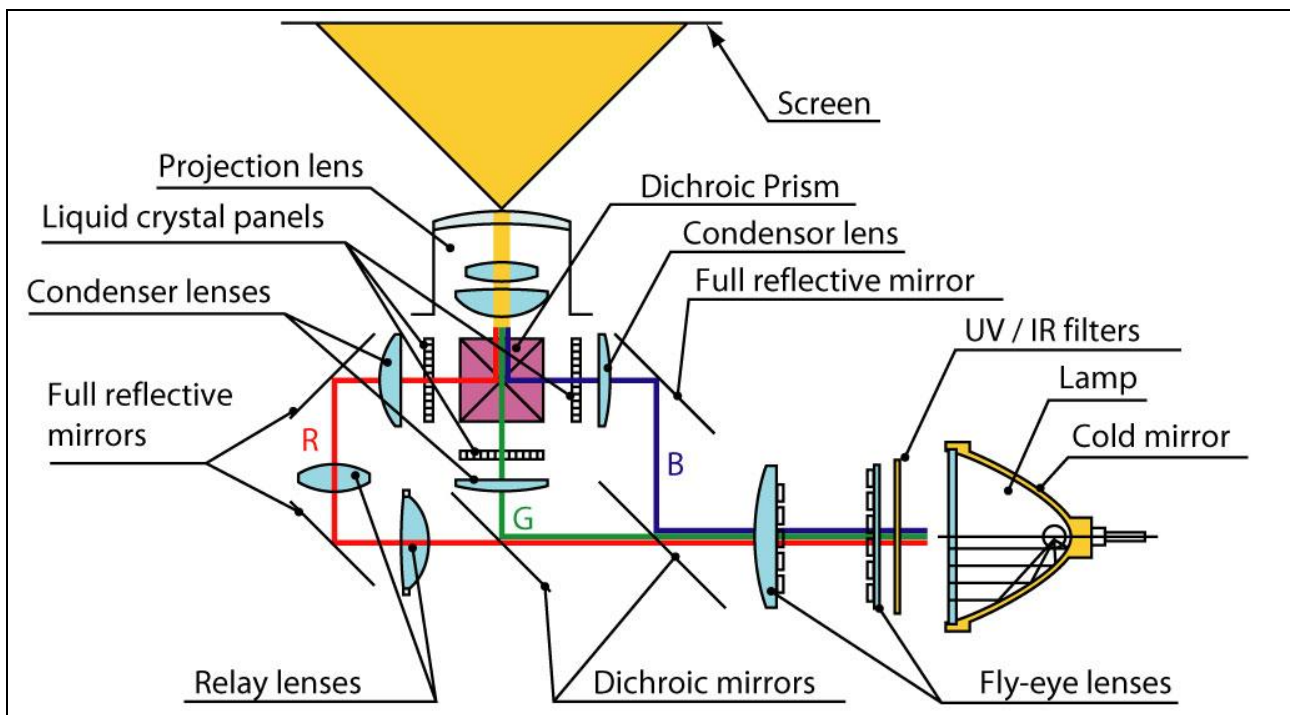
Concave lens

(c)

## 25. DEVICE EXPLANATION

Using the facts below and the scheme of the device, explain the work of the projector:

- ✓ its structure;
- ✓ its purpose;
- ✓ how do you use it.



About the device

Projectors help to improve the viewing experience of movies, but their utility doesn't stop at movie theatre. Projectors are also used in board rooms, conferences, classrooms, and many other places to improve the overall user experience.

The new kind that replaced LCD projectors is DLP projectors. DLP technology is based on a microchip known as the digital micromirror

	device or DMD. A DMD is a chip that contains close to two million tiny mirrors in a square grid.
Working mechanism	<p>An electronic circuit is also present, which helps in deciding the orientation of each mirror. A bright source of light is then shined on the DMD and the electronic circuit individually tilts each mirror back and forth. If a mirror is tilted towards the lamp, it shines the light towards the screen. This one mirror is representative of one pixel. If a mirror is tilted away from the source of light, it cannot reflect the bright source of light, thereby leaving the screen space empty or dark.</p> <p>Each mirror works individually, and the two million mirrors go on to build a high-resolution image. But how is the color formed, you may ask? To add color to the images, the DLP uses an extra bit of technology that consists of a colored wheel placed in the path of the light reflected by the mirrors of the DMD. The wheel consists of the colors red, blue and green. The combination of these colors when bounced onto the mirror and merged gives rise to an endless variety of colors in high definition. Finally, a lens collects all the beams of light to produce the final image.</p>
Tips	Being light-source agnostic, DLP technology can effectively use a variety of light sources. Typically, the main DLP light source is a replaceable high-pressure xenon arc lamp unit. Alternatively, ultra-small or pico DLP projectors use high-power LEDs or lasers.
Warning	<ul style="list-style-type: none"> <li>• The Rainbow effect: Looking away from a projected image on older DLP or from one side of a screen may have “rainbow” effect, or moment of rainbow-colored stripes around brighter objects.</li> <li>• Light leakage: Grey band outside of the image can cause stray light reflecting off the edges of the mirrors on DLP chip. This can be avoided by installing black borders around the older DLP projector screen.</li> </ul>

## TRANSLATION

### 26. Translate from English into Russian

#### The Evolution of the Camera

Photography history and the evolution of the camera as we know them today is kind of similar to that in the sense that the very first versions of the camera, although considered ingenious in their time, had been very crude instruments of photography compared to the advanced and even smart cameras that people have today.

The very first “camera” was the camera obscura or the pinhole camera. This device in the timeline of photography history is said to date back to the ancient Greeks and the ancient Chinese. The device makes use of a pinhole to project the image but the resulting projection was upside down. It is

said that Alhazen or Ibn Al-Haytham, a great authority in the field of optics, was later on known in photography history as the one who created the pinhole camera in 1000 AD.

In the earliest days of photography history, the camera obscura was used for watching solar eclipses, most notably done by Reiners Gemma Frisius from the Leuven University in 1544. Giovanni Batista della Porta recommended using this device as an aid for scientific drawings in 1544. It was in 1685 when Johann Zahn envisioned the first small and portable camera which is closer to the smaller gadgets known today. Although crude, the camera obscura which was the first device in the history of the camera that showed the first signs of the makings of a more advanced device which would lead to the development of cameras as we know them today.

## **27. Translate from Russian into English:**

**ИЗОБРАЖЕНИЕ ОПТИЧЕСКОЕ** — изображение объекта, получаемое в результате действия оптической системы на световые лучи, испускаемые или отражаемые объектом. Оптическое изображение воспроизводит контуры и детали объекта с некоторыми искажениями (абберациями оптических систем); различают действительные и мнимые оптические изображения.

Действительное изображение создается, когда после всех отражений и преломлений лучи, вышедшие из одной точки предмета, собираются в одну точку на поверхности проекции. Действительное изображение создается такими оптическими системами, как объектив (кинопроектора, фотоаппарата) или одна положительная линза.

У мнимого изображения каждой точке предмета соответствует выходящий из оптической системы пучок лучей, которые, если продолжить их обратно прямыми линиями, сошлись бы в одной точке.

Мнимое изображение создается такими оптическими системами, как бинокль, микроскоп, лупа, а также плоское зеркало. Во всякой реальной оптической системе неизбежно присутствуют абберации, в результате чего лучи (или их продолжения) не сходятся идеально в одной точке. Изображение получается несколько размытым и геометрически не полностью подобным предмету.



## PART 4

### Optical Equipment

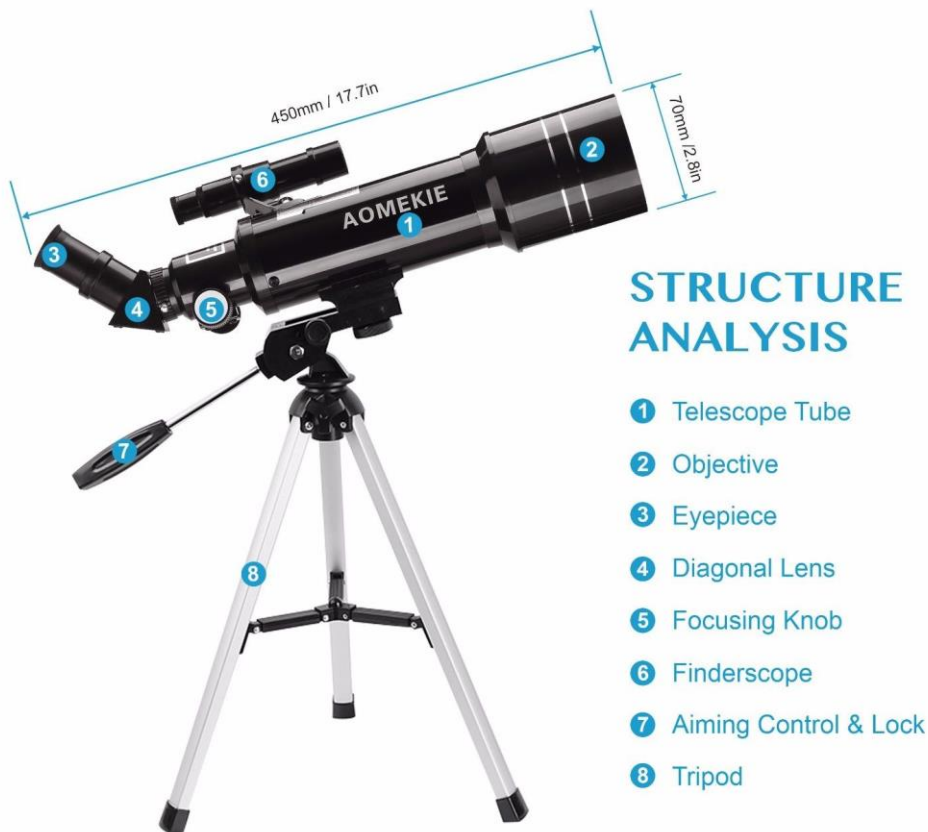
*"The history of astronomy is a history of receding horizons."  
Edwin Powell Hubble*

#### LEAD-IN

1. Recall what equipment includes lenses. Write as many names of devices as you can in one minute. When one minute has passed compare your list with your partner's one.

#### PRE-READING

2. Look at the structure of an ordinary optical telescope. Can you translate all names of its parts into Russian? Have you ever used one yourself? What did you use it for if you have?



#### READING

3. Read the whole text and fill in the spaces (\_\_\_\_) in it with the words after the text:

## A \_\_\_\_\_

The first European that ever visited the International Space Station, Italian astrophysicist Umberto Guidoni, once stated that “I was, I remember, I still remember when the first time I pointed the telescope at the sky and I saw Saturn with the rings. It was a beautiful image.” Observing the skies with the help of a telescope can be a (1\_\_\_\_\_-)changing experience with more benefits than you could ever imagine. Learn more about [...] a telescope **below** and gather all of the information you need to make your experience completely (2\_\_\_\_\_).

## B \_\_\_\_\_

The fascinating observation instrument we now call a telescope has an equally **compelling** history. While we know, for a fact, that the telescope was discovered at the beginning of the 17<sup>th</sup> century, there are quite a few different (3\_\_\_\_\_) **regarding** its invention. Several men stated that they had invented the telescope, such as Zacharias Janssen, but the American Institute of Physics explains that in the Netherlands, in 1608, “the government found the device [telescope] too easy to copy and did not award a patent, but it voted a small award to Jacob Metius and employed Hans Lipperhey to make several binocular versions, for which he was well paid.”

Some of the most significant (4\_\_\_\_\_) to the development of the telescope are Galileo Galilei, Johannes Kepler or Isaac Newton, just to name a few. Galileo is (5\_\_\_\_\_) as the first man to use a telescope for observing the skies. Space.com informs us that “he was able to make out mountains and craters on the moon, as well as a ribbon of **diffuse** light arching across the sky – the Milky Way. He also discovered the sun had sunspots, and Jupiter had its own set of moons”.

(6\_\_\_\_\_) , telescopes come in so many shapes and sizes that the variety available truly is overwhelming.

## C \_\_\_\_\_

The parts of a telescope (7\_\_\_\_\_), depending on what type of telescope you are interested in. Refracting telescopes, for example, mainly come with the following parts: **aperture**, focuser, **finder scope**, eyepiece, optical tube and **mount**. If we were to get into details, refracting telescopes also contain dew **shields**, **cradles**, eyepiece holders, star diagonals, focusing **knobs**, declination setting scales, azimuth **clamps**, altitude clamps, right **ascension** setting scales, forks, (8\_\_\_\_\_) fine **adjustments**, azimuth fine adjustments, **counterweights**, **tripods** and tripod accessories **shelves**.

Reflecting telescopes, on the other hand, are a lot easier to handle and are favorites for amateur astronomers. They basically come with a flat mirror, a parabolic mirror and a convex lens at the eyepiece, as NASA explains on their official website. In the end, “Today’s reflectors are beyond anything Newton could have dreamed of, but their parts are the same he designed centuries ago—a (9\_\_\_\_\_) mirror and a secondary mirror to (10\_\_\_\_\_) the light”.

## D \_\_\_\_\_

Just like lenses in the (11\_\_\_\_\_) of photography, telescope eyepieces are highly (12\_\_\_\_\_), fit for every kind of needs and wallets. Individuals who want to have a truly unique observing experience can **opt** for certain eyepieces, in addition to the **plain** one that came with their telescope. It is said that a high quality eyepiece can make you feel like you have a (13\_\_\_\_\_) telescope altogether.

Telescope eyepieces vary, depending on a series of factors. First of all, the focal length and (14\_\_\_\_) of your eyepiece is an aspect you should take into consideration. To see what magnification your telescope has, all you have to do is divide the focal length of your telescope by the focal length of your eyepiece. The result will be the power your telescope has of magnifying.

Moreover, telescope eyepieces come in various sizes. Most of the ones on the market have a 1 ¼ **inch** diameter, but they can reach a 2 inch diameter, depending on the model. When it comes to types of eyepieces, you can (15\_\_\_\_) a large number of names, from Erfle or Kellner to Ultrawide or Lanthanum. Like we said before, telescope eyepieces can go from (16\_\_\_\_) to expensive, depending on what budget and requirements you have.

credited	perspective	contributors
claims	unforgettable	vary
accessible	nowadays	redirect
altitude	diverse	brand new
primary	field	magnification
coma across		

#### 4. Write suitable headlines in gaps (A, B, C, D) for all parts of the text.

Hint: write all headlines except for the first — the title. It is better to write and translate titles after finishing reading the whole text.

### POST-READING

#### VOCABULARY

#### 5. Explain the phrases underlined in the text with simpler words.

#### 6. Find words in the text (in bold) which fit the following definitions:

- 1) a cover protecting an object from the outside damage;
- 2) a device which holds parts of a construction in one place;
- 3) a flat piece of material attached to the wall or to the sides of a cupboard;
- 4) a measurement unit;
- 5) located under something or at a lower level;
- 6) a device, typically a small auxiliary telescope mounted on the main astronomical telescope along the same line of sight and used to aim the main telescope;
- 7) a support onto which something is fixed;
- 8) moving up;
- 9) irresistibly or keenly interesting;
- 10) to choose something in preference to anything else;
- 11) a part of a construction which purpose is balancing the system;

- 12) on the subject of, about something;
- 13) a stand with three legs that is used to support something such as a camera or a telescope;
- 14) a narrow hole or gap;
- 15) regulation;
- 16) spread across a large area;
- 17) simple, ordinary;
- 18) a frame, rest, or trolley made to support or transport a piece of equipment;
- 19) a round switch on a piece of machinery or equipment.

## 7. Fill in the gaps:

### Part A

to redirect   to diffuse   to claim   to vary   to opt   to come across   to credit   to depend
---

- 1) While studying the movement of pollen on the surface of water, scientists \_\_\_\_\_ a problem they could not credibly explain.
- 2) It is believed that Russian science \_\_\_\_\_ for theoretical rather than experimental approach. I wonder how true it is.
- 3) Sometimes definitions of the same term \_\_\_\_\_ from a source to a source lacking unanimousness.
- 4) We still \_\_\_\_\_ his recent article on spectral analysis despite some critical reviews it has received.
- 5) It is strongly recommended not to \_\_\_\_\_ too much on the opinion of an authority even in science. History shows us that even the brightest can make a mistake.
- 6) The secondary mirror reflects and thus \_\_\_\_\_ a beam of light to the receiver.
- 7) The drop of blue dye \_\_\_\_\_ in the water.
- 8) Researchers \_\_\_\_\_ to have developed a new type of a telescope.

### Part B

plain   inaccessible   diverse   primary   compelling   brand new   below   nowadays
--

- 1) It's possible to observe planets of the Solar System with the use of a(n) \_\_\_\_\_ optical telescope.
- 2) Although methods of study are \_\_\_\_\_, only few can be used in this particular type of research, so consult your scientific advisor before starting to work.
- 3) Temperatures \_\_\_\_\_ 214°C are required for nitrogen to crystalize.

- 4) \_\_\_\_\_ different observatories collaborate to get more precise data on the most distant objects in the universe.
- 5) No matter how developed and precise our equipment is, some data remain \_\_\_\_\_.
- 6) The facilities in the laboratory are \_\_\_\_\_ which enables us to research nature of light on the smallest scale.
- 7) Businesses and consumers say the smartphone has become the \_\_\_\_\_ device they use to access the internet.
- 8) Many astrophysicists consider dark matter to be a(n) \_\_\_\_\_ object of study. More and more choose it as a topic of their scientific research.

**8. Find what word is suitable in all three sentences:**

- A 1 The volume \_\_\_\_\_ is located at the rear of the speaker.
- 2 The sign 'Do not disturb' is placed on the \_\_\_\_\_ of the door outside your room if you don't want anyone to enter or knock.
- 3 Turn the \_\_\_\_\_ in a counter-clockwise direction to make lights brighter.
- 
- B 1 I can't switch on the TV, could you look if the \_\_\_\_\_ is in the socket?
- 2 All gardening tools were piled in the corner. It took me half an hour to find a \_\_\_\_\_ there before I could even start digging.
- 3 When his right arm was healing, he learned to eat holding a \_\_\_\_\_ in his left hand.
- 
- C 1 In the course of the first space travel people were able to see the Earth from a \_\_\_\_\_ they've never had before.
- 2 Consider studying the problem from a different \_\_\_\_\_. It may improve your work.
- 3 The road seems to go up when it becomes more distant because of the phenomenon of the \_\_\_\_\_.

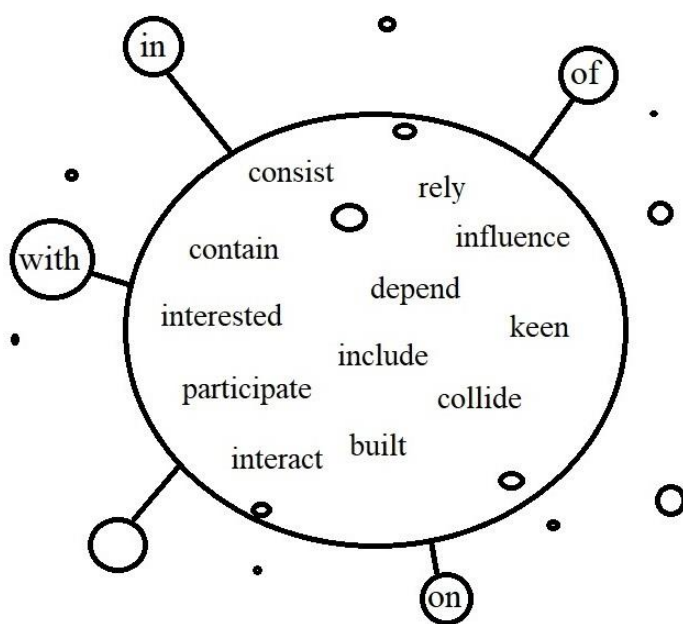
**9. Write a sentence with a set of words:**

- a) unforgettable, altitude, variety
- b) tripod, claim, below
- c) magnifying, come across, depend on

**10. Change words in brackets so that they are grammatically correct for the sentence:**

- 1) Equally \_\_\_\_\_ (mark) was the invention of the light microscope: an instrument that \_\_\_\_\_ (able) the human eye, by means of a lens or combinations of lenses, to observe \_\_\_\_\_ (large) images of tiny objects.
- 2) Other light properties, such as \_\_\_\_\_ (intense) and \_\_\_\_\_ (polarize), can also be used to \_\_\_\_\_ (class) specific light waves.
- 3) The ideal \_\_\_\_\_ (spectrum) response is limited at long wavelengths by the \_\_\_\_\_ (able) of the \_\_\_\_\_ (conduct) to absorb photons with energies below the band gap.
- 4) Series resistance in a solar cell has three causes: \_\_\_\_\_ (first), the \_\_\_\_\_ (move) of current through the \_\_\_\_\_ (emit) and base of the solar cell; \_\_\_\_\_ (second), the contact resistance between the \_\_\_\_\_ (metal) contact and the silicon; and \_\_\_\_\_ (final) the resistance of the top and rear metal contacts.
- 5) Schematic \_\_\_\_\_ (present) of \_\_\_\_\_ (approximate) used in detailed balance. On the left image light is collected from the entire hemisphere which corresponds to maximum \_\_\_\_\_ (concentrate).

**11. Match each verb with a correct preposition:**



**12. Read the following statements and say if they are true or false:**

- 1) Umberto Guidoni was the first who ever saw Saturn with the rings through a telescope.
- 2) The telescope was invented in the 17<sup>th</sup> century.
- 3) It is not known for sure who invented it.
- 4) Jacob Metius got a substantial award for the invention of telescope by government.
- 5) Galileo is considered to be the first who ever put the telescope into use.

- 6) The parts of a telescope are common despite its type.
- 7) Reflecting telescopes are much easier to handle than refracting ones.
- 8) Lenses for the telescope have a 1 ¼ inch diameter.
- 9) Telescope eyepieces differ from each other which reasons are magnification and the focal length.
- 10) Lenses for the telescope are expensive no matter their purpose.

### 13. Answer the questions:

- 1) Who invented the telescope?
- 2) Why did government of the Netherlands not award a patent for the telescope in 1608?
- 3) What types of the telescope are mentioned in the article? How do they differ in construction?
- 4) What does the choice of telescope eyepieces depend on?
- 5) What is said about sizes and types of telescope eyepieces? Give some examples.

### 14. Complete the phrases with your own ideas:

- 1) Observing the skies through a telescope can be perspective changing because \_\_\_\_\_  
\_\_\_\_\_
- 2) If you are an amateur astronomer, it is better to \_\_\_\_\_  
\_\_\_\_\_
- 3) To see what magnification your telescope has, \_\_\_\_\_  
\_\_\_\_\_

### 15. Match beginnings and endings of the sentences:

- |  |  |
|--|--|
| 1) At the interface of the liquid and prism, some of the light is reflected  | a) between two different media, for example a liquid solution and air.                                 |
| 2) Refractometers work because light travels at different velocities in different mediums,   | b) the light beam is bent at the interface between two adjoining materials.                            |
| 3) Air has a refractive index of 1.000293, water's Refractive Index is 1.33298 at 20C, and benzene's is 1.501,   | c) so light passing through higher-temperature samples encounter fewer solute (and solvent) molecules. |
| 4) Refractive Index is based on Snell's Law, which describes the relationship between the angle of incidence and the angle of diffraction for light hitting the boundary | d) back into the refractometer's probe, and some is refracted out into the liquid.                     |

- |   |  |
|---|--|
| 5) Refractive Index is a unique, constant physical characteristic of pure substances, | e) applied to the sample, and the sample temperature.  |
| 6) Refractometry measurements strongly depend on the wavelength of light              | f) while the Refractive Index of the anesthetic Sevoflurane ranges from 1.2745 to 1.2760.                            |
| 7) Liquids and solutions become less dense at higher temperatures,                    | g) such as lemon oil, but its most common use is for calculating the concentration of dissolved substances in water. |

**16. Choose the correct word for each space (only one word is possible):**

### General Tips on How to Use Telescopes

If you truly want to make the (1) \_\_\_\_\_ out of your telescope and what it can offer, you should consider a few aspects beforehand. (2) \_\_\_\_\_ all, one of the decisive factors regarding visibility is the light (3) \_\_\_\_\_ in your area. For example, if the region you live in is rainy and you want to observe the skies when it's dark, you should look into refractors. After that, decide on the main purpose for using your telescope. Do you want to know how to use my telescope for bird watching? How are telescopes used for star (4) \_\_\_\_\_ or observing planets? Once you have your purpose (5) \_\_\_\_\_, you will know if the telescope you need to reach your (6) \_\_\_\_\_ requires higher or lower power. For (7) \_\_\_\_\_, for galaxy observation, you will require a large reflecting telescope with a larger (8) \_\_\_\_\_ than a normal one. You also have to analyze what power your telescope has, or how bright or (9) \_\_\_\_\_ your observation will be.

One of the most important pieces of a telescope is the finder scope, which can usually be found on the side. (10) \_\_\_\_\_, understand the difference between altazimuth and equatorial mounts. The easy version is the altazimuth, which allows you to move the telescope left, right, up and down. An equatorial mount, (11) \_\_\_\_\_ the other hand, works by East to West and North to South and implies (12) \_\_\_\_\_ to the North Star to work. You should always make sure that you set your telescope on a flat surface, with all three feet of the tripod firmly placed on the ground or on a leveled surface. If you are not careful, your telescope will fall down.

- 1) a best   b most   c last   d least
- 2) a before   b at   c first   d above
- 3) a pollution   b presence   c abundance   d environment
- 4) a gazing   b gaping   c goggling   d glaring
- 5) a done   b built   c established   d administered
- 6) a objective   b object   c plan   d idea
- 7) a moment   b second   c now   d instance
- 8) a hole   b aperture   c gap   d opening
- 9) a clear   b clean   c open   d vivid



10) a nevertheless b reversely c furthermore d although

11) a at b on c from d to

12) a alignment b direction c change d movement

## 17. WRITING

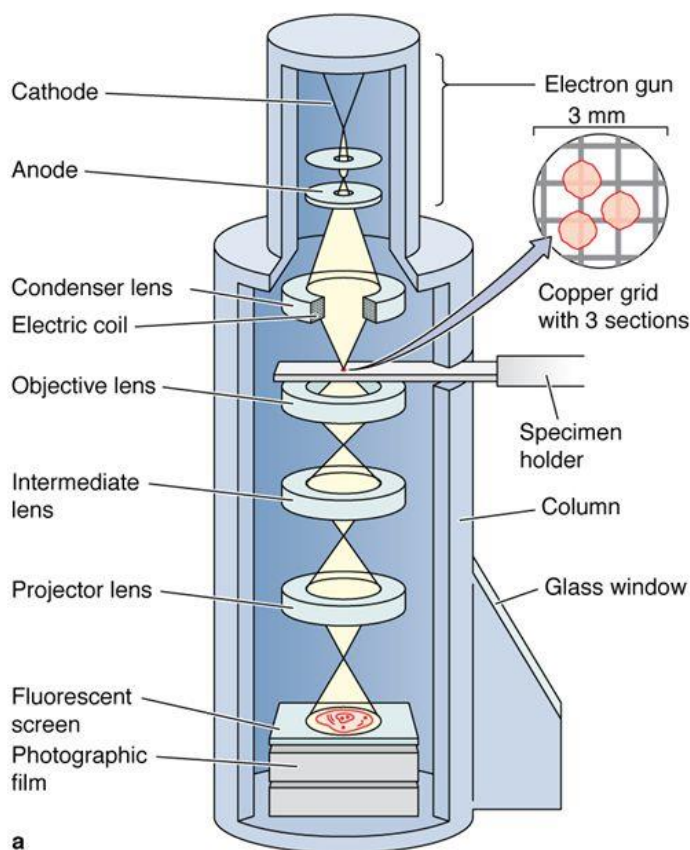
**Search for necessary information yourself and write a short article about the application of a high-speed camera (250-300 words).**

## SPEAKING

### 18. Role-play

**Student A is an instructor, student B is an amateur scientist. Explain how to use a telescope to your partner. When you finish the task, change roles, and student B should explain to student A how to use a microscope.**

**Structure of TEM:**



**Schematic view of a transmission electron microscope (TEM)**

### 19. Questions for extended discussion:

- 1) Time-lapse photography. How has it helped science? What other applications did it find?
- 2) Talk about innovations in the development of measuring optical devices. What have been done? What still needs improvement?
- 3) Innovations connected with the human eye: the eye recognition system, the digital passport, biometric data in ID (e.g. in banks, customs, airports, etc.)

## **20. Challenge questions — test yourself!**

- 1) Explain why dispersion occurs when white light passes through a prism.
- 2) Explain how a lens focuses light at the image point.
- 3) Name some factors that affect the focal length of a lens.
- 4) What is peculiar about the human eye lens?
- 5) Why do some other animals and birds see better than human? What does the strength of vision depend on?
- 6) Compare a prism, a lens and a mirror. What are their common and different features?
- 7) How can you make a telescope stronger? How to make a lens magnify better?

## **LISTENING**

### **21. Before watching the video, explain the meaning of the words:**

vision, midline view, iris, cornea, retina, farsighted

### **22. Watch the video How the Eye Works and choose the correct answer (a—d) for the following questions:**

- 1) The image is formed on  
a the cornea   b the iris   c the retina   d the brain
- 2) The iris is covered by  
a the lens   b the cornea   c the retina   d the image
- 3) The light passes through the cornea and \_\_\_\_\_ onto the lens.  
a is refracted   b reflects   c is reflected   d refracts
- 4) What reverses the image?  
a light sensitive tissue   b the cornea   c the retina   d double bending
- 5) The image appears upside down \_\_\_\_\_ and it is turned right side up \_\_\_\_\_.

a on the retina; in the brain   b on the retina; along an optic nerve   c in the brain; on the retina  
d in the brain; along the optic nerve

6) What keeps things we see in focus is

a the shape of the lens   b focal point   c the shape of the eye   d the brain

7) The nearsighted eye gives a focal point

a on the retina   b on the lens   c in front of the retina   d behind the retina

8) In a situation with an eye shorter than normal it's difficult to see

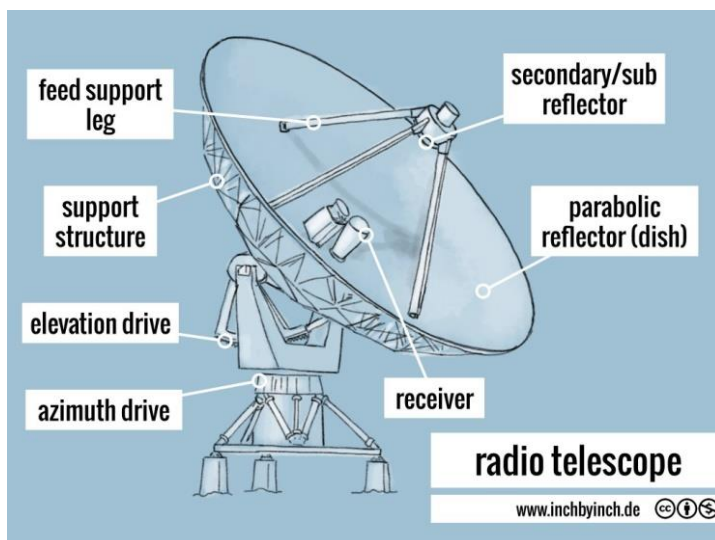
a something blurry   b something moving   c something far away   d something up close

### 23. Watch the video again and describe:

- a) the work of a normal eye;
- b) deviations in the work of a human eye;
- c) the way lenses help to amend these deviations.

### 24. GRAPH DESCRIPTION

**Describe the scheme of the radio telescope. How does it differ from the optical one (look at the beginning of Part 4 for reference)?**



### 25. DEVICE EXPLANATION

**Explain the work of an optical device you have used:**

- ✓ its structure;
- ✓ its purpose;
- ✓ how do you use it.

**Fill in the table about the device yourself.**

?	
About the device	
Working mechanism	
Tips	
Warning	

## **TRANSLATION**

### **26. Translate from English into Russian:**

**Who invented the microscope?**

If a microscope is any instrument that allows the inspection of objects that the unaided eye can't see, then reading stones (meniscal [rounded], polished glass lenses) were the first microscopes, Egypt, ca 7,000+ BC (inventor not known). These were probably very similar to what Leeuwenhoek found being used by cloth merchants (ca. 1648) to count the threads in cloth. The next candidate would be spectacles (eyeglasses). There is little controversy over the date: ca. 1285 CE. There is more contention concerning the inventor, but Salvino D'Armato is most often credited with the first wearable eyeglasses.

If the definition of microscope requires the use of an instrument, in or upon which, to mount the lenses, then eyeglasses fit this definition too. If multiple lenses are the criteria, then the compound microscope is the choice. Three Dutch lens makers are variously credited with this invention, ca. 1590. Hans and Sacharias Janssen (father and son), and Hans Lippershey, apparently working independently but at the same time, developed almost identical concepts.

### **27. Translate from Russian into English.**

#### **Оптические измерительные приборы**

Эти приборы нашли применение в измерительных лабораториях для абсолютных и относительных измерений бесконтактным методом различных изделий сложного профиля (резьб, шаблонов, кулачков, фасонных режущих инструментов) и малых габаритных размеров, для точных измерений длин, углов, радиусов. Эти приборы построены на оптических схемах. К наиболее распространенным оптическим измерительным приборам относятся: микроскопы (инструментальный, универсальный, проекционный), проекторы, оптические длиномеры и угломеры, делительные головки, столы и др.

Инструментальные и универсальные микроскопы предназначены для абсолютных измерений углов и длин различных деталей в прямоугольных и полярных координатах.

Универсальные измерительные микроскопы отличаются от инструментальных большим диапазоном измерений и повышенной точностью. В них вместо микрометрических измерителей применены миллиметровые шкалы с отсчетными спиральными микроскопами.

Несмотря на конструктивные различия инструментальных и универсальных микроскопов принципиальная схема измерения во всех микроскопах общая — визирование различных точек контролируемой детали, перемещаемых для этого по взаимно перпендикулярным направлениям, и измерение этих перемещений посредством отсчетных устройств. Для обеспечения лучшего визирования микроскопы снабжают сменными объективами различной степени увеличения.

## UNIT TWO: BIOPHYSICS

### PART 1

#### The Structure of the Cell

*Over the long term, symbiosis is more useful than parasitism.*

*More fun, too. Ask any mitochondria.*

*Larry Wall*

#### LEAD-IN

##### 1. Answer the questions:

- 1) What is a cell?
- 2) What does a cell consist of?
- 3) What types of cells exist?

#### PRE-READING

##### 2. Write adjectives of the following words (e.g. *a nucleus/nuclei* — *nuclear*):

cell

nutrient

tissue

gene

enzyme

membrane

##### 3. Fill in the gaps with a correct term:

- [ ] are the basic structures of all living organisms. genome (1)
- Cells provide structure for the body, take in [ ] from food and carry out important functions. organs(2)
- Cells group together to form [ ], which in turn group together to form [ ], such as the heart and brain. organelles (3)
- Our cells contain a number of functional structures called [ ]. cells (4)
- These organelles carry out tasks such as making [ ], processing chemicals and generating energy for the cell. nutrients (5)
- The [ ] is based at the centre of the cell and is the ‘control room’ for the cell. tissues (6)
- The [ ] is found within the nucleus. proteins (7)
- The [ ] is found within the nucleus. nucleus (8)

4. Listen to *The Cell Song* to study the pronunciation of terms connected to the structure of a cell. Write out the terms and practice their pronunciation aloud.

## READING

5. Read the whole text and then insert the words at the end of this text into spaces (a — l):

### Cell Structure and Function

The **cell structure** is defined by the cell membrane, the cytoplasm, and the nucleus. A cell is the smallest unit of life and its structure helps it to work as the basic building block of biology.

The **cell function** is to keep all of the functions of the body performing as intended. This includes keeping toxins out of the body, help to break down waste, make nutrients and act as barriers within organelles.

Cells are the basic building blocks of life. Yet what are all the components of a cell that **enable** them to a) \_\_\_\_ their basic functions? Cells are made up of a wide variety of structures and components, and each component plays a necessary and important role.

Different types of cells have different structures, depending on the function of the cell. Certain cells like **algae** cells, for instance, have a tail that helps them propel themselves through the water. While other cells like **pollen** have little b) \_\_\_\_ on them so they can **stick** to insects.

Despite their differences, most cells have structures in common. These common structures include a cell membrane, DNA, ribosomes, and cytoplasm.

### Key Parts of a Cell

Cells have a plasma membrane, cell membrane, or cell wall that surrounds the cell and acts as their skin. It makes up the c) \_\_\_\_ between the cell and their environment and controls what can move in and out of the cell. The cell membrane is d) \_\_\_\_ of a phospholipid bilayer, two layers of lipids **facing** opposite directions. The lipid layers are made out of building blocks of fatty **acids** and consist of a head and body. The body of the lipid is hydrophobic, meaning it repels water while the heads of the lipids are hydrophilic, meaning that it likes water.

In addition to the cell membrane found in animal cells, plant cells also have a cell wall. The cell wall is made out of cellulose and it helps give the cell extra protection and support. A crucial difference is that unlike cell membranes, cell walls do not allow for the **passage** of materials through them. To get around this problem, cell walls have unique structures called plasmodesmata, special holes that allow the material to move in and out.

The cell membrane e) \_\_\_\_ in a cell's cytoplasm. The cytoplasm is a **jelly-like** substance, made up of mostly water, that keeps the various organelles within the cell separate from each other. Many of the cell's biochemical reactions, like metabolic processes, occur within the cytoplasm.

There are gaps in a cell's plasma membrane referred to as f) \_\_\_\_ or channels. These pores or channels are made out of proteins and they control what chemicals, like water and food, are able to move into the cell.

Deoxyribonucleic Acid, or DNA, is frequently g) \_\_\_\_ to as “the h) \_\_\_\_ for life” and it contains the generic information that allows cells to reproduce and perform their respective functions. The DNA of a cell is held within the nucleus of the cells, specifically within the nucleolus.

The cell's nucleus is often referred to as the “brain” of the cell, or the control center. It is the largest part of the cell within the cytoplasm. Cells that have nuclei are found in plants, animals, algae, **protozoa**, and **fungi**. Bacterial cells do not have a nucleus. The nucleus is home to a smaller structure within it called the nucleolus. The nucleolus is an organelle that creates ribosomes. The nucleus has nuclear pores that allow the ribosomes to exit the nucleus and for other materials to move in.

The ribosomes themselves are organelles which i) \_\_\_\_\_ in the creation of proteins. Proteins are necessary for the cell to carry out its essential functions. Ribosomes are made out of one large piece and one smaller unit. Both of the **subunits** in the ribosomes assist in the creation of proteins when they come together with messenger RNA. Though some ribosomes can be found in the cytoplasm itself, most of the ribosomes are found in the endoplasmic **reticulum**. The proteins that ribosomes create while attached to the endoplasmic reticulum will move from the cell to do work within the body or will remain within the cell to synthesize the proteins that the cell needs.

## Other Important Parts of a Cell

The endoplasmic reticulum (ER) is made out of various membranes, and it synthesizes proteins and for the cell. The endoplasmic reticulum is referred to as “rough ER” when it has the ribosomes attached to it, and it is called “smooth ER” when there are no ribosomes attached to it. The rough endoplasmic reticulum synthesizes the proteins, while the smooth endoplasmic reticulum performs two functions. The smooth ER synthesizes lipids for use in the cell, but it also detoxifies harmful substances.

After the proteins of the cell have been synthesized by the ribosomes on the endoplasmic reticulum, they are j) \_\_\_\_\_ by an organelle called the “Golgi complex”. The Golgi complex sorts the proteins out and then sends them to the area that they are needed in. In this respect the Golgi complex is like a post office, distributing packages to their k) \_\_\_\_\_.

The mitochondria are organelles that are responsible for converting the food eaten by an organism into energy. Food is converted into units of energy called ATP by the mitochondria and every cell has differing amounts of mitochondria depending on the cell's function and needs. Cells that do more work, like heart cells, need more mitochondria than other cells.

Plant cells have chloroplasts, while animal cells don't. The chloroplasts in a plant cell are where photosynthesis happens, converting the energy from the sun into chemical energy that the plant cells can use. Plant cells also have a vacuole or seemingly large empty space in the middle of the cell. However, the vacuole of a plant cell actually contains important chemicals like sugar and water.

Tiny organelles called **vesicles** can also be found floating around within the cytoplasm. The vesicles are responsible for carrying materials in, out, and around the cell. The vesicles carry material from one part of the cell to another, but they also transport waste products outside the cell in a process called exocytosis.

There are also some small structures found in the cytoplasm that carry out various functions depending on the type of cell. Peroxisomes are responsible for collecting toxic chemicals and breaking them down into harmless byproducts, while centrioles are unique to animal cells and they guide the division and organization of chromosomes as cells divide. Finally, lysosomes are structures l) \_\_\_\_\_ by the Golgi apparatus which can take large molecules and break them apart into smaller chunks the cell can **utilize**.

Cells are complex systems with many moving parts that work together to form the diverse abundance of life we all around us.

holds

boundary

secreted



assist	pores	constructed out
carry out	referred	blueprints
destinations	spikes	distributed

## VOCABULARY

### 6. Find words in the text (in bold) which fit the following definitions:

- 1) unicellular or multicellular organisms , living in fresh or salt water or moist ground, that have chlorophyll and other pigments but lack true stems, roots, and leaves;
- 2) various tiny unicellular organisms;
- 3) a chemical substance made out of hydrogen which can react with other substances to form salts;
- 4) a fine powder produced by flowers which plays a role in making seeds;
- 5) resembling a transparent substance that is not completely solid;
- 6) moving through something;
- 7) a tiny network, especially in the body composed of cells, fibres, etc;
- 8) to attach oneself to a surface or another body;
- 9) smaller structures, a part of something bigger;
- 10) a cavity;
- 11) being turned towards something;
- 12) to make something possible or somebody capable of doing something;
- 13) an organism lacking chlorophyll, leaves, true stems, and roots which reproduces by spores;
- 14) to employ

### 7. In pairs or small groups define the following words (do not forget to use terms!)

cytoplasm	bacterial	Golgi complex
cell wall	essential	mitochondria
respective	rough	chloroplasts
generic	smooth	vacuole

### 8. Fill in the gaps:

#### Part A

pollen protozoa destination passage organelle acid spike blueprint pore boundary

- 1) The process of substituting one amino \_\_\_\_\_ for another in a protein is not an instantaneous one.
- 2) Amoeboid cells occur not only among the \_\_\_\_\_, but also in fungi, algae, and animals.
- 3) Having shown their ID, they were allowed a free \_\_\_\_\_ to the laboratory.
- 4) We have been studying the \_\_\_\_\_ of the house for hours, but still couldn't agree upon where it'd be safer to establish the set up.
- 5) Sometimes it's not so easy to put a clear \_\_\_\_\_ between unicellular algae and bacteria.
- 6) Leaves of plants found in aquatic environments have a minimal cuticle and many \_\_\_\_\_ that allow water to escape.
- 7) Some animals' hides have \_\_\_\_\_ instead of fur, the primary function of which is the protection against predators.
- 8) Unfortunately, we were unable to reach the \_\_\_\_\_ of the expedition on time since we were delayed on the country border.
- 9) Roses produce heavy \_\_\_\_\_ which is less likely to be spread by the wind.
- 10) The plasma membrane is the \_\_\_\_\_ that encapsulates the contents of the cell.

## Part B

generic distribute smooth assist rough refer essential enable bacterial carry out

- 1) Our bodies are home to ten times as many \_\_\_\_\_ cells as there are human cells themselves.
- 2) The \_\_\_\_\_ part of the lesson was dedicated to the explanation how to derive this type of equation.
- 3) The \_\_\_\_\_ side of the paper gives more friction; hence painting on it proves more challenging.
- 4) Gradually add the rest of icing sugar to produce a creamy and \_\_\_\_\_ consistency.
- 5) To find your particular prescription medicine in this chapter you need to know either its \_\_\_\_\_ or brand name.
- 6) Equally \_\_\_\_\_ medicine gives a chance to maintain a high level of health inside the population.
- 7) He would always \_\_\_\_\_ British teams and investigators when they came here to search.
- 8) The doctor wanted to \_\_\_\_\_ me to an ear, nose and throat specialist.
- 9) The meters will \_\_\_\_\_ power companies to improve energy efficiency by introducing off-peak deals.
- 10) Respiratory function is \_\_\_\_\_ by lungs in land animals.

**9. Change words in brackets so that they are grammatically correct for the sentence:**

- 1) It is already issuing advice through a large public health campaign and is increasing stocks of \_\_\_\_\_ and antibiotic medicines. (virus)
- 2) Protozoa and bacteria are \_\_\_\_\_ organisms while plants and animals are \_\_\_\_\_. (cell)
- 3) Increases in \_\_\_\_\_ can increase light refraction, diffuse reflection and scattering, resulting in a brightening of the material's surface. (pore)
- 4) At the end of the report list any \_\_\_\_\_ used or further reading suggested must be arranged in alphabetic order. (refer)
- 5) It will bring advantages in payment security and the \_\_\_\_\_ of mobile payments. (enable)
- 6) There was a belief for a long time that the equinox - when there are \_\_\_\_\_ equal hours of day and night - affects the weather. (rough)
- 7) We ran out of \_\_\_\_\_ plasters, remind me to get some when we are out for shopping. (stick)
- 8) The \_\_\_\_\_ structure of the material is conditioned by gas escaping from cooling lava. (vesicle)
- 9) What are the risks and opportunities for you with \_\_\_\_\_ to the above? (respective)

**10. In the text, find all synonyms of the words *consist of*. Do you know any other ways to express the same meaning?**

**11. Find what word is suitable in all three sentences:**

A 1) The memory about that holiday \_\_\_\_\_ in my mind for a few next years.

2) A leech \_\_\_\_\_ to a fish to feed.

3) The monkey proved to be able to use a \_\_\_\_\_ to get fruit from a place it couldn't reach with its hands.

B 1) A \_\_\_\_\_ in flu cases around the Christmas period was blamed for piling pressure on already stretched A&Es.

2) This is early purple orchid, which has many purplish or sometimes pink flowers growing all round a long \_\_\_\_\_.

3) That fossil showed that the animal had \_\_\_\_\_ to protect itself from predators.

C 1) The chemical reacts to the amino acids and other components of oils and sweat \_\_\_\_\_ from the skin's pores.

2) The thyroid gland \_\_\_\_\_ hormones that affect growth.

3) The main difficulty was to \_\_\_\_\_ the place from unwanted attention.

**12. Write a sentence with a set of words:**

- a) membrane; carry out; facing
- b) passage; hold; respective
- c) protozoa; generic; distribute

**POST-READING**

**13. Which topics are not discussed in the text:**

- a) the diversity in types of cells;
- b) components of the cell which any living organism consists of;
- c) functions of constituents of a cell;
- d) how plant cells vary from animal ones;
- e) the joint work of organelles;
- f) the individual peculiarities of organelles;
- g) the origin of organelles.

**14. Answer the questions:**

- 1) What is different in different types of cells?
- 2) What common features do most cells have?
- 3) What is a plasma membrane? What functions does it carry out?
- 4) What is a cell wall made of? How does it vary from a membrane?
- 5) What is the function of cytoplasm?
- 6) What is called “the blueprint of life” and why?
- 7) What is “the brain” of the cell? Which organisms have it and which don’t?
- 8) Where are proteins created?
- 9) What are the names of common organelles? Enumerate all of them.
- 10) What are their roles in the work of the cell?

**15. Match beginnings and endings of the sentences:**

- |  |   |
|--|---|
| 1) Whether they be unicellular or multicellular life forms,  | a) which have diameters ranging from 10 to 100 $\mu\text{m}$ .  |
| 2) Eukaryotic cells are called so  | b) from providing energy to producing hormones and enzymes.   |
| 3) Organelles have a wide range of responsibilities within a cell that include everything                      | c) all living organisms are composed of and depend on cells to function normally.   |
| 4) Several cells of one kind that interconnect with each other   | d) but its volume increases as the cube of its radius (much more rapidly).  |
| 5) At 0.1 to 5.0 $\mu\text{m}$ in diameter, prokaryotic cells are significantly smaller than eukaryotic cells, | e) on its cell membrane, called antibodies, to the antigen.   |
| 6) Smaller single-celled organisms have a high surface area to volume ratio,                                   | f) because they have a true nucleus that is enclosed within a membrane.   |
| 7) As the radius of a cell increases, its surface area increases as the square of its radius,                  | g) which allows them to rely on oxygen and material diffusing into the cell (and wastes diffusing out) in order to survive. |
| 8) One type of cell, the T cell, is used to determine  | h) and perform a shared function form tissues.  |
| 9) During this contact, the T cell tries to bind a series of different molecules                               | i) which bodies are foreign so that they can be removed.  |
| 10) What is interesting about this process is that biophysicists recently discovered that the stiffness or     | j) rigidity of the T cells themselves changes once they have been activated.  |

**16. Read the following text and choose the correct variant:**

### Miller-Urey Experiment

The experiment tested the primordial or primeval soup theory developed independently by the Soviet biologist A.I. Oparin and English scientist J.B.S. Haldane in 1924 and 1929 (1)\_\_\_\_\_. The theory propounds the idea that the complex chemical components of life on Earth originated from simple molecules occurring naturally in the reducing atmosphere of the Early Earth, (2)\_\_\_\_\_ oxygen. Lightning and rain energized the said atmosphere to create simple organic compounds that formed an organic “soup”. The so-called soup underwent further changes giving rise to more complex organic polymers and finally life.

The groundbreaking experiment used a (3)\_\_\_\_\_ glass flask of 5 liters attached with a pair of electrodes, to hold water ( $\text{H}_2\text{O}$ ), methane ( $\text{CH}_4$ ), ammonia ( $\text{NH}_3$ ) and hydrogen ( $\text{H}_2$ ), the major components of (4)\_\_\_\_\_ Earth. This was connected to another glass flask of 500 ml capacity half filled with water. On heating it, the water vaporized to fill the larger container with water vapor. The electrodes induced continuous electrical sparks in the gas mixture to (5)\_\_\_\_\_ lightning.

When the gas was cooled, the condensed water made its way into a U-shaped trap at the (6)\_\_\_\_\_ of the apparatus.

After electrical sparking had continued for a day, the (7)\_\_\_\_\_ in the trap turned pink in color. At the end of a week, the boiling flask was removed, and mercuric chloride added to prevent microbial contamination. After stopping the chemical reaction, the scientist duo examined the cooled water collected to find that 10-15% of the carbon present in the system was in the form of organic (8)\_\_\_\_\_. 2% of carbon went into the formation of various amino acids, including 13 of the 22 amino acids essential to make proteins in living cells, glycine being the most (9)\_\_\_\_\_.

Though the result was the production of only simple organic molecules and not a complete living biochemical system, still the simple prebiotic experiment could, to a considerable (10)\_\_\_\_\_, prove the primordial soup hypothesis.

1. a) respectively    b) accordingly    c) mutually
2. a) lack    b) not    c) sans
3. a) flawless    b) clean    c) sterile
4. a) primitive    b) new    c) original
5. a) simulate    b) imagine    c) show
6. a) end    b) base    c) sole
7. a) colony    b) matter    c) solution
8. a) compounds    b) substances    c) cells
9. a) frequent    b) abundant    c) noticeable
10. a) number    b) magnitude    c) extent

## **SPEAKING**

### **17. Search for necessary information and prepare for oral reports:**

- a) can life only be based on carbon?
- b) hypotheses about the origin of life on the Earth;
- c) conditions necessary for life to emerge;
- d) the use of stem cells in medicine.

### **18. Extended discussion topics:**

- a) What is biophysics? What does it deal with? Where are its findings applied?
- b) Are viruses living organisms?
- c) How to distinguish between living and lifeless objects?
- d) Does life influence the Earth? Can it change the planet?

### 19. Challenge questions — test yourself!

- 1) Which organelle is known as a “power house” of the cell?
- 2) Why does plant cell possess a large sized vacuole?
- 3) What are the characteristics of prokaryotic cells?
- 4) What are the functions of a nucleus?
- 5) How could you appreciate the function of a tiny cell in a large body of an organism?
- 6) What is a hydrolase? Give an example.
- 7) Is cholesterol a hydrophobic or a hydrophilic substance?
- 8) Describe the structure of a hemoglobin molecule.
- 9) What are waxes? Give the composition of bee wax.
- 10) What are the two primary types of biomolecules found in the cell membrane?
- 11) What process activates the enzymes inside lysosomes?
- 12) “Cell, in the form of a compartment is an independent unit.” Why?
- 13) List the four major tissue types. Give an example and location of each.
- 14) What is a chloroplast? Mention the types of pigments present in it.

### LISTENING

**20. You will listen to a one-minute speech given by Dr Philippa Binns – a clinical advisor and medical practitioner. Choose the correct answer.**

***Hint: always read all the material connected with listening – the task, the questions, the titles – if you have time. It can help you to raise background information and find useful vocabulary.***

- 1) The speech seems to have been given...
  - a) as part of a conference presentation for professionals
  - b) for educational purposes to inform ordinary people
  - c) as a piece of lecture on biology for students
- 2) What is said about a virus?
  - a) the immune system exists to resist viral infection
  - b) most viruses are much smaller than bacteria

c) it is never harmless unlike a bacterium

3) What is said about a bacterium?

a) it is purely independent from other organisms

b) it is unicellular

c) nearly all animals depend on it for survival

4) Which statement does not coincide with the speech?

a) medicine doesn't eliminate viruses

b) under optimal conditions bacteria can grow and divide rather rapidly

c) antibiotic resistance can be a consequence of trying to fight off infection

5) The main purpose of the speech is...

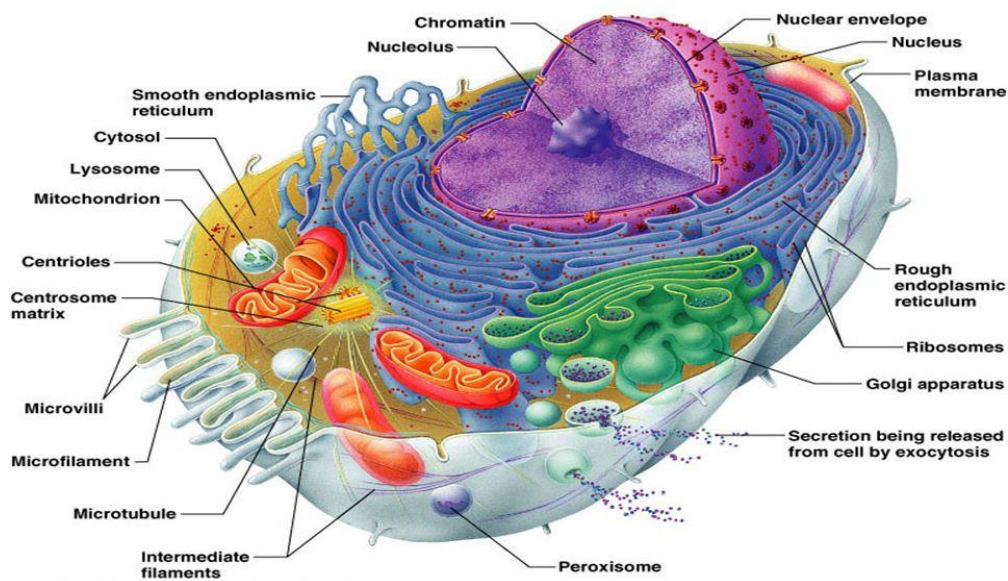
a) to explain that not all bacteria are harmful

b) to describe the diversity of germs inducing the disease

c) to encapsulate the difference between a bacterium and a virus

## 21. GRAPH DESCRIPTION

### Structure of a Generalized Cell

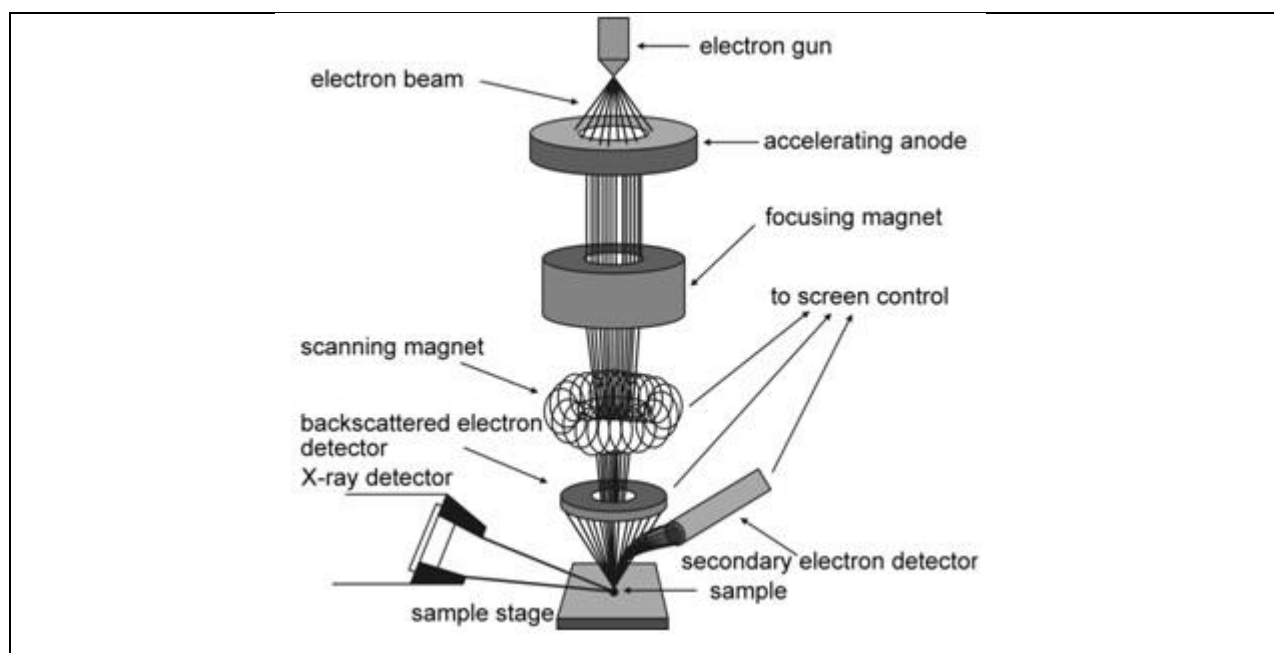


## 22. DEVICE EXPLANATION



Using the facts below and the scheme of the device, explain the work of the interferometer:

- ✓ its structure;
- ✓ its purpose;
- ✓ how do you use it.



About the device	<p>The Scanning electron microscope works on the principle of applying kinetic energy to produce signals on the interaction of the electrons. These electrons are secondary electrons, backscattered electrons and diffracted backscattered electrons which are used to view crystallized elements and photons. Secondary and backscattered electrons are used to produce an image. The secondary electrons are emitted from the specimen play the primary role of detecting the morphology and topography of the specimen while the backscattered electrons show contrast in the composition of the elements of the specimen.</p>
Working mechanism	<p>— The electrons are emitted after thermal energy is applied to the electron source and allowed to move in a fast motion to the anode, which has a positive charge.</p> <p>— The beam of electrons activates the emission of primary scattered (Primary) electrons at high energy levels and secondary electrons at low-energy levels from the specimen surface. The beam of electrons interacts with the specimen to produce signals that give information about the surface topography and composition of the specimen.</p> <p>— Scanning by this microscope is attained by tapering a beam of electrons back and forth over a thin section of the microscope. When the electrons reach the specimen, the surface releases a tiny staw of electrons known as secondary electrons which are then trapped by a special detector apparatus.</p> <p>— When the secondary electrons reach and enter the detector, they strike a scintillator (a luminescence material that fluoresces when struck by a charged particle or high-energy photon). This emits flashes of light which get converted into an electric current by a photomultiplier, sending a signal to the cathode ray tube. This produces an image that looks like a television picture that can be viewed and photographed.</p>

Tips	<p>In addition to topographical, morphological and compositional information, a Scanning Electron Microscope can detect and analyze surface fractures, provide information in microstructures, examine surface contaminations, reveal spatial variations in chemical compositions, provide qualitative chemical analyses and identify crystalline structures.</p> <p>SEMs can be as essential research tool in fields such as life science, biology, gemology, medical and forensic science, metallurgy.</p> <p>In addition, SEMs have practical industrial and technological applications such as semiconductor inspection, production line of miniscule products and assembly of microchips for computers.</p>
Warning	<p>Maintenance involves keeping a steady voltage, currents to electromagnetic coils and circulation of cool water.</p> <p>Special training is required to operate an SEM as well as prepare samples. The preparation of samples can result in artifacts. The negative impact can be minimized with knowledgeable experience researchers being able to identify artifacts from actual data as well as preparation skill. There is no absolute way to eliminate or identify all potential artifacts.</p> <p>In addition, SEMs are limited to solid, inorganic samples small enough to fit inside the vacuum chamber that can handle moderate vacuum pressure.</p>

## WRITING

### 23. Read the material below. What distinguishes an abstract from a summary?

#### ABSTRACT

#### Key points

- an original work, not an excerpted passage;
- fully self-contained, capsule description of the paper;
- it must make sense all by itself;
- word limit - 150 to 200 words (otherwise, there is a possibility it will not be read);
- any major restrictions or limitations on the results should be stated, if only by using "weasel-words" such as "might", "could", "may", and "seem".

#### Parts of an abstract

##### ▪ MOTIVATION

Why do we care about the problem and the results?

- 1) the importance of your work;
- 2) the difficulty of the area;
- 3) the impact it might have if successful.

##### ▪ PROBLEM STATEMENT

What problem are you trying to solve?

What is the scope of your work (a generalized approach, or for a specific situation)?

- APPROACH

How did you go about solving or making progress on the problem?

Did you use simulation, analytic models, prototype construction, or analysis of field data for an actual product?

What was the extent of your work (did you look at one application program or a hundred programs in twenty different programming languages?)

What important variables did you control, ignore, or measure?

- RESULTS

What's the answer?

1) Put the result there, in numbers ;

2) Avoid vague, hand-waving results such as "very", "small", or "significant"

- CONCLUSIONS

What are the implications of your answer?

Are your results general, potentially generalizable, or specific to a particular case?

### Structure of an abstract

Background:	A simple opening sentence or two placing the work in context.
Aims:	One or two sentences giving the purpose of the work.
Method(s):	One or two sentences explaining what was done.
Results:	One or two sentences indicating the main findings.
Conclusions:	One sentence giving the most important consequence of the work.

**24. Look at the abstracts below and evaluate how effective they are. What their pros and cons?**

#### Abstract A

A preliminary design of the multi-meter long collinear dielectric wakefield accelerator that achieves a highly efficient transfer of the drive bunch energy to the wakefields and to the witness bunch is considered. It is made from ~0.5 m long accelerator modules containing a vacuum chamber with dielectric-lined walls, a quadrupole wiggler, an rf coupler, and BPM assembly. The single bunch breakup instability is a major limiting factor for accelerator efficiency, and the BNS damping is applied to obtain the stable multi-meter long propagation of a drive bunch. Numerical simulations using a 6D particle tracking computer code are performed and tolerances to various errors are defined.

#### Abstract B

Microreaction engineering enables new strategies in process intensification, e.g. reactions with high selectivity, through exploitation of the smallest scales. A basis for this is a precise analysis of local mass transfer and hydrodynamics in micro-mixers for different flow regimes. The micro-mixer we used for experimental investigations is a simple T-shaped micro-mixer with rectangular cross-sections and very smooth surfaces (reactive ion etching) to enable a good approximation by numerical models. Although the investigations were performed in the low  $Re$  range without turbulence, the T-shaped micro-mixer intentionally promotes the generation of vortex structures. The goal of this research work is to show that despite laminar flow conditions short diffusion lengths are achievable and to clarify the mechanisms and required conditions. For the determination of the mixing quality and the specific contact area between the species the concentration field is measured using the technique “micro Laser-induced fluorescence” (LIF). For further understanding and verification of numerical models the velocity field is measured by “micro Particle Image Velocimetry” (-PIV).

### Abstract C

**Background:** Since 2000, transcatheter pulmonary valve replacement has steadily advanced. However, the available prosthetic valves are restricted to bioprosthesis which have defects like poor durability. Polymeric heart valve is thought as a promising alternative to bioprosthesis. In this study, we introduced a novel polymeric transcatheter pulmonary valve and evaluated its feasibility and safety in sheep by a hybrid approach.

**Methods:** We designed a novel polymeric trileaflet transcatheter pulmonary valve with a balloon-expandable stent, and the valve leaflets were made of 0.1-mm expanded polytetrafluoroethylene (ePTFE) coated with phosphorylcholine. We chose glutaraldehyde-treated bovine pericardium valves as control. Pulmonary valve stents were implanted in situ by a hybrid transapical approach in 10 healthy sheep (8 for polymeric valve and 2 for bovine pericardium valve), weighing an average of  $22.5 \pm 2.0$  kg. Angiography and cardiac catheter examination were performed after implantation to assess immediate valvular functionality. After 4-week follow-up, angiography, echocardiography, computed tomography, and cardiac catheter examination were used to assess early valvular function. One randomly selected sheep with polymeric valve was euthanized and the explanted valved stent was analyzed macroscopically and microscopically.

**Findings:** Implantation was successful in 9 sheep. Angiography at implantation showed all 9 prosthetic valves demonstrated orthotopic position and normal functionality. All 9 sheep survived at 4-week follow-up. Four-week follow-up revealed no evidence of valve stent dislocation or deformation and normal valvular and cardiac functionality. The cardiac catheter examination showed the peak-peak transvalvular pressure gradient of the polymeric valves was  $11.9 \pm 5.0$  mmHg, while that of two bovine pericardium valves were 11 and 17 mmHg. Gross morphology demonstrated good opening and closure characteristics. No thrombus or calcification was seen macroscopically.

**Conclusions:** This design of the novel ePTFE transcatheter pulmonary valve is safe and effective to deploy in sheep by hybrid approach, and the early valvular functionality is good.

**25. Write an abstract to the article you have recently read following the criteria mentioned above.**

**Hint:** even though you will be writing an abstract to somebody else's work, do not use words like 'authors', 'researchers', or 'they.'

## PART 2

## DNA and RNA

*It is essential for genetic material to be able to make exact copies of itself; otherwise growth would produce disorder, life could not originate, and favourable forms would not be perpetuated by natural selection.*

— Maurice Wilkins

### LEAD-IN

#### 1. Answer the questions:

- 1) What bases does the DNA consist of?
- 2) What is the role of the RNA in the organism?
- 3) What is a chromosome?
- 4) How can decoding genome help humans?

### PRE-READING

#### 2. Match the following word combinations. Sometimes you need to change the order of the words:

- |                |              |
|----------------|--------------|
| 1. heredity    | a. dual      |
| 2. hereditary  | b. traits    |
| 3. inherited   | c. material  |
| 4. inheritance | d. a unit of |
| 5. heritage    | e. tax       |

#### 3. Decipher the abbreviators:

DNA      RNA      A, U, G and C      CFTR      HIV      AIDS

### READING

#### 4. Read the four texts and then insert the conjunctions and prepositions at the end of this text into spaces (a - i). Some words must be used more than once.

##### Text A

Structurally speaking, ribonucleic acid (RNA), is quite similar to DNA. However, a) \_\_\_\_\_ DNA molecules are typically long and double stranded, RNA molecules are much shorter and are typically single stranded. RNA molecules perform a variety of roles in the cell but are mainly involved in the process of protein synthesis (translation) and its regulation.

RNA is typically single stranded and is made of ribonucleotides that are linked by phosphodiester **1) bonds**. A ribonucleotide in the RNA chain contains ribose (the pentose sugar), one of the four nitrogenous **2) bases** (A, U, G, and C), and a phosphate group. The subtle structural difference

between the sugars gives DNA added stability, making DNA more suitable for storage of genetic information, b) \_\_\_\_\_ the relative instability of RNA makes it more suitable for its more short-term functions. The RNA-specific pyrimidine uracil forms a complementary base pair with adenine and is used c) \_\_\_\_\_ the thymine used in DNA. d) \_\_\_\_\_ RNA is single stranded, most types of RNA molecules show extensive **3) intramolecular** base pairing between complementary sequences within the RNA strand, creating a predictable three-dimensional structure essential for their function

## Text B

DNA, or **4) deoxyribonucleic acid**, is the hereditary material in humans and almost all other organisms. Nearly every cell in a person's body has the same DNA. Most DNA is located in the cell nucleus (where it is called nuclear DNA), but a small amount of DNA can also be found in the mitochondria (where it is called mitochondrial DNA or mtDNA). Mitochondria are structures within cells that convert the energy from food into a form that cells can use.

The information in DNA is stored as a code made up of four chemical bases: adenine (A), guanine (G), cytosine (C), and thymine (T). Human DNA consists of about 3 billion bases, and more than 99 percent of those bases are the same in all people. The order, or sequence, of these bases determines the information available for building and maintaining an organism, similar to the way in which letters of the alphabet appear in a certain order to form words and sentences.

DNA bases **5) pair up with** each other, A with T and C with G, to form units called base pairs. Each base is also attached to a sugar molecule and a phosphate molecule. Together, a base, sugar, and phosphate are called a **6) nucleotide**. Nucleotides are arranged in two long strands that form a spiral called a double **7) helix**. The structure of the double helix is somewhat like a ladder, with the base pairs forming the ladder's rungs and the sugar and phosphate molecules forming the vertical side-pieces of the ladder.

An important property of DNA is that it can replicate, or make copies of itself. Each strand of DNA in the double helix can serve as a pattern for duplicating the sequence of bases. This is critical when cells divide because each new cell needs to have an exact copy of the DNA present in the old cell.

## Text C

A gene is the basic physical and functional unit of heredity. Genes are made up of DNA. Some genes act as instructions to make molecules called proteins. e) \_\_\_\_\_, many genes do not code for proteins. In humans, genes vary in size from a few hundred DNA bases to more than 2 million bases. An international research **8) effort** called the Human Genome Project, f) \_\_\_\_\_ worked to determine the sequence of the human genome and identify the genes that it contains, estimated that humans have between 20,000 and 25,000 genes.

Every person has two copies of each gene, one inherited from each parent. Most genes are the same in all people, but a small number of genes (less than 1 percent of the total) are slightly different between people. **9) Alleles** are forms of the same gene with small differences in their sequence of DNA bases. These small differences contribute to each person's unique physical features.

Scientists keep track of genes by giving them unique names. Because gene names can be long, genes are also assigned symbols, which are short combinations of letters (and sometimes numbers)

that represent an abbreviated version of the gene name. g) \_\_\_\_\_, a gene on **10) chromosome 7** that has been associated with **11) cystic fibrosis** is called the cystic fibrosis transmembrane conductance regulator; its symbol is *CFTR*.

## Text D

In the nucleus of each cell, the DNA molecule is packaged into thread-like structures called chromosomes. Each chromosome is made up of DNA tightly **12) coiled** many times around proteins called **13) histones** that support its structure.

Chromosomes are not visible in the cell's nucleus—not even under a microscope—when the cell is not dividing. h) \_\_\_\_\_, the DNA that makes up chromosomes becomes more tightly packed during cell division and is then visible under a microscope. Most of what researchers know about chromosomes was learned by observing chromosomes during cell division.

Each chromosome has a **14) constriction** point called the centromere, i) \_\_\_\_\_ divides the chromosome into two sections, or “arms.” The short arm of the chromosome is labeled the “p arm.” The long arm of the chromosome is labeled the “q arm.” The location of the centromere on each chromosome gives the chromosome its characteristic shape, and can be used to help describe the location of specific genes.

which (2)    however (2)    instead of    whereas (2)    for example    even though

## POST-READING

### VOCABULARY

#### 5. Find words in the text (in bold) which fit the following definitions:

- 1) happening inside a molecule or molecules;
- 2) to come together with smth else;
- 3) any of several compounds that consist of a ribose or deoxyribose sugar joined to a purine or pyrimidine base and to a phosphate group and that are the basic structural units of nucleic acids;
- 4) a constituent of a cell which plays a central role in protein synthesis, and is responsible for the transmission of hereditary characteristics from parents to offspring;
- 5) a connection between elements of smth;
- 6) a spiral;
- 7) a nucleic acid that is frequently single-stranded and folded onto itself;
- 8) a gene that is found in one of two or more different forms in the same position in a chromosome;
- 9) a genetic disorder;
- 10) one of four chemical substances that make up the part of DNA and RNA that controls the structure of genes;
- 11) a string of DNA wrapped around associated proteins that give the connected nucleic acid bases a structure;

- 12) to wrap around;
- 13) a collaboration;
- 14) a localized narrow region of a chromosome.

**6. In pairs or small groups explain the meaning of the following words:**

stranded, subtle, a short-term function, within, a sequence, to arrange, a strand, a rung, a sidepiece, to duplicate, to estimate, to contribute to, to assign, thread-like, to label

**7. Fill in the gaps:**

**Part A**

DNA chromosome bond base rung strand helix thread nucleotide sequence

- 1) The fences were mostly oak posts and wire -- five or six \_\_\_\_\_ of plain wire.
- 2) When they put all the data on the graph, they saw a clear \_\_\_\_\_ in it.
- 3) A chemical \_\_\_\_\_ in compounds is not easily broken, unlike that in mixtures.
- 4) A spring is a \_\_\_\_\_ of wire which returns to its original shape after it is pressed or pulled.
- 5) You have two sets of \_\_\_\_\_, making a total of forty six altogether.
- 6) Find one \_\_\_\_\_ close to the edge of the fold of the hem, and insert your needle there, then come back up through the fold.
- 7) Each \_\_\_\_\_ is a pair of polymers with backbones made up of sugar and phosphate groups connected by ester bonds.
- 8) These four nitrogenous \_\_\_\_\_ pair together in the following way: A with T, and C with G.
- 9) As workers leave the lower \_\_\_\_\_ of the career ladder, others will surely take their place.
- 10) The result of the \_\_\_\_\_ profiling was phoned from the police station an hour later.

**Part B**

within intramolecular subtle label estimate contribute duplicate arrange assign coil

- 1) They tried \_\_\_\_\_ numbers in a sequence which would prove or disprove their claim.
- 2) The history of physics is one of increasingly \_\_\_\_\_ and refined measurement made by increasingly ingenious and indirect means.
- 3) Decoding the information hidden \_\_\_\_\_ a genome has already taken years upon years of research.
- 4) The data collection \_\_\_\_\_ to take at least three more months before preliminary results could be put together.



- 5) Maurice Wilkins was a New Zealand born British biophysicist and molecular biologist who \_\_\_\_\_ to the DNA research at its earliest stages.
- 6) Like all viruses, it invades the host cells, using their machinery \_\_\_\_\_ itself.
- 7) I \_\_\_\_\_ to this research upon entering the chair a year ago, it's not something I'd have chosen myself.
- 8) All folders and files in the cabinet \_\_\_\_\_ neatly to reduce time for the search if one of them is needed.
- 9) In a vehicle, the \_\_\_\_\_ is the part on a petrol engine that sends electricity to the spark plugs.
- 10) All \_\_\_\_\_ electronic transitions in these o-carboranyl compounds were verified by theoretical calculations.

**8. Change words in brackets so that they are grammatically correct for the sentence:**

- 1) Scientific advisors will also set real, practical \_\_\_\_\_ from industry for students to tackle, so they can develop necessary skills. (to assign)
- 2) \_\_\_\_\_ gear would certainly help scientists who research volcanoes directly as a field work due to gas evaporation danger. (acid)
- 3) All expeditions are \_\_\_\_\_ but this one was particularly strained. (effort)
- 4) Examples of common \_\_\_\_\_ solutions include soap or detergent dissolved in water or solutions of sodium hydroxide, potassium hydroxide, or sodium carbonate. (base)
- 5) This method was called quadrature scanning, as opposed to the \_\_\_\_\_ scan transport used by later videotape formats. (helix)
- 6) Mild cognitive impairment is a \_\_\_\_\_ of having multiple concussions while playing types of sport when a player frequently hits his head such as hockey or football. (sequence)
- 7) The \_\_\_\_\_ fertilizer industry includes the production of synthetic ammonia, nitric acid, ammonium nitrate, and urea. (nitrogen)
- 8) A printer that can make double-sided printouts is called a \_\_\_\_\_ printer. (duplicating)
- 9) A \_\_\_\_\_ is a biologist who studies genetics, the science of genes, heredity, and variation of organisms. (gene)
- 10) Gene Therapy is the therapeutic delivery of \_\_\_\_\_ acid polymers into a patient's cells as a drug to treat disease. (nucleus)

**9. Translate the following word combinations into English using words and expressions from the four texts:**

- 1) служить шаблоном
- 2) физические особенности
- 3) точная копия

- 4) конкретные гены
- 5) играть роль
- 6) дополнительная устойчивость
- 7) отличаться размером
- 8) вести учет генов

**10. Find what word is suitable in all three sentences:**

- A 1 The laboratory assistant \_\_\_\_\_ them to stop misbehaving.  
2 I came to the university in \_\_\_\_\_ to pass my calculus tasks.  
3 All peculiarities which each of us has are determined by the \_\_\_\_\_ inside the DNA strand.

- B 1 The surgeon placed catheters through the veins and arteries near the \_\_\_\_\_ of the head.  
2 The majority of \_\_\_\_\_ in a human genome is identical.  
3 This story is \_\_\_\_\_ on those time-honoured economic concepts, namely supply and demand.

- C 1 A row of spruce trees that \_\_\_\_\_ his view of the long north slope of the mountain.  
2 Nuisance calls from a known number can be \_\_\_\_\_ automatically.  
3 Nucleic acids are referred to sometimes as building \_\_\_\_\_ of life.

**11. Write a sentence with a set of words:**

- a) extensive; within; cell
- b) variety; molecular; label
- c) package; hereditary; serve as

**12. In which text is the following theme discussed:**

- a) the definition of nitrogenous bases;
- b) the uniqueness of an individual human being;
- c) the scale of structures necessary for location of genes;
- d) the comparison of DNA and RNA molecules;
- e) the structure of nucleic acids;

- f) how the genetic information is stored;
- g) an example of a research project.

**13. Read the following text carefully and fill in the gaps (you should use only one word in each gap):**

DNA is a 1)\_\_\_\_\_ that carries the genetic instructions for growth, development, functioning and reproduction, and delivers the information in the Correct Time and Sequence. All known 2)\_\_\_\_\_ organisms and many viruses have DNA. All 6 billion A, C, G and T letters provides precise instructions for how our bodies are built, and how they work. Every living thing exists because the translational system receives messages from DNA delivered to it by 3)\_\_\_\_\_ and translates the messages into 4)\_\_\_\_\_. The system centers on a cellular machine called the ribosome, which is made of multiple large molecules of RNA and protein and is ubiquitous in life as we know it. DNA and RNA are 5)\_\_\_\_\_ acids; alongside proteins, lipids and complex carbohydrates (polysaccharides), they are one of the four major types of macromolecules that are essential for all known 6)\_\_\_\_\_ of life. Most DNA molecules consist of two biopolymer 7)\_\_\_\_\_ coiled around each other to form a double 8)\_\_\_\_\_, which refers to the structure formed by double-stranded molecules of 9)\_\_\_\_\_ acids such as DNA, which contains the instructions for life, 10)\_\_\_\_\_ within genes. Within all cells, DNA is organized into very long lengths known as 11)\_\_\_\_\_. In animal and plant cells these are double-ended, like pieces of string or shoelaces, but in bacteria they are circular. Whether stringy or circular, these long 12)\_\_\_\_\_ must be organized and packaged inside a cell so that the genes can be switched on or off when they are required.

**14. Answer the questions:**

- 1) What is RNA?
- 2) How does RNA differ from DNA?
- 3) What is DNA?
- 4) What is called a nucleotide? How does it form a double helix?
- 5) What is the peculiarity of a DNA molecule which makes it so vital?
- 6) What is a gene? How many genes do humans have?
- 7) What is an allele?
- 8) What is the structure of a chromosome?
- 9) Can chromosomes be observed directly?

**15. Match beginnings and endings of the sentences:**

- |   |  |
|---|--|
| 1) Single-stranded RNA can also form many secondary structures in which a single RNA molecule folds over and forms hairpin loops,                 | a) to sequence, assemble, and analyze the function and structure of genomes (the complete set of DNA within a single cell of an organism).                                     |
| 2) Several forms of RNA play pivotal roles in gene expression—  | b) was the aperiodic crystal predicted by Schroedinger in his influential book “What's life”.  |
| 3) Genomics is a discipline in genetics that applies recombinant DNA, DNA sequencing methods, and bioinformatics                                  | c) stabilized by intramolecular hydrogen bonds between complementary bases.  |
| 4) The origin of DNA and DNA replication mechanisms is  | d) may not be coding after all because they have characteristics that are typical of non-coding or pseudogenes (obsolete coding genes).  |
| 5) Such extreme conception was in line with the idea that DNA   | e) these young cells can self-renew and give rise to all other types of blood cells.   |
| 6) Genetic Marker is a gene or DNA sequence with a known location on a chromosome   | f) the process responsible for manifesting the instructions stored in the sequence of DNA nucleotides in either RNA or protein molecules that carry out the cell's activities. |
| 7) Up to 20% of genes classified as coding (those that produce the proteins that are the building blocks of all living things)                    | g) from other low-complexity repetitive elements.  |
| 8) Much of the genomic dark matter is thought to originate from ancient transposable elements and   | h) leads to continual production of the appropriate specialized cells.   |
| 9) For treatment of most diseases by cell therapy, Stem Cells are chosen because their establishment in the patient                               | i) thus a critical question for our understanding of early life evolution.   |
| 10) The gene therapy treatment process currently requires isolating a very small population of hemopoietic stem cells from the blood of patients; | j) that can be used to identify individuals or species.  |

**16. Read the following text and choose the most suitable answer:**

### Genes and Language

*FOXP2* is not *the* gene that makes language happen; it's unlikely that any single gene exists solely to 1) \_\_\_\_\_ us to communicate. But genes like *FOXP2* interact with other genes in complex ways to build a language-ready brain. *FOXP2* could have a 2) \_\_\_\_\_ role in this process because it is a transcription factor — a protein that binds to and controls genetic information within cells. Scientists believe the *FOXP2* protein may help other genes 3) \_\_\_\_\_ themselves in the developing human brain in ways that ensure the learning of speech and language skills.

A 4) \_\_\_\_\_ copy of *FOXP2*, therefore, can 5) \_\_\_\_\_ the way the brain handles language. Indeed, 6) \_\_\_\_\_ brain imaging studies have shown that when people with a faulty *FOXP2* are involved in language tasks, they 7) \_\_\_\_\_ below-normal activity in the Broca's area, a brain region essential for speech production and language processing.

*FOXP2* has changed little throughout vertebrate evolution; the versions found in other species are only 8) \_\_\_\_\_ different than those found in humans. In animals, as in humans, defects in the gene can lead to communication problems. For example, if *FOXP2* is 9) \_\_\_\_\_ in the brains of young zebra finches, they go on to produce 10) \_\_\_\_\_, incomplete songs. When the gene is completely inactivated in baby mice, they have difficulty making their high-pitched squeaks.

- 1) a enable b make c manage
- 2) a performing b leading c playing
- 3) a express b show c provide
- 4) a successful b typical c defective
- 5) a refer b alter c soar
- 6) a sophisticated b ingenious c renounced
- 7) a reduce b prevent c exhibit
- 8) a slightly b absolutely c quite
- 9) a silence b silencing c silenced
- 10) a eaten b garbled c broken

## **SPEAKING**

### **17. Search for necessary information and prepare for oral reports:**

- a) What does deciphering human DNA give to science or industry?
- b) Do all living organisms have DNA?
- c) The connection between DNA and RNA
- d) Which diseases are hereditary?

### **18. Extended discussion:**

- 1) How does cloning work? Does it exist in nature?
- 2) What do we know about the origin of the DNA molecule in living cells?
- 3) What is a mutation? Discuss its pros and cons.

### **19. Challenge questions — test yourself!**

- 1) What is the shape of DNA called?

- 2) What is the function of RNA?
- 3) What role do chromosomes play in heredity?
- 4) How are genes and cancer connected?
- 5) What is evolution?
- 6) What is a nucleotide? Can you give its examples?
- 7) What is the phylogenetic tree?
- 8) How does DNA replication occur?

## **LISTENING**

**20. What senses do human have? What are disabilities connected to them called?**

**21. Listen to the audio from 60 Second Science podcasts from *Scientific American* and choose if the following statements are true or false:**

- 1) The senses of touch and hearing could be interconnected.
- 2) The study mentioned took into account both identical and fraternal twins.
- 3) Deaf people hardly ever have tactile issues.
- 4) Fraternal twins possess the same mutations due to genetic closeness.
- 5) The genome of identical twins has no variations at all.
- 6) All subjects of the research had congenital hearing issues.
- 7) Only a fifth of all people who passed the tests had both tactile and hearing issues.
- 8) Generally the study showed that subjects whose hearing wasn't quite acute couldn't successfully pass the touch test as well.

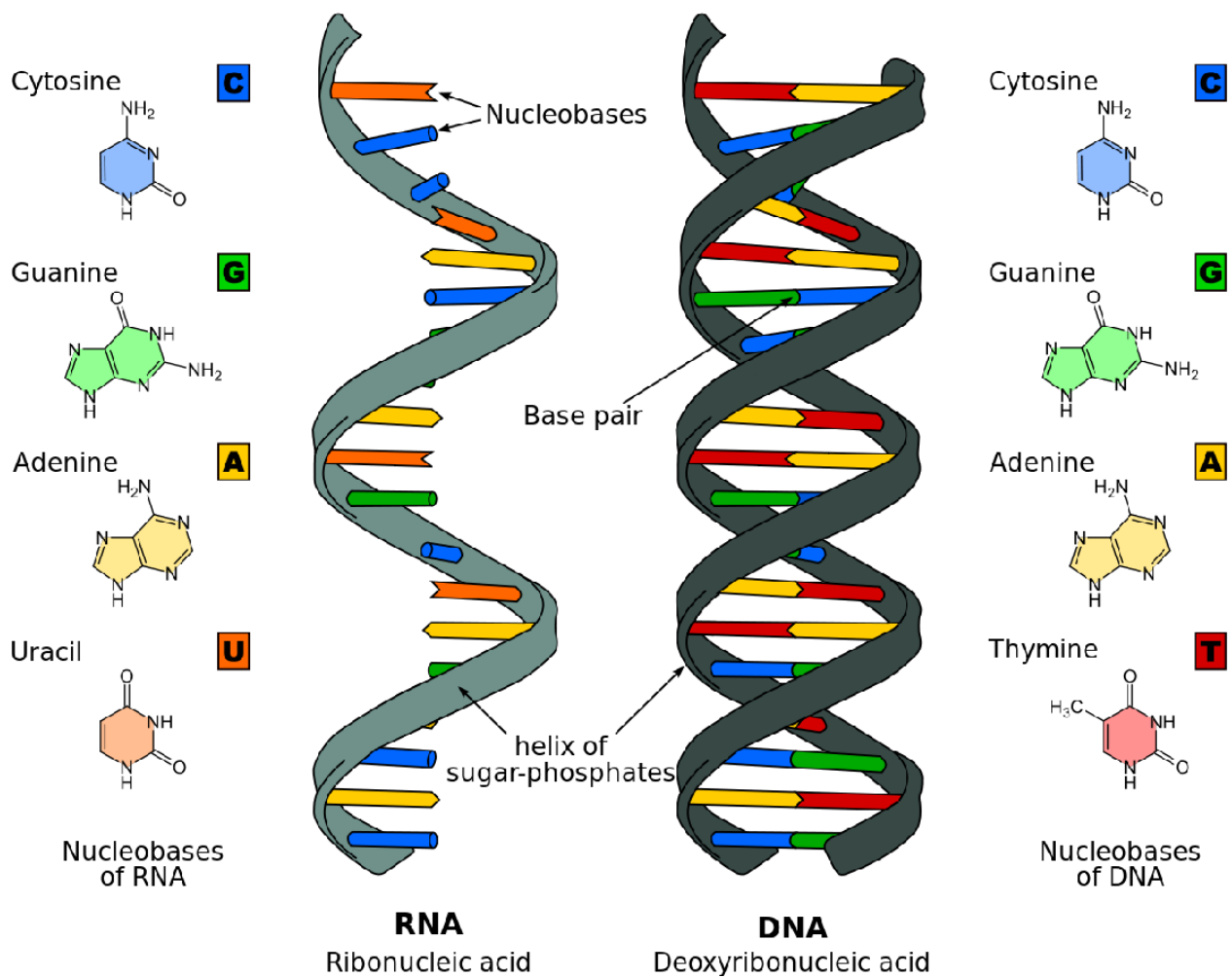
**22. Listen to the audio again and summarize the text in two-three sentences.**

**23. Do you know any other facts about twins? Can you share them with the class? You can think about:**

- 1) the reason twins, or triplets could be born;
- 2) are they truly undistinguishable in their appearance?
- 3) are their personalities alike too?
- 4) etc.

## **24. GRAPH DESCRIPTION**

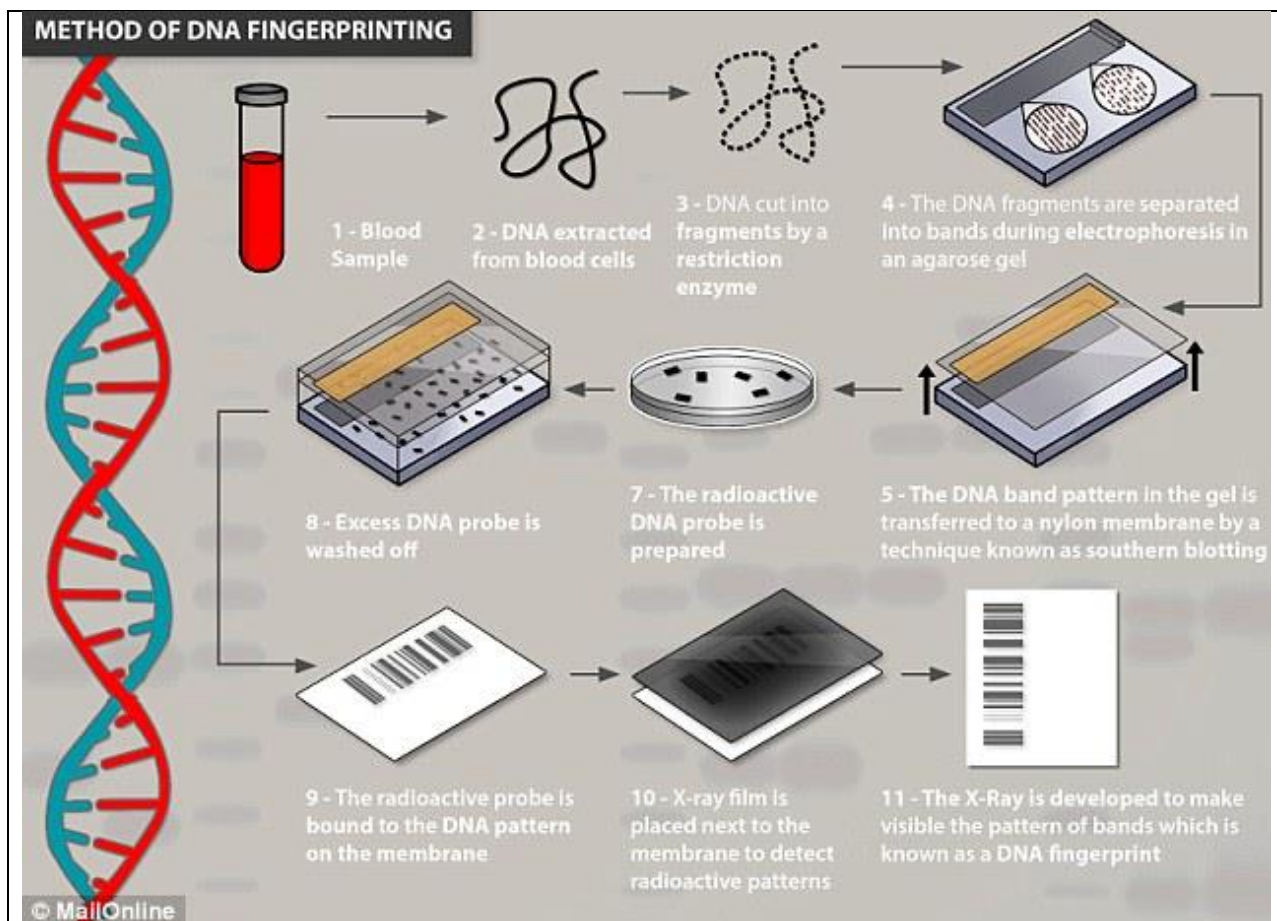
**Describe the graphs and compare the structures of RNA and DNA**



## 25. METHOD EXPLANATION

Using the facts below and the diagram of the method, explain how the method of DNA fingerprinting works:

- ✓ its main stages;
- ✓ its purpose;
- ✓ how do you use it.



About the method	<p>The DNA is isolated from the bodily sample, digested or amplified using restriction digestion or PCR, respectively. Using either agarose gel electrophoresis or sequencing, the DNA fragments are separated and identified.</p> <p>Though the PCR based method for DNA fingerprinting is accurate and too fast but after the discovery of real-time PCR and DNA sequencing, it becomes even more powerful. The molecular tools available nowadays create 100% accurate patterns of a person's DNA.</p>
Working mechanism	<p><b>Step 1: Sample collection:</b> DNA can be obtained from any bodily sample or fluid. Buccal smear, saliva, blood, amniotic fluid, chorionic villi, skin, hair, body fluid, and other tissues are the major types of samples used.</p> <p><b>Step 2: DNA extraction</b> To perform any genetic applications, DNA extraction is one of the most significant steps. Good quality and quantity DNA increases the possibilities of getting good results. The purity and quantity of DNA should be ~1.80 and 100ng, respectively to perform the DNA test. Purify the DNA using the DNA purification kit, if needed.</p> <p><b>Step 3: Restriction digestion, amplification or DNA sequencing</b></p> <p><b>Step 4: Analysis of results</b> As we discussed, using the southern blotting, agarose gel electrophoresis, capillary electrophoresis, real-time amplification, and DNA sequencing, the results for various DNA profiling can be obtained in which rt-PCR and sequencing are frequently used in forensic.</p>



	<p>Step 5: Interpreting results</p> <p>By comparing DNA profiles of various samples, variations and similarities between individuals can be identified. Notably, the entire process is now almost automated. We do not have to do anything, the computer gives us the final results.</p>
Tips	<p>Three common methods are used:</p> <ul style="list-style-type: none"> <li>• RFLP based STR analysis</li> <li>• PCR based analysis</li> <li>• Real-time PCR analysis</li> </ul>
Application	<p>The present method is employed usually in criminal verification and crime scene investigation. However, it is also applicable to establishing a relationship between two persons and to know someone's identity. The testing method is practiced not only for humans but also for any organisms present on earth.</p> <p>Moreover, scientists use the present method to screen inherited &amp; non-inherited disease, to find genetic abnormalities, to detect any genetic disorders or mutations, and to create phylogeny between various organisms.</p>

## WRITING

**26. Imagine that you are writing a scientific article connected with studying DNA, RNA or genes. Write an introductory paragraph to this article explaining the significance of the chosen topic. Volume is 250-300 words.**

In the introduction, teach the reader about your subject. Define the subject; explain the problem under the research. What are you investigating? Why is it important?

Introduce previous studies which are vital to your research: the basis of your research.

Talk about the reason why you need to perform the experiment or do the research: the novelty of your study.

In the end write the major finding of your research.

### Useful vocabulary

#### 1) Linking words representing time and connection between subtopics:

- nowadays, currently, today, here, as a starting point, historically, fundamentally, basically, in recent years, in the last/past few years;
- in this regard, consequently, in addition;

#### 2) Framing phrases explaining the significance of the problem under study:

- [...] is also substantial and estimated to be...
- [...] appears to be of particular interest because it allows...
- To demonstrate the concept,...
- Nowadays, scientists and engineers are intensifying efforts to develop...
- The strategies can entail many aspects/spheres, for example,...

- [...] has received a great deal of attention;
- An active research area in [...] approach to [...] problem is...
- This aspect is essentially important when...
- To the best of our knowledge,...

### **3) Framing phrases about previous works:**

- Previous studies have shown/ indicate (that)...
- There is a large body of literature documenting the use of [...] in characterizing...
- To date, however, no [...] has been applied to study...
- The design/research of [...] has been presented as early as the 1980s;
- [...] is reported so far;
- Some representative theoretical investigations on [...] have been performed;
- All in all, so far limited experimental data of interest exist for...
- The generally accepted reason for this is...
- Upon its discovery in the late 1990s,...
- It is this that starts to form the basis of our...
- The first clues [...] emerged in the 1980s;
- Back in the mid-1990s, while trying to discover new treatments for...
- A consensus is building among researchers that..

### **4) Framing phrases about the current work:**

- A new mechanism was proposed...
- In this paper we report the first such demonstration of ...
- We envision that, in the future, the technique will be applied to...
- This review/research/study is focused on the current state and perspectives of...
- A further investigation into [...] would be helpful to gain an in-depth understanding in many respects;
- In the present study, we aim to probe...
- The results of this work can provide valuable information for...
- Here we present, to our knowledge, the first study...
- One strategy that we and our colleagues have developed is...

## PART 3

### Proteins at Work

*Proteins are the machinery of living tissue that builds the structures and carries out the chemical reactions necessary for life.*

*Michael Behe*

#### LEAD-IN

##### 1. Answer the questions:

- 1) What is a nutrient?
- 2) What nutrients does a human body need?
- 3) Where can we take nutrients from?
- 4) What are pros and cons of these substances?

##### 2. Functions of proteins.

Proteins perform essential functions throughout the systems of the human body. These long chains of amino acids are critically important for:

- catalyzing chemical reactions
- synthesizing and repairing DNA
- transporting materials across the cell
- receiving and sending chemical signals
- responding to stimuli
- providing structural support

#### READING 1

##### 3. Read the following texts and choose the correct variant for the answer.

###### A. Proteins

Proteins (a polymer) are macromolecules composed of amino acid subunits (the monomers ). These amino acids are covalently attached to one another to form long linear chains called polypeptides, which then fold into a specific three-dimensional shape. Sometimes these folded polypeptide chains are functional by themselves. Other times they combine with additional polypeptide chains to form the final protein structure. Sometimes non-polypeptide groups are also required in the final protein. For instance, the blood protein hemoglobin is made up of four polypeptide chains, each of which also contains a heme molecule, which is ring structure with an iron atom in its center.

Proteins have different shapes and molecular weights, depending on the amino acid sequence. For example, hemoglobin is a globular protein, which means it folds into a compact globe-like structure, but collagen, found in our skin, is a fibrous protein, which means it folds into a long extended fiber-like chain. You probably look similar to your family members because you share similar proteins, but you look different from strangers because the proteins in your eyes, hair, and the rest of your body are different.

Because form determines function, any slight change to a protein's shape may cause the protein to become dysfunctional. Small changes in the amino acid sequence of a protein can cause devastating genetic diseases such as Huntington's disease or sickle cell anemia.

**Question A1:**

**What does the example of hemoglobin illustrate in the text A?**

- a) folded polypeptide chains
- b) globe-like structure
- c) a fibrous protein
- d) why strangers look different

**Question A2:**

**The shape of the protein is vital due to... (choose which answer doesn't fit)**

- a) amino acid sequence
- b) the creation of family resemblance
- c) the determination of protein functions
- d) inducing genetic disease

**B. Enzymes**

Enzymes are proteins that catalyze biochemical reactions, which otherwise would not take place. These enzymes are essential for chemical processes like digestion and cellular metabolism. Without enzymes, most physiological processes would proceed so slowly (or not at all) that life could not exist.

Because form determines function, each enzyme is specific to its substrates. The substrates are the reactants that undergo the chemical reaction catalyzed by the enzyme. The location where substrates bind to or interact with the enzyme is known as the active site, because that is the site where the chemistry occurs. When the substrate binds to its active site at the enzyme, the enzyme may help in its breakdown, rearrangement, or synthesis. By placing the substrate into a specific shape and microenvironment in the active site, the enzyme encourages the chemical reaction to occur. There are two basic classes of enzymes:

- Catabolic enzymes: enzymes that break down their substrate
- Anabolic enzymes: enzymes that build more complex molecules from their substrates

Enzymes are essential for digestion: the process of breaking larger food molecules down into subunits small enough to diffuse through a cell membrane and to be used by the cell. These enzymes include amylase, which catalyzes the digestion carbohydrates in the mouth and small intestine; pepsin, which catalyzes the digestion of proteins in the stomach; lipase, which catalyzes reactions need to

emulsify fats in the small intestine; and trypsin, which catalyzes the further digestion of proteins in the small intestine.

Enzymes are also essential for biosynthesis: the process of making new, complex molecules from the smaller subunits that are provided to or generated by the cell. These biosynthetic enzymes include DNA Polymerase, which catalyzes the synthesis of new strands of the genetic material before cell division; fatty acid synthetase, which the synthesis of new fatty acids for fat or membrane lipid formation; and components of the ribosome, which catalyzes the formation of new polypeptides from amino acid monomers.

**Question B1:**

**The connection between a substrate, an enzyme and a chemical reaction is the following:**

- a) enzyme – catalyst, substrate – result, chemical reaction - object
- b) enzyme – object, substrate – result, chemical reaction - catalyst
- c) enzyme – catalyst, substrate – object, chemical reaction - result
- d) enzyme – result, substrate – catalyst, chemical reaction - object

**Question B2:**

**Enzymes may help in several different functions. Which function does an enzyme called pepsin fulfil?**

- a) breakdown
- b) rearrangement
- c) synthesis

**C. Hormones**

Some proteins function as chemical-signaling molecules called hormones. These proteins are secreted by endocrine cells that act to control or regulate specific physiological processes, which include growth, development, metabolism, and reproduction. For example, insulin is a protein hormone that helps to regulate blood glucose levels. Other proteins act as receptors to detect the concentrations of chemicals and send signals to respond. Some types of hormones, such as estrogen and testosterone, are lipid steroids, not proteins.

**Question C:**

**Which of the following is a protein secreted by endocrine cells?**

- a) insulin
- b) lipid steroid
- c) estrogen
- d) testosterone

**D. Other Protein Functions**

Proteins perform essential functions throughout the systems of the human body. In the respiratory system, hemoglobin (composed of four protein subunits) transports oxygen for use in cellular

metabolism. Additional proteins in the blood plasma and lymph carry nutrients and metabolic waste products throughout the body. The proteins actin and tubulin form cellular structures, while keratin forms the structural support for the dead cells that become fingernails and hair. Antibodies, also called immunoglobins, help recognize and destroy foreign pathogens in the immune system. Actin and myosin allow muscles to contract, while albumin nourishes the early development of an embryo or a seedling.

#### **Question D:**

**What function is not mentioned in the text D?**

- a) transportation
- b) protection from diseases
- c) catalysing
- d) nourishing

#### **4. Translate the words and expressions into English using phrases from the texts:**

- a) реагировать на раздражители;
- b) переносить питательные вещества;
- c) неотъемлемы для пищеварения;
- d) малейшие изменения формы;
- e) функционируют самостоятельно;
- f) просочиться через мембрану;
- g) которые в противном случае не произойдут;
- h) по клетке;
- i) дыхательная система;
- j) желудок.

#### **READING 2**

**5. Read the following text and insert phrases taken from it back to their places. There are extra phrases which you don't need.**

- causing a change in protein structure and therefore function;
- and they play an important structural role in most globular and fibrous proteins;
- to determine how the protein gets its final shape or conformation;
- and therefore two different folds of a protein usually have two different levels of energy;
- and are not involved in the H bonds that maintain the  $\alpha$ -helix structure;

- that is, proteins made from more than one polypeptide chain;
- for example, fibrous proteins are not soluble in water;
- so complete protein structures were very slow to be solved;
- when the amino acid glutamic acid is replaced by valine in the  $\beta$  chain;
- that directs which amino acids are linked together;
- the stretches of amino acids in  $\beta$ -pleated sheets are held in their pleated sheet structure;
- once all the secondary structure elements have folded together among each other.

## Protein Structure

The shape of a protein is critical to its function because it determines whether the protein can interact with other molecules. Protein structures are very complex, and researchers have only very recently been able to easily and quickly determine the structure of complete proteins down to the atomic level. (The techniques used date back to the 1950s, but until recently they were very slow and **laborious** to use, 1) \_\_\_\_\_.) Early structural biochemists conceptually divided protein structures into four “levels” to make it easier to get a handle on the complexity of the overall structures. 2) \_\_\_\_\_, we need to understand these four levels of protein structure: **primary**, secondary, **tertiary**, and **quaternary**.

A protein’s primary structure is the unique sequence of amino acids in each polypeptide chain that makes up the protein. Really, this is just a list of which amino acids appear in which order in a polypeptide chain, not really a structure. But, because the final protein structure **ultimately** depends on this sequence, this was called the primary structure of the polypeptide chain. For example, the pancreatic hormone insulin has two polypeptide chains, A and B.

The gene, or sequence of DNA, ultimately determines the unique sequence of amino acids in each peptide chain. A change in nucleotide sequence of the gene’s coding region may lead to a different amino acid being added to the growing polypeptide chain, 3) \_\_\_\_\_.

The oxygen-transport protein hemoglobin consists of four polypeptide chains, two identical  $\alpha$  chains and two identical  $\beta$  chains. In sickle cell anemia, a single amino **substitution** in the hemoglobin  $\beta$  chain causes a change the structure of the **entire** protein. 4) \_\_\_\_\_, the polypeptide folds into an slightly-different shape that creates a dysfunctional hemoglobin protein. So, just one amino acid substitution can cause dramatic changes. These dysfunctional hemoglobin proteins, under low-oxygen conditions, start associating with one another, forming long fibers made from millions of aggregated hemoglobins that distort the red blood cells into crescent or “sickle” shapes, which clog arteries. People affected by the disease often experience breathlessness, **dizziness**, headaches, and **abdominal** pain.

A protein’s secondary structure is whatever regular structures **arise** from interactions between neighboring or near-by amino acids as the polypeptide starts to fold into its functional three-dimensional form. Secondary structures arise as H bonds form between local groups of amino acids in a region of the polypeptide chain. Rarely does a single secondary structure extend throughout the polypeptide chain. It is usually just in a section of the chain. The most common forms of secondary structure are the  $\alpha$ -helix and  $\beta$ -pleated sheet structures 5) \_\_\_\_\_.

In the  $\alpha$ -helix chain, the hydrogen bond forms between the oxygen atom in the polypeptide backbone carbonyl group in one amino acid and the hydrogen atom in the polypeptide backbone amino group of another amino acid that is four amino acids farther along the chain. This holds the stretch of amino acids in a right-handed coil. Every helical turn in an alpha helix has 3.6 amino acid residues. The R groups (the side chains) of the polypeptide protrude out from the  $\alpha$ -helix chain 6)

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In  $\beta$ -pleated sheets, stretches of amino acids are held in an almost fully-extended conformation that “pleats” or zig-zags due to the non-linear nature of single C-C and C-N covalent bonds.  $\beta$ -pleated sheets never occur alone. They have to be held in place by other  $\beta$ -pleated sheets. 7)

\_\_\_\_\_ because hydrogen bonds form between the oxygen atom in a polypeptide backbone carbonyl group of one  $\beta$ -pleated sheet and the hydrogen atom in a polypeptide backbone amino group of another  $\beta$ -pleated sheet. The  $\beta$ -pleated sheets which hold each other together **align** parallel or antiparallel to each other. The R groups of the amino acids in a  $\beta$ -pleated sheet point out perpendicular to the hydrogen bonds holding the  $\beta$ -pleated sheets together, and are not involved in maintaining the  $\beta$ -pleated sheet structure.

The tertiary structure of a polypeptide chain is its overall three-dimensional shape, 8)  
\_\_\_\_\_. Interactions between polar, nonpolar, acidic, and basic R groups within the polypeptide chain create the complex three-dimensional tertiary structure of a protein. When protein folding takes place in the **aqueous** environment of the body, the hydrophobic R groups of nonpolar amino acids mostly lie in the interior of the protein, while the hydrophilic R groups lie mostly on the outside. Cysteine side chains form disulfide linkages in the presence of oxygen, the only covalent bond forming during protein folding. All of these interactions, weak and strong, determine the final three-dimensional shape of the protein. When a protein loses its three-dimensional shape, it will no longer be functional.

The quaternary structure of a protein is how its subunits are oriented and arranged with respect to one another. As a result, quaternary structure only applies to multi-subunit proteins; 9)  
\_\_\_\_\_. Proteins made from a single polypeptide will not have a quaternary structure.

In proteins with more than one subunit, weak interactions between the subunits help to stabilize the overall structure. Enzymes often play key roles in bonding subunits to form the final, functioning protein.

For example, insulin is a ball-shaped, globular protein that contains both hydrogen bonds and disulfide bonds that hold its two polypeptide chains together. Silk is a fibrous protein that results from hydrogen bonding between different  $\beta$ -pleated chains.

## POST-READING

### VOCABULARY

#### 6. Find in the text synonyms (in bold) to the following words:

- |              |              |
|--------------|--------------|
| 1) fully     | 5) the whole |
| 2) stomach   | 6) exchange  |
| 3) four      | 7) first     |
| 4) difficult | 8) three     |



9) water

11) appear

10) disorientation

12) order

## 7. Fill in the gaps:

### Part A

substitution dizziness enzyme headache conformation residue linkage silk backbone  
crescent

1) That day he had a terrible \_\_\_\_\_ and couldn't focus on work at all before taking an aspirin.

2) Ancient astronomers pointed out the connection between people's personalities and the \_\_\_\_\_ of some planets.

3) A \_\_\_\_\_ modeled as a network of rigid links and ideal joints is called a kinematic chain.

4) Some materials such as \_\_\_\_\_ are known not to conduct electricity and to have been used in experiments since old days.

5) The \_\_\_\_\_ of the number in the equation should have changed the result but we don't observe it in this case.

6) A large corporation that has many locations may have a \_\_\_\_\_ network that ties all of the locations together.

7) \_\_\_\_\_ can be a symptom of many diseases, so before jumping to conclusions, you'd better see the doctor.

8) A \_\_\_\_\_ shape represents the lunar phase in the first quarter.

9) In this chemical reaction a \_\_\_\_\_ of the white colour can be observed on the bottom of the vial.

10) Another general improvement is that \_\_\_\_\_ enhance the effectiveness of other supplements, diets, and therapies.

### Part B

arise entire ultimately pancreatic align acidic aqueous laborious primary tertiary

1) Few tasks are as \_\_\_\_\_ as comparing electronic data from several years with archive notes.

2) Our \_\_\_\_\_ goal is to prove the existence of the phenomenon not explaining how it happens.

3) An \_\_\_\_\_ aisle was forbidden for entering after the accident in the laboratory.

- 4) \_\_\_\_\_ juices dissolve proteins.
- 5) Under \_\_\_\_\_ conditions, the solution is red, and under alkaline conditions, the solution is blue.
- 6) New questions \_\_\_\_\_ from previous ones having been answered.
- 7) Taking into consideration its properties, a \_\_\_\_\_ carbon atom cannot occur in linear alkanes.
- 8) Litmus, being used in chemistry as paper or an \_\_\_\_\_ solution, can be found in different species of lichens.
- 9) Does responsibility for the discovery \_\_\_\_\_ lie with the scientists who made it?
- 10) Amino acids in the DNA molecule \_\_\_\_\_ in particular way which determines heredity of an organism.

**8. Change words in brackets so that they are grammatically correct for the sentence:**

- 1) Enzymes can be \_\_\_\_\_ (like) to the starter in your automobile; they ignite the process into action and the speed is \_\_\_\_\_ (depend) on the amount of power under the hood (a full-spectrum of enzymes for specific jobs, working in powerful \_\_\_\_\_ (synchronic) to enhance performance).
- 2) It is also important to remember enzymes are not nutrients \_\_\_\_\_ (they) but rather work with the nutrition that is in the food or \_\_\_\_\_ (supply) you are consuming.
- 3) Botanists of the 19th century \_\_\_\_\_ (general) accepted the idea that yeasts belong to the plant \_\_\_\_\_ (king).
- 4) The \_\_\_\_\_ (apply) of electrophysiological approaches to the analysis of nuclear function was practically \_\_\_\_\_ (continue) because the measurement of NE resistance was carried out with microelectrodes and the concern prevailed with microelectrode \_\_\_\_\_ (plug) during their insertion into the cell and nucleus.
- 5) A decade ago, \_\_\_\_\_ (periphery) channels for ion \_\_\_\_\_ (fuse) were proposed based on EM reconstruction studies.
- 6) Rather than \_\_\_\_\_ (simple) sending single photons toward a volunteer's eye through either the left or the right fiber, the idea is to send photons in a quantum superposition of \_\_\_\_\_ (effect) traversing both fibers at once.
- 7) \_\_\_\_\_ (sequence), enzymes are involved in every \_\_\_\_\_ (metabolism) activity in the body—from digesting and \_\_\_\_\_ (similar) food to catalyzing the thousands of reactions that are necessary for the body to function in the activities of life.
- 8) Since that time, a number of \_\_\_\_\_ (advance) in the field have \_\_\_\_\_ (occurrence) and become commonplace in the world of human health care.
- 9) \_\_\_\_\_ (vary) industries such as manufacturing, pharmaceuticals, health care and government are all estimated to have a larger need for people \_\_\_\_\_ (knowledge) about this field.

10) \_\_\_\_\_ (cell) components, such as the mitotic spindle which is present during division, have also been shown to have elastic properties – for example, the mitotic spindle can regain its shape after \_\_\_\_\_ (part) squashing.

**9. Find what word is suitable in all three sentences:**

A 1) Amino acids interact with each other in order to make a distinct three-dimensional structure, the \_\_\_\_\_ protein, known as the native state.

2) During the pandemic a lot of small business had \_\_\_\_\_ because of lack of customers.

3) He checked that nobody was hiding in the \_\_\_\_\_ of drapery and behind the bookshelf before starting to talk.

B 1) We are trying to bring together several \_\_\_\_\_ of the theory to create the complete picture.

2) Because of thick fog five flights were delayed leaving hundreds of passengers \_\_\_\_\_.

3) The molecule of DNA is proved to consist of two \_\_\_\_\_.

C 1) I was so nervous to give a speech that my \_\_\_\_\_ was in knots.

2) To do this exercise, you must lie on your \_\_\_\_\_, raise both hands and feet and keep them up for a minute.

3) At the dawn of the theory of relativity, quite many people couldn't \_\_\_\_\_ it.

**10. Write a sentence with a set of words:**

a) aqueous; with respect to; environment

b) once; acid; throughout

c) backbone; sequence; align

**11. Choose if the following statements are true or false according to the article:**

1) According to biochemistry, proteins have four levels of complexity.

2) Scientists could easily solve the structure of proteins since 1950s.

3) Nucleotide sequence of how a gene is coded has a connection with protein structure but not its function.

4) The primary structure is name so since it can be considered a foundation of any final protein.

5) Interactions between amino acids located in close vicinity make the secondary structure.

- 6) A single secondary structure almost never fills the whole polypeptide chain.
- 7) The tertiary structure is three-dimensional.
- 8)  $\alpha$ -helix chain and  $\beta$ -pleated sheet are the only types of secondary structure.
- 9) During protein folding, the hydrophobic R-groups are outside and the hydrophilic ones are inside the protein.
- 10) In case of  $\alpha$ -helix chain, two amino acids are connected with a hydrogen bond.
- 11) A protein can't work without its three-dimensional shape.
- 12)  $\beta$ -pleated sheets can be only parallel to each other.
- 13) Any protein has the quaternary structure.
- 14) Rarely are enzymes needed in completing of a protein.

## **12. Answer the questions:**

- 1) What is the protein?
- 2) What is the connection between the shape and function of the protein?
- 3) What is the enzyme?
- 4) What roles does the enzyme play in biology?
- 5) What is the hormone?
- 6) What is the reason to conceptually divide the protein into "levels"?
- 7) How many levels are there in the protein structure?
- 8) What is included in the primary level?
- 9) Which level makes the three-dimensional shape of the protein?
- 10) Do all proteins have a quaternary structure?

## **13. Complete the text using only one word in each gap. The word can be of any part of speech and grammatical form.**

### Enzymes and Aging

As we grow \_\_\_\_\_ our bodies are faced with an array of age-related disorders. If you study societies as they age and their corresponding disease rates, you can see a clear parallel \_\_\_\_\_ increase \_\_\_\_\_ age and the occurrence \_\_\_\_\_ diseases.

Enzymes are the most powerful weapon we have \_\_\_\_\_ these diseases of age, and possibly a significant factor in avoiding age-related diseases.

The benefits of enzymes can be verified by solid scientific \_\_\_\_\_, including clinical studies. We also know that systemic \_\_\_\_\_ therapy is helpful in supporting the immune system and the immune system is affected by every disease.

Enzymes are active throughout and benefit the entire body, \_\_\_\_\_ just the immune system. Generally speaking, aging is a dehydration of the body's protein \_\_\_\_\_ –sometimes referred to as protein polymerization.

This is actually \_\_\_\_\_ we wrinkle as we age. These dehydrated \_\_\_\_\_ lose their flexibility, specifically under the skin. Proteases, such as \_\_\_\_\_ in systemic enzymes, hydrate the proteins \_\_\_\_\_ depolarizing them. This is a very important anti-aging mechanism and may actually prevent \_\_\_\_\_ repair the skin's wrinkled look.

Taking protease enzymes orally may \_\_\_\_\_ reduce the pain, swelling and overall discomfort of varicose veins, phlebitis and post-thrombotic syndrome. Enzymes improve \_\_\_\_\_ circulation and therefore reduce the risk of thrombosis.

\_\_\_\_\_ regular use of enzymes people can enjoy a better quality of life. As more of our aging population realizes the benefit of enzymes, \_\_\_\_\_ 90-year-olds will enjoy life \_\_\_\_\_ good health.

Life is aging and aging is a process. Aging is relative. Compared to the drosophila fly, the human \_\_\_\_\_ span is long; compared to the redwood tree, the human \_\_\_\_\_ span is short.

Aging is a \_\_\_\_\_ parameter. The rate \_\_\_\_\_ which you age is determined by three factors: your genetic \_\_\_\_\_, your life style and your nutritional habits. We can only influence aging \_\_\_\_\_ changing our life style and our nutrition.

#### 14. Match beginnings and endings of the sentences:

- |  |  |
|--|--|
| 1) While the spikes as a whole were over 97% similar,  | a) whether this happened directly from corona-viruses in bats or via an intermediary species.  |
| 2) It is not yet known how SARS-CoV-2 evolved to infect humans and   | b) the researchers took a look at the viral "spike proteins" that are essential for virus entry.   |
| 3) Based on their findings, the researchers suggest it is unlikely that a bat virus similar to RaTG13  | c) therefore have potential to make the virus either more or less able to enter the host's cell.   |
| 4) Changes in the virus' genome, which affect the spike's structure,   | d) the highest affinity for bats and human ACE2, with lower values of affinity for cats, horses, dogs, cattle and chickens.                  |
| 5) The researchers computationally modeled the attachment of SARS-CoV-2 protein spike to ACE2, which is located in the upper respiratory tract and | e) the results highlight the need for further study of the biological mechanisms responsible for COVID-19 infection and disease progression. |

- |   |  |
|---|--|
| 6) Simulations of viral attachment to homologous ACE2 proteins of bats, cattle, chickens, horses, felines and canines showed                  | f) the researchers found a number of significant differences at the location where SARS-CoV-2 binds with a receptor on human cells, called ACE2, and at the surfaces that keep the subunits of the spike together. |
| 7) Understanding the binding behavior of the virus spike with ACE2 and the virus tolerance of these structural spike changes                  | g) serves as the entry point for other coronaviruses, including SARS.  |
| 8) Considering the clinical manifestations of COVID-19, with acute respiratory distress syndrome and extensive damage to the lung parenchyma, | h) leading to upregulation during SARS-CoV-2 infection.  |
| 9) Recent studies suggest that ACE2 could be an interferon-induced gene,  | i) could infect human cells.   |
| 10) To understand how these differences in tissue tropisms can be explained,  | j) could inform future research on vaccine durability and the potential for the virus to spread to other species.  |

**15. Read the following facts about proteins carefully and fill in the gaps (you should use only one word in each gap):**

- 1) Proteins are long \_\_\_\_\_ chains of amino acids;
- 2) Each amino acid has a specific structure which contains a \_\_\_\_\_ backbone similar to all amino acids and a \_\_\_\_\_ which varies between the amino acids;
- 3) A protein's \_\_\_\_\_ determines its function;
- 4) Enzymes catalyze biochemical reactions by speeding up chemical reactions, and can either break down their \_\_\_\_\_ or build larger molecules from their \_\_\_\_\_;
- 5) Hormones are a \_\_\_\_\_ of protein used for cell signaling and communication;
- 6) A protein has multiple levels of structure
  - primary structure – a one-\_\_\_\_\_ chain of amino acids;
  - secondary structure – chains of structural elements, most significant of which are \_\_\_\_\_ and  $\beta$ -sheets;
  - \_\_\_\_\_ and \_\_\_\_\_ structure – 3D structure, of a single amino acid chain or several chains, respectively.

**WRITING**

**16. What is the difference between quotation, paraphrase or summary? Read the following material and match a technique (1-5) with the suitable example (a-e).**

### **Paraphrasing techniques**

1. Use Synonyms
2. Change from Active to Passive
3. Change from Positive to Negative
4. Change Word Forms
5. Change the Order of Information

### **Examples**

The original sentence:

*DNA-based tests are useful to discover, well in advance, whether the individuals or their offspring's are at risk for any genetic disease.*

*(the article Use of DNA in the Diagnosis of Infectious and Genetic Diseases)*

- a) According to the article *Use of DNA in the Diagnosis of Infectious and Genetic Diseases*, to assure that the individuals or their offspring's have no genetic disease as early as possible, the use of DNA-based tests is widespread.
- b) According to the article *Use of DNA in the Diagnosis of Infectious and Genetic Diseases*, DNA-based tests are efficient to discover, well beforehand, if the individuals or their children are susceptible to any genetic disease
- c) According to the article *Use of DNA in the Diagnosis of Infectious and Genetic Diseases*, DNA-based tests can be put into use to discover, well in advance, whether the individuals or their offspring's suffer from any genetic disease.
- d) According to the article *Use of DNA in the Diagnosis of Infectious and Genetic Diseases*, whether the individuals or their offspring's are at risk for any genetic disease can be checked well in advance with the use of DNA-based tests.
- e) According to the article *Use of DNA in the Diagnosis of Infectious and Genetic Diseases*, to discover, well in advance, whether the individuals or their offspring's are at risk for any genetic disease, DNA-based tests are useful.

**17. Paraphrase the following text using techniques from exercise 16 and reporting means (reporting verbs and phrases):**

### **The birth and death of proteins in a single cell**

When it comes to stem cells, the constant variation of transcription factors (proteins that regulate the expression of genes) has important consequences on their ability to differentiate into mature cells. But what we don't know is how protein synthesis and degradation work together to regulate these fluctuations is not known.

The lab of David Suter at EPFL, in collaboration with the team of Félix Naef has now developed a new method that can distinguish changes in protein synthesis from changes in protein degradation in single living cells. The method, published in *Molecular Cell*, uses a fluorescent timer combined with pulse-chase fluorescent labelling, which is a technique that can track a cellular process occurring over time.

Using their new method, the scientists made two discoveries. First, that protein synthesis and degradation rates change significantly during the cell cycle, with almost half of them stopping to be degraded during mitosis.

The second discovery was that protein degradation rates differ largely between individual cells. This variability affects all proteins to a similar extent, suggesting fluctuations in the activity of proteasomes -- the protein complexes that degrade unneeded or damaged proteins. Remarkably, these differences are offset by corresponding changes in protein synthesis rates, thereby allowing to minimize variability in protein expression levels between cells.

"Think of it as two factories," explains David Suter. "Factory A makes a lot of bad quality product X, meaning they are quickly out of order. Factory B makes less of high-quality product Y, which works for a longer period of time."

## **SPEAKING**

**18. Role play: Student A is a teacher on a seminar who is clarifying the role of proteins in a living organism. Student B is a student who doesn't understand the material completely and is prone to ask many questions. Decide what language will be appropriate to use and prepare a dialogue (you are allowed to agree in advance what questions will be asked and find the information together before acting the dialogue out).**

**Example questions: What will happen to the organism if it doesn't consume proteins? Is a protein involved in the work of respiratory system? Are proteins more or less important for the work of the human brain?**

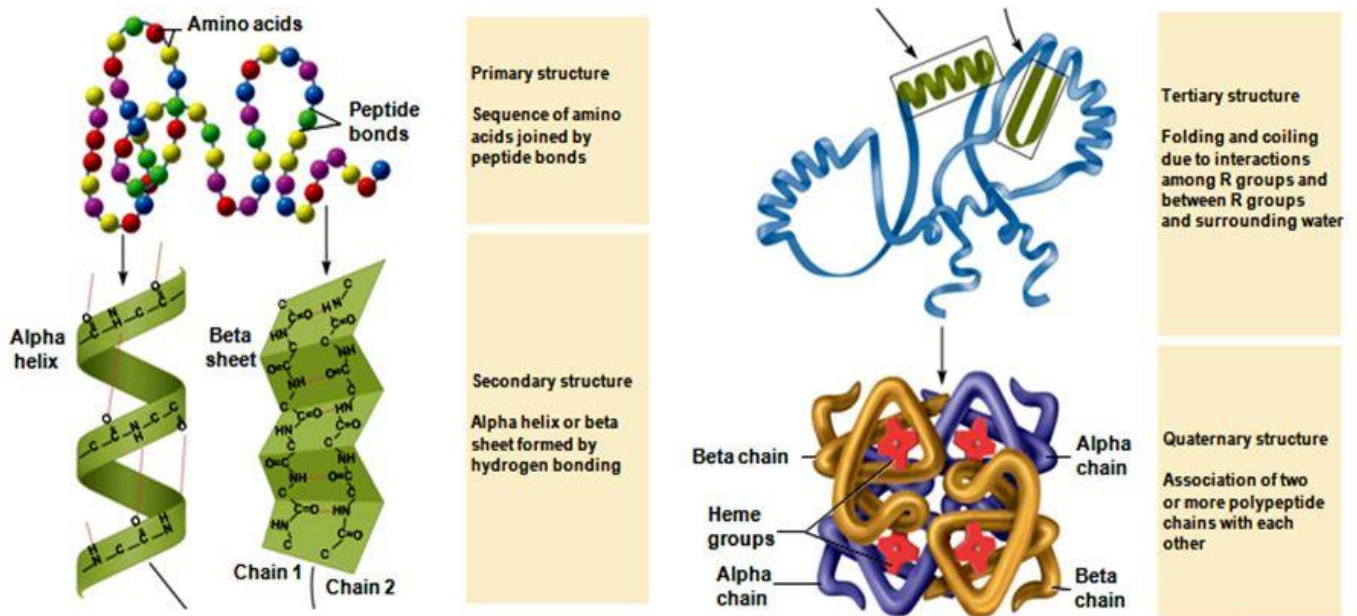
## **19. Challenge questions — test yourself!**

- 1) What human hormones do you know? What do they cause?
- 2) What are the following diseases: rabies, malaria, typhoid, cholera? What are their causative agents?
- 3) What are vitamins? What is their role in the organism? What can their lack lead to?
- 4) Why are enzymes essential for life? Give some examples, e.g. digestive enzyme.
- 5) What does biochemistry study? What questions are essential for its modern research?
- 6) What is bioinformatics? What sphere of life does it deal with?
- 7) What branch of science is neuroproteomics? What are its goals and objectives?
- 8) What are other biologically important molecules apart for proteins? What roles do they play?
- 9) What are AIDS and HIV?



20. Describe the graph:

## Four Levels of Protein Structure



### LISTENING

21. Listen to the monologue and fill in the notes with missing information:

## A 1) \_\_\_\_\_ protein

- o Provide 2) \_\_\_\_\_ support for tissues e.g. collagen
- o Collagen types found in various body parts have 3) \_\_\_\_\_ differences
- o Single amino acid changes in primary sequence can 4) \_\_\_\_\_ tertiary and quaternary structure and have a major effect on function
- o Primary sequence mutations: common cause of inherited diseases e.g. Osteogenesis imperfecta and Brittle 5) \_\_\_\_\_ syndrome

### 22. Listen to the monologue again and choose the correct answer:

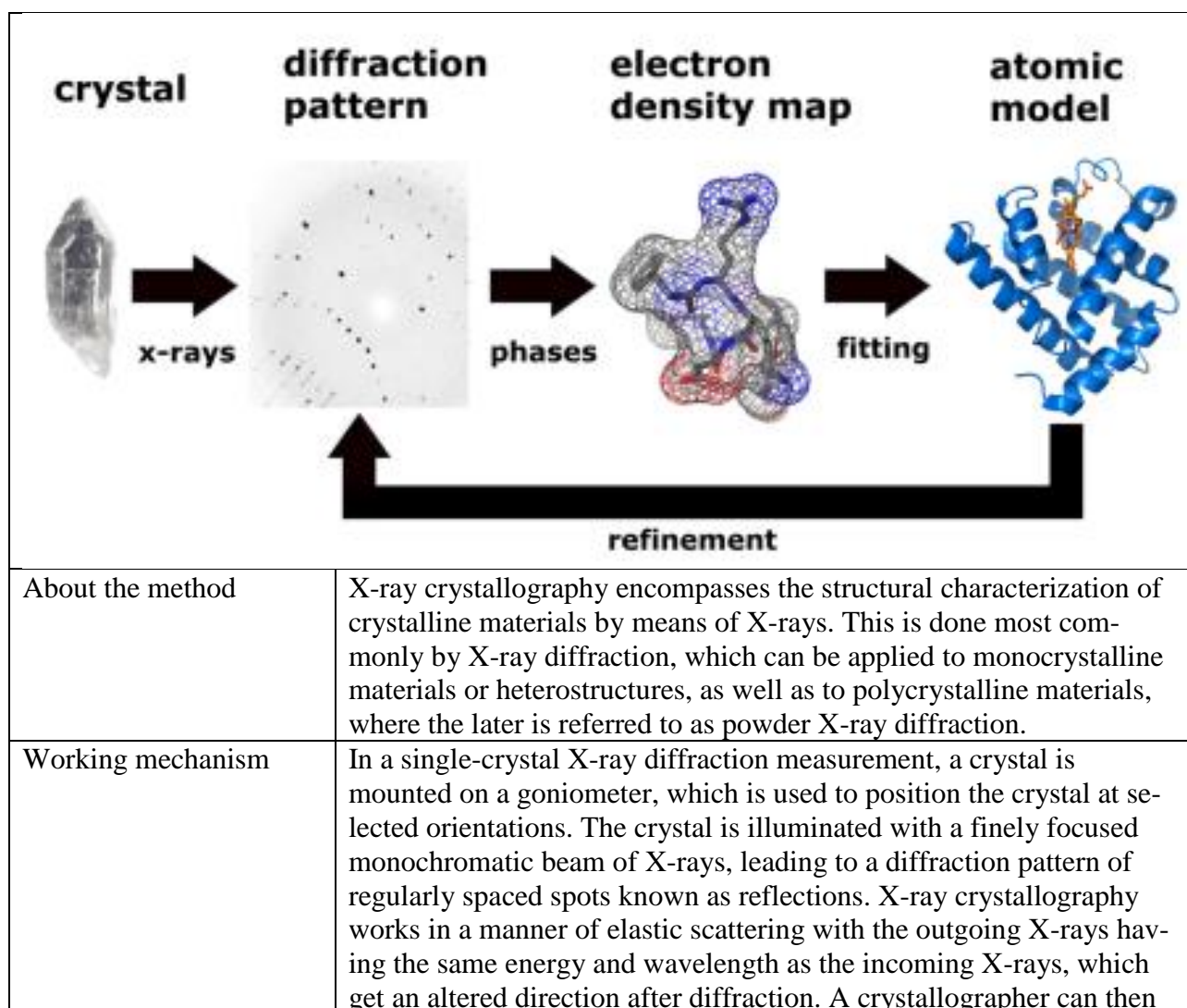
- 1) This monologue is...
  - a) a documentary
  - b) a university lecture
  - c) a school lesson
- 2) Hormones...
  - a) have already been discussed
  - b) will be spoken about in the future
  - c) were not mentioned
- 3) Collagen is said to ...
  - a) be the most plentiful protein in the human body;
  - b) be a catalyst;
  - c) constitute one to two percent of muscle tissue;
- 4) The X-Ray shows that...

- a) the long bones in the upper arm are regular;
  - b) the long bone in the arm is irregular;
  - c) the long bones in the upper arm are abnormal;
- 5) The speaker calls ‘serious situations’ those when...
- a) a baby can’t be born;
  - b) parents are accused of child abuse;
  - c) a child can hit a table and break a bone.

## 24. METHOD EXPLANATION

Using the facts below and the diagram of the method, explain how the method of X-ray crystallography works:

- ✓ its main stages;
- ✓ its purpose;
- ✓ how do you use it.



	produce a three-dimensional picture of the density of electrons within the crystal by measuring the angles and intensities of these diffracted beams under the assistance of the mathematical method Fourier transforms. From this electron density, the mean positions of the atoms, chemical bonds, crystallographic disorder, and some other information in the crystal can be determined. Poor resolution or even errors may occur if the crystals are too small, or not uniform enough in their internal makeup.
Tips	<p>Advantages of X-ray crystallography include:</p> <ul style="list-style-type: none"> <li>• X-Ray crystallography provides a two-dimensional view that gives an indication of the three-dimensional structure of a material;</li> <li>• Relatively cheap and simple;</li> <li>• Useful for large structures: Not limited by size or atomic weight;</li> <li>• Can yield high atomic resolution.</li> </ul>
Application	Modern X-ray crystallography provides the most powerful and accurate method for determining single-crystal structures. Structures containing 100–200 atoms now can be analyzed on the order of 1–2 days, whereas before the 1960s a 20-atom structure required 1–2 years for analysis. Through X-ray crystallography the chemical structure of thousands of organic, inorganic, organometallic, and biological compounds are determined every year.

## PART 4

### Applications in Present and Future

*“The beauty of interdisciplinary conversation is that the mode of expression is essentially different for each practitioner, even if ideas are shared.”*

— Sarah Hall

## LEAD-IN

### 1. Answer the questions:

- 1) What is gene editing?
- 2) Where has it already been used?
- 3) What future uses of editing genes can you think of?

## PRE-READING

**2. CRISPR-Cas9 is used for gene editing. CRISPR stands for “Clustered Regularly Interspaced Short Palindromic Repeats”, Cas9 — associated protein 9.**

**3. Match the following words with correct definitions. Two notions are synonyms, so two definitions are suitable for both of them:**

- |                          |   |
|--------------------------|---|
| 1. bridged nucleic acids | a. a portion of the CRISPR is transcribed and processed into this section |
| 2. the CRISPR-RNA        | b. tested on living cells or organisms                                    |
| 3. locked nucleic acids  | c. dividing or cutting DNA  |
| 4. in vitro              | d. modified RNA nucleotides   |
| 5. in vivo               | e. not involving changes in DNA structure                                 |
| 6. DNA cleavage          | f. inaccessible molecules of RNA  |
| 7. epigenetic            | g. cells removed from animals and kept in artificial environment          |
| 8. cultured cells        | h. research is done outside normal biological context                     |

**4. Before reading the article watch the video 'How to sequence the human genome?' and answer the following questions to check how well you understand the notion of sequencing:**

- 1) What is a genome? (there are three various answers given)
- 2) When was the first genome sequenced? How long did it take?
- 3) What is the goal of the genome sequencing?
- 4) How are A, C, G and T bound in DNA?

- 5) In what case two pieces of DNA can stick together?
- 6) How to read the DNA code? What is the purpose of colours?
- 7) What is reading the sequence of a genome compared with in the video?
- 8) What are scientists still working on?
- 9) What can understanding the genome sequence give us?

## READING

5. Read the whole text and then insert the adverbs from the end of this text into spaces (a — l):

### CRISPR-Cas9 Improved

Scientists at the University of Alberta in Canada have developed a technology that can a)\_\_\_\_\_ improve the specificity of CRISPR-Cas9 gene editing. The approach uses synthetic guide molecules known as bridged nucleic acids (BNAs) in place of the system's native guide RNAs (gRNAs) to direct the Cas9 enzyme to its target DNA sequence, and so reduce **off-target** DNA cleavage.

"We've discovered a way to greatly improve the accuracy of gene-editing technology by replacing the natural guide molecule it uses with a synthetic one called a bridged nucleic acid, or BNA," **claims** lead researcher Basil Hubbard, Ph.D., Canada Research Chair in Molecular Therapeutics and assistant professor at the University of Alberta's Department of Pharmacology. "Our research shows that the use of bridged nucleic acids to guide Cas9 can improve its specificity by over 10,000 times in certain **instances**—a dramatic improvement."

The University of Alberta team and colleagues at Seoul National University in Korea, report on the new technology in Nature Communications, in a paper **entitled** "Incorporation of Bridged Nucleic Acids into CRISPR RNAs Improves Cas9 Endonuclease Specificity."

The CRISPR-Cas9 system has become a key genome-editing tool that has widespread applications in fields spanning model organisms, functional genomics, and epigenetic screens, and b)\_\_\_\_\_ human therapeutics. However, the University of Alberta team **points out**, the system isn't **foolproof**, and while 99% of the time the Cas9 enzyme cuts DNA at c)\_\_\_\_\_ the right sequence, about 1% of the time it will cut the DNA at the wrong site. "...the system is not d)\_\_\_\_\_ specific," Dr. Hubbard comments. "...sometimes it cuts a similar but incorrect gene. However, given that there are trillions of cells in the human body, even one percentage off is quite significant, e)\_\_\_\_\_ because gene editing is **permanent**. One wrong cut and a patient could end up with a serious condition like cancer."

Two noncoding RNA elements are involved in directing the Cas9 enzyme to cleave at its target sequence, the University of Alberta team continues. "The CRISPR-RNA (crRNA) contains a 20-nucleotide (nt) RNA sequence complementary to the target DNA sequence, while the **transactivating** crRNA (tracrRNA) acts as a bridge between the crRNA and Cas9 enzyme." Hybridization of these two elements constitutes the gRNA.

The specificity of Cas9 DNA cleavage is highly dependent on the crRNA sequence and target-crRNA folding stability, and mutations within the target sequence can result in cleavage at off-target DNA sequences. However, while various approaches have been used to improve Cas9 specificity, "off-target cutting and generation of accessory mutations remains a significant barrier for Cas9-based gene editing."

Most of the approaches to improving specificity have involved modifying the Cas9 enzyme itself, but the University of Alberta researchers have instead focused on **incorporating** synthetic

nucleotides—BNAs—at specific locations in crRNAs. “f)\_\_\_\_\_, bridged nucleic acids (BNAs) have g)\_\_\_\_\_ been shown to improve **mismatch discrimination** in nucleic acid duplexes,” they point out. “We **hypothesized** that incorporation of these synthetic nucleotides into crRNAs could improve Cas9 DNA cleavage specificity.”

**Initial** in vitro tests showed that incorporating BNA-modified nucleotides into crRNAs h)\_\_\_\_\_ improved Cas9 specificity and reduced off-target cleavage. i)\_\_\_\_\_, the BNA-substituted crRNAs were also **compatible** with Cas9 variants that scientists have generated j)\_\_\_\_\_ to try and reduce off-target Cas9 activity. “k)\_\_\_\_\_, we found that the combination was additive, resulting in **elimination** of nearly all off-target activity,” say the researchers commenting on the results from testing one combination of modified crRNA and engineered Cas9 and stating that the BNA-modified crRNAs “can complement the specificity enhancements of next-generation Cas9 variants.” **Subsequent** tests confirmed that the BNA-modified crRNAs induced lower cleavage **rates** at off-targets sites in cultured cells, as well as in vitro.

Analyses designed to identify the mechanisms at work indicated that the BNA-substituted crRNAs enhance specificity both by slowing Cas9 kinetics and by impairing formation on off-target sites, of the stable “zipped” conformation that is **prerequisite** for DNA cleavage. l)\_\_\_\_\_, using locked nucleic acids (LNAs) **substitutions** in the crRNAs instead of BNAs also increased Cas9 specificity, but to a lesser extent than the BNA-substituted crRNAs.

“Overall, these findings **unveil** a strategy for improving the specificity of the CRISPR-Cas9 system and illustrate the application of recently developed synthetic nucleic acid technologies to solving problems in enzyme specificity,” the researchers conclude. “We anticipate that these findings will directly contribute to the **ongoing** goal of improving the specificity and safety of genome-editing agents for a wide variety of experimental and **clinical** applications. In addition to describing a **robust** technique for improving the precision of CRISPR/Cas9-based gene editing, this study illuminates an application of synthetic nucleic acids.”

independently  
perfectly  
broadly  
interestingly x2

potentially  
strikingly  
especially  
previously

dramatically  
encouragingly  
precisely

## **POST-READING**

### **VOCABULARY**

#### **6. Find words in the text (in bold) which fit the following explanations:**

- 1) to mention something in order to draw somebody's attention to it;
- 2) a property of being at the beginning;
- 3) the ability to differentiate between two things;
- 4) to happen before the other thing is possible;
- 5) named;
- 6) using something instead of something else, usually an alike object;
- 7) fitting, working if put together;
- 8) to include;
- 9) when someone says something you are not certain is true;
- 10) to reveal a secret;
- 11) easy to understand or use, so no one will make a mistake using it;
- 12) not finished yet;
- 13) to say something is possible after considering different facts about it;
- 14) complete destruction;
- 15) in an incorrect place;
- 16) not undergoing changes;
- 17) size, amount, or frequency;
- 18) case, situation;
- 19) medical;
- 20) directly following;
- 21) when two objects are not fitting, or do not work well together;
- 22) strong and healthy;
- 23) acting from a different molecule.

#### **7. Write definitions for the following words and collocations in pairs or small groups:**

therapeutics, spanning, accessory mutations, duplex, additive, enhancement, to induce, to indicate, impairing, to illuminate



## 8. Fill in the gaps:

### Part A

to point out to claim to incorporate to mismatch to hypothesize compatible initial pre-requisite ongoing permanent

- 1) The researchers were going to recreate the \_\_\_\_\_ conditions to study origins of the phenomenon.
- 2) Mr Lerner \_\_\_\_\_ to have discovered a new law in physics but it is too early to reach this conclusion yet.
- 3) Unfortunately, the improvement he demonstrated throughout the previous year was not \_\_\_\_\_. Recently, there was an apparent relapse in his condition.
- 4) New medicine was \_\_\_\_\_ with those she has been taking, there were no problems whatsoever.
- 5) For chemistry to become a branch of science we are familiar with today, the establishment of scientific methods was a crucial \_\_\_\_\_.
- 6) As my scientific advisor \_\_\_\_\_, calculations should precede the construction of a setup, to rule out as many errors as possible from the very beginning.
- 7) It is said that nowadays there is a \_\_\_\_\_ between skills offered by people and those needed for workplaces.
- 8) The search for the nature of some diseases and their mutations as always \_\_\_\_\_ to get medicine keep up with demand.
- 9) The recent article published by this research group \_\_\_\_\_ all previous studies in hormone influences on immune system.
- 10) The origin of consciousness \_\_\_\_\_ by some scientists as another quantum mechanism.

### Part B

potentially previously especially encouragingly strikingly broadly precisely dramatically perfectly interestingly

- 1) The assumption of artificial intelligence being capable of any task is \_\_\_\_\_ true in theory.
- 2) The initial results of the experiment were \_\_\_\_\_ compatible with predictions.
- 3) It was \_\_\_\_\_ clear that the claim didn't have any solid ground.
- 4) The results described in our article are \_\_\_\_\_ applicable in the sphere of medicine.
- 5) As \_\_\_\_\_ described by my colleague, the phenomenon is observed far more frequently than it was believed.
- 6) You can see from the graph that the line \_\_\_\_\_ falls after iron and nickel showing the change of reaction from exothermal to endothermal.

- 7) The repeated experiment showed that the loss of energy was \_\_\_\_\_ the same every time.
- 8) \_\_\_\_\_ enough, changing the concentrations of one “beneficial” type of coral bacteria can affect other key bacteria in the microbiome.
- 9) A slim silver lining of the current COVID-19 pandemic is that it can help us better prepare for future outbreaks—if we harness what we’ve learned correctly. \_\_\_\_\_, we can better leverage one of the most crucial resources we have when it comes to pandemic preparedness: real-world data.
- 10) Biologists quickly noticed that the skeletons of modern people are \_\_\_\_\_ different from those of the last century.

**9. Change words in brackets so that they are grammatically correct for the sentence:**

- 1) Some experts worry that certain bacteria could \_\_\_\_\_ (accident) spawn new disease \_\_\_\_\_ (break), a possibility that arose in a recent lab test.
- 2) Teams at the institute are creating these \_\_\_\_\_ (resilience) corals using “assisted evolution,” which involves selecting wild corals with \_\_\_\_\_ (desire) genetic traits, such as the ability to survive high ocean temperatures, then cross-breeding them to yield \_\_\_\_\_ (spring) with an abundance of the traits.
- 3) It would be useful to remember at this juncture that – as Chris Fields, an \_\_\_\_\_ (depend) scientist, has said – classical and quantum mechanics are labels humans invented to describe the theories they developed; nature doesn’t have to \_\_\_\_\_ (know) this \_\_\_\_\_ (distinct).
- 4) The \_\_\_\_\_ (advance) of rapid DNA sequencing techniques has \_\_\_\_\_ (signify) accelerated genetics and medical research and discovery.
- 5) To understand what DNA \_\_\_\_\_ (compute) is, first we need to stop \_\_\_\_\_ (think) about it as some kind of \_\_\_\_\_ (place) for our everyday classical computer use; we won’t be playing games on a DNA computer any time soon, if such a thing were even possible.
- 6) Ethanol – is a \_\_\_\_\_ (flame) and \_\_\_\_\_ (new) liquid produced by the fermentation of grain or from \_\_\_\_\_ (advance) technology such as agricultural waste, wood chips, and waste paper.
- 7) With rising \_\_\_\_\_ (conspire) theories regarding gene therapies and CRISPR like things, it was truly designed to cure disease, to treat \_\_\_\_\_ (normal) and to repair \_\_\_\_\_ (fault) genes.
- 8) What you find, is that hemoglobin and the iron atom are essentially in a very strong quantum state that is as electrons, which don’t really have a \_\_\_\_\_ (give) position in space but are \_\_\_\_\_ (local).

**10. Choose which of the words below is the most suitable:**

DNA data storage is the process through which binary data is encoded and decoded in order to form synthetic DNA strands. The application of DNA as a 1) \_\_\_\_\_ to store data bears huge potential 2) \_\_\_\_\_ its incredible storage capacity. The process of storing molecular data is considered an excellent alternative to store highly dense and durable information which is strongly demanded because of the growing 3) \_\_\_\_\_ between the data generation data storage processes. In fact, DNA is the 4) \_\_\_\_\_ example of an effective archival data storing process in molecular form. The 5) \_\_\_\_\_ storage media based on molecular systems are capable of storing data in the DNA of living

organisms lie at the growing 6) \_\_\_\_\_ of computer systems and biotechnology together with in vitro data storage technology.

The idea of using DNA for data storage purposes dates 7) \_\_\_\_\_ the 17th century when the concept of genetic memory was discussed among researchers back then and exactly the time then sequencing and synthesis technologies of DNA were not 8) \_\_\_\_\_ enough. Later on, the concept of DNA data storage was demonstrated experimentally through encoding an image of the ancient Germanic rune for 'female Earth'. It was in 1999 when the concept was proved to be sensible and pragmatic through storing and hiding 9) \_\_\_\_\_ information in DNA microdots on paper which was not only the first practical storage of data but also the data remain until 2012 as the only demonstration of storing DNA that excluded an in vivo step. Apparently, this attempt to store data in DNA was 10) \_\_\_\_\_ enough to be considered a strategic decision since the synthetic DNA was cloned into replicated vectors to process sequencing and selecting the desired and correctly synthesized sequences.

However, the revolutionary change in DNA data storage technology occurred in the early 2010s when the idea of DNA data storage of as 11) \_\_\_\_\_ as hundreds of kilobytes was suggested independently making the progress of reading and writing 12) \_\_\_\_\_. Since then, the 13) \_\_\_\_\_ rate of progress and capacity has reached a rate of approximately 3-fold magnitude in the period of 6 years. In most cases, studies 14) \_\_\_\_\_ phosphoramidite-based DNA synthesis method which has evolved over the decades. Moreover, the enzymatic DNA synthesis is it still considered as a competition technique and has already been used for data storage successfully.

- 1) a medium b place c facility
- 2) a despite b due to c hence
- 3) a space b gap c fence
- 4) a sheer b utter c precipitous
- 5) a live b natural c in vivo
- 6) a bridge b connection c intersection
- 7) a ago b as far as c back to
- 8) a mature b adult c strong
- 9) a filed b classified c ranked
- 10) a fealty b fulfilled c feasible
- 11) a much b well c long
- 12) a viable b complete necessary
- 13) a variable b derivative c exponential
- 14) a hire b apply for c employ

**11. Find what word is suitable in all three sentences:**

A

- 1) Rival \_\_\_\_\_ to Macedonian territory caused conflict in the Balkans.
- 2) There is already a long list of people \_\_\_\_\_ her attention.
- 3) The research group \_\_\_\_\_ that they had found antigravity in their experiments.

B

- 1) Modern DNA \_\_\_\_\_ consists of high-throughput methods which allow entire DNA \_\_\_\_\_ to be discovered in a matter of hours.
- 2) The best \_\_\_\_\_ in the film occurs when Murphy understands that the hands movement of the watch is the code her father left for her.
- 3) For some reason, this shot had ended up out of \_\_\_\_\_ among the Prague photographs.

C

- 1) Doctors suspect he may have a heart \_\_\_\_\_.
- 2) People \_\_\_\_\_ into believing that they have no power over their situation.
- 3) The \_\_\_\_\_ we can see this spring are ripe for the spread of disease.

## 12. Match beginnings and endings of the sentences:

- |  |  |
|--|--|
| 1) Geneticists are now able to understand the function of genes by                                     | a) the reversible chain terminators method uses a cyclic method.               |
| 2) Genetic testing such as paternal or prenatal testing is   | b) more than doubling each year since its inception.                           |
| 3) Metagenomics, the study of genetic material recovered directly from environmental samples, allow us | c) they were too costly and time-intensive.                                    |
| 4) This resulted in data output increasing at a rate that exceeded Moore's law,                        | d) both strands of DNA are sequenced to double-check our work.                 |
| 5) To avoid any ambiguity,   | e) with a class of novel techniques to lower the cost of DNA sequencing.       |
| 6) Instead of promoting irreversible primer extension like the Sanger method,                          | f) becoming more and more commonplace.   |
| 7) The basic methodology is to break up multiple sequences of the same genome in various places,       | g) with hard data showing genetic mutations correlating with specific disease. |
| 8) Although these techniques allowed us to sequence the first human genome,                            | h) finding distinctive coding regions such as DNA-binding sites.               |
| 9) By 2008, consumer genomics began to take hold,  | i) and reassemble them based on overlapping regions.                           |

10) Throughout the 2000's, scientists have come up

j) to identify organisms present in bodies or water, sewage, dirt, etc.

**13. Read the following text carefully and fill in the gaps with the words from the box. Change the form of the verb where necessary:**

demonstrate dilute release shed improve secret standardize provide distribute detect degrade compare last
--

Environmental DNA (eDNA) is nuclear or mitochondrial DNA that is 1)\_\_\_\_\_ from an organism into the environment. Sources of eDNA include 2)\_\_\_\_\_ feces, mucous, and gametes; 3)\_\_\_\_\_ skin and hair; and carcasses. eDNA can be 4)\_\_\_\_\_ in cellular or extracellular (dissolved DNA) form.

In aquatic environments, eDNA is 5)\_\_\_\_\_ and 6)\_\_\_\_\_ by currents and other hydrological processes, but it only 7)\_\_\_\_\_ about 7–21 days, depending on environmental conditions. Exposure to UVB radiation, acidity, heat, and endo- and exonucleases can 8)\_\_\_\_\_ eDNA.

Protocols using eDNA may allow for rapid, cost-effective, and 9)\_\_\_\_\_ collection of data about species distribution and relative abundance. For small, rare, secretive, and other species that are difficult to detect, eDNA 10)\_\_\_\_\_ an attractive alternative for aquatic inventory and monitoring programs. Increasing evidence 11)\_\_\_\_\_ improved species detection and catch-per-unit effort 12)\_\_\_\_\_ with electrofishing, snorkeling, and other current field methods. Thus, detection of species using eDNA may 13)\_\_\_\_\_ biodiversity assessments and provide information about status, distribution, and habitat requirements for lesser-known species.

## **SPEAKING**

**14. How many synonyms to the word 'illness' can you name? Compare your list of words with other students. Can you explain the differences in meanings of the words?**

## **15. The Language of Fact and Opinion**

The ability to distinguish between fact and opinion helps to develop critical and analytical skills in both reading and listening. Fact and opinion are often woven together in texts and speeches. It is therefore imperative to be able to unravel the threads of what is true from what is mere belief to successfully read articles and comprehend speeches.

FACT	OPINION
signal words and phrases	
The annual report <i>confirms</i> ...	He <i>claimed</i> that...

<p>Scientists <i>have</i> recently <i>discovered</i>...</p> <p>According to <i>the results of the tests</i>...</p> <p>The investigation <i>demonstrated</i>...</p> <p>It is <i>clear</i> that...</p> <p>It is <i>certain</i> that...</p>	<p>It is the officer's <i>view</i> that...</p> <p>The report <i>argues</i> that...</p> <p>Many scientists <i>suspect</i> that...</p>
signal grammar	
<p>the use of the verb '<i>be</i>' or '<i>will be</i>'</p> <p>quoting of exact <i>statistics</i> and / or <i>measurements</i></p>	<p>the use of modal verbs of speculation, e.g. <i>may</i>, <i>might</i>, <i>could</i>, <i>would</i>, <i>can</i>, etc.</p> <p>the use of the subjunctive mood, e.g. <i>the second and third conditionals</i>, structures with '<i>hope</i>', '<i>would rather</i>', '<i>had better</i>', '<i>wish</i>', etc.</p>

**16. Read the following statements and decide if they are facts or opinions. Quickly skim the text if necessary:**

- 1) The technology which was developed by the University of Alberta uses BNAs instead of gRNAs.
- 2) This technology will significantly improve the precision of CRISPR-Cas9.
- 3) When BNAs are used in gene-editing technology, in some cases its work improves by more than 10,000 times.
- 4) The CRISPR-Cas9 is applied in functional genomics.
- 5) The CRISPR-Cas9 is applied in human therapeutics.
- 6) This genome-editing tool can make mistakes in the DNA cleavage in 1% of instances.
- 7) The CRISPR-RNA and the transactivating crRNA are involved in directing the gene-editing enzyme to the needed target.
- 8) Inclusion of synthetic nucleotides into crRNAs could improve Cas9 DNA cutting accuracy.
- 9) Those crRNAs which were substituted by BNAs are compatible with the independently generated variants of Cas9 taken for the purpose of reducing off-target Cas9 work.
- 10) BNA-substituted crRNA will add to the specificity of Cas9 variants of next generation.

**17. Find one fact and one opinion in the text not mentioned in the exercise 15, do not repeat the same wording.**

**18. Search for necessary information and prepare for oral reports:**

- a) epigenomics, its pros and cons;
- b) eDNA and its applications;
- c) DNA instead of a quantum computer?
- d) what does quantum biology research?
- e) biofuel as an alternative source of energy;
- f) genetically modified food, its pros and cons.

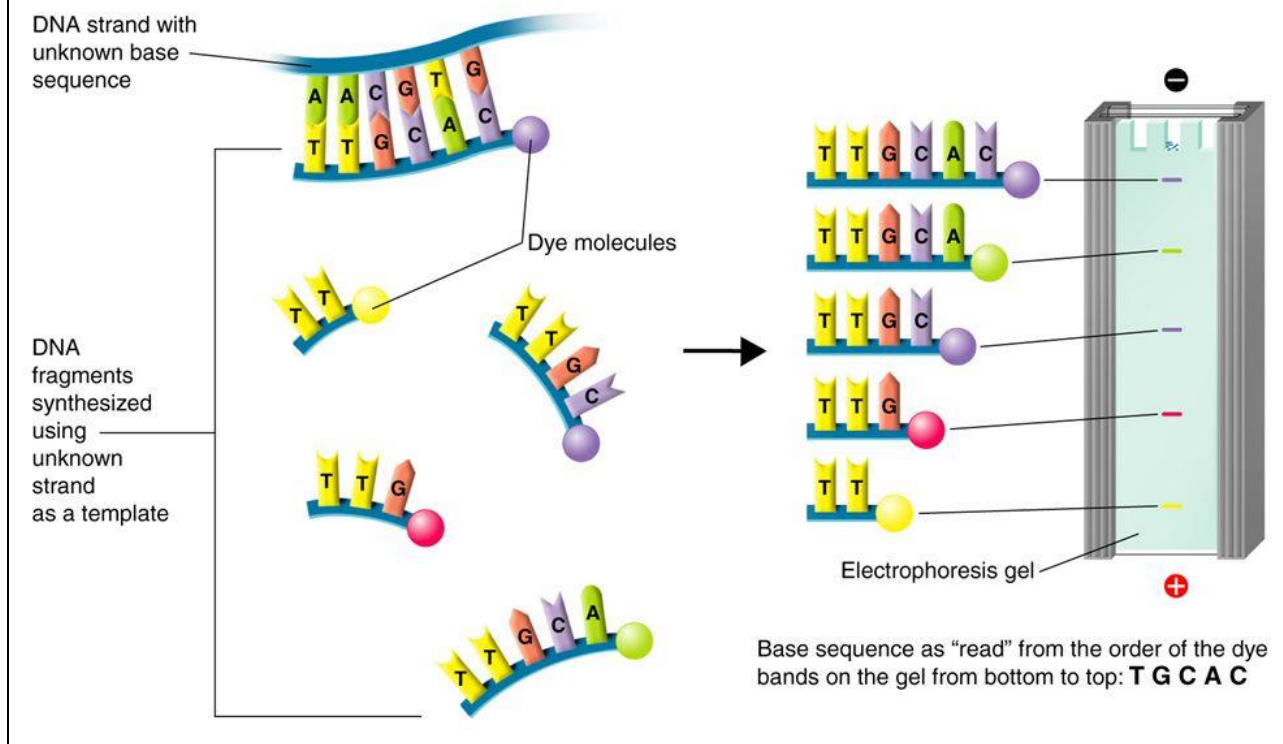
## **LISTENING**

**19. Listen to the explanation of what bioinformatics is and choose if the following statements are true, false or not stated:**

- 1) The human genome will be sequenced by 2025;
- 2) According to estimations, not less than two gigabytes of information from the human genome will be received;
- 3) Data on proteins are likely to be received by life sciences within next ten years;
- 4) The research of genome has already led to groundbreaking discoveries;
- 5) Bioinformatics deals with the combination of life sciences, IT and statistical data;
- 6) The reason some people get diseases is directly linked with structures of proteins in a cell;
- 7) Bioinformatics expertise is highly confidential nowadays.

**20. Describe the scheme:**

# DNA sequencing



## 21. METHOD EXPLANATION

**Prepare a mini-project in pairs or small groups. Search for data about one of DNA sequencing methods (e.g. the Sanger method) and explain how this method works:**

- ✓ its main stages;
- ✓ its purpose;
- ✓ how do you use it.

**Present your project to other pairs or/and small groups. After all projects are presented, discuss advantages and disadvantages of the methods. Which are frequently used now, which are outdated?**



# GRAMMAR REFERENCE

## The Participle

### Forms of the Participle

	Active Voice	Passive Voice
Present Participle	<i>asking</i> <i>writing</i>	<i>being asked</i> <i>being written</i>
Past Participle	-	<i>asked</i> <i>written</i>
Perfect Participle	<i>having asked</i> <i>having written</i>	<i>having been asked</i> <i>having been written</i>

На русский язык the participle может переводиться как прилагательное, причастие или деепричастие в зависимости от времени предложения и роли данного слова в предложении. Также the participle может быть переведен глаголом со словами *который, когда, пока, так как* и др.

### I. Participles as adjectives

Present and past participles can be used as adjectives. **Present Participles** describe an action which is still happening.

*The fascinating observation instrument we now call a telescope has an equally compelling history.*

*История поразительного инструмента наблюдения, который мы теперь называем телескопом, также невероятна.*

*Lighthouses cast reassuring beams of light far across the ocean.*

*Маяки запускают спасительные лучи света далеко в океан.*

**Past participles** describe the result of an action that has happened.

*Not all of the energy is emitted in a given photon, so the emitted photons will be of lower energy.*

*Не вся энергия излучается через какой-то отдельно взятый фотон, потому выпущенные фотоны будут низкоэнергетическими.*

*A lens is a transparent piece of glass or plastic with at least one curved surface.*

*Линза – это прозрачное стекло или пластик с по меньшей мере одной изогнутой стороной.*

### II. Participles as reduced relative clauses

When participles come after a noun, they are like reduced relative clauses.

*In the context of microscopy, refraction is perhaps the most important behavior exhibited by light waves. (= ... behavior which is exhibited by light waves.)*

В рамках микроскопии преломление, вероятно, является наиважнейшим свойством, присущим световым волнам. (... которое присуще световым волнам).

*Our most complete theory of light is a “quantum field” theory having both wavelike and particle-like properties. (= ... theory which has both wavelike and particle-like properties.)*

Самая полная из наших теорий света – это теория «квантового поля», обладающая свойствами и волн, и частиц. (... которая обладает свойствами и волн, и частиц).

### III. Participles in adverb clauses

1) Participles can be used to express time.

— Actions that are going on simultaneously:

*Light waves can also interact with each other by interference, creating complex patterns of motion.*

Световые волны также могут взаимодействовать друг с другом с помощью интерференции, создавая сложные схемы движения.

— Actions that happen consequently:

*Eventually light leaving the toy reaches the mirror, and the reflection is dynamically formed.*

В итоге свет, уделяя от игрушки, достигает зеркала, и отражение формируется динамически.

— When it is important to show that the first action has finished before the second begins, **the perfect participle** is used:

2) Also participles can be used to express reason (the idea of *because*):

*Investigating the response performance of the sensor configuration, the Michelson interferometer with core 2 was used.*

*Для изучения эффективность реакции параметров датчика, мы использовали интерферометр Майкельсона с двумя сердечниками.*

3) You can express the idea of result using participles:

*The scientists found a new answer for the question concluding the debate of last months.*

Ученые нашли новый ответ на вопрос, завершая спор после месяцев.

4) Participle clauses are used to express conditions (the idea of *if*):

*Raising pressure, we can see the liquid vaporize twice faster.*

*Если увеличить давление, мы видим, что жидкость испарилась в два раза быстрее.*

#### Note

In all participle clauses, the subject of the clause and the subject of the main verb must be the same. You have to be careful to make the participle agree with the subject of both verbs:

*Entering the laboratory, I saw the experiment has already started. (= I entered ... and I saw)*

! Otherwise, if you say

*Entering the laboratory, the experiment has already started,*

this means “the experiment entered the laboratory and then started.” Such a sentence makes no sense.

### IV. The Absolute Participle Construction

The Absolute Participle Construction is always separated by a comma and could stand in the beginning or in the end of a sentence.

In the beginning of a sentence, it is translated with ‘если’, ‘так как’, ‘поскольку’, ‘при’, etc.

In the end of a sentence, it is translated with ‘и’, ‘а’, ‘причем’, etc.

<i>Noun in the Common case Pronoun in the Nominative form</i>	<i>Participle (any form)</i>	<i>The Main Clause</i>
The problem / the tools  Them / us / him/ her	discussed,  agreeing,	the team started the experi- ment.
Так как проблему / инструменты обсудили, команда начала эксперимент.		
Поскольку они ( мы / он / она ) согласились, команда начала эксперимент.		

## THE PARTICIPLE EXERCISES

### I. Translate the text and find the examples of the participle.

The electromagnetic spectrum describes light as a wave which has a particular wavelength. The description of light as a wave first gained acceptance in the early 1800's when experiments by Thomas Young, François Arago, and Augustin Jean Fresnel showed interference effects in light beams, indicating that light is made of waves. By the late 1860's light was viewed as part of the electromagnetic spectrum. However, in the late 1800's a problem with the wave-based view of light became apparent when experiments measuring the spectrum of wavelengths from heated objects could not be explained using the wave-based equations of light. This discrepancy was resolved by the works of M. Planck “Distribution of energy in the normal spectrum” in 1900, and A. Einstein “Generation and transformation of light” in 1905. Planck proposed that the total energy of light is made up of indistinguishable energy elements, or a quanta of energy. Einstein, while examining the photoelectric effect (the release of electrons from certain metals and semiconductors when struck by light), correctly distinguished the values of these quantum energy elements. For their work in this area Planck and Einstein won the Nobel prize for physics in 1918 and 1921 respectively and based on this work light may be viewed as consisting of "packets" or particles of energy, called photons.

### II. Identify the function of the participle in the following sentences. Translate the sentences paying attention to the participle.

1) In some situations, light may behave in a manner which seems to defy common sense, based on the simple explanations given here.

2) Because conventional imaging hardware is slow compared to the speed of light, traditional computer graphics and computer vision algorithms typically analyze transport using low time-resolution photos.

3) As an example, for a table-top scene illuminated by a 100W bulb, only about 1 photon on average would reach the sensor during a 2 ps open-shutter period.

4) Time taken by light to travel distances  $z_1 + d_1$  and  $z_2 + d_2$  is responsible for the existence of two different time frames and the need of computational correction to visualize the captured data in the world time frame.

- 5) Relativistic rendering techniques have been developed using our data.
- 6) Please refer to the video in the supplementary material to watch the reconstructed movies.
- 7) The following quotation taken from a widely used physics textbook illustrates the point.
- 8) Following that, Fabry spent a number of years teaching state secondary school while simultaneously working on a doctoral dissertation on interference phenomena.
- 9) By integrating all the frames in novel ways, we can visualize and highlight different aspects of the light flow in one photo.
- 10) Instead of the interference fringes falling on a simple screen, often they're directed into a camera to produce a permanent image called an interferogram.

### III. Choose the best way to complete the sentence.

- 1) After \_\_\_\_ the camera, I put the lid on to cover the lens.
  - a) having switched off
  - b) switching off
  - c) switched off
- 2) A beam of light travels through vacuum, \_\_\_\_ any specific medium.
  - a) not needing
  - b) not needed
  - c) not having needed
- 3) \_\_\_\_ the equipment, he asked the laboratory assistant if everything was correct.
  - a) Setting
  - b) Set
  - c) Having set
- 4) \_\_\_\_ the electric ray, the scientists noticed a \_\_\_\_ pattern in its body and that eventually led to understanding how the creature used electricity.
  - a) Having studied; repeating
  - b) Studying; repeated
  - c) Studied; repeating
  - d) Studying; repeating
- 5) \_\_\_\_ too simple to be recreated, the telescope didn't give a patent to its inventor, so even now we're not certain who exactly it was.
  - a) Considered
  - b) Considering
  - c) Having considered
- 6) There are all kinds of eyeglass lenses, \_\_\_\_ light-sensitive photochromic ones that darken in sunlight and double-up as sunglasses.
  - a) having included
  - b) including

- c) included
- 7) The results \_\_\_\_ like that we couldn't help but doubt the correctness of our experiment.
- a) been
  - b) having been
  - c) being
- 8) Leaving the university, \_\_\_\_.
- a) it was raining
  - b) I saw it was raining
  - c) the rain has already started
- 9) The mistake appeared \_\_\_\_ the programme.
- a) shut down
  - b) having shut down
  - c) shutting down
- 10) \_\_\_\_ into consideration, the constant didn't allow us to get the result we've got.
- a) Taken
  - b) Taking
  - c) Having taken

#### IV. Correct the sentences:

- 1) Opening the door of the refrigerator, the smell was bad.
- 2) Changing gear, the bus had difficulty getting up the hill.
- 3) Burning the rubbish, my papers for the presentation were destroyed.
- 4) After having closed the door, I searched for the switch on the wall to the left.
- 5) Releasing by the source, the ray reaches the first mirror and bends reflected.
- 6) Having changed the parameters, different results appeared on the graph.
- 7) We then compare the travel time captured by our streak sensor with the real travel time computing from the known geometry.
- 8) Having explained in the next section, this visualization of the bottle scene reveals significant light transport phenomena that could not be seen with the rainbow fusion visualization.
- 9) Some of this reflected object beam then meets the reference beam at the holographic film, produced an interference pattern which is recorded in the light sensitive emulsion.
- 10) Scanned interferometers over objects, you can also make very detailed maps of surfaces.

#### V. Change the sentences as in the example.

*Calculations **which were done the day before yesterday** need checking.*

*Calculations **done the day before yesterday** need checking.*

- 1) A television is a device which is shaped like a box with a screen that receives electrical signals and changes them into moving images and sound.

- 2) On the radio, television, or telephone, interference is noise, lines, etc., that prevents a clear sound from being received.
- 3) The government has produced a series of leaflets which were designed to extent public awareness of the dangers of AIDS.
- 4) Time lapse is usually a short video that consists of separate images which were taken at set intervals over a certain period.
- 5) One of the earliest explicit written evidence of a magnifying device is Pliny the Elder's "lens", a glass globe that was filled with water, which had been used to cauterise wounds.
- 6) A laser is a device that produces a concentrated beam of coherent light.
- 7) An object beam is the light from the laser beam that illuminates the object, and is reflected to the holographic film.
- 8) Light which contains most of the wavelengths in the visible spectrum, such as light from the sun or a spotlight is called white light.
- 9) There are also many modified telescopes or telescopes with combined technologies; for example, there is the catadioptric telescope which merges the technologies of the refracting telescope and the reflecting telescope.
- 10) For example, in Fig. 1 we have a particle with charge  $q$  which is moving near a charged plate.

## VI. Combine simple sentences to make the sentence with participles as in the example.

*Cameras work the opposite way. They **catch** light rays from a distance and **bring** them to focus on chemically treated plastic film*

*Cameras work the opposite way, **catching** light rays from a distance and **bringing** them to focus on chemically treated plastic film.*

- 1) A shielding electrode reduces the trap capacitance and the power dissipation. It also permits a range of fabrication techniques.
- 2) We capture time scales orders of magnitude faster than the exposure times of conventional cameras, in which photons are integrated into a single value. These photons reach the sensor at different times. This makes it impossible to observe ultrafast optical phenomena.
- 3) Part of the light refracted on the table is reflected back to the candy. It creates secondary caustics on the table.
- 4) As the figure (and the supplementary movie) shows, most of the light propagates at the blaze angle. This light was reflected from the grating.
- 5) For each horizontal scanline, the camera records a scene and averages light. The scene is illuminated by the pulse. The light is scattered by 4:5 108 pulses.
- 6) We have explored several ways to visualize the information in an intuitive way. The information was contained in the captured x-y-t data cube.
- 7) Plastic debris causes all kinds of problems, from killing wildlife when mistakenly ingested to releasing toxic compounds. Such debris accumulates in the ocean.

8) Like standard plastics, biodegradable versions consist of polymers (long-chain molecules) that can be molded while in their fluid state into a variety of forms. Standard types of plastic is derived from petrochemicals.

**VII. Change the sentences in this text about *Squeezed states* opening the brackets and changing the verbs into participles.**

A splendid demonstration of Heisenberg's uncertainty principle can be given by reducing the quantum noise in one quadrature of the light field (for example the phase) 1 \_\_\_\_\_ (enhance) it in the complementary observable (i.e. the amplitude, or vice versa). This can be done by methods of nonlinear optics, for example parametric amplification and deamplification. The so 2 \_\_\_\_\_ (generate) states of the light field are called 3 \_\_\_\_\_ (squeeze) since the quantum noise got squeezed at a specific phase angle. Their wave packets do not only move back and forth in time like the ones you have seen for the coherent state, they also get wider and narrower: they *breathe*. The 4 \_\_\_\_\_ (correspond) phase space distribution has an elliptical shape. 5 \_\_\_\_\_ (Squeeze) states have been investigated in many experiments in the past 15 years, since they can be used to reduce the amount of noise in specially 6 \_\_\_\_\_ (design) optical precision measurements. The amount of squeezing, the amplitude of the coherent excitation as well as the relative angle between the 7 \_\_\_\_\_ (squeeze) quadrature and the coherent excitation of the light can vary. Thus there is a whole family of such 8 \_\_\_\_\_ (squeeze) states of light. The 9 \_\_\_\_\_ (follow) graphs show the 10 \_\_\_\_\_ (measure) quantum noise, 11 \_\_\_\_\_ (move) wave packets (b) and Wigner functions (c) of characteristic representatives of this family. The degree of squeezing, i.e. the amount of noise reduction is a factor of four in the 12 \_\_\_\_\_ (squeeze) quadrature for the 13 \_\_\_\_\_ (present) measurements. The shifting of the 14 \_\_\_\_\_ (squeeze) angle corresponds to a rotation of the state's distribution in phase space.

**VIII. Combine the sentences as in the example using the Absolute Participle Construction.**

*As the conditions were fulfilled, both parties had to agree.*

*The conditions fulfilled, both parties had to agree.*

- 1) As the moral aspect of cloning remained, the technology wasn't accepted.
- 2) As our opponent insisted, we asked an independent group to check the results.
- 3) As the technique allowed this, I processed the whole data in one go.
- 4) As the parameters were given, all we had to do is insert them into the program.
- 5) As real-time video input was processed, we could track the motion of vehicles.
- 6) As fiber optic cable is protected by sheathing and armor to make it resistant, the government, commercial business and other industries widely adopted it.
- 7) As any warming of the mount induces temperature difference, researchers shouldn't touch it with the hand during experiments.
- 8) As photodiodes are highly sensitive, an integrating sphere uses them for sensor heads.
- 9) As the depletion region formed, there is no more diffusion of charge carriers from one side to another in the diode.

10) As the company's roots are foundational, in 1999, Motorola spun off its standard products semiconductor business into an independent company called ON Semiconductor.

**IX. Combine the sentences as in the example using the Absolute Participle Construction.**

<i>No one explained what to do and I wrote a message to my scientific advisor.</i>	<i>No one explaining what to do, I wrote a message to my scientific advisor.</i>
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- 1) Two consecutive frames are separated and objects are not displaced significantly.
- 2) These assumptions were considered and we could take a small 3x3 window (neighborhood) around the features.
- 3) Optical fiber demands grow and we need to continue the research to improve its efficiency.
- 4) The photons move in a stream of particles but overall behave like a wave.
- 5) The voltage of the circuit is higher than the reverse breakdown voltage and the diode is able to conduct electricity in the reverse direction.
- 6) White noise didn't stop and they suspected it wasn't a coincidence.
- 7) The formulae were similar to those we've already used and we solved the problems fast.
- 8) All doubts were forgotten and the scientific society accepted the theory of relativity.

**X. Translate into English using the participle.**

- 1) Линза - деталь из прозрачного однородного материала, имеющая две преломляющие полированные поверхности.
- 2) Оптическая сила линзы, измеряющаяся в диоптриях, также зависит от показателя преломления окружающей среды  $n_0$ .
- 3) Имеющие более жесткую форму, ночные линзы используются исключительно во время сна.
- 4) Подготовив препарат и поместив его на предметный столик, будьте осторожны настраивая микроскоп: не повредите стекло.
- 5) Как потомок богатой семьи, Генри Кавендиш не нуждался в деньгах и большую их часть вкладывал в свои исследования.
- 6) Посредством тщательного анализа полученных данных ученые заметили закономерность проявления того свойства.
- 7) Изображение, даваемое простой линзой, нередко имеет множество недостатков.
- 8) Детонаторы можно разделить на химические и физические, исходя из природы возбуждающего подрыв процесса.

**XI. Translate into English using the Absolute Participle Construction.**

- 1) Если принять во внимание все обстоятельства, мне кажется, мы не можем удовлетворить вашу просьбу.



- 2) Если позволит погода, мы поедем кататься на лыжах.
- 3) При поддержке второй группы, мы решили вопрос быстрою
- 4) Так как альтернативные источники энергии пока не надежны, власть продолжала настаивать на добыче природных ископаемых.
- 5) Поскольку грант не был получен, исследование отложили до будущих времен.
- 6) При отсутствии осложнений, мы закончим проект в срок.
- 7) Так как нас попросил академический совет, мы добавили данные и в новый проект.
- 8) При учете последнего открытия, картина начинала складываться все отчетливее.
- 9) Постольку, поскольку нашу исследовательскую группу пригласили на участие в конференции, нужно выбрать представителя.
- 10) Если забыть о конкуренции, мнения и цели наших команд совпадали.

# The Gerund

## Forms of the Gerund

	Active Voice	Passive Voice
Simple	<i>asking</i> <i>writing</i>	<i>being asked</i> <i>being written</i>
*Perfect	<i>*having asked</i> <i>*having written</i>	<i>*having been asked</i> <i>*having been written</i>

На русский язык the gerund может переводиться как существительное или инфинитив. В предложении может быть подлежащим (subject), дополнением (object), обстоятельством (adverbial modifier).

\*Perfect forms are very rare. We use them when the fact that the action happened earlier or finished already is very significant in the sentence.

### 1) The Gerund as subject:

*Understanding the matter at hand proved not as easy as it seemed.*

*Понять происходящую ситуацию оказалось не так просто, как казалось.*

*No reading can be enough without due practice.*

*Одного только чтения недостаточно без должной практики.*

### 2) The Gerund as object

We use the gerund after certain verbs:

to approve (of) — одобрять  
 to admit — признавать  
 to appreciate — понимать, оценивать  
 to avoid — избегать  
 to be worth — стоить чего-либо  
 to carry on — продолжать  
 to complain (of) — жаловаться  
 to contemplate — рассматривать, обдумывать  
 to delay — откладывать  
 to deny — отрицать  
 to depend on — зависеть  
 to endure — выдерживать  
 to entail — влечь за собой  
 to finish — закончить  
 to include — включать  
 to involve — включать  
 to insist on — настаивать  
 to mention — упоминать  
 to necessitate — обязывать  
 to object to — возражать  
 to postpone — откладывать

to prevent (from) — предотвратить  
 to practice — практиковать  
 to propose — предлагать  
 to put off — откладывать  
 to rely on — полагаться  
 to report — доложить  
 to reproach (with) — упрекать  
 to resist — противостоять  
 to require — требовать  
 to succeed in — преуспеть

*The government contemplates funding the project starting from next year.*  
*Правительство рассматривает финансирование этого проекта со следующего года.*  
*He contemplated injecting the medicine to the mice from the second group.*  
*Он обдумывал ввести лекарство мышам из второй группы.*

There are verbs after which **both the gerund and the infinitive** can be used, but the meaning will change:

**try**

try to do = make an effort  
try doing = try a new activity

**regret**

regret to do = about a future action  
regret doing = about a past action

**remember**

remember to do = about a future action which you need to do  
remember doing = about a past completed action

**need**

need to do = both active and passive action  
need doing = passive action

**stop**

stop to do = stop the earlier action and start a new one  
stop doing = stop the action

**forget**

forget to do = not to do smth because you forgot  
forget doing = do smth and forget about it

**verbs of perception: see, notice, watch, hear, feel, perceive, etc.**

see + object + do = you saw the full action from the beginning till the end  
see + object + doing = when you caught the object in the process of an action

This computer needs repairing. — Этот компьютер нужно отремонтировать.  
I need to repair this computer. — Мне нужно отремонтировать этот компьютер.  
I forgot to check the updates. — Я забыл проверить обновления.  
I forgot checking the updates. — Я забыл, что уже проверил обновления.  
He tried to call his friend but no one answered.  
Он попытался позвонить другу, но никто не ответил.  
He tried using Linux before.  
Он уже пробовал использовать Линукс.  
She stopped at the front desk to ask about train timetable.  
Она остановилась у портье спросить расписание поездов.  
She stopped asking about timetable after downloading the app.  
Она перестала спрашивать расписание после того, как скачала это приложение.

**3) The Gerund as adverbial modifier:**

*After speaking with the colleagues he tried a new method.*

*После разговора с коллегами он попробовал новый метод.  
The question was solved after being neglected for weeks.  
Вопрос решили после того, как оставили без внимания на несколько недель.*

Gerund clauses can be introduced by the words *while, when, after, by, on, and since*.

*The laser probe was collected at the output by another fiber before being routed to a power meter.  
Лазерный датчик был собран на выходе другим волокном, прежде чем быть направленным на измеритель мощности.*

*Possible losses were modeled by using computer simulation.*

*Возможные потери были показаны с использованием компьютерного моделирования.*

## THE GERUND

### I. Translate the text and find the examples of the gerund.

Genome sequencing is particularly useful for identifying the causes of rare genetic disorders. While more than 7800 diseases are associated with a Mendelian inheritance pattern, less than 4000 of those diseases have been definitively linked to a specific gene or mutation. Early analysis of the exon-genome, or exome, consisting of all the expressed genes of an organism, showed promise in identifying the causal alleles for many inherited illnesses. In one particular case, sequencing the genome of a child suffering from a severe form of inflammatory bowel disease connected the illness to a mutation in a gene associated with inflammation – XIAP. While the patient initially showed multiple symptoms suggestive of an immune deficiency, a bone marrow transplant was recommended based on the results of DNA sequencing. The child subsequently recovered from the ailment.

In addition, HTS (High-throughput screening) has been an important player in developing a greater understanding of tumors and cancers. Understanding the genetic basis of a tumor or cancer enables doctors to have an extra tool in their kit for making diagnostic decisions. The Cancer Genome Atlas and International Cancer Genome Consortium have sequenced a large number of tumors and demonstrated that these growths can vary vastly in terms of their mutational landscape. This has also given a better understanding of the kind of treatment options that are ideal for each patient. For instance, the sequencing of the breast cancer genome identified two genes – BRCA1 and BRCA2 – whose pathogenic variants have an enormous impact on the likelihood of developing breast cancer. People with some pathogenic alleles even choose to have preventive surgeries such as double mastectomies.

### II. Change sentences using the gerund as an object.

- 1) He avoids (to criticize) their ideas publicly out of politeness.
- 2) We take every opportunity of (to speak) about our findings to colleagues.
- 3) They are thinking of (to invite) a Chinese professor for collaboration.
- 4) I am responsible for (to set up) the equipment in my team.
- 5) She insists on (to check) the journal for updates every day.
- 6) They discuss (to apply) for work in a firm abroad sooner than they complete the degree.
- 7) I am looking forward to (to work) in a genome deciphering institute.

- 8) He objects to (to allow) us to see his work before publishing.
- 9) We require (to formulate) the definitions clearly before (to use).
- 10) You should carry on (to write) on this topic in master's course.

### III. Choose the best way to complete the sentence.

entail postpone accept endure appreciate help contemplate deny recollect require

- 1) He couldn't (...) losing to his opponent, so he prepared to a debate on the next meeting.
- 2) When the teacher was explaining a new topic I couldn't (...) asking him tons of questions.
- 3) The material efficiently (...) being pressed by up to 60 kilograms.
- 4) It is hard to (...) working of the Newton's first law on earth with air resistance constantly present.
- 5) Mark (...) having switched off the power before leaving the lab yesterday. Someone else did it after he'd left.
- 6) The task (...) computing the data and analyzing the results achieved.
- 7) John (...) being asked after his speech on a conference but not what the questions were about.
- 8) Failing a laboratory assignment (...) getting a special permission to have one more chance at passing it from the chair.
- 9) Sarah (...) studying abroad after graduating from the bachelor's course but only half-heartedly.
- 10) Assistant professor (...) giving the lecture to the next week due to his work leave to Stanford.

### IV. Correct the sentences.

- 1) The participants kept on were talking in the hall after the check-in.
- 2) Called parents and friend to the graduation ceremony was a tradition.
- 3) Believe in implausible theories have always been typical of her.
- 4) They began asked members of committee questions about the criteria of evaluation.
- 5) I thought of check with the front desk but noticed my missing phone on a window sill.
- 6) Refering to the thesis gave me a new angle of the problem.
- 7) The infected mustn't stay in the same room as healthy people to avoid further being spread of a disease.
- 8) He considered stop the experiment but changed his mind.
- 9) I heard the drilling noise without stoping since 11 a.m.
- 10) Agree with me didn't seem to have been easy to him.

### V. Choose which form to use in the sentences: the Infinitive or the Gerund?

- 1) The tem tried (apply) a new method to see if it was more efficient.
- 2) He tried (apply) to the position of an engineer but was declined.

- 3) I regretted (inform) my colleagues of our new problem.
- 4) He regretted (go) to a holiday and (give) his opponent extra time to finish the invention before him.
- 5) He stopped (talk) to his scientific advisor on the way to the classroom.
- 6) I stopped (research) diodes last year and changed my theme.
- 7) The secretary forgot (send) invitations to the conference and sent the same file again.
- 8) He realized that he forgot (study) the words for today's test.
- 9) I saw the virus (get) destroyed. The medicine seemed to work.
- 10) I saw scientists in the lab (process) data with the help of this program. Now I know how to use it too.

#### VI. Change the sentences as in the example.

<i>It is necessary for agriculture to forecast the behavior of insects and animals like rodents to prevent bad harvest.</i>	<i>Forecasting the behavior of insects and animals like rodents is necessary for agriculture to prevent bad harvest.</i>
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- 1) It involves learning from mistakes to be a researcher.
- 2) It has been a part of our plans to design memory device based on biomedical interactions,
- 3) It requires only a single step to carry out this experiment.
- 4) It is beneficial for global economy to both keep traditional and develop new sources of energy.
- 5) It serves to our goal to publish articles in as many journals as we can.
- 6) It was wrong of him to criticize without solid arguments.
- 7) It is needed to get correct results not to touch the sensitive equipment.
- 8) It is sure to raise suspicions to claim you've achieved antigravity.

#### VII. Add *while, once, after, thereby, before, by, as, or since* where they are needed:

*Ex. The conductivity may also be changed **by** applying a voltage or current in one part of the materials to cause a large change in the conductivity in another part of the device.*

- 1) This performance improvement will have far reaching implications allowing rapid prototyping, \_\_\_\_\_ retaining the ability to fabricate complex circuits.
- 2) \_\_\_\_\_ treating with chemicals, it is clear that all almost traces of the bacteria are gone.
- 3) The temperatures involved in the post-annealing process are insufficient for deeper influence, \_\_\_\_\_ preserving the core of the vessel.
- 4) We heat the chip to 600°C in 6 hours, then up to 750°C in additional 2 hours, \_\_\_\_\_ cooling it down to 18°C in 120 hours.
- 5) The fabricated cells are characterized and the presence of rubidium vapor inside the cells is verified \_\_\_\_\_ observing an absorption spectrum.
- 6) The prototype was fabricated using the same writing-laser \_\_\_\_\_ described above with 40 nJ pulse energies.
- 7) \_\_\_\_\_ receiving growing attention, the field of laser has developed greatly.
- 8) \_\_\_\_\_ reached the maximum temperature must be maintained, otherwise fusion will stop.

#### VIII. Put the word from the brackets in a correct form of the gerund (active or passive):

- 1) \_\_\_\_ (call) to the student conference was expected but appreciated all the same.

- 2) Since \_\_\_\_ (publish), the article got plentiful attention.
- 3) \_\_\_\_ (recognise) the virus took some time but eventually it was done.
- 4) \_\_\_\_ (believe) in pure rumors borders danger, he must listen to common sense.
- 5) We checked the final result with the lab assistant after \_\_\_\_ (complete) a circuit.
- 6) The initiative was able to take a photo of a distant cosmic object by \_\_\_\_ (collect) the light from it for a month.
- 7) Nothing could stop her from \_\_\_\_ (apply) for the university after her \_\_\_\_ (decide) to it.
- 8) \_\_\_\_ (pull) with this much force tore the star apart.
- 9) Many company workers insisted on \_\_\_\_ (certify) in working with new applications, the director called IT professionals for a special course.
- 10) He started to write the course paper after \_\_\_\_ (call) to his scientific advisor.

**IX. Combine the sentences using the perfect form of the gerund as in the example:**

<i>They participated in the conference. It is crucial to their project.</i>	<i><b>Their having participated</b> in the conference is crucial to their project.</i>
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- 1) Researchers have demonstrated a bandage that applies electrical pulses to a wound. It is one of new achievements.
- 2) Nanoimprint lithography was used to produce sensors. It improves the detection of COVID-19 and other viruses.
- 3) In the past few centuries, imaging has become a critical tool in the diagnosis of a disease. It is beyond doubt.
- 4) Quantum dots have finally taken a step from pure demonstration experiments to real application. It can't be overlooked.
- 5) The mechanical production approach was used to manufacture metallic and ceramic nanomaterials. This approach yields product powders with relatively broad particle-size range.
- 6) Carbon nanotubes surface has been coated with antigens that are also expressed by the cancer cells. It triggers an immune response.
- 7) Nanomedicines have been used routinely in clinics since 1994. It doesn't mean they don't need development.
- 8) Limited success has been observed. It can partly be explained by the lack of robust and reproducible manufacturing.
- 9) Modern science has led to the development of a wide range of products. It is have a great impact in the clinical area at the moment.
- 10) For the past decade, microfluids have shown the potential to influence pharmaceutical research. It is promising and so backed by governmental agencies.

#### **X. Translate into Russian paying attention to the use of the gerund:**

- 1) Johnathan objected having approached the installation without permission.
- 2) Ventilating the room is a good way to reduce the concentration of some pollutants.
- 3) Being able to study wherever you like is one of the advantages of the modern society.
- 4) The surface endures being pressed upon by ten tons.
- 5) Glass screen on the second floor was restored after having been broken a month ago.
- 6) He checked the program by running a trial.
- 7) A way of handling a problem depends on personality.
- 8) The professor insisted on the lesson being held in a room with a smartboard.
- 9) Since the test results having been sent not even 20 minutes passed.
- 10) Recollecting attending the lecture on this theme didn't help much on the exam.

#### **XI. Translate into English using the gerund:**

- 1) Проверка оборудования займет некоторое время.
- 2) Мы были против его ухода из нашей команды.
- 3) Измеримость всех показателей кажется обычным свойством реальности.
- 4) Я проверил свое решение, сравнив его с ответами одноклассников.
- 5) По мере обработки алмаз приобретает прозрачность и четкую форму.
- 6) Опрошенные дали весьма похожие ответы.
- 7) Он откладывал принятие решения с тех пор как узнал, как трудно учиться в магистратуре.
- 8) То, что задали дополнительный вопрос, не обязательно значит, что оценка будет низкой.
- 9) После отправки в институт данные не использовались.
- 10) Изучение старого метода помогло мне в сравнительной работе.

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