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Ministry of Education
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English translation (3)

מדינת ישראל
משרד החינוך
סוג הבחינה: בגרות
מועד הבחינה: קיץ תשפ"ו, 2026
מספר השאלון: 43386
תרגום לאנגלית (3)

Practical Exam in Biology

בחינת בגרות מעשית בביולוגיה

Experiment 1

ניסוי 1

Instructions:

א. Duration of the exam: Three hours

ב. Material that may be used during the exam:
(1) Calculator
(2) Hebrew–foreign language / foreign language–Hebrew dictionary

ג. Special instructions:
(1) Read the instructions carefully and think carefully before each step.
(2) Write all of your observations and answers in pen (including drawings).
(3) Base your answers on your observations and the results you obtained, even if they are not as expected.

הוראות:

א. משך הבחינה: שלוש שעות.

ב. חומר עזר מותר בשימוש:
(1) מחשבון.
(2) מילון עברי–לועזי / לועזי–עברי.

ג. הוראות מיוחדות:
(1) יש לקרוא את ההנחיות ביסודיות, ולשקול היטב את צעדיכם.
(2) יש לרשום בעֵט את כל התצפיות והתשובות (גם סרטוטים וציורים).
(3) יש לבסס את התשובות על תצפיותיכם ועל התוצאות שקיבלתם, גם אם הן אינן תואמות את הצפוי.

Write in the answer booklet only. Write the word "טיוטה" at the top of each page you use as a draft page. If you write any draft material outside the exam booklet, your exam may be disqualified.

יש לכתוב במחברת הבחינה בלבד. יש לרשום "טיוטה" בראש כל עמוד המשמש טיוטה. כתיבת טיוטה בדפים שאינם במחברת הבחינה עלולה לגרום לפסילת הבחינה.

Good Luck!

בהצלחה!

Experiment 1

In this experiment you will examine a process that takes place in Swiss chard cells.

The questions in this exam are numbered **1–12**. The point value of each question is given to the left of the question.

Answer all of the questions in your answer booklet.

Part א – Observing the epidermis of a Swiss chard leaf under the microscope

On your table you have:

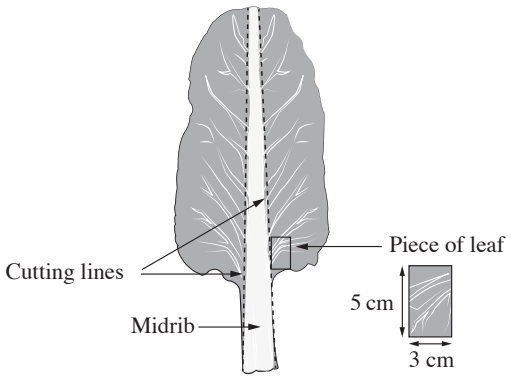
- paper towels
- a microscope and supplies for microscope viewing
- a Swiss chard leaf
- a waste container
- tweezers

א. You will be preparing a slide for viewing under the microscope: the epidermis of a Swiss chard leaf.
   – Using the dropper, apply one drop of water to a blank slide.

ב. Arrange three paper towels one on top of the other on your table. Place the Swiss chard leaf on the paper towels.
   – Tear off a small piece (about 5×3 cm) from the bottom part of the leaf, close to the midrib (Figure 1).
   – Fold the piece of leaf in half. Press the fold until it cracks a little. Gently tear the piece (as you would tear a piece of paper) along the cracked crease. You will see a transparent layer in the torn area—this is the epidermis.
   – Use the tweezers to gently pull off the epidermis from the piece of leaf. Place the epidermis specimen in the drop of water you prepared on the blank slide.
   – If you did not get a specimen of epidermis suitable for the slide, tear another small piece from the leaf, close to the midrib, and repeat the instructions for preparing a slide.

   Note: You can use the specimen even if there is some green tissue in it.

Figure 1: Swiss chard leaf



   – Place a coverslip over the specimen on the slide, and use filter paper to soak off excess water.

ג. Using the low power magnification, look at the epidermis under the microscope and find an area that contains a single, transparent layer of cells.

   Center the cells in the field of view.
   – Switch to the medium power magnification, and then to the high power magnification.

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Answer Questions **1–2**.

(8 points) **1.** You will see two types of cells on the slide.
In your answer booklet, draw two cells of each type of cell visible on the slide.
- Label one type of cells "1" and the other type of cells "2".
- Mark two cell parts in your drawing and write their name.
- Give your drawing a suitable title, and write down the magnification at which you viewed the slide.

(4 points) **2.** **א.** **Determine** in which type of cells, 1 or 2, photosynthesis takes place. **Explain** your answer.

(4 points) **ב.** 'Structure fits function' is an important biological principle.
Based on your observation of the epidermal tissue, **name** a structure that helps reduce the plant's water loss.
Explain how this structure does this.

Place the slides in your waste container.

Part ב–Examining the effect of distance from a light source on the process that takes place in Swiss chard leaves

Step I: Preparing discs from Swiss chard leaves

On your table you have:

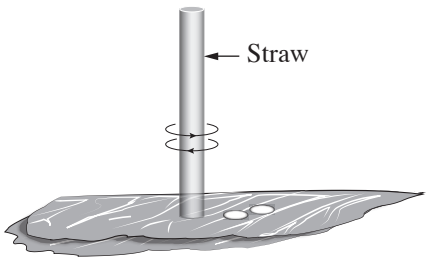
- a knife
- a Q-tip (cotton swab)
- a dish lined with a damp paper towel
- a short straw

ד. Separate the midrib (the white part) from the leaf, as follows: first cut with the knife along the midrib on one side, and then cut along the other side of the midrib (see cutting lines in Figure 1).
– Discard the midrib into the waste container.

ה. Use the straw to prepare 24 discs from the Swiss chard leaf, as follows:
– Place the two parts of the leaf one on top of the other on the paper towels that are on the table.

ו. Hold the straw at a 90° angle to the leaf, and press it into the leaf (Figure 2).

Figure 2: Preparing the discs



/continued on page 4/

Keeping the straw pressed into the leaf, twist the straw slightly left and right a few times, then tip the straw a little sideways and pull it out.

Attention: The discs should remain inside the straw.

– Repeat this operation three times, until you have 6 discs inside the straw.

Note: If a disc stays attached to the leaf, use the tweezers to move the disc to the paper towel-lined dish.

– Hold the straw over the paper towel-lined dish. Push the end of the cotton swab into the straw and carefully push the discs out onto the paper towel-lined dish.

ז. Repeat the procedure described in Item ו, until you have 24 discs.

– You do not need to separate discs that are stuck together.

– If a disc gets damaged in the preparation process, discard it into the waste container and prepare a new disc.

Step II: Discharging the gases in the leaves, and submerging the discs in a solution

In this experiment we will observe how the discs float in a solution.

Gases in the intracellular spaces of the leaf will cause the leaf discs to float.

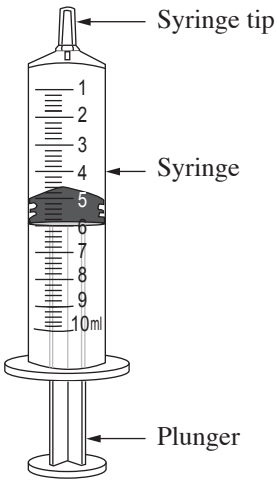
In this step you will release the gases that are inside the leaf.

Informational Note 1:
When gases are discharged from the intracellular spaces, fluid enters these spaces making the leaf discs sink into the solution.

On your table you have:

- a 10 ml syringe (Figure 3a)
- a container marked "תמיסה 1" [Solution 1] with a solution for discharging the gases from the leaves

Figure 3a: Syringe structure



/continued on page 5/

Items ח–יג list the actions you must do to make the discs sink into the solution.
Read the instructions to the end, and only then proceed.

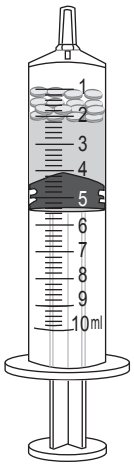
ח. Pull the plunger out of the syringe.
   – Use the tweezers to place all the discs you prepared into the syringe barrel; tap the tip of the syringe on the table to nudge the discs closer to the tip.

ט. Replace the plunger in the syringe and push it in gently towards the tip, without damaging the discs, up to the 2 ml marking on the syringe.

Carry out the actions listed below in Items יג–י over the dish.

י. Withdraw 2 ml of 1 תמיסה into the syringe.
   – Hold the syringe with its tip pointing up and the plunger's base pointing down. The discs will float to the top of the solution inside the syringe (Figure 3b).

Figure 3b: Discs floating in the syringe



יא. Remove all the air remaining in the syringe by pushing the plunger in gently; do not eject any solution from the syringe.

יב. Seal the syringe tip with your thumb to prevent air from entering (Figure 4a). Use your other hand to pull the plunger outwards without pulling it out of the syringe. This releases the gases that are in the leaf. Continue to hold the syringe and the plunger in this position for 10 seconds.
Attention: The position of the discs inside the syringe is unimportant.

Figure 4a: How to hold the syringe

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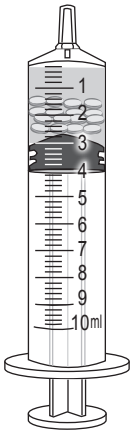
יג. Take your thumb off the syringe tip after 10 seconds.
- Expel all the air remaining in the syringe. Do this as follows: with the syringe tip pointing up, push the plunger in gently, without ejecting any solution from the syringe.
- Repeat the procedure in Items יב–יג until all the discs sink into the liquid in the syringe (Figure 4b).

Note: If after repeating the procedure in Items יב–יג at least four times some of the discs do not sink into the solution, ask the lab teacher for help.

Figure 4b: Discs submerged in the solution in the syringe



יד. Hold the syringe over the dish, with the tip pointing up.
- Pull the plunger out of the syringe. The liquid in the syringe and the discs will spill out onto the paper towel.
  Note: If any discs remain in the syringe, gently remove them using a cotton swab.

Step III: Testing the effect of distance from the lamp on the process taking place in the discs

On your table you have:
- three small cups
- a 2% solution of sodium bicarbonate
- a lamp
- a ruler

Informational Note 2:
- An aqueous solution of sodium bicarbonate is a source of carbon dioxide (CO_2).
- One of the products of the process taking place in the leaf discs is a gas, and this is why the discs float.

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טו. Mark the three small cups "1", "2", and "3".

- Using the ruler to measure, mark a line on each cup at a height of 2 cm from the bottom of the cup.

טז. Pour some bicarbonate solution into each cup up to the line you marked.

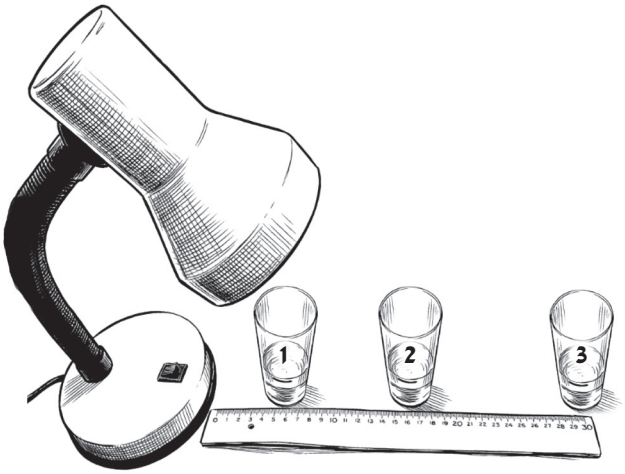
- Place the ruler against the base of the lamp, as shown in Figure 5.
- Place Cup 1 against the ruler so that the center of the cup is 6 cm from the base of the lamp.
- Place Cup 2 against the ruler so that the center of the cup is 16 cm from the base of the lamp.
- Place Cup 3 against the ruler so that the center of the cup is 30 cm from the base of the lamp.
- Using the tweezers, place 6 discs in each cup.
- Arrange the lamp so that it is about 10 cm above Cup 1. Do not turn on the lamp yet.
- Check that the discs are submerged in the liquid in all the cups.

Attention:

- If some of the discs did not sink, gently push them down into the liquid using a cotton swab. If some discs are still floating, remove them with the tweezers and replace them with other discs from the dish.
- If necessary, use the cotton swab to separate discs that are stuck together at the bottom of the cups.

Note: In each cup, the six discs are at different distances from the lamp.

Figure 5: Positioning the lamp and cups



יז. Turn on the lamp.

- Record the time: _____ .
- Next, you will record how many discs float in each of the cups after 5 minutes and after 10 minutes.
- While you are waiting, prepare a table (Table 1) in your answer booklet for collecting the information from the experimental setup and the results from Items טו–יח. Include two columns in your table for recording the results of your experiment.

יח. 5 minutes after the time you recorded in Item יז, count the number of floating discs in each of the cups. Do not move the cups.

- Record your results in the table in your answer booklet, in the first column for results.
- Wait an additional 5 minutes. While you are waiting, answer **Question 3**.

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(3 points) **3.** **א.** What is the independent variable in your experiment?

(4 points) **ב.** What is the dependent variable in your experiment?

יט. 10 minutes after the time you recorded in Item יז , count the number of floating discs in each of the cups, and record the results in the table in your answer booklet in the second column for results.

Answer Questions **4–9**.

(15 points) **4.** Give Table 1 in your answer booklet a title.
– Give each column a heading.

(4 points) **5.** Is the method of measurement of the dependent variable qualitative or quantitative? Explain your answer.

(6 points) **6.** Explain the results you obtained in each of the treatments (cups) 5 minutes and 10 minutes from the time you recorded. Base your answer on Informational Note 2. Discuss the method of measurement in your answer.

7. A student conducted a similar experiment with a different concentration of sodium bicarbonate solution.

(3 points) **א.** The student added 16 ml of water to 4 ml of 2% bicarbonate solution. What was the concentration of the solution he obtained? Provide a detailed calculation **in your answer booklet**.

(4 points) **ב.** **Hypothesize** how the concentration prepared by the student, described in Item א, could affect the results of the student's experiment compared to the experiment you conducted (there is no need to make calculations). **Explain** your hypothesis.

(4 points) **8.** A student suggested adding a control to the experiment you conducted. The control is a cup with discs. The cup is covered with aluminum foil and is impermeable to light. The cup is placed at the same distance from the lamp as Cup 1 in your experiment. Explain the importance of this control in your experimental setup.

(6 points) **9.** **א.** **List** <u>two</u> factors that remained constant in your experimental set up (other than the concentration of sodium bicarbonate solution).
Choose <u>one</u> of the factors you listed and **explain** why it is important for **this specific** factor to be a constant factor in your experimental setup in Part ב.

(4 points) **ב.** Explain why it is important to use 6 discs in each treatment rather than a single disc.

/continued on page 9/

Part ג – Analyzing research results: The effect of global warming on processes that take place in a plant called eelgrass (*Zostera marina*)

The concentration of carbon dioxide (CO_2) in the air has increased greatly over the last few decades due to deforestation and extensive use of fuels in industry and transportation.

Informational Note 3:
Carbon dioxide (CO_2) is a greenhouse gas. Greenhouse gases contribute to the increase in average air temperature on Earth.

Scientists measured CO_2 concentration in the air and the temperature in several regions in the world over several years. They calculated the average concentration of CO_2 in the air and the change in average annual temperature, compared with the average annual temperature measured in 1875. The data are shown in Table 2.

Table 2: CO_2 concentration in the air and changes in average annual temperature over several years

Year	Average CO_2 concentration in the air (relative units)	Change in average annual temperature (compared with average measured in 1875) (^oC)
1974	330	+0.35
1990	354	+0.55
2007	383	+0.75
2024	423	+1.55

Answer Question **10** Item **א.**

(2 points) **10. א.** Describe the association between the change in CO_2 concentration in the air and the change in average temperature, based on the data shown in Table 2.

The plant commonly known as eelgrass grows in shallow, saline water, forming extensive beds. This globally widespread plant is ecologically important: eelgrass captures CO_2 dissolved in water more effectively than any other aquatic plant on Earth. Some of the CO_2 dissolved in water originates in the air.

Answer Question **10** Item **ב**.

(5 points) **ב.** Explain how an increase in CO_2 concentration in the air can affect the growth rate of eelgrass.

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Researchers cultivated eelgrass plants in the laboratory in five containers. They tested the plants' photosynthesis rate and cellular respiration rate at several temperatures. They illuminated all the containers with suitable lighting of identical intensity, and the other factors were also kept constant. The results are shown in Table 3.

Table 3

Water temperature (^oC)	**Photosynthesis rate*** (micromole oxygen/unit of leaf surface area/minute)	**Cellular respiration rate**** (micromole oxygen/unit of leaf surface area/minute)
10	0.30	0.05
15	0.65	0.10
25	0.90	0.20
30	0.90	0.25
35	0.55	0.30

* amount of oxygen emitted
** amount of oxygen absorbed

Answer Questions **11–12**.

(10 points) **11.א.** **(1)** What type of graphical representation would be best for describing the results shown in Table 3, a continuous graph or a bar diagram? Explain your answer.

(2) Present the experimental results shown in Table 3 **in your answer booklet** using a suitable graphic representation.

Note: Present the photosynthesis rate and the cellular respiration rate on the same coordinate system.

(4 points) **ב.** Describe the experimental results based on the graphical representation you prepared in your answer booklet.

(6 points) **12.א.** Hypothesize what the effect might be of a rise in temperature to a range of 30°C–35°C over time on the quantity of organic matter in eelgrass plants. Explain your hypothesis. In your explanation, discuss the rate of photosynthesis and rate of cellular respiration in the experiment conducted by the researchers.

Informational Note 4:
The reaction between carbon dioxide (CO_2) and water produces an acid (carbonate) that causes a drop in pH.

(4 points) **ב.** When the water temperature in the containers in which the researchers grew the eelgrass was in the range of 30°C–35°C, water acidity increased (pH decreased). Explain this finding. Base your answer on the results of the researchers' experiment (Table 3) and the information in Informational Note 4.

Protecting eelgrass will help protect biological diversity, slow down climate change, and increase people's food security.

Give the lab teacher your exam paper and your answer booklet.

Good Luck!

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תרגום לאנגלית (3)

Practical Exam in Biology

בחינת בגרות מעשית בביולוגיה

Experiment 2

ניסוי 2

Instructions:

א. Duration of the exam: Three hours

ב. Material that may be used during the exam:
(1) Calculator
(2) Hebrew–foreign language / foreign language–Hebrew dictionary

ג. Special instructions:
(1) Read the instructions carefully and think carefully before each step.
(2) Write all of your observations and answers in pen (including drawings).
(3) Base your answers on your observations and the results you obtained, even if they are not as expected.

הוראות:

א. משך הבחינה: שלוש שעות.

ב. חומר עזר מותר בשימוש:
(1) מחשבון.
(2) מילון עברי–לועזי / לועזי–עברי.

ג. הוראות מיוחדות:
(1) יש לקרוא את ההנחיות ביסודיות, ולשקול היטב את הצעדים.
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(3) יש לבסס את התשובות על תצפיותיכם ועל התוצאות שקיבלתם, גם אם הן אינן תואמות את הצפוי.

Write in the answer booklet only. Write the word "טיוטה" at the top of each page you use as a draft page. If you write any draft material outside the exam booklet, your exam may be disqualified.

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Good Luck!

בהצלחה!

Experiment 2

In this experiment you will be examining the effect of salt solutions on processes in mung bean seedlings.

The questions in this exam are numbered **13–24**. The point value of each question is given to the left of the question.

Answer all of the questions in your answer booklet.

Part א – Learning the measurement method

On your table you have:

- a base (NaOH) solution in a short test tube marked "לחלק א NaOH"
- a Pasteur pipette
- bromothymol blue solution in a vial with dropper
- hydrochloric acid (HCℓ) solution in a vial with dropper labeled "HCℓ"
- Solution A in a container labeled "A תמיסה"
- a sheet of white paper
- a straw
- pipettes and test tubes
- a waste container

א. Mark three test tubes "1", "2", and "3" at the top near the rim.
   – Mark a 10 ml pipette "A".
   – Use Pipette A to transfer 5 ml of Solution A to each of the test tubes 1, 2, and 3.

ב. Add two drops of bromothymol blue solution to each of the test tubes.
   – Shake each test tube gently.
   – Record the color of the solution obtained in each test tube:
   Test Tube 1: _____
   Test Tube 2: _____
   Test Tube 3: _____

Informational Note 1: Bromothymol blue is an acid-base indicator.
In an environment of pH > 8 (basic environment) it is blue;
in an environment of 6 < pH < 8 it is blue-green to green;
in an environment of pH < 6 (acidic environment) it is yellow.

ג. Apply one drop of solution from the test tube marked "לחלק א NaOH" to Test Tube 1. Shake the test tube gently, and record the resulting color of the solution: _____ .
   – Apply one drop of solution from the vial marked HCℓ to Test Tube 2. Shake the test tube gently, and record the resulting color of the solution: _____ .

ד. Put the straw in the liquid in Test Tube 3 and blow through it gently. Shake the test tube occasionally. Continue blowing into the test tube in the same way only until the solution turns green.

/continued on page 3/

Informational Note 2:
The reaction between carbon dioxide (CO_2) and water produces an acid (carbonate) which reduces pH.

Table 1

	1	2	3	4	5	6	7	8
Test Tube	**Solution A** (ml)	**Two drops of bromothymol blue solution**	**Initial color of solution after adding bromothymol blue** (blue/blue–green/ green/yellow)	**One drop of hydrochloric acid solution HCℓ added to the test tube** (+/–)	**One drop of the base solution NaOH added to the test tube** (+/–)	**Blowing into the liquid in the test tube** (+/–)	**Color of the solution after performing Items ד–ג** (blue/blue–green/ green/yellow)	**Number of drops of the solution NaOH לחלק א added to Test Tube 3**
1	5	+						–
2	5	+						–
3	5	+						

Answer Question **13.**

(8 points) **13.** Copy Table 1 to your answer booklet.

- Write the initial color of the solution in <u>each</u> of the test tubes 1, 2, 3, as recorded in Item ב, in the correct column in Table 1 in your **answer booklet**.
- Fill in the missing information in columns 3, 4, 5, 6, 7 of the table.

Read the instructions in Item ה <u>to the end</u>, and only then proceed.

ה. You will now add NaOH solution to Test Tube 3. Do this as follows:
Using a Pasteur pipette, apply solution from the test tube marked "<u>לחלק א</u> NaOH" to Test Tube 3 <u>one drop at a time</u>, until the color of the liquid in Test Tube 3 resembles the color of the liquid in Test Tube 1 as closely as possible. Count the number of drops you needed for this. Shake the test tube a little after you add each drop.

- Look at the color of the solution against the background of your sheet of white paper. When the color of the liquid in Test Tube 3 resembles the color of the liquid in Test Tube 1 and remains stable for 10 seconds, cap the test tube and place it in the test tube rack.
- If the color of the liquid in Test Tube 3 continues to change, continue adding drops of NaOH solution, counting the drops as you add them, until you get a color that remains stable for 10 seconds (this process is called titration).
- If you have added 30 drops and the color of the liquid in Test Tube 3 still does not resemble the color of the liquid in Test Tube 1, stop adding drops.
- Record the total number of drops of NaOH solution you added to Test Tube 3 in the correct row in Column 8 of the table.

/continued on page 4/

Answer Questions **14–15**.

(4 points) **14. א.** Explain what caused the change in color in Test Tube 3 after you blew into the liquid.

(4 points) **ב.** Explain what caused the change in color in Test Tube 3 after you added NaOH solution.

(4 points) **15.** In Part א you used two methods—the color change in an indicator, and titration. Determine which method is qualitative and which method is quantitative. Explain your answers.

Give the lab teacher the test tube marked "לחלק א NaOH" and receive a vial marked "לחלק ב NaOH".

– Place Test Tubes 1, 2, and 3 in the waste container.

Part ב – Experiment: Effect of germination in salt solutions (NaCℓ) on a biological process that takes place in mung bean seedlings

On your table you have:

- 3-day-old mung bean seedlings and swollen seeds
- three rolled-up pieces of mesh that are closed at one end
- a thermometer
- a cup labeled "אמבט" [bath]
- a container marked "מים לאמבט" [water for bath]
- tweezers, a cotton swab (Q-tip), a teaspoon
- a base (NaOH) solution in a vial with dropper labeled "לחלק ב NaOH"

In this part you will use mung bean seeds and seedlings that are placed in three containers.
The mung bean seeds were germinated for three days in solutions of the salt sodium chloride (NaCℓ) at concentrations of 0% , 2% , and 5% .
Each container is marked with the concentration of the solution in which the seeds were germinated. The container marked 0% contains seedlings germinated in distilled water.
Note: In the containers are swollen seeds and seedlings. Going forward, we will use the term "seedlings" to refer to all of the seeds and seedlings that may be in the containers.

ו. Mark four test tubes "א", "ב", "ג", "ד" at the top of the test tube near the rim.

ז. Use Pipette A to transfer 2 ml of Solution A to each of Test Tubes א, ב, ג, ד.
   – Add one drop of bromothymol blue to each of the test tubes.

ח. Place a mesh piece in front of you.
   – Use the teaspoon to move 15 seedlings from the container marked 0% to the mesh.
   Note: The seedlings have a green seed coat; you do not need to remove it. If the seed coat falls off, leave it in the container.
   – Spread the seedlings along the length of the mesh (see Figure 1 on the following page).
   – Place the mesh with its seedlings in the container marked 0% .

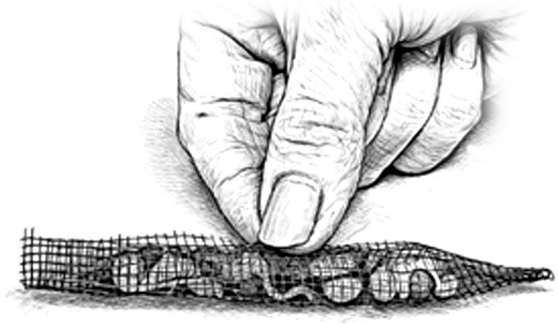
/continued on page 5/

Figure 1: Mung bean seedlings in the mesh

ט. Perform the procedure described in Item ח with the seedlings in the containers marked 2% and 5%. Move each mesh with its seedlings to the respectively marked containers, 2% and 5%.

י. Close up the mesh that you placed in the container marked 0% by rolling it up with your fingers (see Figure 2).

Figure 2: Closing up the mesh



– Insert the closed end of the mesh into Test Tube א. Push it in until the top edge of the mesh is level with the test tube rim (Figure 3). You can use the cotton swab to push the mesh down into the test tube.
– Place the test tube in the rack.

Figure 3: Position of the mesh with seedlings inside the test tube

יא. Perform the procedure in Item י with the mesh and seedlings in the containers marked 2% and 5%, placing them in Test Tubes ב and ג, respectively.

– Do not put seedlings in Test Tube ד.
– Record the color of the solution in each test tube:

Test Tube א: _____ Test Tube ב: _____ Test Tube ג: _____ Test Tube ד: _____

/continued on page 6/

יב. You will now be preparing a hot water bath in the temperature range of 40°C–45°C.
Attention: To keep the water bath stable, insert the thermometer into the bath only after you have poured in hot water.
Ask the lab teacher to pour hot water into the cup marked אמבט up to the bottom marking on the cup.
Pour water from the מים לאמבט container into the cup marked אמבט up to the top marking on the cup.
Make sure that the water level in the cup marked אמבט does not pass the top marking.

יג. Cap Test Tubes א, ב, ג, ד and place them in the water bath.
- Make sure the bath water temperature is in the range of 40°C–45°C.
  Note: The water temperature will drop while you are waiting. There is no need to measure water temperature again.
- Record the time _____ , and wait 10 minutes.
- Check that the markings on the test tubes were not erased.
- While you are waiting, perform the procedure in Item יד.

יד. Prepare Table 2 in your answer booklet to summarize the experimental setup (Items יח–יז). Include two columns in your table for recording the results of your experiment.

טו. 10 minutes after the time you recorded in Item יג, take the test tubes out of the bath, gently shake them for about 20 seconds, and then place them in the rack.
- Uncap Test Tube א.
- Use the tweezers to take out the mesh with seedlings. Re-cap the test tube immediately.
- Place the mesh in the waste container.
- Perform the procedure in this item with Test Tubes ב and ג.

טז. Check the color of the solution in each of Test Tubes א, ב, ג, ד against the background of your sheet of white paper. Record the colors in the correct column in Table 2 in your answer booklet.

Read the instructions in Item יז to the end, and only then carry them out.

יז. You will now add NaOH solution to Test Tubes א, ב, and ג, as follows:
Apply solution from the vial labeled לחלק ב NaOH, one drop at a time, to Test Tube א until the color of the liquid in Test Tube א resembles the color of the liquid in Test Tube ד as closely as possible. Count the number of drops needed to do this. Gently shake the test tube after adding each drop.
- Look at the color of the solution against the background of your sheet of white paper. Once the color of the liquid in Test Tube א resembles the color of the liquid in Test Tube ד and remains stable for 10 seconds, cap the test tube and put it in the rack.
- If the color of the liquid in Test Tube א continues to change, continue adding drops of NaOH solution, counting the drops, until you obtain a stable color that remains unchanged for 10 seconds (titration).
- If you have added 30 drops and the color of the liquid in Test Tube א still does not resemble the color of the liquid in Test Tube ד, stop adding drops.
- Record the total number of drops of NaOH solution that you added to Test Tube א in the correct column in Table 2 in your answer booklet.

/continued on page 7/

יח. Perform the procedure in Item יז for Test Tubes ב and ג, comparing the color of the solution in these test tubes to the color of the solution in Test Tube ד.

Answer Questions **16–21.**

(15 points) **16.** Give Table 2 in your answer booklet a title.
- Give each column a heading.

(3 points) **17. א.** What is the independent variable in the experiment you conducted in Part ב?

(4 points) **ב.** What is the dependent variable in the experiment you conducted in Part ב?

Informational Note 3:
The salt sodium chloride (NaCℓ) dissolves in water and breaks down into ions. The sodium ions from the salt penetrate cells, and at certain concentrations they affect the spatial structure of proteins.

(6 points) **18. א.** Explain the results obtained in Test Tubes א, ב, and ג. Base your explanation on Informational Note 3 and the results recorded in Table 2 in your answer booklet. In your answer, also discuss the method of measurement.

(4 points) **ב.** Test Tube ד is a control. Explain the importance of this control in your experimental setup.

(2 points) **19. א.** Name <u>two</u> factors that were kept constant in your experimental setup.

(4 points) **ב.** Choose <u>one</u> of the constant factors you named and explain why it was important to keep **this specific** factor constant in the experimental setup you ran in Part ב.

20. In the experiment you ran in Part ב you used a NaOH solution with a concentration of 0.005M .

(3 points) **א.** A student added 30 ml of water to 10 ml of 0.1M NaOH solution.
Calculate the concentration of the diluted solution. Provide a **detailed** calculation in your answer booklet.

(4 points) **ב.** A student ran the same experiment as you did in Part ב. During his experiment, when he reached Item יז, he used a solution of NaOH whose concentration was the same as the one you calculated in Question **20א**. He added the solution to Test Tube א, one drop at a time, and counted the number of drops needed to obtain a stable color.
In your opinion, did he need more, less, or the same number of drops compared to the number of drops you needed? Explain your answer.

(4 points) **21.** Explain why it was important to use 15 mung bean seedlings in each treatment and one seedling was not enough.

/continued on page 8/

Part ג – Analyzing research results: The effect of global warming on processes that take place in a plant called eelgrass (*Zostera marina*)

The concentration of carbon dioxide (CO_2) in the air has increased greatly over the last few decades due to deforestation and extensive use of many types of fuels in industry and transportation.

Informational Note 4:
Carbon dioxide (CO_2) is a greenhouse gas. Greenhouse gases contribute to the increase in average air temperature on Earth.

Scientists measured CO_2 concentration in the air and the temperature in several regions in the world over several years. They calculated the average concentration of CO_2 in the air and the change in average annual temperature, compared with the average annual temperature measured in 1875. The data are shown in Table 3.

Table 3: CO_2 concentration in the air and changes in average annual temperature over several years

Year	Average CO_2 concentration in the air (relative units)	Change in average annual temperature (compared with the average measured in 1875) (^oC)
1974	330	+0.35
1990	354	+0.55
2007	383	+0.75
2024	423	+1.55

Answer Question **22** Item **א.**

(2 points) **22. א.** Describe the association between the change in CO_2 concentration in the air and the change in average temperature, based on the data shown in Table 3.

The plant commonly known as eelgrass grows in shallow, saline water, forming extensive beds. This globally widespread plant is ecologically important: eelgrass captures CO_2 dissolved in water more effectively than any other aquatic plant on Earth. Some of the CO_2 dissolved in the water is CO_2 from the air.

Answer Question **22** Item **ב**.

(5 points) **ב.** Explain how an increase in CO_2 concentration in the air can affect the growth rate of eelgrass.

/continued on page 9/

Researchers cultivated eelgrass plants in the laboratory in five containers. They tested the plants' photosynthesis rate and cellular respiration rate at several temperatures. They illuminated all the containers with suitable lighting of identical intensity, and the other factors were also kept constant. The results are shown in Table 4.

Table 4

Water temperature (^{o}C)	**Photosynthesis rate*** (micromole oxygen/unit of leaf surface area/minute)	**Cellular respiration rate**** (micromole oxygen/unit of leaf surface area/minute)
10	0.30	0.05
15	0.65	0.10
25	0.90	0.20
30	0.90	0.25
35	0.55	0.30

* amount of oxygen emitted
** amount of oxygen absorbed

Answer Questions **23–24**.

(10 points) **23.א.** **(1)** What type of graphical representation would be best for describing the results shown in Table 4, a continuous graph or a bar diagram? Explain your answer.

(2) Use a suitable graphical representation to present the experimental results shown in Table 4 **in your answer booklet**.

Note: Present the photosynthesis rate and the cellular respiration rate on the same coordinate system.

(4 points) **ב.** Describe the experimental results based on the graphical representation you prepared in your answer booklet.

(6 points) **24.א.** Hypothesize what the effect might be of a rise in temperature to a range of 30°C–35°C, over time, on the quantity of organic matter in eelgrass plants. Explain your hypothesis. In your explanation, discuss the rate of photosynthesis and rate of cellular respiration in the experiment conducted by the researchers.

(4 points) **ב.** When the water temperature in the containers in which the researchers grew the eelgrass was in the range of 30°C–35°C, water acidity increased (pH decreased). Explain this finding. Base your answer on the results of the experiment you conducted in Part א and on the researchers' experimental results (Table 4).

Protecting eelgrass will help protect biological diversity, slow down climate change, and increase human food security.

Give the lab teacher your exam paper and your answer booklet.

Good Luck!

State of Israel
Ministry of Education
Type of exam: *Bagrut*
Exam date: Summer 2026
Exam number: 43386
English translation (3)

מדינת ישראל
משרד החינוך
סוג הבחינה: בגרות
מועד הבחינה: קיץ תשפ"ו, 2026
מספר השאלון: 43386
תרגום לאנגלית (3)

Practical Exam in Biology

בחינת בגרות מעשית בביולוגיה

Experiment 3

ניסוי 3

Instructions:

א. Duration of the exam: Three hours

ב. Material that may be used during the exam:
(1) Calculator
(2) Hebrew–foreign language / foreign language–Hebrew dictionary

ג. Special instructions:
(1) Read the instructions carefully and think carefully before each step.
(2) Write all of your observations and answers in pen (including drawings).
(3) Base your answers on your observations and the results you obtained, even if they are not as expected.

הוראות:

א. משך הבחינה: שלוש שעות.

ב. חומר עזר מותר בשימוש:
(1) מחשבון.
(2) מילון עברי–לועזי / לועזי–עברי.

ג. הוראות מיוחדות:
(1) יש לקרוא את ההנחיות ביסודיות, ולשקול היטב את צעדיכם.
(2) יש לרשום בעֵט את כל התצפיות והתשובות (גם סרטוטים וציורים).
(3) יש לבסס את התשובות על תצפיותיכם ועל התוצאות שקיבלתם, גם אם הן אינן תואמות את הצפוי.

Write in the answer booklet only. Write the word "טיוטה" at the top of each page you use as a draft page. If you write any draft material outside the exam booklet, your exam may be disqualified.

יש לכתוב במחברת הבחינה בלבד. יש לרשום "טיוטה" בראש כל עמוד המשמש טיוטה. כתיבת טיוטה בדפים שאינם במחברת הבחינה עלולה לגרום לפסילת הבחינה.

Good Luck!

בהצלחה!

Experiment 3

In this experiment you will be examining a process that takes place in mung bean seedlings.

The questions in this exam are numbered **25–36**. The point value of each question is given to the left of the question.

Answer all of the questions in your answer booklet.

Part א – Learning the measurement method

On your table you have:

- a base (NaOH) solution in a short test tube marked "לחלק א NaOH"
- a Pasteur pipette
- bromothymol blue solution in a vial with dropper
- hydrochloric acid (HCℓ) solution in a vial with dropper labeled "HCℓ"
- Solution A in a container labeled "תמיסה A"
- a sheet of white paper
- a straw
- pipettes and test tubes
- a waste container

א. Mark three test tubes "1", "2", and "3" at the top near the rim.
   – Mark a 10 ml pipette "A".
   – Use Pipette A to transfer 5 ml of Solution A to each of the test tubes 1, 2, and 3.

ב. Add two drops of bromothymol blue solution to each of the test tubes.
   – Shake each test tube gently.
   – Record the color of the solution obtained in each test tube:
   Test Tube 1: _____
   Test Tube 2: _____
   Test Tube 3: _____

Informational Note 1: Bromothymol blue is an acid-base indicator.
In an environment of pH > 8 (basic environment) it is blue;
in an environment of 6 < pH < 8 it is blue-green to green;
in an environment of pH < 6 (acidic environment) it is yellow.

ג. Apply one drop of solution from the test tube marked "לחלק א NaOH" to Test Tube 1. Shake the test tube gently, and record the resulting color of the solution: _____ .
   – Apply one drop of solution from the vial marked HCℓ to Test Tube 2. Shake the test tube gently, and record the resulting color of the solution: _____ .

ד. Put the straw in the liquid in Test Tube 3 and blow through it gently. Shake the test tube occasionally. Continue blowing into the test tube in the same way only until the solution turns green.

/continued on page 3/

Informational Note 2:
The reaction between carbon dioxide (CO_2) and water produces an acid (carbonate) which reduces pH.

Table 1

	1	2	3	4	5	6	7	8
Test Tube	**Solution A** (ml)	**Two drops of bromothymol blue solution**	**Initial color of solution after adding bromothymol blue solution** (blue/blue–green/ green/yellow)	**One drop of hydrochloric acid solution HCℓ added to the test tube** (+/–)	**One drop of the base solution NaOH added to the test tube** (+/–)	**Blowing into the liquid in the test tube** (+/–)	**Color of the solution after performing Items ד–ג** (blue/blue–green/ green/yellow)	**Number of drops of the solution NaOH לחלק א added to Test Tube 3**
1	5	+						–
2	5	+						–
3	5	+						

Answer Question **25.**

(8 points) **25.** Copy Table 1 to your answer booklet.

- Write the initial color of the solution in <u>each</u> of the test tubes 1, 2, 3, as recorded in Item ב, in the correct column in Table 1 in your **answer booklet**.
- Fill in the missing information in columns 3, 4, 5, 6, 7 of the table.

Read the instructions in Item ה <u>to the end</u>, and only then proceed.

ה. You will now add NaOH solution to Test Tube 3. Do this as follows:
Using a Pasteur pipette, apply solution from the test tube marked "<u>לחלק א</u> NaOH" to Test Tube 3 <u>one drop at a time</u>, until the color of the liquid in Test Tube 3 resembles the color of the liquid in Test Tube 1 as closely as possible. Count the number of drops you needed for this. Shake the test tube a little after you add each drop.

- Look at the color of the solution against the background of your sheet of white paper. When the color of the liquid in Test Tube 3 resembles the color of the liquid in Test Tube 1 and remains stable for 10 seconds, cap the test tube and place it in the test tube rack.
- If the color of the liquid in Test Tube 3 continues to change, continue adding drops of NaOH solution, counting the drops as you add them, until you get a color that remains stable for 10 seconds (this process is called titration).
- If you have added 30 drops and the color of the liquid in Test Tube 3 still does not resemble the color of the liquid in Test Tube 1, stop adding drops.
- Record the total number of drops of NaOH solution you added to Test Tube 3 in the correct row in Column 8 of the table.

/continued on page 4/

Answer Questions **26–27**.

(4 points) **26. א.** Explain what caused the change in color in Test Tube 3 after you blew into the liquid.

(4 points) **ב.** Explain what caused the change in color in Test Tube 3 after you added NaOH solution.

(4 points) **27.** In Part א you used two methods—the color change in an indicator, and titration. Determine which method is qualitative and which method is quantitative. Explain your answers.

Give the lab teacher the test tube marked "לחלק א NaOH" and receive a vial marked "לחלק ב NaOH".

– Place Test Tubes 1, 2, and 3 in the waste container.

Part ב – Experiment: Effect of temperature on a biological process that takes place in mung bean seedlings

On your table you have:

- 3-day-old mung bean seedlings
- three rolled-up pieces of mesh that are closed at one end
- a thermometer
- three cups labeled "אמבט א", "אמבט ב", "אמבט ג" [Bath א, Bath ב, Bath ג]
- a container marked "מים לאמבט" [water for bath]
- a dish padded with a damp paper towel
- tweezers, a cotton swab (Q-tip), a teaspoon

ו. Mark six test tubes "א", "א1", "ב", "ב1", "ג", "ג1" at the top of the test tube near the rim.

– Use Pipette A to transfer 2 ml of Solution A to each of Test Tubes א, א1, ב, ב1, ג, ג1.

– Add one drop of bromothymol blue to each of the test tubes.

ז. Count out 15 mung bean seedlings and put them on the dish near the marking א.

Note: The seedlings have a green seed coat; you do not need to remove it. If the seed coat falls off, leave it in the container.

– Repeat this action two more times, placing a second group of seedlings next to the marking ב, and a third group of seedlings next to the marking ג on the dish.

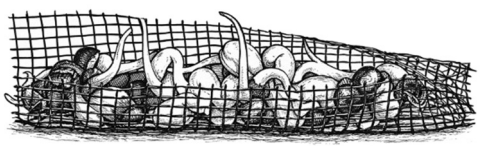
ח. Place a mesh piece in front of you.

– Use the teaspoon to move the seedlings from Area א on the dish into the mesh.

– Spread the seedlings along the length of the mesh (Figure 1).

– Move the mesh with its seedlings to Area א on the dish.

Figure 1: Mung bean seedlings in the mesh



/continued on page 5/

ט. Perform the procedure described in Item ח with the seedlings from Areas ב and ג on the dish. Move each mesh with its seedlings to its respective area, ב or ג, on the dish.

י. Close up the mesh that you placed in Area א by rolling it up with your fingers (see Figure 2).

Figure 2: Closing up the mesh

– Insert the closed end of the mesh into Test Tube א. Push it in until the top edge of the mesh is level with the test tube rim (Figure 3). You can use a cotton swab to push the mesh down into the test tube.
– Place the test tube in the rack.

Figure 3: Position of the mesh with seedlings inside the test tube

יא. Perform the procedure in Item י with the mesh and seedlings from Areas ב and ג, placing them in Test Tubes ב and ג, respectively.
– Do not put seedlings in Test Tubes א1, ב1, and ג1.
– Cap all six test tubes.
– Record the color of the solution in each test tube:

Test Tube א: _____ Test Tube א1: _____

Test Tube ב: _____ Test Tube ב1: _____

Test Tube ג: _____ Test Tube ג1: _____

/continued on page 6/

Preparing baths:

יב. You will be preparing three water baths with the following water temperature ranges:
אמבט א: 45°C–50°C
אמבט ב: 20°C–25°C (room temperature)
אמבט ג: 5°C–10°C

יג. Prepare a hot water bath in the temperature range of 45°C–50°C.
Attention: To keep the water bath stable, insert the thermometer into the bath only after you have poured in hot water.
– Ask the lab teacher to pour hot water into the cup marked אמבט א up to the bottom marking on the cup.
– Pour water from the מים לאמבט container into the cup marked אמבט א up to the top marking on the cup.
– Make sure that the water level in the cup marked אמבט א does not pass the top marking.

יד. Pour water from the מים לאמבט container into the cup marked אמבט ב up to the marked line. Measure the water temperature in אמבט ב.
Record the temperature: _____.

טו. Ask the lab teacher for five ice cubes. Place the ice cubes in the cup marked אמבט ג, and pour in some water from the מים לאמבט container, up to the marked line. Make sure the bath water temperature is in the range of 5°C–10°C.
Record the temperature: _____.

טז. – Place Test Tubes א and א1 in the cup marked אמבט א.
– Place Test Tubes ב and ב1 in the cup marked אמבט ב.
– Place Test Tubes ג and ג1 in the cup marked אמבט ג.
– Check that the temperature in each bath is within the correct range.
– Record the time _____ , and wait 10 minutes.
– Check that the markings on the test tubes were not erased.
– While you are waiting, perform the procedure in Item יז.
Note: The water temperature will change while you are waiting. There is no need to measure water temperature again.

יז. Prepare Table 2 in your answer booklet to summarize the experimental setup (Items כא–ו). Include two columns in your table for recording the results of your experiment.

יח. 10 minutes after the time you recorded in Item טז, take all the test tubes out of their baths, holding them all in both hands. Gently shake all the test tubes together for about 20 seconds, and then place them in the rack.
– Uncap Test Tube א.
– Use the tweezers to take out the mesh with seedlings. Re-cap the test tube immediately.
– Place the mesh on the dish.
– Perform the procedure in this item with Test Tubes ב and ג.

יט. Check the color of the solution in each of the test tubes against the background of your sheet of white paper. Record the colors in the correct column in Table 2 in your answer booklet.

/continued on page 7/

Read all the instructions in Item כ to the end, and only then carry them out.

כ. You will now add NaOH solution to Test Tubes א, ב, and ג only, as follows:
Apply solution from the vial labeled לחלק ב NaOH, one drop at a time, to Test Tube א until the color of the liquid in Test Tube א resembles the color of the liquid in Test Tube א1 as closely as possible. Count the number of drops needed to do this. Gently shake the test tube after adding each drop.
- Look at the color of the solution against the background of your sheet of white paper. Once the color of the liquid in Test Tube א resembles the color of the liquid in Test Tube א1 and remains stable for 10 seconds, cap the test tube and put it in the rack.
- If the color of the liquid in Test Tube א continues to change, continue adding drops of NaOH solution, counting the drops, until you obtain a stable color that remains unchanged for 10 seconds (titration).
- If you have added 30 drops and the color of the liquid in Test Tube א still does not resemble the color of the liquid in Test Tube א1, stop adding drops.
- Record the total number of drops of NaOH solution that you added to Test Tube א in the correct column in Table 2 in your answer booklet.

כא. Perform the procedure in Item כ for the test tube pairs ב, ב1 and ג, ג1.

Answer Questions **28–33.**

(15 points) **28.**
- Give Table 2 in your answer booklet a title.
- Give each column a heading.

(3 points) **29. א.** What is the independent variable in the experiment you conducted in Part ב?

(4 points) **ב.** What is the dependent variable in the experiment you conducted in Part ב?

(6 points) **30. א.** Explain the results obtained in Test Tubes א, ב, and ג. Base your explanation on the results recorded in Table 2 in your answer booklet. In your answer, also discuss the method of measurement.

(4 points) **ב.** Test Tubes א1, ב1, ג1 are controls. Explain the importance of these controls in your experimental setup.

(2 points) **31. א.** Name two factors that were kept constant in your experimental setup.

(4 points) **ב.** Choose one of the constant factors you named and explain why it was important to keep **this specific** factor constant in the experimental setup you ran in Part ב.

32. In the experiment you ran in Part ב you used a NaOH solution with a concentration of 0.005M .

(3 points) **א.** A student added 40 ml of water to 10 ml of 0.1M NaOH solution.
Calculate the concentration of the diluted solution. Provide a **detailed** calculation in your answer booklet.

(4 points) **ב.** A student ran the same experiment as you did in Part ב. During his experiment, when he reached Item כ, he used a solution of NaOH whose concentration was the same as the one you calculated in Question **32א**. He added the solution to Test Tube א, one drop at a time, and counted the number of drops needed to obtain a stable color.
In your opinion, did he need more, less, or the same number of drops compared to the number of drops you needed? Explain your answer.

/continued on page 8/

(4 points) **33.** Explain why it was important to use 15 mung bean seedlings in each treatment and one seedling was not enough.

/continued on page 9/

Part ג – Analyzing research results: The effect of global warming on processes that take place in a plant called eelgrass (*Zostera marina*)

The concentration of carbon dioxide (CO_2) in the air has increased greatly over the last few decades due to deforestation and extensive use of many types of fuels in industry and transportation.

Informational Note 3:
Carbon dioxide (CO_2) is a greenhouse gas. Greenhouse gases contribute to the increase in average air temperature on Earth.

Scientists measured CO_2 concentration in the air and the temperature in several regions in the world over several years. They calculated the average concentration of CO_2 in the air and the change in average annual temperature, compared with the average annual temperature measured in 1875. The data are shown in Table 3.

Table 3: CO_2 concentration in the air and changes in average annual temperature over several years

Year	Average CO_2 concentration in the air (relative units)	Change in average annual temperature (compared with the average measured in 1875) (^oC)
1974	330	+0.35
1990	354	+0.55
2007	383	+0.75
2024	423	+1.55

Answer Question **34** Item **א.**

(2 points) **34. א.** Describe the association between the change in CO_2 concentration in the air and the change in average temperature, based on the data shown in Table 3.

The plant commonly known as eelgrass grows in shallow, saline water, forming extensive beds. This globally widespread plant is ecologically important: eelgrass captures CO_2 dissolved in water more effectively than any other aquatic plant on Earth. Some of the CO_2 dissolved in the water is CO_2 from the air.

Answer Question **34** Item **ב**.

(5 points) **ב.** Explain how an increase in CO_2 concentration in the air can affect the growth rate of eelgrass.

/continued on page 10/

Researchers cultivated eelgrass plants in the laboratory in five containers. They tested the plants' photosynthesis rate and cellular respiration rate at several temperatures. They illuminated all the containers with suitable lighting of identical intensity, and the other factors were also kept constant. The results are shown in Table 4.

Table 4

Water temperature (^{o}C)	**Photosynthesis rate*** (micromole oxygen/unit of leaf surface area/minute)	**Cellular respiration rate**** (micromole oxygen/unit of leaf surface area/minute)
10	0.30	0.05
15	0.65	0.10
25	0.90	0.20
30	0.90	0.25
35	0.55	0.30

* amount of oxygen emitted
** amount of oxygen absorbed

Answer Questions **35–36**.

(10 points) **35.א.** **(1)** What type of graphical representation would be best for describing the results shown in Table 4, a continuous graph or a bar diagram? Explain your answer.

(2) Use a suitable graphical representation to present the experimental results shown in Table 4 **in your answer booklet**.

Note: Present the photosynthesis rate and the cellular respiration rate on the same coordinate system.

(4 points) **ב.** Describe the experimental results based on the graphical representation you prepared in your answer booklet.

(6 points) **36.א.** Hypothesize what the effect might be of a rise in temperature to a range of 30°C–35°C, over time, on the quantity of organic matter in eelgrass plants. Explain your hypothesis. In your explanation, discuss the rate of photosynthesis and rate of cellular respiration in the experiment conducted by the researchers.

(4 points) **ב.** When the water temperature in the containers in which the researchers grew the eelgrass was in the range of 30°C–35°C, water acidity increased (pH decreased). Explain this finding. Base your answer on the results of the experiment you conducted in Part א and on the researchers' experimental results (Table 4).

Protecting eelgrass will help protect biological diversity, slow down climate change, and increase human food security.

Give the lab teacher your exam paper and your answer booklet.

Good Luck!