State of Israel
Ministry of Education
Type of exam: *Bagrut*
Exam date: Summer 2024
Exam number: 43386
English translation (3)

מדינת ישראל
משרד החינוך
סוג הבחינה: בגרות
מועד הבחינה: קיץ תשפ"ד, 2024
מספר השאלון: 43386
תרגום לאנגלית (3)

Practical Exam in Biology

בחינת בגרות מעשית בביולוגיה

Experiment 1

ניסוי 1

יש לרשום את מספר תעודת הזהות שלך כאן:
Write your ID number here:

Instructions:

הוראות:

א. Duration of the exam: Three and a half hours.

א. משך הבחינה: שלוש שעות וחצי.

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

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

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 sketches).
(3) Base your answers on your observations and the results you obtained, even if they are not as expected.

ג. הוראות מיוחדות:
(1) יש לקרוא את ההנחיות ביסודיות, ולשקול היטב את הצעדים.
(2) יש לרשום בעֵט את כל התצפיות והתשובות (גם סרטוטים).
(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 be examining the passage of the pigment betanin out of the cells of beetroot.

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 – Measurement method based on color scale

Step א1: Preparing a color scale

Put gloves on.

On the table, you have:

- a container of distilled water
- a container with extract of beets cooked in water at a temperature of 60°C

Note: In the course of the experiment you will be using pipettes to transfer liquids. When adding liquid to a test tube that has another liquid in it, make sure that the tip of the pipette does not touch the liquid inside the test tube.

א. Use a marking pen to mark 4 test tubes: "0", "2", "4", and "6".

– Write "מים מזוקקים" [distilled water] on a 10 ml pipette.

– Write "מיצוי סלק" [beet extract] on a 5 ml pipette.

– Use the appropriate pipettes to transfer distilled water and beet extract to Test Tubes 0, 2 , 4, and 6, according to the information in Table 1.

Table 1

Test Tube	**Volume of distilled water** (ml)	**Volume of beet extract** (ml)
0	8	0
2	7.5	0.5
4	6	2
6	0	8

You now have four test tubes containing different concentrations of beet extract. These four test tubes are a color scale with four color levels: 0, 2, 4, and 6. Arrange the color scale test tubes in the test tube rack according to their color level from 0 to 6.

Later in the experiment you will determine color level by comparing the color intensity in the experimental test tubes with the color level in the color scale test tubes.

Note 1:

- Betanin is a red-violet pigment produced in the cells of certain plants.
- Betanin stays inside the cells and does not pass through cell membranes.

/continued on page 3/

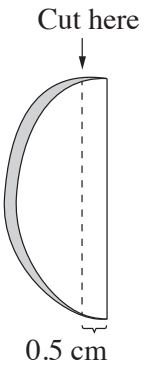
Step א2: Preparing strips of beet and soaking them in ethanol solution

On the table, you have:

- a bag containing a slice of beet
- a container marked "שטיפה" [rinsing]
- a container of tap water
- a container of 70% ethanol solution
- a knife, ruler, spoon, paper towels, a funnel lined with a piece of gauze, and two collection containers.

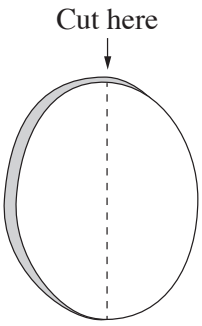
ב. Arrange 3 square paper towels on the table, one on top of another.
   – Remove the slice of beet from the bag and place it on the paper towels.
   – Use the knife to cut the slice in two lengthwise (see Figure 1א).

Figure 1ב



Half a beet slice

Figure 1א



Beet slice

ג. Use the ruler to measure 0.5 cm from the cut, and use the knife to cut a long section of beet that is 0.5 cm wide (Figure 1ב).
   – Repeat this procedure and prepare 3 long beet sections. Remove the skin from both ends of the sections (Figure 1ג).
   – Cut one of these long sections into two strips, each of which is 3 cm long (Figure 1ג). If the long section is not long enough to make two 3 cm strips, use another long section.

Figure 1ד: Cutting the strip into 8 pieces

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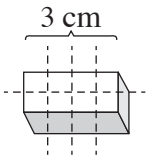
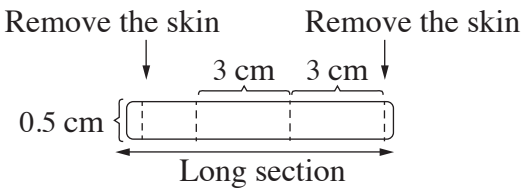


Figure 1ג: Removing the skin and preparing two 3 cm strips



   – Transfer one 3 cm strip to the container labeled "שטיפה".
   – Cut the other 3 cm strip into 8 pieces, as equal in size as possible. To do this, cut once lengthwise, and 3 times crosswise (Figure 1ד).
   – Transfer all 8 pieces to the container labeled "שטיפה".

/continued on page 4/

ד. Rinsing the beet pieces:

Pour tap water from the "מי ברז" container into the "שטיפה" container up to the line marked on the inside of the "שטיפה" container.

– Use the spoon to stir the strip and pieces of beet in the water in the "שטיפה" container.
– Hold the gauze-lined funnel over the liquid collection container and pour the contents of the "שטיפה" container into the funnel.

ה. Put the beet strip and 8 beet pieces back into the "שטיפה" container, and repeat the rinsing procedure described in Item ד.

– Lay the beet strip and 8 beet pieces on a paper towel and gently pat them dry.

ו. Label two empty test tubes "I" and "II", and place them in the test tube rack.

– Label a 5 ml pipette "אתנול" [ethanol].

Note 2:
- Ethanol is a fat solvent.
- Ethanol damages the spatial structure of proteins.

ז. Use the "מים מזוקקים" pipette to transfer 2 ml of distilled water to each of the test tubes "I" and "II".

– Use the "אתנול" pipette to add 2 ml of ethanol solution to each of the test tubes "I" and "II".
– Transfer the uncut beet strip to Test Tube I and all 8 beet pieces to Test Tube II. Make sure that all beet samples are completely immersed in the liquid.
– Gently shake the test tubes.
– Write down the time, _____ and wait for 10 minutes.

While you are waiting, carry out the instructions in Item ח, copy Table 2 into your answer booklet, fill in the details missing from the table, and answer Question 1.

Table 2

Test Tube	**Beet samples**	**Volume of distilled water** (ml)	**Volume of 70% ethanol solution** (ml)	**Results: Color level in "בדיקה" test tubes I, II**
I	uncut beet strip			
II	8 beet pieces			

Answer Question **1.**

(3 points) **1. א.** List two functions of the cell membrane.

(4 points) **ב.** Choose one of the functions you listed in Item א and explain how ethanol solution damages this function.

ח. Label two empty test tubes: "I בדיקה" and "II בדיקה".

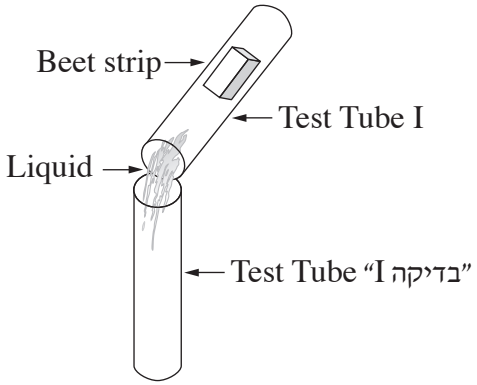
/continued on page 5/

10 minutes after the time you wrote down in Item ז, carry out the instructions in Item ט.

ט. To determine the color level in the test tubes "I בדיקה" and "II בדיקה" using the color scale you prepared in Item א, carry out the following procedure:

- Gently shake the test tubes to mix the liquid inside them.
- Carefully transfer the liquid from Test Tube I to Test Tube "I בדיקה", without transferring the beet strip (Figure 2).

Figure 2



- In the same way, carefully transfer the liquid from Test Tube II to Test Tube "II בדיקה", without transferring the 8 beet pieces.
- Compare the intensity of the color of the liquid in Test Tube "I בדיקה" and in Test Tube "II בדיקה" with the color scale test tubes.
  If the color you see in these "בדיקה" test tubes falls between two color levels, define an intermediate level. For example: If the color you see is between the color in Test Tube 0 and the color in Test Tube 2, define its color level as 1.
- Determine the color level in each of the "בדיקה" test tubes and write it down:
  In Test Tube "I בדיקה" _____ and in Test Tube "II בדיקה" _____ .
  Note: The color of the solution obtained may be a slightly different shade to the shade on the color scale. Consider the intensity of the color, and not the shade.

Answer Question **2.**

(5 points) **2. א.** Copy the color levels you determined for the liquids in Test Tube "I בדיקה" and Test Tube "II בדיקה" into the appropriate places in Table 2 **in your answer booklet**.

(4 points) **ב.** Suggest an explanation for the difference between the results in Test Tube "I בדיקה" and the results in Test Tube "II בדיקה".

י. Transfer Test Tubes I and II and Test Tubes "I בדיקה" and "II בדיקה" to the test tube collection container.

/continued on page 6/

Part ב – Experiment: Examining the effect of ethanol solution on the passage of betanin out of beetroot cells

יא. Label 4 test tubes: "A", "B", "C", and "D".

– Label two 1 ml pipettes: "אתנול" [ethanol], "מים מזוקקים" [distilled water]. Reminder: You still have the two pipettes that you labeled in Part א.

– Use the appropriate pipettes to transfer ethanol solution and distilled water to each of the test tubes A, B, C, and D, according to the information in Table 3.

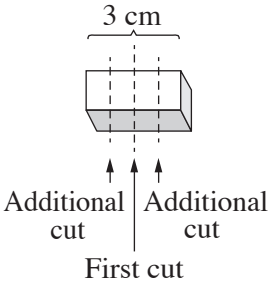
Table 3

Test Tube	**Volume of 70% ethanol solution** (ml)	**Volume of distilled water** (ml)
A	0	4
B	0.3	3.7
C	1	3
D	4	0

יב. Prepare 4 strips of beet, each 3 cm long, according to the instructions in Item ג. If necessary, use the other half of the slice of beet that you still have.

– Cut a 3 cm strip in two, and then cut each half strip in two again (Figure 3), so that you obtain 4 small pieces.

Figure 3: Cutting a strip into four small pieces



– Repeat the previous procedure with 3 more 3 cm-long strips, so that you have a total of 16 small pieces.

– Transfer all the small pieces to a "שטיפה" container and rinse them twice with tap water, according to the instructions in Items ד and ה.

– Place all the small pieces on a paper towel and gently pat them dry.

יג. Put 4 small beet pieces into each of the test tubes A, B, C, and D.

– Write down the time _____, and wait for 10 minutes.
While you are waiting, carry out the instructions in Items יד and טו, and answer Question 3.

יד. Label 4 test tubes: "A בדיקה", "B בדיקה", "C בדיקה", "D בדיקה".

טו. **In your answer booklet**, draw a table in which you will summarize the **experimental setup and results for Part ב** (Items יא–יז).

– Add a column to the table for the results of the calculation of ethanol solution concentration that you will make in Question 3.

– Add a column to the table for the color level you will obtain in each of the "בדיקה" test tubes.

/continued on page 7/

Answer Question **3.**

(5 points) **3.** **Calculate** the concentration of ethanol solution in each of the test tubes A, B, C, D.
Write the results of your calculation in the appropriate column of the table **in your answer booklet**.

Note: The concentration of ethanol in the solution you used is 70%, and the total volume in the test tube is 4 ml.

טז. 10 minutes after the time you wrote down in Item יג, carefully transfer all the liquid in Test Tube A to Test Tube "A בדיקה" (according to the instructions in Item ט).

– Repeat this action with Test Tubes B, C, and D, and Test Tubes "B בדיקה", "C בדיקה", and "D בדיקה", respectively.

יז. Use the color scale test tubes that you prepared in Part א to determine the color level of the liquid in the "בדיקה" test tubes (according to the instructions in Item ט).
Write your answers in the appropriate column of the table **in your answer booklet**.

Answer Questions **4–9.**

(10 points) **4.** **א.** Fill in the missing information in the table in your answer booklet.

(3 points) **ב.**
– Give the table a title.
– Give each column a heading.

(2 points) **5.** What is the independent variable in the experiment you conducted in Part ב?

(3 points) **6.** **א.** What is the dependent variable in the experiment you conducted in Part ב?

(4 points) **ב.** Is the measurement method you used qualitative or quantitative?
Explain your answer.

(4 points) **7.** **א.** Why was it important to rinse all pieces of beet in water, as instructed in Items ד, ה, and יב?

(6 points) **ב.** Explain the results of the experiment you obtained in each of the "בדיקה" test tubes A, B, C, and D.

(3 points) **ג.** The treatment in Test Tube A is a control. Explain why this treatment is important in the experimental setup.

(2 points) **8.** **א.** List two factors that were kept constant in the experimental setup.

(4 points) **ב.** Choose one of the factors you listed in Item א and explain why it was important for this **specific** factor to remain constant in the experimental setup.

(5 points) **9.** In a follow-up experiment, a student emptied all the liquid from Test Tubes A and D, leaving only 4 small beet pieces in each of them.
The student then added 4 ml of distilled water to each of these test tubes and waited for 10 minutes. After 10 minutes, he compared the intensity of the colors to the color scale test tubes. The color level of the liquid in Test Tube A was 1, and the color level of the liquid in Test Tube D was 4.
Below are two explanations, I and II, for the results that the student obtained in his follow-up experiment.
Determine which is the **correct** explanation for the difference in results between Test Tube A and Test Tube D, and explain your answer.

I. Ethanol solution damaged the beet cell membranes in Test Tube D temporarily.
II. Ethanol solution damaged the beet cell membranes in Test Tube D irreversibly.

/continued on page 8/

Part ג – Analyzing research results: Betanin and agriculture of the future

In recent decades, the salinity of the soil and many water sources has increased. One of the salts whose concentration has increased is sodium chloride (NaCℓ).

If the concentration of the salt NaCℓ in the soil or in plant irrigation water rises above a certain threshold (salt stress), it changes the spatial structure of the proteins in the plant's cells. In addition, the plant can dry out. That is why salination of soil and water sources damages agricultural crops.

Answer Question **10.**

(4 points) **10. א.** Explain why high salinity of irrigation water and soil can cause plants that are not adapted to a saline environment to dry out.

(5 points) **ב.** The change in proteins as a result of high salinity in the water or soil may interfere with the process of photosynthesis in plants. Give <u>one</u> example of the importance of photosynthesis for plants and explain this example.

In certain betanin-producing plants that grow in salt-rich soil, the betanin concentration in the cells was found to be high, compared to the betanin concentration in the same plants growing in similar conditions but in soil with low salinity.

Researchers wanted to examine the advantages that betanin-producing plants have when growing in soil with a high salt level.

They chose a certain plant with two varieties: Variety A and Variety B. The leaves of both varieties contain chlorophyll.

Variety A, which has green leaves, <u>does not produce betanin</u>, and Variety B, which has red leaves, <u>does produce betanin</u>.

Experiment 1

Researchers wanted to examine the relationship between the presence of betanin and the rate of <u>chlorophyll breakdown</u> in the leaves of both plant varieties, under the influence of the salt NaCℓ.

The researchers prepared two separate series of containers of NaCℓ solutions at different concentrations, one series for Variety A and one series for Variety B (Table 4).

They prepared small disks of equal size from leaves of both varieties. They then placed an equal number of leaf disks of the same variety in each of the containers in that variety's series. All the containers were kept under the same conditions.

The researchers measured the initial quantity of chlorophyll in the disks of both varieties, and found that the quantity of chlorophyll in Variety A was different from the quantity of chlorophyll in Variety B. The quantity of chlorophyll measured in each variety at the beginning of the experiment is considered to be 100%.

The researchers tested the effect of the salt concentrations on the quantity of chlorophyll, relative to the initial quantity, in each of the two varieties.

48 hours after the experiment began, they measured the quantity of chlorophyll <u>left</u> in the leaf disks in each of the two varieties, and calculated its percentage out of the initial quantity.

/continued on page 9/

Table 4 shows the results.

Table 4

Salt concentration in the solution (mM)*	**Relative quantity of chlorophyll left after 48 hours** (%)	
	Variety A	**Variety B**
0	85	98
50	70	95
100	55	90
150	45	88
200	40	85

* mM = a thousandth of a molar

Answer Question **11.**

(10 points) **11. א.** **(1)** What kind of graphical representation is best suited to describe the results shown in Table 4 – a line graph or a bar graph? Explain your answer.

(2) Draw a suitable graphical representation of the results of the experiment shown in Table 4 **in your answer booklet**.

(6 points) **ב.** Describe the results of the experiment shown in the graph you drew in your answer booklet.

Some cellular processes produce harmful substances as byproducts. One effect that these substances have is to damage various enzymatic processes. Cells have mechanisms for reducing the effect of these substances.

It was found that the production of harmful substances in cells increases in an environment with a high salt concentration, compared to an environment with a low salt concentration.

(Note: The exam continues on the next page.)

/continued on page 10/

Experiment 2

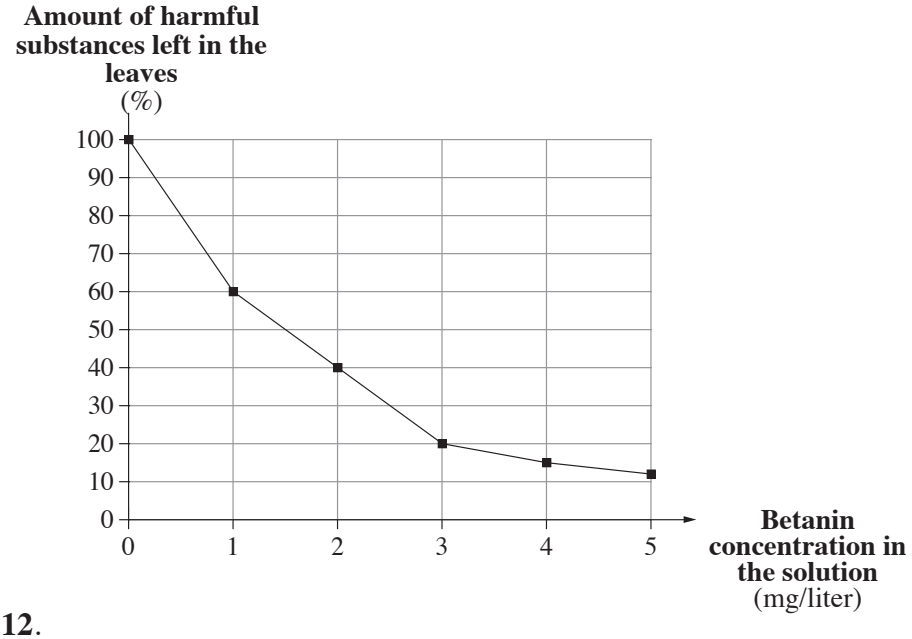
Researchers wanted to examine the effect of betanin on the extent to which the harmful substances in the leaves break down.

In this experiment they placed leaves of the Variety A plant (which does not produce betanin) into a series of containers all of which contained salt solutions of a high, constant concentration. Different concentrations of betanin were then added to these solutions. (The experiment used leaves whose cell membranes had been treated to allow the passage of betanin through the membrane. Cellular processes continue to take place in these cells.)

24 hours later, the researchers measured the quantity of harmful substances left in the leaves, and calculated the percentage of the measured value out of the initial amount.

The graph below shows the results.

Graph: Effect of betanin concentration in the solution on the breakdown rate of harmful substances in Variety A leaves



Answer Question **12**.

(3 points) **12.** **א.** At which concentration of betanin in the solution was the breakdown rate of harmful substances fastest? Explain your answer.

The researchers hypothesize that the effect of the betanin in the solution on the leaves of Variety A is similar to the effect of the betanin in the leaves of Variety B.

(5 points) **ב.** It was found that in highly saline soil, plant Variety B (which produces betanin) photosynthesizes more efficiently than plant Variety A (which does not produce betanin).

Suggest an explanation for this finding. In your explanation, discuss the results of both experiments—Experiment 1 and Experiment 2—and the information presented in this part (Part ג).

Climate changes cause increased soil salinity. Many agricultural crops are not adapted to saline soil. In order to use saline soil for agriculture, researchers are planning further research aimed at developing varieties of betanin-producing edible plants. These plants will be adapted to salt-rich soil and will provide a nutrition source rich in substances that can break down the harmful substances in cells.

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 2024
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English translation (3)

מדינת ישראל
משרד החינוך
סוג הבחינה: בגרות
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מספר השאלון: 43386
תרגום לאנגלית (3)

Practical Exam in Biology

בחינת בגרות מעשית בביולוגיה

Experiment 2

ניסוי 2

יש לרשום את מספר תעודת הזהות שלך כאן:
Write your ID number here:

Instructions:

א. Duration of the exam: Three and a half 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 sketches).
(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 וחצי.

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.
(2) יש לרשום בעֵט את כל התצפיות והתשובות (גם סרטוטים).
(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 2

In this experiment you will be examining the passage of the pigment betanin out of the cells of beetroot.

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 – Measurement method based on color scale

Step א1: Preparing a color scale

Put gloves on.

On the table, you have:

- a container of distilled water
- a container with extract of beets cooked in water at a temperature of 60°C

Note: In the course of the experiment you will be using pipettes to transfer liquids. When adding liquid to a test tube that has another liquid in it, make sure that the tip of the pipette does not touch the liquid inside the test tube.

א. Use a marking pen to mark 4 test tubes: "0", "2", "4", and "6".

– Write "מים מזוקקים" [distilled water] on a 10 ml pipette.

– Write "מיצוי סלק" [beet extract] on a 5 ml pipette.

– Use the appropriate pipettes to transfer distilled water and beet extract to Test Tubes 0, 2 , 4, and 6, according to the information in Table 1.

Table 1

Test Tube	**Volume of distilled water** (ml)	**Volume of beet extract** (ml)
0	8	0
2	7.5	0.5
4	6	2
6	0	8

You now have four test tubes containing different concentrations of beet extract. These four test tubes are a color scale with four color levels: 0, 2, 4, and 6. Arrange the color scale test tubes in the test tube rack according to their color level from 0 to 6.

Later in the experiment you will determine color level by comparing the color intensity in the experimental test tubes with the color level in the color scale test tubes.

Note 1:

- Betanin is a red-violet pigment produced in the cells of certain plants.
- Betanin stays inside the cells and does not pass through cell membranes.

/continued on page 3/

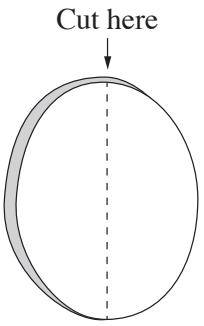
Step א2: Preparing strips of beet and soaking them in detergent solution

On the table, you have:

- a bag containing a slice of beet
- a container marked "שטיפה" [rinsing]
- a container of tap water
- a container of 6% detergent solution
- a knife, ruler, spoon, paper towels, a funnel lined with a piece of gauze, and two collection containers.

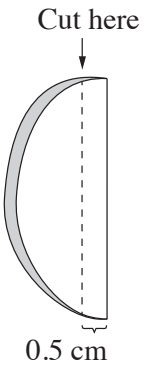
ב. Arrange 3 square paper towels on the table, one on top of another.
  – Remove the slice of beet from the bag and place it on the paper towels.
  – Use the knife to cut the slice in two lengthwise (see Figure 1א).

Figure 1א



Beet slice

Figure 1ב



Half a beet slice

ג. Use the ruler to measure 0.5 cm from the cut, and use the knife to cut a long section of beet that is 0.5 cm wide (Figure 1ב).
  – Repeat this procedure and prepare 3 long beet sections. Remove the skin from both ends of the sections (Figure 1ג).
  – Cut one of these long sections into two strips, each of which is 3 cm long (Figure 1ג). If the long section is not long enough to make two 3 cm strips, use another long section.

Figure 1ג: Removing the skin and preparing two 3 cm strips

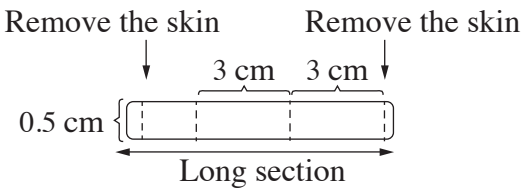
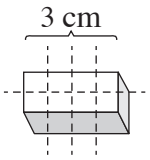


Figure 1ד: Cutting the strip into 8 pieces

.



  – Transfer one 3 cm strip to the container labeled "שטיפה".
  – Cut the other 3 cm strip into 8 pieces, as equal in size as possible. To do this, cut once lengthwise, and 3 times crosswise (Figure 1ד).
  – Transfer all 8 pieces to the container labeled "שטיפה".

/continued on page 4/

ד. Rinsing the beet pieces:

Pour tap water from the "מי ברז" container into the "שטיפה" container up to the line marked on the inside of the "שטיפה" container.

– Use the spoon to stir the strip and pieces of beet in the water in the "שטיפה" container.

– Hold the gauze-lined funnel over the liquid collection container and pour the contents of the "שטיפה" container into the funnel.

ה. Put the beet strip and 8 beet pieces back into the "שטיפה" container, and repeat the rinsing procedure described in Item ד.

– Lay the beet strip and 8 beet pieces on a paper towel and gently pat them dry.

ו. Label two empty test tubes "I" and "II", and place them in the test tube rack.

– Label a 5 ml pipette "דטרגנט" [detergent].

Note 2:

- Detergent is a fat solvent.
- Detergent damages the spatial structure of proteins.

ז. Use the "מים מזוקקים" pipette to transfer 2 ml of distilled water to each of the test tubes "I" and "II".

– Use the "דטרגנט" pipette to add 2 ml of detergent solution to each of the test tubes "I" and "II".

– Transfer the uncut beet strip to Test Tube I and all 8 beet pieces to Test Tube II. Make sure that all beet samples are completely immersed in the liquid.

– Gently shake the test tubes.

– Write down the time, _____ and wait for 10 minutes.

While you are waiting, carry out the instructions in Item ח, copy Table 2 into your answer booklet, fill in the details missing from the table, and answer Question 13.

Table 2

Test Tube	**Beet samples**	**Volume of distilled water** (ml)	**Volume of 6% detergent solution** (ml)	**Results: Color level in "בדיקה" test tubes I, II**
I	uncut beet strip			
II	8 beet pieces			

Answer Question **13.**

(3 points) **13.א.** List two functions of the cell membrane.

(4 points) **ב.** Choose one of the functions you listed in Item א and explain how detergent solution damages this function.

ח. Label two empty test tubes: "I בדיקה" and "II בדיקה".

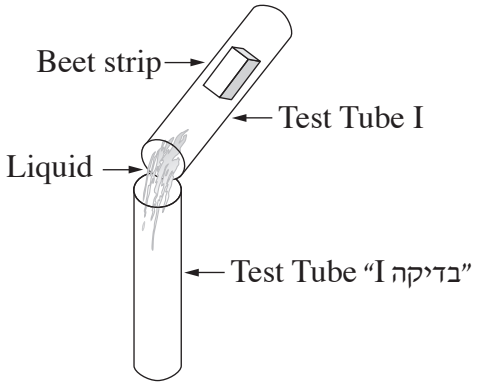
/continued on page 5/

10 minutes after the time you wrote down in Item ז, carry out the instructions in Item ט.

ט. To determine the color level in the test tubes "I בדיקה" and "II בדיקה" using the color scale you prepared in Item א, carry out the following procedure:

- Gently shake the test tubes to mix the liquid inside them.
- Carefully transfer the liquid from Test Tube I to Test Tube "I בדיקה", without transferring the beet strip (Figure 2).

Figure 2



- In the same way, carefully transfer the liquid from Test Tube II to Test Tube "II בדיקה", without transferring the 8 beet pieces.
- Compare the intensity of the color of the liquid in Test Tube "I בדיקה" and in Test Tube "II בדיקה" with the color scale test tubes.
  If the color you see in these "בדיקה" test tubes falls between two color levels, define an intermediate level. For example: If the color you see is between the color in Test Tube 0 and the color in Test Tube 2, define its color level as 1.
- Determine the color level in each of the "בדיקה" test tubes and write it down:
  In Test Tube "I בדיקה" _____ and in Test Tube "II בדיקה" _____ .
  Note: The color of the solution obtained may be a slightly different shade to the shade on the color scale. Consider the intensity of the color, and not the shade.

Answer Question **14.**

(5 points) **14.א.** Copy the color levels you determined for the liquids in Test Tube "I בדיקה" and Test Tube "II בדיקה" into the appropriate places in Table 2 **in your answer booklet**.

(4 points) **ב.** Suggest an explanation for the difference between the results in Test Tube "I בדיקה" and the results in Test Tube "II בדיקה".

י. Transfer Test Tubes I and II and Test Tubes "I בדיקה" and "II בדיקה" to the test tube collection container.

/continued on page 6/

Part ב – Experiment: Examining the effect of detergent solution on the passage of betanin out of beetroot cells

יא. Label 4 test tubes: "A", "B", "C", and "D".

– Label two 1 ml pipettes: "דטרגנט" [detergent], "מים מזוקקים" [distilled water]. Reminder: You still have the two pipettes that you labeled in Part א.

– Use the appropriate pipettes to transfer detergent solution and distilled water to each of the test tubes A, B, C, and D, according to the information in Table 3.

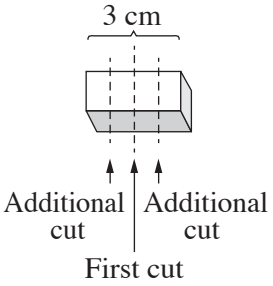
Table 3

Test Tube	Volume of 6% detergent solution (ml)	Volume of distilled water (ml)
A	0	4
B	0.3	3.7
C	1	3
D	4	0

יב. Prepare 4 strips of beet, each 3 cm long, according to the instructions in Item ג. If necessary, use the other half of the slice of beet that you still have.

– Cut a 3 cm strip in two, and then cut each half strip in two again (Figure 3), so that you obtain 4 small pieces.

Figure 3: Cutting a strip into four small pieces



– Repeat the previous procedure with 3 more 3 cm-long strips, so that you have a total of 16 small pieces.

– Transfer all the small pieces to a "שטיפה" container and rinse them twice with tap water, according to the instructions in Items ד and ה.

– Place all the small pieces on a paper towel and gently pat them dry.

יג. Put 4 small beet pieces into each of the test tubes A, B, C, and D.

– Write down the time _____, and wait for 10 minutes.
While you are waiting, carry out the instructions in Items יד and טו, and answer Question 15.

יד. Label 4 test tubes: "A בדיקה", "B בדיקה", "C בדיקה", "D בדיקה".

טו. **In your answer booklet**, draw a table in which you will summarize the **experimental setup and results for Part ב** (Items יא–יז).

– Add a column to the table for the results of the calculation of detergent solution concentration that you will make in Question 15.

– Add a column to the table for the color level you will obtain in each of the "בדיקה" test tubes.

/continued on page 7/

Answer Question **15.**

(5 points) **15.** **Calculate** the concentration of detergent solution in each of the test tubes A, B, C, D.
Write the results of your calculation in the appropriate column of the table **in your answer booklet**.
Note: The concentration of detergent in the solution you used is 6%, and the total volume in the test tube is 4 ml.

טז. 10 minutes after the time you wrote down in Item יג, carefully transfer all the liquid in Test Tube A to Test Tube "A בדיקה" (according to the instructions in Item ט).
– Repeat this action with Test Tubes B, C, and D, and Test Tubes "B בדיקה", "C בדיקה", and "D בדיקה", respectively.

יז. Use the color scale test tubes that you prepared in Part א to determine the color level of the liquid in the "בדיקה" test tubes (according to the instructions in Item ט).
Write your answers in the appropriate column of the table **in your answer booklet**.

Answer Questions **16–21.**

(10 points) **16.א.** Fill in the missing information in the table in your answer booklet.
(3 points) **ב.** – Give the table a title.
– Give each column a heading.

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

(3 points) **18.א.** What is the dependent variable in the experiment you conducted in Part ב?
(4 points) **ב.** Is the measurement method you used qualitative or quantitative?
Explain your answer.

(4 points) **19.א.** Why was it important to rinse all pieces of beet in water, as instructed in Items ד, ה, and יב?
(6 points) **ב.** Explain the results of the experiment you obtained in each of the "בדיקה" test tubes A, B, C, and D.
(3 points) **ג.** The treatment in Test Tube A is a control. Explain why this treatment is important in the experimental setup.

(2 points) **20.א.** List two factors that were kept constant in the experimental setup.
(4 points) **ב.** Choose one of the factors you listed in Item א and explain why it was important for this **specific** factor to remain constant in the experimental setup.

(5 points) **21.** In a follow-up experiment, a student emptied all the liquid from Test Tubes A and D, leaving only 4 small beet pieces in each of them.
The student then added 4 ml of distilled water to each of these test tubes and waited for 10 minutes. After 10 minutes, he compared the intensity of the colors to the color scale test tubes. The color level of the liquid in Test Tube A was 1, and the color level of the liquid in Test Tube D was 4.
Below are two explanations, I and II, for the results that the student obtained in his follow-up experiment.
Determine which is the **correct** explanation for the difference in results between Test Tube A and Test Tube D, and explain your answer.
I. Detergent solution damaged the beet cell membranes in Test Tube D temporarily.
II. Detergent solution damaged the beet cell membranes in Test Tube D irreversibly.

/continued on page 8/

Part ג – Analyzing research results: Betanin and agriculture of the future

In recent decades, the salinity of the soil and many water sources has increased. One of the salts whose concentration has increased is sodium chloride (NaCℓ).

If the concentration of the salt NaCℓ in the soil or in plant irrigation water rises above a certain threshold (salt stress), it changes the spatial structure of the proteins in the plant's cells. In addition, the plant can dry out. That is why salination of soil and water sources damages agricultural crops.

Answer Question **22.**

(4 points) **22. א.** Explain why high salinity of irrigation water and soil can cause plants that are not adapted to a saline environment to dry out.

(5 points) **ב.** The change in proteins as a result of high salinity in the water or soil may interfere with the process of photosynthesis in plants. Give <u>one</u> example of the importance of photosynthesis for plants and explain this example.

In certain betanin-producing plants that grow in salt-rich soil, the betanin concentration in the cells was found to be high, compared to the betanin concentration in the same plants growing in similar conditions but in soil with low salinity.

Researchers wanted to examine the advantages that betanin-producing plants have when growing in soil with a high salt level.

They chose a certain plant with two varieties: Variety A and Variety B. The leaves of both varieties contain chlorophyll.

Variety A, which has green leaves, <u>does not produce betanin</u>, and Variety B, which has red leaves, <u>does produce betanin</u>.

Experiment 1

Researchers wanted to examine the relationship between the presence of betanin and the rate of <u>chlorophyll breakdown</u> in the leaves of both plant varieties, under the influence of the salt NaCℓ.

The researchers prepared two separate series of containers of NaCℓ solutions at different concentrations, one series for Variety A and one series for Variety B (Table 4).

They prepared small disks of equal size from leaves of both varieties. They then placed an equal number of leaf disks of the same variety in each of the containers in that variety's series. All the containers were kept under the same conditions.

The researchers measured the initial quantity of chlorophyll in the disks of both varieties, and found that the quantity of chlorophyll in Variety A was different from the quantity of chlorophyll in Variety B. The quantity of chlorophyll measured in each variety at the beginning of the experiment is considered to be 100%.

The researchers tested the effect of the salt concentrations on the quantity of chlorophyll, relative to the initial quantity, in each of the two varieties.

48 hours after the experiment began, they measured the quantity of chlorophyll <u>left</u> in the leaf disks in each of the two varieties, and calculated its percentage out of the initial quantity.

/continued on page 9/

Table 4 shows the results.

Table 4

Salt concentration in the solution (mM)*	**Relative quantity of chlorophyll left <u>after 48 hours</u>** (%)	
	Variety A	**Variety B**
0	85	98
50	70	95
100	55	90
150	45	88
200	40	85

* mM = a thousandth of a molar

Answer Question **23.**

(10 points) **23. א.** **(1)** What kind of graphical representation is best suited to describe the results shown in Table 4 – a line graph or a bar graph? Explain your answer.

(2) Draw a suitable graphical representation of the results of the experiment shown in Table 4 **in your answer booklet**.

(6 points) **ב.** Describe the results of the experiment shown in the graph you drew in your answer booklet.

Some cellular processes produce harmful substances as byproducts. One effect that these substances have is to damage various enzymatic processes. Cells have mechanisms for reducing the effect of these substances.

It was found that the production of harmful substances in cells increases in an environment with a high salt concentration, compared to an environment with a low salt concentration.

(Note: The exam continues on the next page.)

/continued on page 10/

Experiment 2

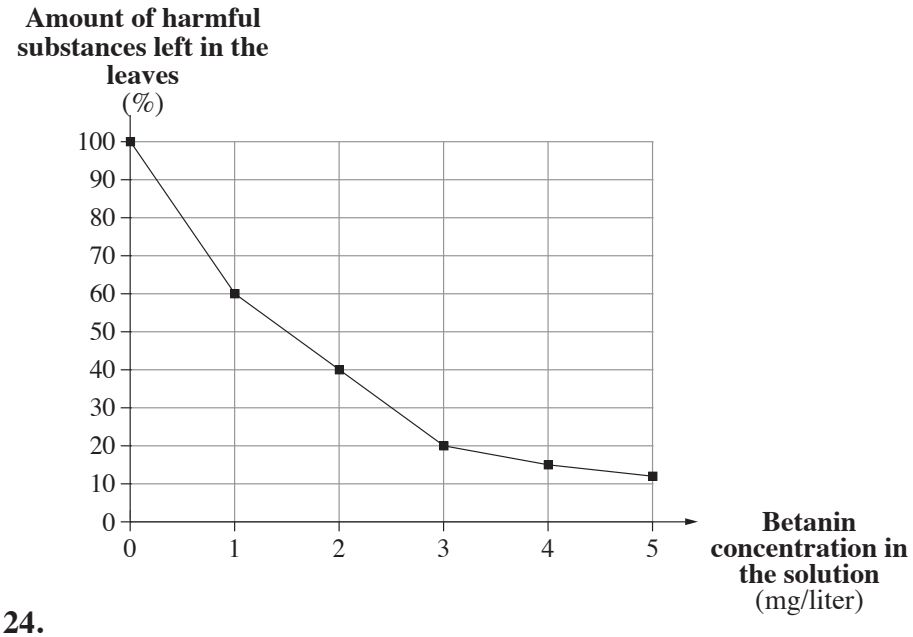
Researchers wanted to examine the effect of betanin on the extent to which the harmful substances in the leaves break down.

In this experiment they placed leaves of the Variety A plant (which does not produce betanin) into a series of containers all of which contained salt solutions of a high, constant concentration. Different concentrations of betanin were then added to these solutions. (The experiment used leaves whose cell membranes had been treated to allow the passage of betanin through the membrane. Cellular processes continue to take place in these cells.)

24 hours later, the researchers measured the quantity of harmful substances left in the leaves, and calculated the percentage of the measured value out of the initial amount.

The graph below shows the results.

Graph: Effect of betanin concentration in the solution on the breakdown rate of harmful substances in Variety A leaves



Answer Question **24.**

(3 points) **24.** **א.** At which concentration of betanin in the solution was the breakdown rate of harmful substances fastest? Explain your answer.

The researchers hypothesize that the effect of the betanin in the solution on the leaves of Variety A is similar to the effect of the betanin in the leaves of Variety B.

(5 points) **ב.** It was found that in highly saline soil, plant Variety B (which produces betanin) photosynthesizes more efficiently than plant Variety A (which does not produce betanin).

Suggest an explanation for this finding. In your explanation, discuss the results of both experiments—Experiment 1 and Experiment 2—and the information presented in this part (Part ג).

Climate changes cause increased soil salinity. Many agricultural crops are not adapted to saline soil. In order to use saline soil for agriculture, researchers are planning further research aimed at developing varieties of betanin-producing edible plants. These plants will be adapted to salt-rich soil and will provide a nutrition source rich in substances that can break down the harmful substances in cells.

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 2024
Exam number: 43386
English translation (3)

מדינת ישראל
משרד החינוך
סוג הבחינה: בגרות
מועד הבחינה: קיץ תשפ"ד, 2024
מספר השאלון: 43386
תרגום לאנגלית (3)

Practical Exam in Biology

בחינת בגרות מעשית בביולוגיה

Experiment 3

ניסוי 3

יש לרשום את מספר תעודת הזהות שלך כאן:
Write your ID number here:

Instructions:

א. Duration of the exam: Three and a half 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 sketches).
(3) Base your answers on your observations and the results you obtained, even if they are not as expected.

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.

Good Luck!

הוראות:

א. משך הבחינה: שלוש שעות וחצי.

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.
(2) יש לרשום בעֵט את כל התצפיות והתשובות (גם סרטוטים).
(3) יש לבסס את התשובות על תצפיותיכם ועל התוצאות שקיבלתם, גם אם הן אינן תואמות את הצפוי.

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

בהצלחה!

Experiment 3

In this experiment you will be examining the passage of the pigment betanin out of the cells of beetroot.

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 – Measurement method based on color scale

Step א1: Preparing a color scale

Put gloves on.

On the table, you have:

- a container of distilled water
- a container with extract of beets cooked in water at a temperature of 60°C

Note: In the course of the experiment you will be using pipettes to transfer liquids. When adding liquid to a test tube that has another liquid in it, make sure that the tip of the pipette does not touch the liquid inside the test tube.

א. Use a marking pen to mark 4 test tubes: "0", "2", "4", and "6".

– Write "מים מזוקקים" [distilled water] on a 10 ml pipette.

– Write "מיצוי סלק" [beet extract] on a 5 ml pipette.

– Use the appropriate pipettes to transfer distilled water and beet extract to Test Tubes 0, 2 , 4, and 6, according to the information in Table 1.

Table 1

Test Tube	**Volume of distilled water** (ml)	**Volume of beet extract** (ml)
0	8	0
2	7.5	0.5
4	6	2
6	0	8

You now have four test tubes containing different concentrations of beet extract. These four test tubes are a color scale with four color levels: 0, 2, 4, and 6. Arrange the color scale test tubes in the test tube rack according to their color level from 0 to 6.

Later in the experiment you will determine color level by comparing the color intensity in the experimental test tubes with the color level in the color scale test tubes.

Note 1:

- Betanin is a red-violet pigment produced in the cells of certain plants.
- Betanin stays inside the cells and does not pass through cell membranes.

/continued on page 3/

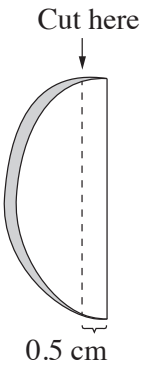
Step א2: Preparing strips of beet and soaking them in SDS solution

On the table, you have:

- a bag containing a slice of beet
- a container marked "שטיפה" [rinsing]
- a container of tap water
- a container of 0.5% SDS solution
- a knife, ruler, spoon, paper towels, a funnel lined with a piece of gauze, and two collection containers.

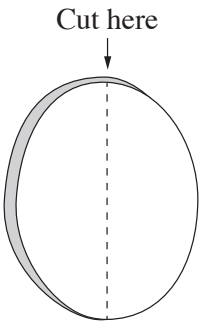
ב. Arrange 3 square paper towels on the table, one on top of another.
- Remove the slice of beet from the bag and place it on the paper towels.
- Use the knife to cut the slice in two lengthwise (see Figure א1).

Figure ב1



Half a beet slice

Figure א1



Beet slice

ג. Use the ruler to measure 0.5 cm from the cut, and use the knife to cut a long section of beet that is 0.5 cm wide (Figure ב1).
- Repeat this procedure and prepare 3 long beet sections. Remove the skin from both ends of the sections (Figure ג1).
- Cut one of these long sections into two strips, each of which is 3 cm long (Figure ג1). If the long section is not long enough to make two 3 cm strips, use another long section.

Figure ד1: Cutting the strip into 8 pieces

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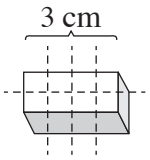
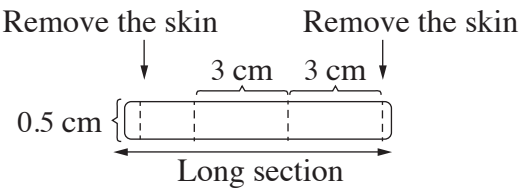


Figure ג1: Removing the skin and preparing two 3 cm strips



- Transfer one 3 cm strip to the container labeled "שטיפה".
- Cut the other 3 cm strip into 8 pieces, as equal in size as possible. To do this, cut once lengthwise, and 3 times crosswise (Figure ד1).
- Transfer all 8 pieces to the container labeled "שטיפה".

/continued on page 4/

ד. Rinsing the beet pieces:

Pour tap water from the "מי ברז" container into the "שטיפה" container up to the line marked on the inside of the "שטיפה" container.

– Use the spoon to stir the strip and pieces of beet in the water in the "שטיפה" container.

– Hold the gauze-lined funnel over the liquid collection container and pour the contents of the "שטיפה" container into the funnel.

ה. Put the beet strip and 8 beet pieces back into the "שטיפה" container, and repeat the rinsing procedure described in Item ד.

– Lay the beet strip and 8 beet pieces on a paper towel and gently pat them dry.

ו. Label two empty test tubes "I" and "II", and place them in the test tube rack.

– Label a 5 ml pipette "SDS".

Note 2:

- SDS (sodium dodecyl sulfate) is a fat solvent.
- SDS damages the spatial structure of proteins.

ז. Use the "מים מזוקקים" pipette to transfer 2 ml of distilled water to each of the test tubes "I" and "II".

– Use the "SDS" pipette to add 2 ml of SDS solution to each of the test tubes "I" and "II".

– Transfer the uncut beet strip to Test Tube I and all 8 beet pieces to Test Tube II. Make sure that all beet samples are completely immersed in the liquid.

– Gently shake the test tubes.

– Write down the time, _____ and wait for 10 minutes.

While you are waiting, carry out the instructions in Item ח, copy Table 2 into your answer booklet, fill in the details missing from the table, and answer Question 25.

Table 2

Test Tube	**Beet samples**	**Volume of distilled water** (ml)	**Volume of 0.5% SDS solution** (ml)	**Results: Color level in "בדיקה" test tubes I, II**
I	uncut beet strip			
II	8 beet pieces			

Answer Question **25.**

(3 points) **25.א.** List two functions of the cell membrane.

(4 points) **ב.** Choose one of the functions you listed in Item א and explain how SDS solution damages this function.

ח. Label two empty test tubes: "I בדיקה" and "II בדיקה".

/continued on page 5/

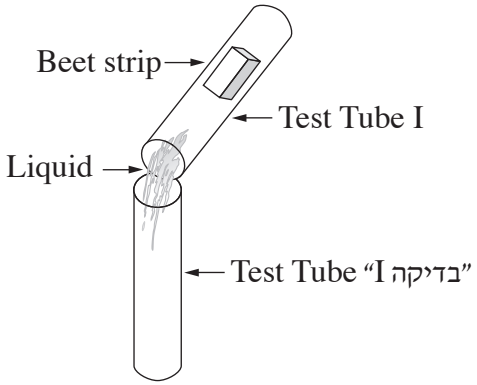
10 minutes after the time you wrote down in Item ז, carry out the instructions in Item ט.

ט. To determine the color level in the test tubes "I בדיקה" and "II בדיקה" using the color scale you prepared in Item א, carry out the following procedure:

– Gently shake the test tubes to mix the liquid inside them.

– Carefully transfer the liquid from Test Tube I to Test Tube "I בדיקה", without transferring the beet strip (Figure 2).

Figure 2



– In the same way, carefully transfer the liquid from Test Tube II to Test Tube "II בדיקה", without transferring the 8 beet pieces.

– Compare the intensity of the color of the liquid in Test Tube "I בדיקה" and in Test Tube "II בדיקה" with the color scale test tubes.
If the color you see in these "בדיקה" test tubes falls between two color levels, define an intermediate level. For example: If the color you see is between the color in Test Tube 0 and the color in Test Tube 2, define its color level as 1.

– Determine the color level in each of the "בדיקה" test tubes and write it down:
In Test Tube "I בדיקה" _____ and in Test Tube "II בדיקה" _____ .
Note: The color of the solution obtained may be a slightly different shade to the shade on the color scale. Consider the intensity of the color, and not the shade.

Answer Question **26.**

(5 points) **26.א.** Copy the color levels you determined for the liquids in Test Tube "I בדיקה" and Test Tube "II בדיקה" into the appropriate places in Table 2 **in your answer booklet**.

(4 points) **ב.** Suggest an explanation for the difference between the results in Test Tube "I בדיקה" and the results in Test Tube "II בדיקה".

י. Transfer Test Tubes I and II and Test Tubes "I בדיקה" and "II בדיקה" to the test tube collection container.

/continued on page 6/

Part ב – Experiment: Examining the effect of SDS solution on the passage of betanin out of beetroot cells

יא. Label 4 test tubes: "A", "B", "C", and "D".

– Label two 1 ml pipettes: "SDS", "מים מזוקקים" [distilled water]. Reminder: You still have the two pipettes that you labeled in Part א.

– Use the appropriate pipettes to transfer SDS solution and distilled water to each of the test tubes A, B, C, and D, according to the information in Table 3.

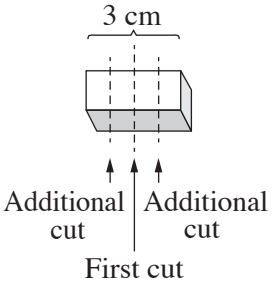
Table 3

Test Tube	Volume of 0.5% SDS solution (ml)	Volume of distilled water (ml)
A	0	4
B	0.3	3.7
C	1	3
D	4	0

יב. Prepare 4 strips of beet, each 3 cm long, according to the instructions in Item ג. If necessary, use the other half of the slice of beet that you still have.

– Cut a 3 cm strip in two, and then cut each half strip in two again (Figure 3), so that you obtain 4 small pieces.

Figure 3: Cutting a strip into four small pieces



– Repeat the previous procedure with 3 more 3 cm-long strips, so that you have a total of 16 small pieces.

– Transfer all the small pieces to a "שטיפה" container and rinse them twice with tap water, according to the instructions in Items ד and ה.

– Place all the small pieces on a paper towel and gently pat them dry.

יג. Put 4 small beet pieces into each of the test tubes A, B, C, and D.

– Write down the time _____, and wait for 10 minutes.
While you are waiting, carry out the instructions in Items יד and טו, and answer Question 27.

יד. Label 4 test tubes: "A בדיקה", "B בדיקה", "C בדיקה", "D בדיקה".

טו. **In your answer booklet**, draw a table in which you will summarize the **experimental setup and results for Part ב** (Items יא–יז).

– Add a column to the table for the results of the calculation of SDS solution concentration that you will make in Question 27.

– Add a column to the table for the color level you will obtain in each of the "בדיקה" test tubes.

/continued on page 7/

Answer Question **27.**

(5 points) **27.** **Calculate** the concentration of SDS solution in each of the test tubes A, B, C, D.
Write the results of your calculation in the appropriate column of the table **in your answer booklet**.
Note: The concentration of SDS in the solution you used is 0.5%, and the total volume in the test tube is 4 ml.

טז. 10 minutes after the time you wrote down in Item יג, carefully transfer all the liquid in Test Tube A to Test Tube "A בדיקה" (according to the instructions in Item ט).
– Repeat this action with Test Tubes B, C, and D, and Test Tubes "B בדיקה", "C בדיקה", and "D בדיקה", respectively.

יז. Use the color scale test tubes that you prepared in Part א to determine the color level of the liquid in the "בדיקה" test tubes (according to the instructions in Item ט).
Write your answers in the appropriate column of the table **in your answer booklet**.

Answer Questions **28–33.**

(10 points) **28.א.** Fill in the missing information in the table in your answer booklet.
(3 points) **ב.** – Give the table a title.
– Give each column a heading.

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

(3 points) **30.א.** What is the dependent variable in the experiment you conducted in Part ב?
(4 points) **ב.** Is the measurement method you used qualitative or quantitative?
Explain your answer.

(4 points) **31.א.** Why was it important to rinse all pieces of beet in water, as instructed in Items ד, ה, and יב?
(6 points) **ב.** Explain the results of the experiment you obtained in each of the "בדיקה" test tubes A, B, C, and D.
(3 points) **ג.** The treatment in Test Tube A is a control. Explain why this treatment is important in the experimental setup.

(2 points) **32.א.** List two factors that were kept constant in the experimental setup.
(4 points) **ב.** Choose one of the factors you listed in Item א and explain why it was important for this **specific** factor to remain constant in the experimental setup.

(5 points) **33.** In a follow-up experiment, a student emptied all the liquid from Test Tubes A and D, leaving only 4 small beet pieces in each of them.
The student then added 4 ml of distilled water to each of these test tubes and waited for 10 minutes. After 10 minutes, he compared the intensity of the colors to the color scale test tubes. The color level of the liquid in Test Tube A was 1, and the color level of the liquid in Test Tube D was 4.
Below are two explanations, I and II, for the results that the student obtained in his follow-up experiment.
Determine which is the **correct** explanation for the difference in results between Test Tube A and Test Tube D, and explain your answer.
I. SDS solution damaged the beet cell membranes in Test Tube D temporarily.
II. SDS solution damaged the beet cell membranes in Test Tube D irreversibly.

/continued on page 8/

Part ג – Analyzing research results: Betanin and agriculture of the future

In recent decades, the salinity of the soil and many water sources has increased. One of the salts whose concentration has increased is sodium chloride (NaCℓ).

If the concentration of the salt NaCℓ in the soil or in plant irrigation water rises above a certain threshold (salt stress), it changes the spatial structure of the proteins in the plant's cells. In addition, the plant can dry out. That is why salination of soil and water sources damages agricultural crops.

Answer Question **34.**

(4 points) **34. א.** Explain why high salinity of irrigation water and soil can cause plants that are not adapted to a saline environment to dry out.

(5 points) **ב.** The change in proteins as a result of high salinity in the water or soil may interfere with the process of photosynthesis in plants. Give <u>one</u> example of the importance of photosynthesis for plants and explain this example.

In certain betanin-producing plants that grow in salt-rich soil, the betanin concentration in the cells was found to be high, compared to the betanin concentration in the same plants growing in similar conditions but in soil with low salinity.

Researchers wanted to examine the advantages that betanin-producing plants have when growing in soil with a high salt level.

They chose a certain plant with two varieties: Variety A and Variety B. The leaves of both varieties contain chlorophyll.

Variety A, which has green leaves, <u>does not produce betanin</u>, and Variety B, which has red leaves, <u>does produce betanin</u>.

Experiment 1

Researchers wanted to examine the relationship between the presence of betanin and the rate of <u>chlorophyll breakdown</u> in the leaves of both plant varieties, under the influence of the salt NaCℓ.

The researchers prepared two separate series of containers of NaCℓ solutions at different concentrations, one series for Variety A and one series for Variety B (Table 4).

They prepared small disks of equal size from leaves of both varieties. They then placed an equal number of leaf disks of the same variety in each of the containers in that variety's series. All the containers were kept under the same conditions.

The researchers measured the initial quantity of chlorophyll in the disks of both varieties, and found that the quantity of chlorophyll in Variety A was different from the quantity of chlorophyll in Variety B. The quantity of chlorophyll measured in each variety at the beginning of the experiment is considered to be 100%.

The researchers tested the effect of the salt concentrations on the quantity of chlorophyll, relative to the initial quantity, in each of the two varieties.

48 hours after the experiment began, they measured the quantity of chlorophyll <u>left</u> in the leaf disks in each of the two varieties, and calculated its percentage out of the initial quantity.

/continued on page 9/

Table 4 shows the results.

Table 4

Salt concentration in the solution (mM)*	**Relative quantity of chlorophyll left <u>after 48 hours</u>** (%)	
	Variety A	**Variety B**
0	85	98
50	70	95
100	55	90
150	45	88
200	40	85

* mM = a thousandth of a molar

Answer Question **35.**

(10 points) **35. א.** **(1)** What kind of graphical representation is best suited to describe the results shown in Table 4 – a line graph or a bar graph? Explain your answer.

(2) Draw a suitable graphical representation of the results of the experiment shown in Table 4 **in your answer booklet**.

(6 points) **ב.** Describe the results of the experiment shown in the graph you drew in your answer booklet.

Some cellular processes produce harmful substances as byproducts. One effect that these substances have is to damage various enzymatic processes. Cells have mechanisms for reducing the effect of these substances.

It was found that the production of harmful substances in cells increases in an environment with a high salt concentration, compared to an environment with a low salt concentration.

(Note: The exam continues on the next page.)

/continued on page 10/

Experiment 2

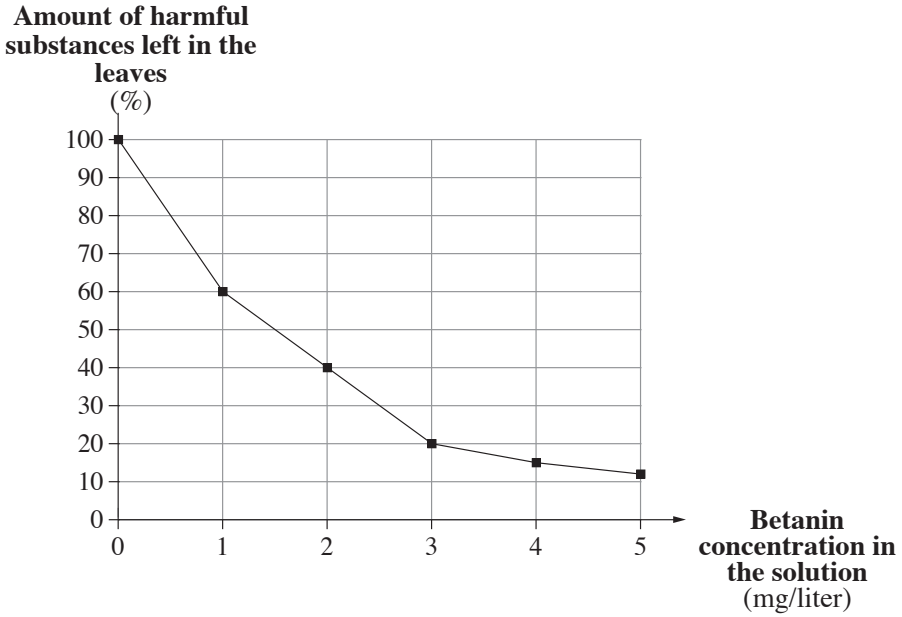
Researchers wanted to examine the effect of betanin on the extent to which the harmful substances in the leaves break down.

In this experiment they placed leaves of the Variety A plant (which does not produce betanin) into a series of containers all of which contained salt solutions of a high, constant concentration. Different concentrations of betanin were then added to these solutions. (The experiment used leaves whose cell membranes had been treated to allow the passage of betanin through the membrane. Cellular processes continue to take place in these cells.)

24 hours later, the researchers measured the quantity of harmful substances left in the leaves, and calculated the percentage of the measured value out of the initial amount.

The graph below shows the results.

Graph: Effect of betanin concentration int the solution on the breakdown rate of harmful substances in Variety A leaves



Answer Question **36.**

(3 points) **36.** **א.** At which concentration of betanin in the solution was the breakdown rate of harmful substances fastest? Explain your answer.

The researchers hypothesize that the effect of the betanin in the solution on the leaves of Variety A is similar to the effect of the betanin in the leaves of Variety B.

(5 points) **ב.** It was found that in highly saline soil, plant Variety B (which produces betanin) photosynthesizes more efficiently than plant Variety A (which does not produce betanin).

Suggest an explanation for this finding. In your explanation, discuss the results of both experiments—Experiment 1 and Experiment 2—and the information presented in this part (Part ג).

Climate changes cause increased soil salinity. Many agricultural crops are not adapted to saline soil. In order to use saline soil for agriculture, researchers are planning further research aimed at developing varieties of betanin-producing edible plants. These plants will be adapted to salt-rich soil and will provide a nutrition source rich in substances that can break down the harmful substances in cells.

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

Good Luck!